DIVISION 23 - HVAC
23 30 00 HVAC Air Distribution

PART 1 - GENERAL

1.01 GENERAL CRITERIA

A. General Design Criteria

1. System standards require that buildings be fully ducted (supply, exhaust and return air).

2. Provide positive exhaust ventilation for all custodial closets, toilet rooms and mechanical rooms. Mechanical room exhaust systems shall be thermostatically controlled.

3. Roof-mounted fans and other roof-mounted mechanical equipment shall be housed in a penthouse. The Consultant shall coordinate design to avoid unsightly clutter of other exposed mechanical equipment scattered over roof areas.

4. For ease in maintenance, the insulation for ducted air systems shall be on the exterior of the ductwork instead of the interior, except as needed for acoustical purposes at the discharge of terminal boxes.

5. Provide liquid flow measuring/control devices for air handling coils, branch lines serving fan coil units, heat exchangers, selected pumped systems, etc., that will aid in future balancing and troubleshooting.

6. Install each run with the minimum necessary joints and couplings, but with adequate and readily accessible unions for disassembly, maintenance, or replacement of valves and equipment.

7. Provide manual air vents at high points of all pumped piping systems.

8. All heating and air conditioning designed and installed on the WSU campus shall be installed with individual room control.

PART 2 - PRODUCTS

2.01 AIR DISTRIBUTION EQUIPMENT

A. Motors

1. All HVAC equipment motors shall meet the following criteria:

i. Premium Efficiency

ii. Totally Enclosed Fan-Cooled (TEFC)

iii. Inverter-Rated

2. Preferred Manufacturers:

i. Reliance

ii. Toshiba

iii. US Motor

iv. General Electric/AO Smith

B. Fans

1. Base fan selection shall be based on AMCA certified ratings.

2. Fan Drives: The nominal horsepower rating of V-belt drives shall be derated for arc of contact, service factor and line start factor and shall be rated not less than 175 percent of motor horsepower.

3. Direct drive fans with Variable Frequency Drives (VFD) shall not exceed 60 Hz at maximum operating conditions.

i. See VFD requirements in section 26 29 23 Variable Frequency Motor Controllers.

4. Specify sound rating in terms of octave band sound power.

5. Fan submittals shall include software-validate fan selection and related family of performance curves.

6. Incorporate Hand-Off-Auto switches in all fan circuits.

7. Engineering design of fan enclosure shall provide for noise attenuation to reduce fan noise levels in and around the structure to comply with the requirements of WAC 296-62.

C. Hoods

1. See section 23 38 00 Ventilation Hoods (Fume Hoods).

2. For grease hoods, the fire protection system shall be subject to approval of the WSU Life Safety Shop and the Fire Marshal.

D. Air Distribution System

1. Single blade quadrant volume dampers shall not be used immediately behind diffusers or grilles because of tendency to throw air to one side and prevent uniform air flow across outlet face.

2. Turning vanes shall be installed perpendicular to the entering air and leaving air to minimize air flow turbulence.

3. Manual volume dampers shall be provided in duct drops or take-offs to diffuser and registers to limit total air to the face damper of the registers or neck damper of the diffuser. With proper manual volume dampers, face and neck damper should be deleted for savings in cost. The use of neck and face dampers to limit air quantities produces objectionable noise levels.

4. Outside air louvers can create objectionable air noise on large systems. Use widely spaced louver blades with edges rounded (or double folded) to prevent high pitch air noises. Use intake screens with openings of at least one-half inch squares to prevent clogging and still keep large objects out.

5. Install manual dampers downstream of hot and cold zone dampers on each zone of a double duct system.

6. Use double thickness or extended edge turning vanes in all elbows, return as well as supply.

7. Extractors shall not be used.

8. Install manual balancing dampers at each branch duct inlet on vertical duct chases or main return ducts.

9. Provide extension, ceiling mounted hardware wherever possible.

10. Install adequate size access doors within working distance of volume dampers, fire dampers, pressure reducing valves, reheat coils, mixing boxes, constant volume regulators, etc., to permit required adjustments.

11. Avoid placing a return air opening directly in or adjacent to the return air plenum. Even sound lining of the duct opening and plenum will not reduce transmitted noise to acceptable levels.

12. Motorized opposed blade or parallel blade volume dampers used as mixed air damper or variable volume dampers shall be provided with felt or foam rubber on damper blade for positive shutoff when blades are in closed position. Damper actuator shall not be located in the outside air stream or outside the building.

13. All duct joints, seams, casing and plenum connections shall be sealed to assure a maximum duct leakage of 3 percent or less on systems less than 2" wg, 1 percent on 2" and above. Duct tape not allowed. Consult with

WSU Engineering Services on duct seal class requirements, sealant types, and methods of sealing**.**

14. Duct design for pressure classes above 2” should utilize spiral round or oval duct for low noise consideration and sealing capabilities. Rectangular duct in these pressure ranges need to be sealed at all joints transverse or longitudinal with high pressure liquid duct sealant. All duct sections shall be tested for leakage as part of the work.

15. Masonry or composition walls shall not be used in lieu of sheet metal for exhaust systems in multi-story buildings.

16. Place volume damper locations at accessible points and at a distance no closer than five duct diameters from duct transitions or fittings. Ensure that sheet metal fasteners do not protrude into duct and interfere with damper operation.

17. Size the duct split fittings or branches based on cfm requirements of each resulting duct. When uneven duct pressures result in the branches and outlets, readjust the proportions of the split.

18. Provide dampers at all duct split fittings to permit balancing without raising noise levels. However, these dampers do not eliminate the necessity for volume dampers in the resulting branch ducts.

19. Built-up Air Handling Units shall be welded or soldered, depending on material and/or application. The system shall be pressurized to a minimum of 2 inches water column positive and all joints, seams, gaskets, fittings, etc. tested for leakage with soap solution. All testing shall be witnessed and approved by the WSU Construction Manager. It shall be the Contractor's responsibility to provide all leakage test equipment and make all necessary system changes, modifications, and repairs to achieve a successful zero-leakage test. Consult with WSU Engineering Services for specific applications.

20. Utilize equal friction method for duct sizing, not static regain method.

E. Coils

1. General Requirements:

   i. Water to air heating and cooling coil capacities, pressure drops, and selection procedures shall be certified in accordance with ARI Standard 410.

   ii. Unless otherwise stated, temperature profile of discharge air from entire coil face shall be uniform within 12” of the coil face.

iii. Coils shall have minimum 18 inches drop from outlet to floor drain for proper drainage. AHU elevation and total mechanical room layout shall accommodate this requirement.

iv. Minimum tube wall thickness for all coils is 0.035 inch.

v. Provide a water hose connection outside plenum downstream of coils for coil washdown.

vi. Provide supply shut-off ball valve, return balancing valve, drain valve, and air vent for each coil in air handling units with multiple coils. Valves shall be readily accessible by Maintenance and Utilities personnel.

vii. Provide piping flexible connections for floor-mounted coils.

viii. Flex hose connections are for pipe misalignment only and do not prevent vibration transfer to piping. Designed vibration couplings may be employed, but only those designed specifically for this purpose.

2. Preheat Coils: Preheat coils in fresh air inlet shall be specifically designed for preheating air in built-up air systems.

   i. The coil shall be vertical tube with integral face and bypass damper design, with full steam pressure at all times at outside air temperature below 50 degrees Fahrenheit.

   ii. Frost coils shall be installed upstream of filter bank to eliminate snow clogging of filter bank.

   iii. Multiple full-size trapping required. All steam coils shall be provided with vacuum relief to allow free drainage when steam is shut off.

3. Steam Heating Coils:

   i. Steam coils shall have minimum 18 inches drop from outlet to trap inlet for proper trap drainage.

   ii. Outside air coils shall have traps sized for 3x coil capacity and shall be redundant.

   iii. Shall be provided with vacuum relief to allow free draining when steam is shutoff.

4. Hot Water Coils:

   i. Shall be constructed of 1/2” or 5/8” OD seamless copper tube with aluminum fins suitable for working pressures to 200 psig and temperatures to 220^{o} F. Coils shall be tested at 250 psig under water.

   ii. Coil fins shall be continuous serpentine or plate fin type.

iii. The following materials are acceptable for coil header construction:

iv. Cast iron, with tubes expanded into headers

v. Steel pipe, with brazed tube connections

vi. Heavy seamless copper, with tubes brazed to header

vii. Casings shall be minimum 16ga galvanized steel, with galvanized steel end supports and top and bottom channels of rigid construction, with allowance for expansion and contraction of finned tube section.

viii. Coils shall be equipped with bronze spring turbulators where required to provide capacities indicated.

ix. Isolation valves and coil drain with hose fittings; ball valve or high-performance butterfly valves are required.

5. Cooling Coils and Outside Air Energy Recovery Coils:

i. Shall be constructed of 5/8” OD seamless copper tube with aluminum fins suitable for working pressures to 200 psig. Coils shall be tested at 250 psig under water.

ii. Coil fins shall be continuous plate fin type.

iii. The following materials are acceptable for coil header construction:

iv. Cast iron, with tubes expanded into headers

v. Steel pipe, with brazed tube connections

vi. Heavy seamless copper, with tubes brazed to header

vii. Casings shall be minimum 16ga galvanized steel, with galvanized steel end supports and top and bottom channels of rigid construction, with allowance for expansion and contraction of finned tube section.

viii. Select coils for tube velocity not less than 3.0 fps.

ix. Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows.

x. Coils shall be drainable type, having separate header for each tube row and separate drain and vent plugs to assure complete drainage.

xi. Coils shall be cleanable type having removable, gasketed headers for complete access to tubes for cleaning.

xii. Provide and install floor drain ahead of and behind coils.

xiii. Provide air vent and drain valve at each water coil located outside the unit housing.

xiv. Design and select cooling coils for a minimum temperature rise of 20°F. No exceptions.

xv. Coils shall be without spray or other means of humidification.

xvi. Shall include the following:

xvii. Tertiary pumping loop

xviii. Two-way control valve

xix. Check valve

xx. Griswold autoflow valve (see connection standards in section 22 00 00 Plumbing)

xxi. Isolation valves and coil drain with hose fittings; ball valve or high-performance butterfly valves are required.

6. Exhaust Air Energy Recovery Coils

   i. Shall be constructed of 5/8" OD seamless copper tube with aluminum fins suitable for working pressures to 200 psig. Coils shall be tested at 250 psig under water.

   ii. Coil fins shall be continuous plate fin type.

   iii. The following materials are acceptable for coil header construction:

   iv. Cast iron, with tubes expanded into headers

   v. Steel pipe, with brazed tube connections

   vi. Heavy seamless copper, with tubes brazed to header

   vii. Casings shall be minimum 16ga 304 stainless steel, with stainless steel end supports and top and bottom channels of rigid construction, with allowance for expansion and contraction of finned tube section.

   viii. Maximum allowable fin spacing shall be 10 fins per inch. Coil depth shall not exceed 8 rows.

   ix. Coils shall be drainable type, having separate header for each tube row and separate drain and vent plugs to assure complete drainage.

   x. Provide corrosion protection on coils. Protect with coating similar to Heresite P-413 baking phenolic with plasticizer.

7. Mechanical Space: Shall be designed for unobstructed access for coil removal and replacement.

   i. All coil pull space shall be free and clear in front of the coils for a minimum of coil length plus two feet.

   ii. Coil pull space shall be constructed without impediment from pumps, motors, piping, electrical panels and similar devices.

iii. Confirm coil length and necessary coil pull space on the drawings and with the manufacturer.

iv. Design and install coil piping to facilitate quick disconnect of coils without manifold removal.

v. Install adequate drains for each coil section.

vi. Air handling units shall be elevated above the mechanical room floor to allow proper sloping of drain lines to the floor drains.

8. Humidification: Verify with WSU Engineering Services where controlled humidification is required.

i. Where accurate humidification is required, use steam ejector humidifier. See specifications for steam humidifiers in section 23 22 00 Steam and Condensate Piping and Pumps.

ii. Hot tube humidifiers (Dri-Steam or Armstrong) are generally preferred.

iii. Indirect humidifiers are not acceptable due to poor quality domestic water.

iv. Design and locate humidifiers to prevent damage to adjacent equipment. If installed in a duct system, the air must be capable of absorbing the added moisture.

F. Expansion Tanks

1. Where expansion tanks are required, specify bladder expansion tanks.

G. Filters

1. All air supply systems shall be filtered. Each filter bank shall be provided with differential pressure gauge (0" to 3" water column) and a pressure differential transmitter compatible with the WSU BAS.

2. Air handling systems shall include housings for bag filters and prefilters:

i. BAG FILTERS: Shall be a high performance extended area disposable type media. Filters shall have an average atmospheric dust spot efficiency of 60-65 percent, an average synthetic dust weight resistance not less than 98 percent and minimum dust holding capacity of 80 to 85% with special applications requiring more; all in accordance with ASHRAE test standard 52-76.

ii. PREFILTERS: Shall be fiberglass disposable media two inches thick. Filters shall have an average atmospheric dust spot efficiency of 32.8 percent, an average synthetic dust weight arrestance not less than 93 percent and a minimum dust holding capacity of 76 grams/square foot

at 0.5 inch water gauge; all in accordance with ASHRAE test standard 52-76.

3. Install MERV 14 Electrostatic Media 3M Filtrete or equivalent.

4. HEPA filters may be employed to meet facility requirements in accordance with CDC standards.

5. Contractor shall furnish two sets of replacement filter media.

H. VAV Reheat Boxes

1. Fan-powered reheat boxes shall be avoided. These are high maintenance items which are inefficient to operate and expensive to maintain.

2. Design location of VAV reheat boxes to provide for optimum accessibility with minimal potential for capital damage in event of leak or other failure. Locate all reheat boxes above ceiling in corridors or other public spaces. Do not locate boxes in offices or small rooms behind locked doors or where desks and equipment may hinder access or create potential for leak damage.

3. Provide pressure independent, single duct Variable Air Volume air terminal units with air tempering coils.

4. Air Tempering Coil: Copper tube type with copper or aluminum fins, designed for hot water heating. Locate heating coil proper distance downstream from the air inlet to insure equal air velocities across the coil. (Consultant shall ensure capacities for VAV boxes are scheduled.)

5. Component Operation:

   i. The air distribution assembly shall be designed to maintain essentially required CFM setpoint, regardless of inlet flow variations.

   ii. The air flow sensor and controller shall be designed to prevent contamination and stoppage by building dust.

   iii. The air flow sensor shall amplify the sensed air flow signal.

   iv. The controller and damper operator shall be mounted in a 9 x 9” NEMA 1 rated box.

6. Assembly casing: Casing shall be constructed of 22 gauge galvanized steel, externally lined with 1", 1-1/2 lb. density fiberglass insulation which complies with UL and NFPA requirements.

7. Pre-Approved Manufacturers:

    i. Nailor

    ii. Titus DESV Single Duct

I. Dampers: Dampers shall have extruded aluminum blades pivoted in Delrin self- lubricating bearings. Blades shall seat against closed-cell foam gasketed stops, with less than 2% leakage at 6" static pressure, as rated by ADC standards.

J. Fire/Smoke Damper (FSD) Actuators:

1. Pre-Approved Manufacturer/Model: Belimo Small FSLF120-S Electric Actuator, with Auxiliary Switch. No substitutions shall be accepted.

K. Air Handling Unit Access Panels:

1. Air Handling Unit access panels shall be snug, hinged with latch, and sized as required for access, in compliance with SMACNA. Unless otherwise indicated, panels shall swing so that fan pressure or suction holds the panel door closed.

2. See general requirements for all Access Doors and Panels in section 08 31 00 Access Doors and Panels.

L. Instrument Test Holes: Provide instrument test holes in ductwork and plenums. These must be capped or plugged after testing.

M. Sound Attenuation: For low pressure systems, sound attenuation shall be accomplished with acoustically lined flex connections at the diffusers (minimum 5 feet in length).

PART 3 - EXECUTION (NOT USED)

END OF SECTION