DESIGN GUIDELINE 230013
AIR HANDLING UNITS

General

This section describes design requirements, types, and arrangements of air handlers required, sizing considerations, and minimum air handler construction features. Testing, temporary use, and training are also covered.

Related Sections

U-M Design Guideline Sections:
230000 – Basic Mechanical Requirements
230011 – Fans and Accessories
230012 – Air Filters

U-M Master Specification Sections:
220514 – Variable Frequency Drives
230900 – Mechanical Systems Controls
230905 – Mechanical Systems Controls (Hospital Projects)
233400 – Fans
234000 – HVAC Air Cleaning Devices
237323 – Custom Air Handling Units
237324 – Semi-Custom Air Handling Units
238216 – Coils and Drain Pans

Design Requirements

Air handlers shall be specified using the U-M master specifications: 237323 - Custom Air Handling Units, or 237324 – Semi-Custom Air Handling Units. Edit these specification sections to make them project specific. Note that when using these specifications the U-M related master specifications for fans (233400), filters (234000) and coils (238216) must be included since these components are not specified within the air handler specifications. Turn on hidden text and read all spec. editor's notes when editing specifications.

For all air handling equipment greater than 2000 CFM, the engineer shall provide a scaled elevation of the unit on the design drawings. This elevation shall indicate component arrangement and identify each unit component: dampers, access sections, doors (including door size), door windows, access panels, pre and final filter, coils, humidifiers, fans, blenders, eliminators, diffuser plates, lights, drain pans, flex connectors, and all significant accessories. Maximum height, width, and depth, as well as base rail height, shall also be indicated.

For all air handling equipment, the plan view drawings shall indicate the arrangement of each component, overall unit size, coil pull space, and access door swings. The plan views shall also indicate the unit's designation and the maximum unit CFM.

Units shall be labeled with sequential alpha-numeric designators. For retrofit designs, do not repeat the numerical designator of existing units; coordinate with U-M Utilities and Plant Engineering for campus projects and with UMH Facilities Planning & Development for hospital projects via the U-M Design Manager to determine the appropriate designator.

Designate adequate roof curb or housekeeping pad height to allow proper trapping of cooling coil drain pans. Provide a detail that indicates the trap height dimensions for every coil trap.

To avoid snow entrainment, limit air velocity through intake louvers to 300 FPM through the louver free area at outside air volumes that occur at 35ºF or less (for example, this volume is the maximum supply air volume for 100% outside air units; for units with return, it is half the maximum supply air volume assuming 75ºF return air and 35ºF outside air being mixed to 55ºF), and limit intake plenum velocities to 500 FPM in all directions. Slope the bottom of plenum/duct connections to the louver so that water drains out the louver. Provide access into outside air plenums to facilitate power washing the outside air louvers.

Air Handling Unit Types

For the purposes of this guideline, semi-custom units are defined as air handlers for light to medium duty use, consisting of manufacturer's pre-engineered standard modules, with limited selections in terms of quality, features, and arrangement.

Semi-custom units should normally be specified for applications such as offices, class rooms, hospital outpatient clinics/offices, and light duty lab applications (e.g. dry labs with very few or no fume hoods) where operation is generally limited to 5 days per week, 8-12 hours per day. For units greater than 20,000 CFM, the design should normally be based on custom units.

Custom units should normally be specified for large wet labs and dry labs, all hospital inpatient applications, all applications serving critical hospital pressurized rooms (see SBA 5.16), all low discharge air temperature (i.e. <50 degree F) applications, 100% outside air applications (except mechanical or electrical room ventilation), vivariums, clean rooms, 24/7 applications, and other medium to heavy duty applications.

Contact the U-M Design Manager early in the SD phase to establish custom versus semi-custom AHU locations.

Roof top mounted air handling units are not preferred and shall not be used except when approved by the U-M Design Manager. If approved for use, roof top mounted air handlers shall be provided with a heated service vestibule (full length of unit, minimum 40" wide) to allow full access to the air handler components. All utilities feeding the air handling unit (power, chilled water, etc.) shall be routed into the service vestibule from below (not exposed on roof). Packaged gas fired/DX roof top mounted air handlers shall not be used on facilities with central utilities (i.e. chilled water, heating hot water) and shall only be used in offsite facilities that do not have nor can justify centralized plants/utilities. See DG 230014 and 230010-H (hospital facilities).

Arrangement

Fan Arrangement: Draw through units are normally preferred, except for exterior units.

Returns fan configurations shall be used. Configurations using exhaust/relief fans or no return fan should be avoided and shall be used only when dictated by unusual circumstances.

Units shall be arranged to allow proper access for routine maintenance of all components. At minimum, access shall be provided for the replacement of the following components: Filters, coils, fan shafts, bearings; without unit disassembly or partial demolition of the unit or adjacencies.

Sizing

For applications where load growth is likely to occur over the life of the unit, e.g. lab buildings, size all air handler components (fans, coils, filters, etc.), with additional capacity for future use. Determine the appropriate additional capacity in consultation with the U-M Design Manager. See DG 230010 and DG 230010-H for sizing guidelines.

When sizing units, assume 5% duct leakage and 1°F temperature heat gain in supply ducts.

Fans shall be sized assuming dirty filter pressure drops, which are typically 1" w.g. static pressure drop across the pre filters and 1" w.g. static pressure drop across the final filters.

Construction

Unit Casing

Solid inner walls are preferred whenever possible. Perforated walls should only be utilized when external sound attenuators or other means are found to be ineffective in meeting the required noise criteria.

The minimum wall thickness for semi-custom units shall be 2". The minimum wall thickness for custom units with fiberglass insulation shall be 4", except 2" foam insulated panels are permitted if such panels match the performance of 4" thick fiberglass insulated panels. See the U-M AHU master specifications for details.

For roof top mounted units, consult the Architect and the U-M Design Manager to determine if a custom paint color or screening is required.

For units above 10,000 CFM, each access section shall be illuminated. See the U-M master specifications for details.

Drain Pans

Drain pans shall be designated as above floor type. Avoid floor recessed drain pans whenever possible due to the difficulty of replacement.

Drain pans shall be stainless steel. Plastic drain pans are acceptable in units of less than 2000 CFM.

Access Sections

Access sections shall be provided to allow up and down stream access to every unit component. For example, an access module shall be provided between each heating coil and cooling coil section; both the air entering and air leaving side of each coil shall be visible for inspection. The designer must accommodate these access sections when fitting units into the available space.

For large custom and semi-custom units (> 20,000 CFM), in particular those with a large outside air component, consider (with the U-M Design Manager) providing an access section between the pre and final filters of adequate size to allow the final filters to be replaced from the upstream side without removing the pre-filters. As an alternative to the above, a hinged pre-filter section may be specified. For hinged pre-filter configurations, also specify a gap between the pre-filter and final filter frames to allow a static pressure tap to be installed so that a separate pressure drop reading may be taken across the pre and final filter banks.

Access Doors

Hinged access doors are required in each access section.

Minimum door widths are specified in the U-M AHU master specifications. For semi-custom units, doors shall be a minimum 18" wide, but 24" width is strongly preferred. Widths narrower than 18" should be avoided and are unacceptable for sections requiring personnel (vs. inspection/arm reach only) access. For custom units, minimum door width shall be 24". In all cases, provide doors that are the full height of the unit, maximum 6' high.

Windows shall be provided in all access doors on units greater than 5000 CFM, and for all air handlers providing service to areas that might be compromised by opening an access door for inspection, e.g. clean room units, hospital units, lab units with stringent temperature, pressure, or humidity control, etc.

Mixing Box Section/Air Blenders

The use of air blenders is strongly discouraged since U-M's experience is that such devices are ineffective in preventing stratification problems, leading to frequent nuisance freeze stat trips or more severe problems. Instead, arrange outside air and return ducts so that after combining, at least two directional changes occur prior to entering the air handler proper, or utilize blow through or other fan arrangements that completely eliminate such stratification problems. Use air blending devices only as a last resort and only with the permission of the U-M Design Manager.

When used, air blending devices should be factory fabricated and should consist of fixed blades capable of providing a mixed air temperature within 6ºF of the theoretical mixed air temperature. In a variable air volume AHU, this 6ºF maximum deviation should apply throughout the CFM range specified. The devices should be sized to provide a maximum pressure drop of 0.15 inches water, with a stratification range not exceeding +/- 6º from the mean temperature. The A/E should lay out the AHU to provide a plenum sized for a minimum of 1/2 blender diameter upstream between return air duct and blender, and 3 blender diameters downstream between the blender and the first air flow obstruction (filter, coil, etc.). In lieu of the traditional air blending devices, in applications where effective mixing in the return air ductwork is not possible, consider the use of

"channel blenders" integrating outside air and return air dampers into a packaged component ensuring efficient mixing and velocity.

Coils and Face/Bypass Modules

The maximum face velocity for cooling coils in both custom and semi-custom units shall be limited to 450 FPM. This face velocity shall be based on the actual coil face area without any safing around the coil.

Maximum face velocities shall be based on any future capacity allowance for the AHU.

For units 10,000 CFM or greater, coil tracks and individual coil access panels shall be specified. See the U-M AHU master specifications for further details.

Coils shall have a maximum of six rows, and maximum fin spacing of 10 FPI. When these criteria cannot be met, provide two coils piped in a series arrangement.

When multiple coils are stacked vertically, each coil in the stack shall be equipped with a balancing valve (circuit setter).

For 100% outside air units, mixed air units capable of air side economizing, and for all units located outdoors, "run-around" pumped hot water heating coils are preferred in lieu of steam coils for preheating applications. When a pumped hot water heating coil is used, the pump and piping shall be installed per the standard detail located on the UM AEC website. Simplex pump shall be the default requirement. Duplex pumps (100% inline spare) shall only be required for critical applications such as hospital surgical suites. Consult with the UM Design Manager to determine whether an application is deemed critical. The pump shall be sized for the coil water flow required at maximum heating design conditions. The pump shall operate continuously when outside air temperature is 40F or below (configurable). If a minimum of 30% glycol by volume is utilized in the heating hot water serving the unit, then pumping the coil is not required. If preheat steam coils are used, multiple staged on/off steam coils shall be used, or a face/bypass arrangement may be used. For face/bypass arrangements, internal bypass or "Wing" coils shall not be utilized, rather an external coil bypass shall be utilized. The external bypass shall be routed to the downstream side of all unit coils (i.e. downstream of both the preheat coil and the cooling coil) and shall be sized to exert the same relative pressure drop on the fan as flow through the coils would exert.

For 100% outside air units, mixed air units capable of air side economizing, and for all units located outdoors that require chilled water cooling coils; a "run-around" pump shall be used for the chilled water cooling coil when the unit either has no preheating coil, or if the preheating coil utilizes steam. Mixed air units with a hot water preheating coil upstream of the chilled water cooling coil do not require a pump for the chilled water cooling coil. Other example applications, when a pump is not required for the chilled water cooling coil, include but are not limited to:

1. Units with hydronic energy recovery coils upstream of the chilled water cooling coil
2. Units with total energy wheels upstream of the chilled water cooling coil
3. Units with a low percentage of outside air and that have a minimum of 3 duct elbows after mixing of outside air and return air takes place.

4. Any other application that cannot reliably result in a mixed air temperature of 45F, with temperature variation of less than +/- 5F across the face of the coil. Consult the UM Design Manager if there is any question regarding whether a chilled water cooling coil pump should be used for a particular application.

When a pump for the chilled water cooling coil is used, the pump and piping shall be installed per the standard detail located on the U-M AEC website. Simplex pump shall be the default requirement. Duplex pumps (100% inline spare) shall only be required for critical applications such as hospital surgical suites. Consult with the UM Design Manager to determine whether an application is deemed critical. The pump shall be sized for 50% of the coil water flow required at maximum cooling design conditions. The pump shall operate continuously when outside air temperature is 40F or below (configurable). If a minimum of 30% glycol by volume is utilized in the chilled water serving the unit, then pumping the coil is not required.

Dampers

Damper construction is designated in U-M master specification 230900 - Mechanical Systems Controls. The U-M AHU master specifications also reference 230900 for damper construction. All air handler specifications shall utilize this damper specification for dampers provided by air handler manufacturers. This includes smoke and combination fire and smoke dampers that are provided by air handler manufacturers.

Filters

Units shall include pre-filters and final filters, except that very small, non-critical units or units serving spaces less susceptible to dirt, e.g. mechanical rooms, may include pre-filters only.

Units serving substation rooms shall always be equipped with pre and final filters.

Filters shall be designated as face mounted with the filter seals sealing against the upstream side of the filter frame. Side slide filters shall only be used in unusual circumstances.

See U-M HVAC Air Cleaning Devices master specifications, DG 230012 and DG 230012-H for additional filter requirements.

Humidifiers

Humidifiers shall be located either in the air handling unit or in the supply air ductwork. Ensure minimum manufacturer absorption distance is being met (with safety factor) prior to any downstream obstructions (i.e. coils, duct fittings, etc.)

For air handling units with larger outside air percentages (i.e. >20%), the preference is to locate the humidifier in the air handling unit, upstream of the cooling coil and downstream of the preheating coil.

Mount humidifier on stainless steel supports of adequate height to facilitate proper steam trapping.

Ensure humidifiers mounted upstream of air handling unit final filters are of sufficient distance upstream (i.e. minimum 10ft) to prevent wetting of the filter media.

Fans

Limit fans speeds to 1200-1400 RPM.

Forward curved fans shall not be specified accept when air foil or backward inclined fans are not available, or when a forward curved fan provides significant performance advantages. Semi-custom units are often available with either forward curved or backward inclined/air foil fans. Determine if backward/air foil type are available and always provide a design based on same when available, except as qualified above.

When plenum fans are utilized, specify a "guard cage" around the fan for safety. The impacts on fan performance of such cages as well as impacts from any inlet mounted back draft dampers shall be evaluated when selecting such fans. Assure proper up and downstream and side-to-side (relative to plenum walls and any adjacent fan(s) in the same plenum) clearances are maintained around plenum fans to prevent system effect problems or poor air distribution across upstream components.

Extended lube lines shall be specified where bearings are difficult to access or for air handlers providing service to areas that might be compromised by opening an access door for bearing lubrication, e.g. clean room units, lab units with stringent temperature, pressure, or humidity controls, etc.

Testing, Temporary Use, Training

Factory Testing

Custom units should normally be factory tested for air volume, pressure, leakage, and sound performance. Such factory testing is normally not required for semi-custom units, however it should be considered for air handlers that are not arranged in simple horizontal or vertical configurations, e.g. a fan section stacked on top of the coil sections. See the U-M AHU master specifications for details.

Temporary Use/Field Testing

The U-M AHU master specifications contain specific criteria regarding the temporary use and field testing of air handling units.

Training

Training is not typically required on air handlers and should not be specified unless directed to do so by the U-M Design Manager. Consider need for training if units include direct expansion cooling.