

DIVISION 230000

REQUIREMENTS FOR MECHANICAL/PLUMBING WORK

Systems Description and Performance Criteria for Design/Build Procurement

PART 1 - GENERAL

1.1 SUMMARY

- A. The Mechanical contractor shall be responsible for the mechanical design and construction of the building and provide mechanical specifications and construction drawings stamped by an mechanical engineer licensed to practice in the State of Maine. The mechanical work includes providing all labor, materials, equipment, consumable items, supervision, administrative tasks, tests and documentation required to provide complete and fully operational mechanical systems. The mechanical contractor shall completely coordinate the work of this section with the work of other trades.
- B. The mechanical contractor shall file documents, obtain permits and licenses, pay fees and obtain necessary inspections and approvals from all applicable authorities that have jurisdiction.
- C. The mechanical contractor's work shall begin at the utility connection 5 feet outside the building foundation. Mechanical work shall be complete from point of service to each space with all accessory construction and materials required to make each item of equipment or system complete and ready for operation. Mechanical systems shall include the following:
 - 1. Occupied spaces will be heated, cooled and ventilated with two(2) Trane packaged gas heating/electric cooling rooftop units to serve the new dental space layout with (8) zones of control. There will be air handling units on the roof with 65% filtration and heating and cooling. Mechanical cooling will be provided by the RTU. Room temperature sensors will be electronic and have a digital display and local setpoint adjustment. Each major space will be individually zoned and temperature controlled – proposed 9 zones Waiting area/Vestibule, Business Office, Treatment1,2, Treatment 3,4,5,6,7,8,9, interior spaces, private office, lunch room, staff lounge. Server room shall have dedicated mini-split with condensing unit on roof, low ambient controls.
 - 2. Mechanical exhaust will be provided for common area toilet rooms, utility room (more than code required to insure low odor level). Exhaust fans shall be roof mounted. Normally “unoccupied” areas such as storage rooms will be heated by cabinet heaters. Temperature sensors located in public spaces will be tamper-resistant or have tamperproof guards.
 - 3. System design will be in conformance with IBC 2003, NFPA, ASHRAE and Maine Energy Standards (ASHRAE 90.1).

Plumbing

- 1. The building will be served by Public Water and Sewer utilities from Forest Avenue. (2” domestic, 4” sanitary) The building will have one water meter. Coordinate with architectural floor plans. Plumbing fixtures will be provided as indicated on the Architectural drawings and to comply with IBC 2006 and Maine

State Plumbing Code. Fixture type and manufacturer will be Kohler, Eljer, American-Standard, or equal. Water closets will be floor mount tank type as indicated. Drop in stainless steel sinks will be provided in the lounge areas. Restroom will be either wall hung or drop in coordinate with architect. Plumbing for dental equipment will need to be coordinated with Henry Schein dental equipment supplier and owner. This shall include vacuum and compressed air piping, compressor and vac pump provided by dental equipment supplier piped and installed by mechanical contractor. Mount vac pump and air compressor on sound attenuating SPRINGS. Coordinate with dental equipment supplier for connections to operatory equipment either from below slab or from above. All fixtures will be water-conserving type and ADA-compliant where applicable. A floor drain will be provided in the water service closet and in the attic mechanical room. A minimum of four (4) exterior frost-proof sillcocks will be provided. Any showers shown on architectural plans shall be fiberglass with ceiling and dome light, 36" width, hand held head and grab bars. The domestic water service will be provided with dual reduced-pressure principle backflow preventers in parallel. The domestic water heater will be one commercial grade 120 gallon storage type water heater by Superstor set to provide 140°F with a mixing valve set to provide 110°F to the building. The domestic hot water system will be recirculated by an all-bronze circulator. Water hammer arrestors will be provided where required. Floor drains will be provided in restrooms with showers and mechanical room. Finishes on faucets shall be stainless steel. Provide gas piping to rooftop equipment.

1.2 SUBMITTALS

- A. The following information shall be submitted to the architect in a timely manner allowing for review and revision as may be necessary before work is begun:
 - 1. Name, address and telephone number of the Maine licensed mechanical engineer.
 - 2. Detailed engineering documents, drawings and specifications, as prepared and stamped by the engineer of record.
- B. Manufacturer's product data and installation instructions for each material and product proposed for use in areas exposed to view.

PART 2 - DESIGN CRITERIA

- A. Load Calculations: Shall be performed in accordance with procedures and methods as described in ASHRAE Handbook of Fundamentals and ASHRAE GRP-158 Cooling and Heating Load Calculation Manual. Loads shall be calculated for each zone of control, for each air system, and for the building total peak load.

1. General Data:

Weather Data Location - Portland, ME

Latitude: 44°

Outdoor Design Temperatures:

Winter: -10°F

Summer: 86°F dry bulb/72°F wet bulb (coincident)
74°F wet bulb

Building hours of operation: 24 hours/day, 7 days/week, or as specified by the Owner.

Internal Gain: Lighting: as designed
 Equipment: as scheduled
 People: 315 BTUH sensible, 325 BTUH latent

Indoor Temperature and Relative Humidity (conditioned spaces only):

Relative humidity: 25-60%RH
Summer (conditioned spaces only): 75°F
Winter (Offices, Meeting Rooms and other Occupied Areas): 70°F
Winter (Storage Areas): 68°F

Population Density: per ASHRAE standards for occupied spaces.

Ventilation Rate: ASHRAE Standard 62.

Roof R Value: See architectural drawings.
Wall R Value: See architectural drawings.
Glass U Value: See architectural drawings.
Infiltration: 1/2 air change/hr minimum, not coincident with ventilation load.

B. System Design:

1. Zones of Control: Each major use area or exposure shall constitute an independent thermostatically-controlled zone. Each major space will be individually zoned and temperature controlled – proposed zones Waiting area/Vestibule, Business Office, Treatment 1,2, Treatment 3,4,5,6,7,8,9, interior spaces, private office, lunch room, staff lounge . Provide supplemental electric perimeter heat where required (vestibule, restrooms, storage spaces, mechanical room).
2. Air Device Selection: Diffusers shall be selected to provide the design airflow in each zone. One, two, three, or four way patterns may be used. The diffuser shall be selected such that the room noise criteria (Nc) does not exceed the scheduled values, and the diffuser throw results in room air velocities less than 50 FPM and greater than 20 FPM in the occupied zone. Manufacturers catalog data throw data shall be corrected for actual ceiling height. Manufacturer's noise data shall be adjusted to delete any arbitrary credit taken for room absorption, and shall be corrected to reflect the actual number of diffusers in the space an actual room absorption. Return grilles shall be selected using the same noise limitations outlined for diffusers. Air device performance ratings shall be Air Diffusion Council (ADC) certified.
3. Low Pressure Ductwork: Shall be designed for a maximum pressure drop of 0.08" WG per 100 ft. of duct. Acoustical duct liner (Armaflex SA) shall be applied to rectangular ductwork as required to assure that design room noise (Nc or RC) levels are not exceeded.
4. Piping: Water piping shall be sized for a maximum velocity of 4 ft./sec. Piping systems shall be designed within the criteria indicated in the ASHRAE Handbooks.
5. Air handling Unit(s): Shall be sized to provide the peak building ventilation air quantity at the static pressure calculated. Trane or equal. Condensing unit EER shall meet and qualify for Efficiency Maine rebates contractor to coordinate paperwork for owner.

6. Acoustical considerations: Sound-producing HVAC equipment shall not be located in or adjacent to acoustically sensitive areas.
7. Exhaust Fans: Shall be provided for ventilation of all bathrooms, janitor closets, and special exhaust. Fans shall be sized for double code required ventilation. Fans shall be selected such that the specified acoustic levels are not exceeded in the occupied spaces.
8. Automatic Temperature Control - Furnishing of labor, materials, equipment, transportation, permits, inspections and incidentals and the performing of operations required to install the automatic temperature control system indicated. The system shall be electric/electronic to provide the sequences as described below. The ATC system shall be complete including required components including, low voltage and line voltage wiring.
 - a. Ventilation air Handling Units:
 - 1) Supply Fan: The DDC system (located in the mechanical room) shall control the "occupied"-"unoccupied" cycle. The supply fan shall run continuously.
 - 2) Discharge Air Temperature Control: Shall be determined by the central control panel and space temperatures.
 - 3) Economizer Cooling: When the space air temperature rises above setpoint, the enthalpy economizer shall function for natural cooling. The heat wheel shall stop when in economizer mode.
 - 4) Freeze Protection: A manual reset freezestat located in the discharge ductwork (in the heated space) shall shut down the fan and close the outside air damper if the discharge supply temperature falls below 45°F (adjustable).
 - 5) Duct smoke detectors in the discharge and return air shall de-energize the unit and close the outside air dampers. The smoke detector shall be wired to interface with the building fire alarm system.
 - b. Exhaust Fans: Toilet rooms that are not exhausted by the heat recovery unit(s) shall have an exhaust fan operating continuously during "occupied" periods.
9. Return Air Ductwork:
 - a. Return air shall be ducted directly from each space. Return air plenums shall not be used.

PART 3 PRODUCTS

3.1 PIPING MATERIALS

- A. Belowground Heating Loop Water Piping: Spears, Harvel or Charlotte Pipe Schedule 40 pressure-rated PVC pipe and fittings with solvent-welded joints and

long radius elbows (minimum rated working pressure of 180 psig. Installation shall be in accordance with the manufacturers recommendations.

- B. Soil and Waste (Sanitary) and Vent Piping: Cast iron with push-on joints below grade. Cast iron "no Hub" above grade. Sanitary and vent piping may be PVC at contractor's option, cast iron (ONLY) thru roof.
- C. Domestic Water Piping:
 - 1. Above Slab: Type L hard copper tubing and cast bronze or wrought copper solder fittings.
- D. Exposed Water and Waste Piping at Fixtures: I.P.S. copper with cast brass fittings chrome plated finish, with deep one piece escutcheon plates at traverse points.
- E. Solder: Lead-free (ONLY), Englehard Silvabrite 100, 440°F melting point, ASTM B32.

3.2 VALVES

- A. Ball Valves:
 - 1. 1/2" thru 2" copper, Apollo Model 70-203 thru 70-208.
 - 2. 1/2" thru 2" IPS, Apollo Model 70-103 thru 70-108.
 - 3. 1-1/2" thru 4" IPS, Victaulic style 721.
- B. Gate Valves: Nibco.
 - 1. 1/2" thru 2", copper, Model S-113.
 - 2. 1/2" thru 2-1/2" IPS, Model T-113.
- C. Check Valves:
 - 1. 1/2" thru 2" copper, Nibco Model S-413.
 - 2. 1/2" thru 2" IPS, Nibco Model T-413.
 - 3. 2" thru 4" IPS, Victaulic series 712.
- D. Butterfly Valves:
 - 1. 2-1/2" thru 6", 150 psi working pressure, Centerline or Norris. Lug type, iron body, 316SS disc and shaft, Buna-N seat.
- E. Outside Screw and Yoke (OS&Y) Gate Valves: Nibco Class 250 Model F-667-0, iron body, flanged.

3.3 FITTINGS FOR STEEL PIPE

- A. Fittings in sizes 1/2" through 2": Steel or malleable iron with requirements as follows:
 - 1. Steel fittings socket welding or screwed type conforming to ANSI B16.11.
 - 2. Malleable iron fittings screwed type conforming to ANSI B16.3.
 - 3. Victaulic rolled or cut grooves with rigid couplings and flexible couplings where required for expansion.

- B. Fittings in sizes 2-1/2" and larger:
 - 1. Butt welding type conforming to ANSI B16.9.
 - 2. Flanged type conforming to ANSI B16.5.
 - 3. Victaulic rolled or cut grooves with rigid coupling and flexible couplings where required for expansion.
- C. Steel Flanges: Forged steel, welding type conforming to ANSI B16.5. Bolting and gaskets shall be as follows:
 - 1. Bolting: Material used for bolts and studs shall conform to ASTM A 307, Grade B, and material for nuts shall conform to ASTM A 194, Grade 2. Dimensions of bolts, studs, and nuts shall conform to ANSI B18.2.1 and ANSI B18.2.2 with threads conforming to ANSI B1.1 coarse type, with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt-studs shall extend completely through the nuts.
 - 2. Gaskets: Gaskets shall be of a material that resists attack by the fluid or gas in the pipeline and shall be suitable for the pressure and temperature ranges encountered. Gaskets shall be as thin as the finish of surfaces will permit. Raised-face steel flanges shall have ring gaskets with an outside diameter extending to the inside of the bolt holes. Gaskets shall have an inside diameter equal to or larger than the port openings.
- D. Butt Weld Joints: Shall conform to ANSI B31.1. The use of backing rings shall conform to ANSI B31.1. Ferrous rings shall be of weldable quality and shall not exceed 0.05 percent sulfur. Backing rings shall be of the continuous machined or split band type.

3.4 HANGERS

- A. Adjustable Swivel Hanger: Carpenter and Paterson Fig. 800 or Clevis hanger Carpenter and Paterson Fig. 100.
- B. Riser Clamp: Carpenter and Paterson Fig. 126 for steel pipe and Fig. 126 CT for copper tube.

3.5 PIPING SPECIALTIES

- A. Thermometers: Hot Water and Heat Pump Loop Water Service - Terice, No. V80445, or Ashcroft with a 4-1/2" diameter face. System thermometers shall have a range of 30°F to 240°F (hot water) or 0-100°F. (heat pump loop) with 2° increments. Provide with brass thermometer wells projecting a minimum of 2" into the pipe with extension to face of insulation.
- B. Pressure Gauges: Gauges shall be 3-1/2" case, Terice Series 800, or Ashcroft installed with shut off petcock, 0-100 psig.
- C. Expansion Tank: Taco Model CA butyl bladder type expansion tank, full acceptance volume, ASME rated for 125 psig working pressure and 240°F maximum temperature, air-charging fitting, drain fitting.

- D. Strainers: 125 psig minimum rating wye strainers, with blowdown valve; as manufactured by Sarco or Barnes and Jones.
- E. Automatic Air Vents: Armstrong air vent traps No.1-AV 1/2" with stainless steel trim. Other acceptable manufacturers are Amtrol, Sarco or Hoffman. Valves shall be installed with each vent. Drains from the vents shall be run to the nearest indirect waste.
- F. Manual Air Vents: Consist of air chamber with a 3/8" pipe off the top and a 3/8" ball valve. The valve shall be installed in an accessible location. An air chamber shall be installed at each air vent and shall be line size for piping smaller than 2" and 2" for larger piping.
- G. Pumps: Paco Type LF or Taco Type FE frame mounted end suction centrifugal pump with base, cast iron body, bronze fitted, 1750 rpm, 175 psig working pressure, 250°F working temperature, flanged connections. Motors shall be premium high efficiency.
- H. Balancing Valves: Armstrong circuit setter.
 - 1. Balancing devices shall have provisions for connecting a portable differential pressure gauge. Each balancing device to be sized to provide a differential pressure reading between 2 and 5 feet with the valve full open at design flow rates.
 - 2. Install per manufacturer's recommendations for adjacent length of straight pipe.
 - 3. Balancing devices shall have memory stops for use as a tight shutoff without disturbing the balancing setting.
 - 4. Balancing devices shall have drain connections with shutoffs.
 - 5. Shop drawings shall indicate gpm, size, wide open differential pressure meter reading, and actual water pressure drop.
- I. Flexible Connectors:
 - 1. Pumps: Mason Industries Model MFTNC neoprene connectors, rated at 150 psig and 220°F.
- J. Triple Duty Valve: Taco "Plus One" combination gate, check and balancing valve with metering connections, cast iron body, 175 psig working pressure. Valves shall be sized to provide a differential pressure reading between 2 and 5 ft. with the valve full open at design flow rates.
- K. Water Pressure Reducing Valve: Watts Regulator Series USB with thermal expansion bypass, integral stainless steel strainer, 140°F maximum temperature, 175 psig working pressure, 25 to 75 psi reduced pressure range.
- L. Backflow Preventer: Watts Regulator Series 909 double check valve backflow preventer, 175 psig working pressure, 210°F working temperature, bronze body, stainless steel seats, shafts and bolts.
- M. Air Separator: Taco Model AC air separator, flanged connections, 125 psig design pressure.

3.6 PIPE INSULATION

- A. Steam Piping and Equipment: heavy density fiberglass with thermal conductivity of 0.29 BTU-in/hr-ft²-°F at 150°F mean temperature. Insulation shall be suitable for 400°F service. Pipe fitting insulation shall be same material used for pipe. Underground chilled water piping shall be Schedule 40 PVC with solvent-welded joints.
- B. Insulation Jacket: All service (ASJ) type, with maximum flame spread of 25, fuel contribution of 50 and smoke developed of 50 (ASTM E84). Jacket permeability shall not exceed 0.02 perms (ASTM E96). Pipe fitting jacket shall be molded PVC covers with pressure sensitive taped joints.
- C. See "Execution" section for insulation thickness.

3.7 DUCT INSULATION AND ACOUSTIC LINING

- A. Duct Insulation: Fiberglass duct wrap with foil-scrim-kraft facing/vapor barrier, 1.0 lb/cu.ft. density, 0.29 but-in/hr-sf-°F conductivity, 0.05 permeance rating, fire hazard classification (flame/fuel/smoke) 25/50/50. Insulation shall meet the requirements of NFPA 90A & B and shall be UL rated.
- B. Acoustical Duct Lining: Acoustic lining and insulation: Armstrong Type SA "Armaflex" closed cell, installed in accordance with the manufacturers recommendations.

3.8 SHEETMETAL WORK AND MATERIALS

- A. Low Pressure Ductwork (Static Pressure ≤ 2" WG):
 - 1. Rigid Ductwork: Galvanized steel conforming to ASTM A527, weight of galvanized coating shall be not less than 1-1/4 ounces total for both sides of one sq. ft. of a sheet. Construction, metal gage, and reinforcements shall conform with SMACNA "Duct Construction Standards" and NFPA 90A for 1" W.G. pressure class for exhaust ductwork, return ductwork.
 - 2. Low Pressure Flexible Ductwork: Wiremold Type "WG" with 1" thick thermal insulation. The duct shall be suitable for working pressures up to 10" WG.
 - 3. Access Doors: Ruskin Model ADC2, 10"x10" size, 24 gauge galvanized steel, steel on both sides of door, foam gasket seals, 1" insulation, 4 cam locks, no hinge.
 - 4. Turning Vanes: Solid, single blade, mounted with the long edge down stream.
 - 5. Spin-in Fittings: General Environmental Corporation "Genflex" Model SM-2DE or Model SM-2DEL.
 - 6. Manual Balancing Dampers: Ruskin Model MD-35 opposed blade with locking quadrant.
- B. Access Doors:
 - 1. Low Pressure Duct Systems: Ventlok 10" x 12" or as indicated with #99 Ventlok cam locking latches and no hinge.

- C. Automatic Control Dampers:
1. Automatic dampers not furnished as an integral part of an item of equipment shall conform to this paragraph. Automatic dampers shall be constructed and installed in accordance with the following Minimum Standards and shall be Arrow "Arrow-Foil" Model PBDAF-206, OBDAF-207 or Ruskin Model CD-50:
 - a. Damper Blades: Automatic dampers, including dampers for static pressure control, shall be of the balanced type, factory-fabricated, with fully gasketed extruded aluminum airfoil blades, mounted in welded frames. Damper blades shall be not more than 8 inches wide, shall have interlocking edges and be capable of operation against 4" static pressure differential.
 - b. Proportioning Dampers: Proportioning dampers shall be of the opposed blade type.
 - c. Damper Size and Bearings: Damper blades shall have steel trunnions mounted in oil-impregnated bearings. Dampers shall be not more than 48 inches in length between bearings.
 - d. Frames: Damper frames shall be of welded channel or angle-iron, with heavy steel corner gussets and braces or stiffened with steel tie-rods where necessary. Frames shall be painted with aluminum paint to prevent rusting.
 - e. Dampers shall be guaranteed to close tight, and shall provide substantially the full area of the opening when open. Outdoor air intakes and exhaust ducts to outside and fresh air, return air and exhaust air dampers in systems shall have damper blades with inflatable seals or other devices to guarantee low leakage, not to exceed 6 CFM/SF at 1 in. WG pressure differential.
 - f. Damper Linkages: Damper-operating links shall be steel or brass rods, adjustable in length with ball and socket joints and of such proportions that they will withstand, without appreciable deflection, a load equal to not less than twice the maximum operating force of the damper motor. Linkages shall be concealed in the frame.
 - D. Louvers: Ruskin ELF-6375DX, box frame, for masonry walls, drainable blade, extruded aluminum construction. Provide 1/2" expanded metal bird screen on interior. Louver finish shall be Kynar 500, color selected by Architect. Coordinate sizes, shapes and locations with the architectural drawings. Pitch duct connecting to louver toward outside to facilitate draining. Seal duct water tight at connection point to louver. Refer to architectural drawings for further details.
 - E. Fire Dampers: Ruskin Model IBD2 curtain type with blades out of the airstream, 1-1/2 Hr. rated in accordance with UL and NFPA requirements in all horizontal and vertical penetrations.
 - F. Volume Extractors: Anemostat Model DTA, adjustable, with worm gear operator accessible thru the branch opening. Unit shall be suitable for tight shut-off.
 - G. Flexible Collars and Connectors: Ventfabrics, Inc. "Ventglass" neoprene coated glass fabric.

- H. Joint Sealant: For ductwork that is not visible from finished spaces, use Hardcast, Inc., type DT5300 gypsum impregnated tape and Model FTA-20 activator/adhesive for indoor applications.

3.9 FANS

- A. Fans shall be Greenheck, Cook Ventilator, or Penn Ventilator. Fans shall be furnished with a safety switch or other suitable disconnect switch and backdraft damper or motorized damper.
- B. Roof exhaust fans, if used, shall have an Epoxy coating with color selection by the Architect.
- C. Provide ACME "Sonemaster" (ONLY) sound attenuating curbs for rooftop exhaust fans.

3.10 GRILLES, REGISTERS AND DIFFUSERS (Price, Krueger or Metalaire)

- A. Ceiling Diffusers: Square neck louver faced with "lay-in" type frame (Krueger Model DL) for acoustic tile ceilings and or flanged frame (Model DF), for drywall ceilings pattern as required.
- B. Return Grilles: Rectangular neck, 45° curved blade 1/2" blade spacing, for acoustic the ceilings (Model SAC35LD), or 3/4" blade spacing for acoustic ceilings (Model SAC3LD), 3/4" blade spacing with flanged frame for drywall ceilings (Model S3HD), and 1/2" blade spacing with flanged frame for plaster ceilings (Model S35HD). Straight blade, 3/4" spacing, flanged frame (Model S3HS).
- C. Exhaust Grilles: Square neck, 45° curved blade 1/2" spacing, aluminum construction.
- D. Transfer Grilles: Square neck, 45° curved blade 1/2" spacing with lay-in frame (Model SAC35LD) or flanged frame (Model S35HD).
- E. Supply Register: Rectangular neck, double deflection, front blades horizontal, steel construction with 1/2" blade spacing (Model S25HO) or 3/4" blade spacing (Model S2HO). Registers shall be provided with opposed blade balancing dampers.
- F. Supply Grille: Square neck, double deflection, steel construction, front blades horizontal, 1/2" spacing (Model S25H), or 3/4" spacing (Model S2HO).

3.11 ROOFTOP PACKAGED AIR HANDLER(S)

- A. Trane or equal. Sizes, types and performance shall be as required. The supply air shall be conditioned to the space requirements. Units shall be provided with gas furnace, DX cooling coil and dampers and filter sections. Nameplates shall be fixed to the unit. Installation and maintenance bulletin shall be supplied with each unit. Locations of units including service access requirements shall be coordinated with the Architect.
- B. Cabinet:
 - 1. Unit cabinet shall be designed to operate at a total static pressure up to 4.5".

2. Exterior panels of sections shall be double-wall construction with 18-gauge or heavier galvanized steel exterior sheetmetal and 22 gauge (minimum) interior liner. Access doors downstream of the supply air fan section shall include 20-gauge galvanized steel door liners. (Galvanized steel liners shall be provided on access doors and over floor insulation in traffic areas.)
 3. Hinged, latched and gasketed access doors shall be provided for each section.
- C. Supply Air Fan Section:
1. Supply fans shall be double width, double inlet centrifugal, forward curved (FC), airfoil (AF), backward curved (BI) type. Fans shall be statically and dynamically balanced for quiet operation. The forward curved fan wheel and housing shall be fabricated from steel. Backward curved and airfoil fan wheels shall be Class II type and fabricated from aluminum with the fan blades continuously welded to the back plate and end rim, and shall operate in a galvanized steel housing. Units shall have solid steel shafts mounted in heavy-duty greasable ball bearings. The entire fan assembly shall be completely isolated from the unit bulkhead with neoprene gasketing and mounted on double deflection spring isolators.
 2. Fan motors shall be heavy-duty, 1800 RPM, open drip-proof type with greasable ball bearings, operating at 60 Hz, 3 phase. Motors shall be premium high efficiency. The motors shall have a variable pitch sheave and be mounted on an adjustable base for proper alignment and belt tension adjustment.
- E. The filter section shall be supplied with galvanized steel filter racks as an integral part of the unit. Filters shall be accessible from both sides of the unit. The prefilter section shall be provided with panel filters. Panel prefilters shall be 2" thick throwaway pleated media type mounted in a galvanized steel filter frame. The panel filter section shall be designed for face velocities not to exceed 380 FPM. Filters shall be rigid 2" thick extended media disposable type of 30% efficiency as tested by ASHRAE test standard 52-76. Filters shall have an average arrestance of 95% in accordance with that standard.
- F. Return Air/Outdoor Air Section:
1. A return air plenum shall provide 100% return air capability for night setback (unoccupied).
 2. 0-100% economizer dampers shall allow for modulating 0 to 100% outdoor air intake. The 0 to 100% economizer damper shall consist of outside air, return air and exhaust air dampers. The unit floor of the outside air section shall be sloped for water drainage. The outside and return air damper shall be sized to handle 100% of the supply air volume and be of a low leak design including gasketing and side seals on blade edges. Blades shall be of a heavy-duty, airfoil design allowing larger blades running the full cabinet height and a minimum of 7" wide. Leakage shall not exceed 1/2% at 1-1/2" WC.
- G. Submit fan curves for each fan with the design operating point clearly marked.
- H. Submittal data shall include sound power data for inlet, discharge and radiated sound. CAUTION: Submittals without this data will be rejected.

- I. Variable frequency inverter drives shall be furnished for each fan and shall be Toshiba, Safronics or Square D.

PART 4 EXECUTION

4.1 DESIGN AND INSTALLATION OF PIPING SYSTEM

- A. Provide and erect in accordance with the best practice of the trade piping system required to complete the intended installation. Make offsets as required to place piping in proper position to avoid other work and to allow the application of insulation and finish painting to the satisfaction of the Owner.
- B. The size and general arrangements, as well as the methods of connecting piping, valves, and equipment, shall be as designed, or so as to meet the requirements of the Owner.
- C. Piping system shall be erected so as to provide for the easy and noiseless passage of fluids under working conditions. Inverted eccentric reducing fittings shall be used whenever water pipes reduce in size.
- D. Water mains shall be run level or pitch slightly upward so that no air pockets are formed in the piping. The mains shall be set at elevations such that the runouts feeding equipment shall have no pockets where air can collect except where vents are provided. Provide drains at low points in the piping systems.
- E. Piping shall be run concealed above ceilings in occupied areas.
- F. In the design of water piping, make proper allowances for expansion and contraction. Piping shall be anchored as necessary to control expansion. Loop water runouts to units shall come off the main downward or off the side with a minimum of two 90° elbows provided on runout from main.
- G. Install stop valves and unions to facilitate maintenance and removal of equipment.
- H. Steel piping 2" and smaller shall have screwed connections, or Victaulic connections. Threads on piping must be full length and clean-cut with inside edges reamed smooth to the full inside bore. Close nipples shall not be used.

Pipe threads shall be standard pipe threads, machine cut and full length. Pipe shall be reamed to remove burrs and up-ended and rapped to dislodge dirt and scale. Joint compound shall be applied to male thread only. If necessary to back off a screwed joint after it is made, the thread shall be cleaned and new compound applied. Caulked threads will not be permitted.

- I. Steel Piping 2-1/2" and larger shall have welded connections or Victaulic couplings.
 1. Welded Joints:
 - a. Welding Procedure: Before any welding is performed, submit copies of welding procedure for metals included in the work together with proof of qualification as outlined in ANSI B31.1.
 - b. Performance Qualification Record: Before any welder or operator shall perform any welding, submit 2 copies of the Welder's Performance Qualification Record in conformance with ANSI B31.1 showing that the

welder was tested under the approved procedure submitted. In addition also submit each welder's assigned number, letter, or symbol which shall be used to identify the work of the welder, affixed to the joint immediately upon completion of the weld. Welders making defective welds after passing a qualification test shall be given a requalification test and upon failing to pass the test shall not be permitted to work on this project.

- c. Previous Qualification: Welding procedures, welders and welding operators previously qualified by test may be accepted for this project without requalification subject to approval of the Owner and provided that the conditions delineated in ANSI B31.1 are met before a procedure can be used.
- d. Surface Conditions: Welding shall not be done when the atmospheric temperature is less than 0 degrees F, when the surfaces are wet, when rain or snow is falling or moisture is condensing on the surfaces to be welded, nor during periods of high wind, unless the welder and the work are protected properly. At temperatures between 32 degrees and 0 degrees F, the surfaces for an area within 3 inches of the joint to be welded shall be heated with a torch to a temperature warm to the hand before welding. Surfaces to be welded shall be free from loose scale, slag, rust, paint, oil and foreign material. Joint surfaces shall be smooth, uniform, and free from fins, tears and other defects which might affect proper welding. Slag shall be removed from flame cut edges to be welded by grinding, temper colors need not be removed. Each layer of weld metal shall be cleaned thoroughly by wire brushing prior to inspection and deposition of additional weld metal.
- e. Base Metal Preparation: Preparation of pipe ends shall be done by machining and/or grinding, except that oxygen or arc cutting will be permitted on carbon steel pipe only if the cut is reasonably smooth, true and heavy oxide is thoroughly cleaned from the flame cut surfaces by grinding.

The ends of pipe-to-pipe, and pipe-to-fitting, joints shall be aligned accurately within a tolerance of twenty percent of the pipe thickness. Alignment shall be maintained during welding by suitable clamps, jigs, tack welds, or other devices. If tack welds are used to maintain alignment, they shall be kept below the outside surfaces of the pipe and shall not exceed twice the pipe thickness in length or two thirds the pipe thickness in depth, shall be the same quality as the final welds, and shall be fused thoroughly in the final weld. Defective tack welds shall be removed before the final weld is made.

- f. Quality of Welds: The quality of welds shall be in accordance with ANSI B31.1. The surface of the finished welds shall have a bright metallic luster after cleaning, shall be fairly smooth with regular, even ripples, and shall be uniform in contour. Except as necessary to correct defects, the surfaces shall not be dressed, smoothed, or finished for improving their appearance. Welds shall be sound throughout and fused thoroughly, and shall be free from gas pockets, oxides, slag inclusions, and surface porosity, except that very small pores or specs of oxides or slag will be allowed if dispersed widely and if not larger or more numerous than those produced in passing qualification tests. Welds shall be free from overlaps, undercuts and

excessive convexity. The inside of the pipe shall be free from blobules of weld metal which would restrict the pipe area or might become loose.

- g. Correction of Defects: Defective or unsound welds shall be corrected by removing and replacing the welds with new welds, or as follows:
 - 1) Excessive convexity - chip or grind weld to required size.
 - 2) Undercutting, shrinkage cracks, craters, blowholes, and excessive porosity - chip or grind weld to sound weld and base metal and deposit additional weld metal.
 - 3) Undersize and excessive concavity - clean weld and deposit additional weld metal.
 - 4) Overlapping and lack of fusion - remove weld by chipping or grinding and reweld.
 - 5) Slag inclusions - chip or grind weld to remove slag and fill with weld metal.
 - 6) Removal of adjacent base metal during welding - chip or grind weld to sound base and weld metal and form full size by depositing additional weld metal. Pipe or fittings which cannot be rewelded satisfactorily shall be replaced with new pipe or fittings at the Contractor's expense. Caulking of welds shall not be done. Before adding weld metal or rewelding, the surfaces shall be cleaned thoroughly. The removal of weld metal from a defective weld shall not extend into the base metal beyond the weld penetration. Where incomplete fusion is disclosed by chipping or grinding to correct defects, the part of the weld shall be removed and rewelded. In chipping or grinding welds, the weld or base metal shall not be nicked or undercut.

2. Victaulic Joints:

- a. Pipe Preparation: Pipe shall be prepared in accordance with the latest published Victaulic specifications.
 - 1) Standard Weight Pipe: Shall be roll grooved without metal removal or square cut grooved.
 - 2) Plain End for FIT: pipe ends shall be thoroughly cleaned on the OD, for 1" from the pipe end to remove pipe coatings, mill scale, rust and raised weld beads, OD burrs and sharp edges shall be removed. Pipe shall be marked 1-1/2" from the end, and pipe end configuration shall be in conformance with Victaulic specifications.
- b. Assembly: Couplings, fittings, valves and pipe shall be assembled in accordance with latest published manufacturer's instructions.
 - 1) Pipe: pipe shall be checked to be certain it is sufficiently free of indentations, projections, grooves, weld seams, or roll marks on the exterior of the pipe over the entire gasket, that pipe ends are

square cut and that preparation (grooving, cleaning, hole cutting) is in accordance with Victaulic pipe preparation standards.

- 2) Gasket: gaskets shall be of the central cavity pressure-responsive design. Gasket style and elastomeric material (grade) shall be checked to be certain gasket supplied is suitable for the intended service.
- 3) Lubrication: Use manufacturer's recommended lubricant. Lubrication shall be used for proper coupling/fitting assembly as follows: A thin, uniform coat of Victaulic Lubricant shall be applied by brush or by hand by: 1) brushing lubricant on the gasket lips (ID) and the entire exterior of the gasket; 2) brushing lubricant on the pipe ends around the entire pipe circumference and inside with coupling housing.

- J. High points in water piping shall be provided with manual vents.
- K. Connections between copper and steel piping shall be made with brass fittings.
- L. Thermometers shall be installed in common supply to zones and in each separate circuit return. Install thermometer wells for thermometers projecting a minimum of 2" into the pipe with extension to face of insulation. Piping 2" and smaller shall be enlarged to 1-1/2" where wells are installed.
- M. Solder joints shall be made with Harris Stay-Safe 50 lead free solder. Clean surfaces to be soldered and use a paste flux. Wash joints with sodium bicarbonate and water to remove corrosive effects of heated solder paste. Hot wipe solder at each fitting. Lead bearing solder is not permitted.
- N. Points of traverse of piping through walls and floors shall be through pipe sleeves of the same material and thickness as the pipe. Sleeves shall be of the next clearance size. Traverse points of piping shall be escutcheoned with split chrome floor and ceiling plates and spring anchors, where visible to occupancy. Insulation shall be continuous thru sleeves.

4.2 PIPE HANGERS

- A. Copper Tubing: supported at intervals as follows, with rod sizes as follows, double nuts on hangers and on beam clips.

Copper Size	Hanger Intervals	Rod Sizes
1/2"	5'	3/8"
3/4"	6'	3/8"
1"	6'	3/8"
1-1/4"	7'	3/8"
1-1/2"	8'	3/8"
2"	9'	3/8"
3"	10'	3/8"

- B. Iron Pipe: supported at intervals and with rod sizes as follows, double nuts on hangers and on beam clips.

Iron Pipe	Hanger Intervals	Rod Sizes
1/2"	6'	3/8"
3/4"	6'	3/8"
1"	7'	3/8"
1-1/4"	7'	3/8"
1-1/2"	9'	3/8"
2"	10'	3/8"
2-1/2"	11'	3/8"
3"	12'	3/8"
4"	14'	1/2"

- C. Verticals: supported at not more than 16 ft. intervals by use of clamp hangers.

4.3 INSULATION OF PIPING AND EQUIPMENT

- A. Insulate hot water supply and return piping, condensate piping, equipment, valves and fittings. Fittings shall be mitered fiberglass insulation segments of same thickness as adjacent insulation. Fitting and valve body insulation shall be covered with molded PVC fittings covers. Secure overlap at cover throat with stainless steel tacks. Tape joints with pressure sensitive vapor barrier tape.
- B. Hangers: On insulation shields.
- C. Unions shall be covered as are fittings but shall have collared enlargement at least 1" larger than the OD of the line insulation.
- D. Pipe Insulation Thickness:
1. Hot Water Supply and Return:
 - a. 2" and smaller piping - 1" thick.
 - 2-1/2" and larger piping and equipment - 1-1/2" thick.

4.4 DESIGN AND INSTALLATION OF DUCTWORK AND AIR DEVICES

- A. Provide and erect in accordance with the best practice of the trade ductwork required to complete the intended installation. Make offsets required to place ductwork in proper position to avoid conflicts with other work and to allow the application of insulation and finish painting to the satisfaction of the Owner. Ducts shall be arranged to adjust to "field conditions". The Sheet Metal trades shall coordinate his work with other trades. Work shall conform to ASHRAE duct construction recommendations, SMACNA "Duct Construction Standards," NFPA, and the requirements of BOCA code.
- B. Construction for Low Pressure Round and Rectangular Ductwork:
1. Metal Gauge:
 - a. Thickness of metal for low pressure rectangular ducts, including elbows and other fittings, shall be as follows:

<u>Longest Rectangular Dimension of Duct Inches</u>	<u>Galv. Steel & Stainless Steel USS Gauge</u>
Up thru 12	26
13 thru 30	24
31 thru 54	22
55 thru 84	20
Over 85	18

- b. Thickness of metal for low pressure round ducts, including elbows and other details, shall be as follows:

<u>Duct Diameter Inches</u>	<u>Galv. Steel USS Gauge</u>
Up thru 10	24
11 thru 20	22

2. Round Duct: Use properly sized and beaded male couplings (ONLY). Assembly shall be made in accordance with the manufacturer's recommendations and sealed airtight with the manufacturer recommended duct sealer. The joints shall be fastened in place by three or more sheet metal screws spaced not over eight inches apart.
3. Longitudinal Seams: Longitudinal joints in ducts shall be Pittsburgh lockseams (ONLY). CAUTION: Button punch lock joints are not acceptable.
4. Transverse Joints and Bracing Angles: Transverse joints and bracing angles of rectangular duct shall be as follows:

<u>Duct Size Long Side Inches</u>	<u>Transverse Joints</u>	<u>Bracing Angles Size - Inches</u>	<u>Flat Bar</u>
18 or less	Hemmed S slip	None	None
19 thru 30	Hemmed S slip	1" x 1" x 1/8" @ 60"	1" x 3/16"
31 thru 42	1" Reinforced Bar Slip	1" x 1" x 1/8" @ 60"	1-1/4" x 1/4"
43 thru 60	1-1/2" Reinforced Bar Slip	1-1/2" x 1-1/2" x 1/8" @ 60"	1-1/2" x 1/4"
61 thru 96	1-1/2" Angle Re- inforced Pocket Lock	1-1/2" x 1-1/2" x 3/16" @ 30"	1-1/2" x 1/4"

5. Transverse Joints: Drive slips shall be used on short sides of transverse duct joints if side is less than 24 inches. Metal and thickness of S slips and drive slips shall be same as duct. Ends of drive slips shall be bent over at least 1/2 inch at corners. Bar slips shall be fastened with sheet metal screws on 12 inch

centers. Corners of bar slip joints shall be folded over and riveted. Pocket slips shall be riveted to duct on 6-inch centers, and corners shall be overlapped and riveted.

6. Stiffeners: Ducts over 18 inches wide shall be provided with stiffeners, which may be either transverse joints or angle bracing, as indicated above. The center-to-center spacing of stiffeners shall be not over four feet for ducts not exceeding 60 inches (long side) and shall be not over two feet for ducts not exceeding 8 feet in any case. Flat area of uninsulated ducts over 18 inches wide shall be stiffened by cross-bracing. Uninsulated exposed ducts shall have flat bar reinforcement and flush seams in lieu of bracing angles and projecting seams.
 7. Bracing Angles: Bracing angles shall be of the same metal as the duct. Angles shall be riveted to the ducts on 6-inch centers, and shall be applied on four sides. On vertical ducts, set of bracing angles shall be located with heel down at the floor line wherever duct passes through floor. End of two opposite angles shall extend as required to catch floor construction.
 8. Long Radius Elbows: Long radius elbows shall be constructed with a throat radius equal to not less than the dimensions of the duct width in the plane of the duct turn. Where space does not permit the use of a long radius elbow, vaned mitered elbows shall be provided.
 9. Mitered Elbows: Low pressure mitered (square) elbows shall be constructed with single wall turning vanes. A 12" x 12" access door shall be installed adjacent to each elbow with turning vanes.
- D. Joint Sealing:
1. Low Pressure Ductwork: lateral duct joints and clinch connections shall be sealed to SMACNA seal Class B.
 2. Pressure Taps: Provide near end of each duct run, between components of air handling systems and as required by the Air Balance Subcontractor, pressure taps of 1/4" copper tube, soldered to duct or plenum, and provided with neoprene cap to prevent air leakage. Where required, also provide taps for velocity traverse equipment.
- E. Turns shall be made with long radius elbows.
- F. Field Changes to Ductwork: Field changes of ducts such as those required to suit the sizes of factory-fabricated equipment actually furnished shall be designed to minimize expansion and contraction. Use 4:1 transitions in field changes as well as modifications to connecting ducts.
- G. Deflectors: Provide deflectors in duct-mounted supply outlets, take-off or extension collars to supply outlets, and tap-in branch-off connections. Adjust supply outlets to provide air volume and distribution as indicated.
- H. Fire Dampers: Install fire dampers for ducts penetrating fire-rated walls or floors.
- I. Access Doors: Provide access doors for automatic dampers, counter balanced dampers, volume dampers, fire dampers, coils, thermostats, temperature controllers, valves, filters, and other concealed apparatus requiring service and inspection in the duct system.

- J. Duct Sleeves and Prepared Openings: Install duct sleeves and prepared openings for duct mains, duct branches, and ducts passing through walls, roofs, and ceilings. Ensure the proper size and location of sleeves and prepared openings. Allow one-inch clearance between duct and sleeve or one-inch clearance between insulation and sleeve for insulated ducts, except at grilles, registers, and diffusers.
- K. Closure Collars: Provide closure collars of not less than 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts and insulation. Grind smooth edges of collar to preclude tearing or puncturing insulation covering or vapor barrier. Use nails with maximum 6-inch centers on collars.
- L. Duct Supports: Provide duct supports of not less than two one-inch by 1/16 inch galvanized strip-iron hangers spaced one on each side of ducts. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements. Attach supports only to structural framing members and concrete slabs. Anchor supports to metal decking only if a means is provided for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable immediate metal framing. Where C clamps are used, use retainer clips.
- M. Flexible Collars and Connections: Provide flexible collars between fans and ducts or casings and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw-band. For rectangular ducts, lock flexible connections to metal collars.
- N. Longitudinal joints shall be Pittsburg Hammered Lockseam.
- O. Transitions with a slope greater than 4 to 1 will be ordered removed from the system and replaced with a transition which meets this criteria.
- P. Installation of Air Devices:
 - 1. Curved blade transfer grilles installed in vertical walls above the line of sight shall be installed with the blade opening facing the ceiling.
 - 2. Curved blade transfer and return grilles installed in ceilings shall be installed with the blade opening facing the nearest wall.
 - 3. Ductwork visible to the occupants thru the face of supply, return, transfer grilles or diffusers shall be painted with flat black paint.

4.5 INSULATION OF DUCTWORK

- A. Insulate the concealed supply air ductwork from the HVAC units to the ceiling diffuser with 1-1/2" thick fiberglass duct wrap with a factory applied "FSK" vapor barrier facing. Laps to be sealed and held in place with sealing tape adhesive and flared staples (sealing tape shall be SMACNA approved). On the bottom of the ducts 24" and wider, mechanical fasteners shall be provided approximately 12" on center.
- B. Acoustically line ductwork as required to meet the occupied space acoustic criteria listed. Lining shall be applied to the interior of the ductwork. Acoustic liner shall be applied to the flat sheet metal with adhesive and fabricated in the break. Provide stick clips on 12" centers for additional support in ducts over 12" wide. Liner shall be Armaflex Type SA.

4.6 CLOSING IN UNINSPECTED WORK

- A. General: Cover up or enclose work after it has been properly and completely inspected and reviewed.
- B. If any of the work is covered or enclosed prior to required inspections and acceptance, uncover the work as required for the test and inspection. After inspection, tests and acceptance, repairs and replacements shall be made by the appropriate trades with such materials as necessary for the acceptance by the Engineer and at no additional cost to the Owner.

4.7 TEST AND ADJUST

- A. Supply and return piping shall be tested with water to a pressure of 75 psi and held for a period of two hours. Any leaks shall be repaired and another test applied to the piping. Piping shall be tested before it is insulated.
- B. Before operating the system the piping shall be flushed out to remove oil and foreign materials.
- C. After the installation is complete and ready for operation, the system shall be tested under normal operating conditions in the presence of the Engineer and demonstrated that the system functions as designed.
- D. It shall be demonstrated that the piping systems have free and noiseless circulation of water and that parts including packing glands are tight.
- E. If any defects in operation develop during the test periods, correct them immediately and additional tests will then be conducted.

4.8 CLEANING

- A. Prior to acceptance of the work, thoroughly clean exposed portions of the installation, removing labels and foreign substance.

4.9 INSTRUCTIONS

- A. On completion of the project, provide a competent technician to thoroughly instruct the Owner's representative in the care and operation of the system. The total period of instruction shall not be less than eight(8) hours.

The time of instruction shall be arranged with the Owner. In addition to the prime HVAC Contractor, the control system Contractor, Balancing Contractor, and Owner's representative shall be present and participate in the Owner's instruction.

4.10 EQUIPMENT IDENTIFICATION

- A. Each pump, unit heater, fan, damper motor, water circulating pump switch and control device shall be identified with plastic laminated identification tags. "Dymo" type tags are prohibited. Set points shall be indicated on tag.

END OF OUTLINE SPECIFICATION