

**PART 1 - GENERAL**

These standards apply to the design and installation of air-handling, ventilation and exhaust equipment and accessories. Exceptions to these standards require MUST approval.

**1.01      DESIGN CRITERIA**

**A. General:**

HVAC System Air Handlers delivering air to occupied spaces at Sea Tac International Airport shall be in a mechanical penthouse at roof-level. Air Handlers shall be “custom” manufactured. The mechanical penthouse must include adequate room to house all required ancillary equipment and to perform all maintenance activities.

**B. Drawings and Specifications:**

1. Indicate unit dimensions, weight loading, required clearances, electrical characteristics and connection requirements. Provide multiple sections to indicate elevations and spatial requirements.
2. Include equipment schedules: Identification tag, fan capacities, coil capacity, balancing requirements, sound power levels, electrical requirements, weights, etc. Indicate future and installed operating parameters on mechanical equipment schedule
3. Indicate required service access (filters, coils, fans, terminal boxes, electrical equipment, etc.) requirements on plans. Air handling units greater than 4 feet width shall be provided with side access doors on both sides. Units greater than 8 feet width or units greater than 4 feet width with single side access shall be provided with plenums (24-inch wide) and access doors upstream and downstream of coils, dampers, and filters. Fan side access doors shall be of adequate size for removal of largest piece of equipment (fan wheel, motor, etc.). Service aisle access (minimum clearance of height of 7 feet above floor and 4 feet wide) shall be provided for floor mounted primary air handling units exposed to weather. Suspended primary air handling systems shall be provided with service platforms.
4. Provide access doors for cleaning coils, drain pans, fan blades and for checking fan speed.

5. Special construction features shall include: double sloped drain pans, motor removal rail to cabinet door, sliding racks for prefilters, all filters upstream loaded, extended grease lines where applicable, access doors open such that pressure effects seal, access doors sized for removal of largest internal component, receptacles located inside motor sections, cooling coil drain pan extending 12 inches downstream of cooling coil, magnehelic pressure gauge at each filter section, gaskets or boots at all factory and field cabinet penetrations (caulking not acceptable)
6. Fan coil units shall be located to allow full opening of access doors.
7. All air handling units shall be located in dedicated mechanical rooms.
8. Air handlers above a suspended ceiling shall be provided with servicing platforms, extending a minimum of 1.5 feet from the edge of the equipment, and a clear space 3 feet high on the control side and other side where access is necessary.
9. Indicate control valve, DDC control panel, and variable frequency drive locations.
10. All coils shall be provided with isolation valves and low point drains to allow for isolation and full drainage of coils.
11. For all roof mounted equipment, provide duplex 115V outlet within 10 feet from the equipment.
12. Do Not Use the Following:
  - a. Heat Pumps (only allowed in specific locations / applications with approval of F&I).
  - b. Unit Ventilators.
  - c. Packaged air handlers.

C. Design:

1. Capacity: Main air handling units should be sized with 10 to 15-percent extra capacity.
2. Economizers: 1000-1200 fpm maximum damper velocity.
3. Air Intake and Exhaust: Outside air inlets shall be located on the roof and face away from the airfield and preferably face North or Northeast. Exhaust shall face airside (West) or as agreed upon in MUST. Intake/exhaust shall be sized for 700-900 fpm maximum velocity.

4. Hot Water Heating: Design for 180°F heating water capacity. Coils shall be sized for 160°F entering water and 20°F  $\Delta t$ . Maximum Face Velocity at 500 fpm, 10 fins per inch (maximum), not to exceed 10-foot  $\Delta p$  water pressure drop.
5. Chilled Water Cooling: Design for 42°F chilled water with coils sized for 52°F entering water (16°F  $\Delta t$ ). Maximum Face Velocity at 500 fpm, 10 fins per inch (maximum), not to exceed 10-foot  $\Delta p$  water pressure drop. System shall be designed to utilize free cooling provided by the water side economizer.
6. Filters: Maximum face velocity shall not exceed 400 fpm. Provide with rack for gas phase filtration system for units with outside air (subjected to aircraft fuel fumes) serving occupied spaces. Pre, Bag and Gas Phase Filters shall be installed in new air handlers as specified herein before initial startup and at all times during construction and operation.
7. Fans: AMCA Certified, in general, non-overloading, backward incline, airfoil wheels. Air handlers shall be provided with a minimum of dual fans for backup operation. Fan wall technology or other fan applications shall be agreed upon in MUST prior to design. Direct drive is acceptable up to 25,000 CFM. Each fan shall be provided with shutoff damper in case of fan out of service. All air handling equipment shall be scheduled or specified with acoustical values for all fans in units, including all 8 sound bands, and a total weighted average dB. Engineer to coordinate sound power levels with all manufacturers allowed in specification and check with MUST for acceptable levels prior to finalizing contract documents.
8. “Fan walls” or multiple fans in excess of “two” supply or two return fans in air handler are prohibited. In either case, two fans will be required for air handlers supply and two fans for air handlers return/exhaust.
9. Variable Frequency Drives (VFD): Provide VFD for each fan application per code. Inlet vanes or bypass dampers will not be permitted. As a minimum, provide DDC system enable/disable, speed control, frequency and amp feedback, run status, and alarm monitoring.
10. Controls: Direct Digital Controls shall be utilized for all air handlers and air handling equipment. As a minimum provide DDC System enable/disable speed control, frequency and amp feedback, run status, and alarm monitoring. Controls: Direct Digital Controls shall be utilized for all air handlers and air

handling equipment. Provide standalone DDC controller for each air-handling unit. Air handling unit damper and valve actuators shall be pneumatic with existing compressed air system extended. Locate control valves, balancing valves and control components for accessibility and out of damper face area. Provide outside air measurement for variable volume applications. All dampers shall have end switches for monitoring purposes.

11. Vibration Isolation and Seismic Restraints: Comply with current IBC code requirements for seismic. Provide internal vibration isolated fans with seismic restraints. Secure unit, components and accessories in accordance with seismic requirements per code.
12. Shutoff for Smoke Control: Smoke detector(s) shutdown to be provided under Division 26. Coordinate smoke detector(s) location and shutdown requirements with Division 26 electrical.
13. Air handling unit coils shall be independently supported to allow removal of a coil or coil section without impacting operating of the remaining sections.
14. All coil condensate drains shall be sized properly to allow proper flow of condensate and prevent backflow due to negative pressure caused by fans. At a minimum of 1" plus fan external static pressure of difference between inlet and outlet pipes of trap assembly.
15. Exhaust fans may require motorized dampers if not in continuous operation as required by Washington State Energy Code.
16. Freeze-protection pump: Provide AHU heating coils with a freeze-protection pump connecting hot water lines to circulate water to prevent freezing. Refer to section 232123 for pumps.

## **PART 2 - PRODUCTS**

### **2.01      AIR HANDLING UNITS (VARIABLE AND CONSTANT VOLUME SYSTEMS)**

- A. Manufacturers: Haakon, Trane Custom, or approved equal.
- B. Wall Casing: Double wall, 16 gauge galvanized steel outside, 22 gauge galvanized steel inside, perforated in fan sections, solid for other sections. Insulation (between inside and outside casing): R16 for fiberglass or R26 for sprayed insulation – 4" panel thickness minimum. Maximum allowable

deflection for wall (and roof) sections shall not exceed  $L/250$  at 1.5 times the maximum plenum pressure, where  $L$  is defined as the wall panel height (unit width for roof). Maximum plenum pressure is defined as the greater of either the supply fan intake or discharge plenum pressure relative to ambient conditions. Casing deflection shall be certified by the manufacturer.

- C. Bases: Unit bases shall be constructed from ASTM A36 structural steel channel iron around the entire perimeter of the unit and provided with intermediate structural channels to support all internal components. All channel and angle joints to be solid welded. Bolted construction or formed channel bases are not allowed.
- D. Floor Plate: Insulated Double panel, 12 gauge solid checker-plated aluminum diamond plate upper panel, internally watertight; 22 gauge solid galvanized steel lower panel.
- E. Insulation: R26 sprayed insulation – 4” panel thickness minimum for walls, roof and base, including allowances for unit framing.
- F. Roof Panels:
  - 1. Indoor Units: Flat with smooth surfaces constructed similar to wall casing.
  - 2. Outdoor Units: Weather tight construction, Insulated Double panel, 14 gauge steel outside, 20 gauge inside, sloping. Outdoor units shall have rain gutters placed over all access doors to prevent rain from entering unit.
- G. Cabinet Accessories:
  - 1. Access Doors: Continuous Hinged Side Access Doors: Double wall construction to match wall panels, 16 gauge galvanized interior door panels continuously welded corners for rigidity. Doors shall be fully insulated and sealed. Continuous heavy duty stainless steel piano hinges. Metal Latches shall be Haakon custom, Ventlok No. 310 or approved equal and shall be operable from interior and exterior of unit with airtight gaskets. Plastic door handle components are not allowed. Each access door shall be sized to allow the largest component located within that section to be removed and installed without removal of the door. Doors shall open against pressure. Doors to be provided with double high performance airtight gaskets made of closed cell replaceable neoprene bulb around the entire perimeter of door and door frame. Gaskets required on both doors and frame. Standard door size shall be 24”x60” high, unless unit is shorter than allowable standard height. Doors over 30” high shall contain viewing windows. Windows to be thermally

isolated, hermetically sealed wire glass minimum 9"x9" up to 12"x12" maximum as unit allows. Round windows of min size are also acceptable. Doors and all sections shall include pressure rated test ports for Balancing and measuring.

2. Filter gauges: Each filter bank to be provided with a Dwyer Series A3000 Photohelic differential pressure gauge and pressure switch combination, Sensicon, HK, or approved equal. Air Filter Gauge to be 4" dial size, +/-2% accuracy min at 70 deg F and have adjustable signal flags and 2 alarm points to alarm to the DDC control system. One alarm to be set at loaded filter (typically 0.5" wc) and one at filter alarm (typically 0.8" wc). Pressure switch to be +/-2% FS repeatability, adjustable, 120V or 24V. Provide gauge range to match the type used in filter bank from unloaded to loaded conditions. Differential pressure switch to be installed face flush in air handler, sealed air and weather tight, and be pre-wired by the air handling unit manufacturer. Tubing for all pressure gauges to be copper. Plastic tubing products not allowed.
3. Motor Service Rails: Fan sections of 5 HP or greater shall be provided with overhead motor/fan removal system consisting of I-beam service rail and trolley capable of lifting all fan motors from their point of service and take the motor directly outside the unit. Include lifting hoist and chain for size of fan.
4. Lights: All sections with doors shall have lights installed and be integral to the unit electrical pre-wired at the factory. Lights to be rated to be installed in pressure rated plenums and have protective cages. Lights shall be controlled with minimum of 2 switches per unit.
5. Controls wiring conduit: Control wiring conduit shall be coordinated with 200920 Direct Digital Controls and conduit installed in the factory for field installation of controls.

H. Fans:

1. Manufacturers: Twin Cities, Howden-Buffalo, New York Blower, or approved equal.
2. Fan performance shall be based on tests run in an AMCA certified laboratory as administered in accordance with AMCA Standard 210. Fan performance shall include all fan inlet and discharge system losses (which are not included in the AMCA rating) based on the air handling unit, ductwork layout, and

configuration. Fan shall be sized to perform at design airflow, allowing for all internal static pressure losses, external static pressure losses, and filter loading. Filter loading allowance shall be 1.0" w.g. minimum. Drive: Direct drive to 25,000 CFM allowed. AMCA Fan Arrangement 4, direct drive plenum fan, industrial grade, AMCA Publication 99, Class I, II, or III as required by operating conditions. All fans above 25,000 CFM to be belt drive with fixed Sheaves, AMCA Fan Arrangement 1, AMCA Publication 99, Class I, II, or III as required by operating conditions. Direct drive fans to be fully welded aluminum and belt drive fans to be fully welded aluminum or steel. All fans to be dynamically balanced to G6.3 per AMCA 204 or better. Inlet cones to be heavy gauge spun steel matched to wheel intake rim. Frames to be heavy gauge continuously welded steel with bearing cross frame, industrial grade only. Fan shafts to be AISI 1040 or 1045 hot rolled steel. Bearings shall be heavy duty grease lubricated, spherical roller or anti-friction ball (must be able to withstand all force directions including moments) AFBMA L-50 of 200,000 hrs or more. All bearings shall have lube extension lines of copper, extending to an easily accessible service point outside of protective grilles. Protective grilles to enclose entire fan for personnel protection, see belt guard below. Fan selections within 10% of the class rpm shall be selected as the next higher class fan. Fan Motors: See Section 230513 "Motors."

3. Grease lines – copper tubing (no plastic) extended from bearing grease area to accessible space for servicing. Bearing grease lines shall also employ grease relief fittings such as Alemite, Fastenal, Lincoln Brown or equal.
- I. Belt Guards and Fan Guard: OSHA approved belt and fan guards. Guards shall be minimum .125" diameter welded steel protective mesh/grille or expanded metal with ½" size maximum openings. A frame that properly restrains movement or deflection to comply with OSHA and 29CFR regulations. Guard must be easily removable with no more than 4 fasteners per side. Finish to be primed and coated with epoxy or enamel paint.
- J. Vibration Isolation: Fan, Fan motor and drive shall be mounted and isolated on the same integral steel base, with seismically restrained integral steel isolators.
- K. Finish: The exterior of the unit shall be painted with 2 component primer and industrial air dried alkyd enamel paint. Color for interior units to be gray. Color of exterior units to match existing roof surroundings.



- L. Coils: AHRI rated, 500 fpm maximum face velocity, 10 fins per inch maximum, hydrostatic tested to 250 psig. Provide a hose end drain valve on each water coil.
- M. Drain Pans: Drain pans shall be 304 stainless double wall construction with stainless or copper drains to exterior. Provide drawing detail that assures sufficient depth for coil condensate trap to accommodate fan static pressure without conflict from the floor.
- N. Dampers:
  - 1. Manufacturers: Ruskin, American Warming, T.A. Morrison, or approved equal.
  - 2. AMCA Certified, low leakage, airfoil blades, concealed linkages with blade and jamb seals. Leakage shall be less than 5.2 cfm at 4.0 w.g. pressure difference (based on 48"x48" damper).
  - 3. Parallel arrangement for mixing application.
- O. Certified Testing:
  - 1. Fan Testing: Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
  - 2. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
  - 3. Air Leakage Testing: Pressure test each air handling unit at the factory to ensure the leakage rate of the casing does not exceed 1 percent of the unit air flow at 1.5 times the rated static pressure. Test shall be conducted in accordance with SMACNA. If unit to be separated for shipment, manufacturer to provide instructions and field acceptance inspection of re-assembly to validate factory pressure test.
  - 4. Flood Testing: Flood test each air handling unit at the factory. Air handling unit bases shall be flooded at a level of 1-1/2-inches after manufacturing to ensure there is no leakage through the floor and the perimeter water barrier.

**2.02      FAN COIL UNIT (FOR UNOCCUPIED SPACES ONLY – MACHINE ROOMS, SWITCH GEAR ROOMS ETC.)**

- A. Manufacturers: Liebert, Haakon, Temtrol, Daikin or approved equal.



- B. Same construction as air handling units except 2-inch, insulated double wall construction for roofs, walls, and floors.
- C. Sprinklers and flood testing not required.
- D. Horizontal flow, packaged ceiling-mounted type unit (use for units of .5 ton capacity or less) and vertical flow packaged floor-mounted unit; factory assembled and pre-wired, consisting of cabinet and frame, supply fan, chilled water-cooling coil and air filters.
- E. Units shall have 81% or better sensible cooling ratio.
- F. Forward curved centrifugal fans are also acceptable.
- G. Unit shall consist of supply fan, coil, one filter, mixing box, controls, motor and accessories.
- H. All components in units shall be controlled by Siemens. Controls are provided by Siemens for temperature and fan and include the chilled water valve.

**2.03      VANE AXIAL FANS**

- A. Manufacturers: Cook, Woods, Howden Buffalo, or approved equal.
- B. Direct or belt drive, controllable or fixed, pitch unit. Construction:
- C. Continuously welded 1/4-inch hot rolled steel housing with 3/4-inch end flanges and motor support ring, 3/4-inch motor support plate. Eight 3/16-inch stationary guide vanes welded to inside of housing.
- D. Cast aluminum rotor hub and airfoil blades. Maximum 0.10-inch blade tip clearance. 1/4-inch steel cross-braced supports.

**2.04      TUBE AXIAL FAN**

- A. Manufacturers: Cook, Howden Buffalo, Woods, or approved equal.
- B. Factory assembled unit consisting of housing, fan, motor and accessories. AMCA rated and UL approved.

**2.05      CENTRIFUGAL ROOF EXHAUST FAN**

- A. Manufacturers: Penn, Cook, Acme, or approved equal.
- B. Centrifugal fan in spun aluminum housing, AMCA rated capacities. ETL and UL approved.

**2.06      IN-LINE FAN**

- A. Manufacturers: Penn, Cook, Acme, or approved equal.

B. Forward curved, Centrifugal fan, AMCA rated, and UL approved.

**2.07      UTILITY FAN**

A. Manufacturers: Penn, Cook, Acme, or approved equal.

B. Forward curved centrifugal fan in steel scroll and housing with support frame for drive and motor, AMCA rated, and UL approved.

**2.08      PROPELLER FAN**

A. Manufacturers: Penn, Cook, Acme, or approved equal.

B. General: Belt driven steel propeller fan mounted in factory sleeve, AMCA rated capacities and UL approved.

**2.09      FILTERS**

See Section 233000 “Air Distribution System.”

**2.10      FANS AND ACCESSORIES**

Air handling units, fans and accessories shall be mounted within 8’0” of the “Floor” or shall be provided with complete service platform to allow standard maintenance including change out of filters, motor, fan section, etc.

END OF SECTION