SECTION 23 73 00_AIR HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Modular custom & semi-custom built indoor air handling units
   2. Modular custom & semi-custom built outdoor air handling units

B. The intent of these standards are to provide input to the design team on the University’s preference of manufacturers, design, equipment options and quality assurance to maintain the longevity of its assets.

1.2 REFERENCES

A. Common Work for HVAC Systems 23 05 00
B. Common Requirements for HVAC Systems 23 05 01
C. Identification of HVAC Equipment and Piping 23 05 53
D. Testing and Balancing of HVAC Systems 23 05 93
E. Air Distribution Systems 23 30 00
1.3 ENGINEERING AND DESIGN REQUIREMENTS

A. Air handling units shall be designed to eliminate air stratification in the air handling unit.

B. Maximum air velocity through the cooling coil is 500fpm.

C. Maximum air velocity through the heating coil is 750fpm.

D. Allow for dirty coils and filters when determining the air pressure drop through the air handling unit.

E. Determine the condensate trap requirements using attachment 1. Allow for condensate trap installation when determining height of the base rail.

F. Poor inlet and discharge conditions often lead to underperformance of air handling unit fans in relation to design. Air handling unit inlet and discharge duct shall be designed without abrupt transitions and have the required distance between inlet/outlet and any elbows or tees.

G. Heating and cooling coils shall be selected to maintain a minimum water velocity of 3fps through the coil without the use of supplemental pumps.

H. Hot water is the heating medium of choice for the University of Delaware. Consult the University of Delaware Energy and Engineering Department if steam heating is required.

I. Hinged man way doors, lights and GFCI receptacles shall be supplied on all sections that require access. These include but not limited to sections that have filters, dampers, fans, UVC lights, and equipment and/or controls that need maintenance.

J. Air handling units shall not be used to provide temporary heating and cooling during construction. Air handling units shall not be used to cure materials during the construction process. Temporary heating, cooling and dehumidification must be provided as part of the project.

1.4 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data, Submit the following:
   1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
   2. Air handling performance parameters as listed on the air handling unit schedule.
3. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
4. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
5. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
7. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

C. Manufacturer's Installation Instructions

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for calibrating instruments, lubrication, filter replacement, motor and drive replacement, spare parts lists, wiring diagrams, installation instructions and replacement parts list.

B. Air Handling Unit start up report

C. Completed Air Handling Unit Data Sheet

D. As Built operating characteristics that are revised to include all changes to air system made during construction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Protect units from weather and construction traffic by storing in dry, roofed location.

1.7 EXTRA MATERIALS

A. Furnish three sets of filters for each unit. (one set for start-up and two spares)

PART 2 PRODUCTS

2.1 DOUBLE WALL INDOOR & OUTDOOR AIR HANDLING UNITS (Single Wall Air Handling Units are Not Acceptable)

A. Manufacturers:
   1. Air Enterprises Inc.
   2. Buffalo Air Handling
3. Engineered Aire
4. Governair Corporation
5. Haakon Industries
6. Ingenia Technologies
7. Temtrol
8. Trane

B. Configuration shall be based on the unique requirements of the project. Consult with University of Delaware Energy and Engineering Department when determining the configuration of the air handling unit.

C. Fabrication: Conform to AMCA 99 and ARI 430.

D. Casing materials will be based on air handling unit application and location. Consult with University of Delaware Energy and Engineering Department to determine materials of construction.

E. Channel base of welded steel or aluminum with a minimum height of 12 inches. Variance from the minimum height will be considered if height constraints are present. Consult with University of Delaware Energy and Engineering Department to determine if a shorter base can be used.

F. Insulation shall have the following operating characteristics:
   ‘K’ factor at 75 degrees F: Maximum 0.26 Btu/h·in·f·°F.

G. Steel or aluminum constructed air handling units located outside shall have the following finish: Three coat system of epoxy applied over shot-blasted surface, to total thickness of 5-6 mils Finish: Manufacturers standard color on exterior.

H. Walk-in Access Doors: 30 x 60 inch. Material same as cabinet insulated sandwich construction, for flush mounting, with hinges, gasket, latch, and handle assemblies, and 12 x 12 inch inspection window of 1/4 inch thick Plexiglas.

I. Lights: Located in all accessible sections suitable for damp locations with wire guards, factory wired to weatherproof switch and duplex outlet mounted on casing exterior. In humidifier sections, furnish lights suitable for wet locations.

J. Drain Pans: Double thickness stainless steel with insulation between layers with welded corners. Cross break and pitch to drain connection. Furnish drain pans cooling coil section and humidifier section.

K. Bottom Inlet Units: Furnish stainless steel or aluminum walking grate on structural supports.
L. **Strength:** Furnish structure to brace casings for design suction pressure with maximum deflection of 1 in 200.

M. **Outdoor Units:**
   1. Outdoor units shall be supplied as to be mounted on a structural steel platform.
   2. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
   3. Roof shall be double-wall, pitched to facilitate drainage at a minimum roof slope of 1/4-in. per foot across the width of the unit. No penetrations shall be made in pressure sensitive panels. Roof shall incorporate a standing top seam. All seams in the roof shall be gasketed and capped to prevent water infiltration into the unit.
   4. Outdoor units shall be supplied with piping enclosures at each coil section to house coil piping connections. Piping enclosures shall be the same construction as the air handling unit.
   5. Outdoor units shall have service corridors incorporated into the chassis and enclosure.

N. **FANS**
   1. All fan types will be considered, however the University of Delaware has a preference for air foil and plug type fans.
   2. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
   3. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
   4. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing.
   5. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Mount base on vibration isolators.
   6. Fans shall be direct drive with no belts. Variance will require approval from the University of Delaware Energy and Engineering Department.
7. Fans speed shall be balanced and modulated via variable frequency drive.


9. Variable frequency drives shall be mounted external to the air chamber.

O. MOTORS
1. Fan motors shall be rated for inverter duty.

P. BEARINGS AND DRIVES
1. Bearings: Pillow block type, self-aligning, grease-lubricated roller bearings, or ABMA 11, L-50 life at 400,000 hours.

2. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

Q. COILS
1. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

2. Drain Pans: 24 inch downstream of coil and intermediate drain pans for cooling coil banks more than one coil high. Drain pans shall be construction of corrosion resistant material such a stainless steel or a composite material and be double wall insulated.

3. Eliminators: Type 304 stainless steel mounted over drain pan.

4. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.

5. Fabrication:
   a. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.

   b. Fins: Aluminum.


6. Water Heating Coils:
   a. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
b. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

7. Steam Heating Coils: (The use of steam heating coils must be approved by the University of Delaware Engineering and Energy Department)
   a. Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.
   b. Configuration: Drainable, with threaded plugs for drain and vent, threaded plugs in return bends and in headers opposite each tube, sloped within frame to condensate connection.
   c. all steam coils shall have integral face and bypass dampers.

8. Water Cooling Coils:
   a. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
   b. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

R. FILTERS
1. Filter Box: Section with filter guides, access doors from one side for side loading with gaskets and blank-off plates.

2. Filter Media: Filter media will be selected based on the operating requirements of the space being conditioned. Consult with the University of Delaware Energy and Engineering Department when selecting filter media

3. Magnehelic gages must be supplied for each filter bank

S. UVC GERMICIDAL LAMPS
1. UVC germicidal lamps may be used to control biological growth on chilled water coils if required by the design.

2. Emitters and fixtures for UV-C lamps shall be designed for use inside an HVAC system. Individual lamp output shall be measured in an ASME nozzled test apparatus using a 45
F airstream moving at not less than 400 fpm. Lamp output at 253.7 nm shall not be less than 10 μW/cm² per inch of arc length measured at a distance of one meter.

3. Power supplies for UV-C lamps shall be a high-efficiency electronic type which are matched to the emitters and are capable of producing the specified output intensity with an input power no more than 80 watts.

4. Fixtures for UV-C lamps shall be factory installed and wired to a SPDT disconnect switch and door interlock switches in each door. Fixtures are wired for 120 v/single ph requiring a minimum circuit ampacity of 15 amps. Lamps shall ship separately for field installation to minimize the chance for bulb damage.

5. Emitters and fixtures shall be installed in sufficient quantity and arranged so as to provide an equal distribution of UV-C energy on the coil and drain pan.

6. The minimum UV-C energy striking the leading edge of the coil pan shall be not less than 820 μW/cm² at the closest point and through placement, not less than 60% of that value at the farthest point. Equal amounts are to strike the drain pan, either directly or indirectly through reflection.

7. Emitters and fixtures shall be installed such that UV-C energy strikes all surfaces of the coil, drain pan, and the available line of sight airstream.

T. DAMPERS

1. Dampers shall have edge seals and self-lubricating nylon bearings. Dampers shall have opposed blade arrangement with damper blades positioned across short air opening dimension. Furnish removable, full width support for freeze-protection thermostat, with removable end panel to permit support removal.

2. Outside Air Damper Leakage: Maximum 3.0 cfm per square foot at 1.0 inches wg pressure differential.


4. Face and Bypass Dampers: Factory mount in casing with access doors, opposed blades, and edge seals, self-lubricating nylon bearings. Arrange to match coil face with bypass, blank-off and division sheets, internal linkage, access doors, and adjustable resistance plate.

5. Damper Actuators: Damper actuators shall be supplied by the BAS vendor (Tri-M) for factory mounting.
U. OUTSIDE AIR MEASURING DEVICE
   1. Consult with the University of Delaware Energy and Engineering Department if outdoor air measuring is required.
   2. Airflow measurement assembly shall be sized to accommodate minimum and economizer outside airflow.
   3. Allow for air straightening into the airflow measuring station to maximize accuracy of the data

V. REFRIGERANT BASED ENERGY RECOVERY COILS

   Advanced Cooling Technology and Heat Pipe Technologies are the vendors of choice for energy recovery coils for the University of Delaware. Please consult manufacturer as well as the University of Delaware Energy and Engineering Department for design of refrigerant based energy recovery coils

W. HUMIDIFIER SECTION

   If humidifiers are required, humidifier dispersion tubes will be supplied with the humidifier.

   Dispersion tube section shall be long enough to allow for steam to be absorbed into the air stream.

PART 3 PRODUCTS

3.1 INSTALLATION

   A. Install in accordance with ARI 430.

   B. Install flexible connections between unit and inlet and discharge ductwork if not provided with air handling unit. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running.

   C. Install assembled units with vibration isolators. Install isolated fans with spring type isolators and flexible electrical leads. Install restraining.

   D. Install floor mounted units on concrete housekeeping pads at least 6 inches high and 6 inches wider and longer than unit.
E. Install condensate piping with trap and route from drain pan to nearest floor drain. See attachment 1 for cooling coil trapping requirements.

3.2 INSTALLATION – REFRIGERANT ENERGY RECOVERY COILS

A. Install sight glass in liquid line within 12 inches of coil. Refer to Section 23 63 00.
B. Install piping specialties in accordance with Section 23 63 00.

3.3 INSTALLATION CHILLED WATER, COOLING COIL

A. Make connections to coils with unions or flanges to accommodate removal of coils.
B. Connect water supply to leaving airside of coil (counter flow arrangement).
C. Locate water supply at bottom of supply header and return water connection at top.
D. Install water coils to allow draining and install drain connection at low points.
E. Install automatic air vents at high points complete with shutoff valve.

3.4 INSTALLATION HOT WATER HEATING COIL

A. Make connections to coils with unions or flanges to accommodate removal of coils.
B. Connect water supply to leaving airside of coil (counter flow arrangement).
C. Locate water supply at bottom of supply header and return water connection at top.
D. Install water coils to allow draining and install drain connection at low points.
E. Install automatic air vents at high points complete with shutoff valve.

3.5 INSTALLATION - STEAM HEATING COIL

A. Make connections to coils with unions or flanges to accommodate removal of coils
B. Install steam traps with outlet minimum 12 inches below coil return connection. Allow for enough elevation to gravity feed steam condensate to condensate receiver.
C. Install vacuum breaker at high points.

3.6 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up of air handling units.
3.7 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.8 DEMONSTRATION

A. Demonstrate unit operation and maintenance.

B. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to University of Delaware representative of training date.

3.9 PROTECTION OF FINISHED WORK

A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

ATTACHMENT 1: CONDENSATE TRAPPING REQUIREMENTS
CONDENSATE TRAPS for Cooling Coils

Ensuring easy inspection and maintenance of these often-overlooked and commonly misunderstood devices

The condensate trap perhaps is the most overlooked item in the design and installation of fan coils and air handlers with cooling coils. Often, condensate traps are inadequately described in contract documents, and sometimes, are not described at all, which leaves important details to be determined by the installing contractor. It is the designer, however, who is in the best position to make these decisions because of his or her knowledge of the pressures in the air-distribution system.

There are widespread misconceptions about how condensate traps work and how to properly size them, and often, little or no thought is devoted to simple, inexpensive details that can make them much easier to inspect and maintain.

FIGURE 1. Trap for draw-thru unit, fan off.

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The purpose of one of these traps is to allow accumulating condensate to drain off while preventing air from entering a draw-thru unit or escaping a blow-thru unit. A cooling coil's drain-pan opening is located at the point in an airflow system where the air pressure—either positive or negative—is the greatest. It makes sense to prevent an air "leak" at this location, especially in view of the effort we typically expend to seal and pressure-test system ductwork. However, even if we were not concerned about leaking air, draw-thru units would allow little or no condensate drainage if not equipped with a properly designed trap.

In short, the fundamental purpose of one of these traps is to use a column of condensate in such a way as to prevent air movement into or out of the equipment casing, while still allowing the condensate to drain away.

POTENTIAL PROBLEMS

An improperly constructed or missing trap can cause the following problems.

No trap or trap outlet too low. For draw-thru units in either of these situations, condensate accumulating in the pan will be subjected to a "jet" of incoming air, which often results in spray being carried over into the fan-inlet area. This sometimes is referred to as "geysering." For blow-thru units, escaping air may be the most serious consequence, but in the presence of copious condensation, a turbulent air/water mix in the pan also may cause some spillage or spraying of water downstream of the coil.

Trap outlet too high. In draw-thru units with this problem, an air seal will be maintained; however, if the condensate's net "column" height in the trap ("H" in the accompanying figures) is less than the equipment's negative air pressure in inches of water column, the condensate will be unable to drain.
Condensate Traps

Away. This will cause the accumulating condensate to overflow the pan into the surrounding parts of the equipment casing sometimes referred to as "floodback". In a blow-thru unit, an outlet as high as the inlet will work during fan operation as long as the rest of the trap is properly dimensioned. However, one school of thought holds that it is best to specify the outlet a little lower (at least \( \frac{1}{4} \) in.) than the inlet. Providing this little extra "head" at the trap inlet will assist in draining the pan of residual condensate after the fan is stopped. To discourage microbial growth, it is best to keep the pan as dry as possible during fan-off periods.

One Trap Shared by Two or More Fan-Coil Units. If one of the fan-coil units sharing a trap is shut down, the other(s) will blow air into or draw air from the inactive system, depending on whether the units are of the draw-thru or blow-thru variety. For this reason, each fan-coil unit should have its own trap.

Dry Trap. A common problem in very arid climates and during periods when cooling coils are inactive, such as winter, is evaporation of the water in traps. A liquid seal can be maintained by either continuous drip or intermittent trap "priming." Designers uncertain whether or not evaporation occurs or who anticipate that it does should specify either a means of priming or trap features that will allow priming to be easily added later. A dry trap on a draw-thru unit can be the source of objectionable odors and noxious fumes in a building. At a military air base in the desert, a draw-thru air handler was located near a flight line. While the unit's fresh-air intake was located well away from any source of contaminated air, the floor drain for the trap was not. And building occupants were sickened by the fumes of burned jet fuel inducted through the dry trap. Priming the trap solved the problem. Priming water should be applied to the downstream side of the trap, and care should be taken to assure adherence to plumbing codes regarding air gaps for protecting potable-water sources.

Draw-Thru Traps

Figure 1 shows the necessary dimensions of a trap on a draw-thru unit and the maximum level of condensate that will exist in such a trap with the fan off. The recommended safety factor of 1 in. added to the casing pressure is a reasonable balance between the need to account for unanticipated increases in that (negative) pressure and the practical need to keep the total trap depth (\( L \)) to a minimum, especially on pad-mounted equipment. Many traps are improperly installed because dimension \( L \) was not taken into account in mounting the air handler high enough to accommodate the trap.

Figure 2 shows the position of the condensate columns when the fan starts, while Figure 3 shows the water levels when enough condensate has accumulated in the trap to begin draining away.

 Blow-Thru Traps

Figure 4 shows the required dimensions of traps on blow-thru units and the maximum level of condensate that can exist in such traps with the fan off. Here again, the 1-in. safety factor is a practical recommendation, for accounting for an increase in casing pressure caused by a situation beyond the designer's control (e.g., filter loading, higher installed duct losses, etc.). In most systems, 1 in. of water gauge is a significant percentage of the casing air pressure. Of course, the designer can increase the calculated equipment pressure as necessary.

Figure 5 shows the condensate-column levels when the fan starts. After the fan starts, additional condensate coming from the pan drains away. Again, it is important to take into account the total trap depth—dimension \( L \)—to ensure an adequate mounting height for the air handler.
priming. Although the plugs can be wrench-tight, a hand-tight condition usually prevents air leakage on the inlet side, and one does not have to have a wrench to inspect the trap. The purpose of the plug on the outlet side is to keep dirt, small animals, and insects out of the trap. Traps commonly are constructed of either copper or plastic pipe. Although Figure 6 shows a draw-thru trap, tees and plugs can, of course, also be used for traps on blow-thru units.

Under the pressure of design deadlines, it often is difficult to pay the attention to detail that all projects deserve. In the matter of condensate traps, however, a couple of simple, standard drawings in a designer's CADD repertoire, with fill-in-the-blank dimensions, will go a long way toward demonstrating completeness of design and preventing problems.

FIGURE 5. Trap for blow-thru unit, fan running and condensate beginning to drain away.

FIGURE 6. Recommended use of tees and plugs.