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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 is 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. HVAC Design Guidelines 23 00 00

B. Common Work for HVAC Systems 23 05 00

C. Common Requirements for HVAC Systems 23 05 01

D. Identification of HVAC Equipment and Piping 23 05 53

E. Testing and Balancing of HVAC Systems 23 05 93

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

C. Calculate the condensate trap requirements. Allow for condensate trap installation when determining height of the base rail.

D. 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.

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

F. Hot water is the heating medium of choice for the University of Delaware. Consult the University of Delaware Sustainability Energy and Engineering Department if another heating source is required.

G. 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.

H. 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.

I. The air handling unit assembly must have an UL or OSHA approved equivalent label. All mechanical, electrical and electronic devices that are used in the air handling unit assembly must have an UL or ASHA approved equivalent label.

I. Reference the University of Delaware Standard 23 00 00; HVAC Design Guidelines for further air handling unit requirements.

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, MERV rating, 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.

6. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.

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. Environmental Air Systems
5. Governair Corporation
6. Haakon Industries
7. Ingenia Technologies
8. Temtrol
9. TMI

B. Configuration shall be based on the unique requirements of the project. Consult with University of Delaware Sustainability 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 Sustainability 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 Sustainability 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 Btuh inch/ sq ft/ degrees F.

G. 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 a minimum 12 x 12-inch inspection window transparent damage resistant material.

H. 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. All lights shall be LED type only.

I. Bottom Inlet Units: Furnish stainless steel or aluminum walking grate on structural supports.

J. Strength: Furnish structure to brace casings for design suction pressure with maximum deflection of 1 in 200.

K. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.

L. Outdoor Units:

1. Outdoor units shall be supplied as to be mounted on a structural steel platform.

2. 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.

3. 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.

4. Outdoor units shall have service corridors incorporated into the chassis and enclosure. Service corridors shall be heated (to 50F) and cooled (to 85F).

5. Outdoor units casing materials shall be either aluminum or stainless steel

M. FANS

1. On critical applications such as laboratories, clean rooms, dining halls…etc. fan redundancy in the form of fan arrays or dual fans shall be built into the air handling unit. The University of Delaware Sustainability Energy and Engineering Department will lead in the determination of criticality of the application.

2. All fan types will be considered; Consulting engineer shall base their design on either air foil or plug type fans. Any other fan type shall be approved by the University of Delaware Sustainability Energy and Engineering (SEE) Department. Consulting engineer must prove to SEE that the desired fan type will perform better than an air foil or plug type fan.

3. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.

4. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

5. 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.

6. 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.

7. Fans shall be direct drive with no belts. Variance will require approval from the University of Delaware Sustainability Energy and Engineering Department.

8. Fans speed shall be balanced and modulated via variable frequency drive.

9. Flexible Connection: Separate unit from connecting ductwork.

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

11. Fan/motor assemblies shall be mounted on a vibration isolation spring base.

12. Fan sections shall have a fan/motor removal rail.

N. MOTORS

1. Manufacturers:
Baldor/Reliance

2. Fan motors shall be rated for inverter duty

3. Fan motors shall be premium efficiency TEFC type.

4. Fan motors shall have grounding rings

5. All motors shall be supplied with a Fluke model 3561 FC Vibration Sensor and Fluke model 3502 FC Wireless Gateway.

6. All motors shall be supplied with a Fluke model 80BK-A Integrated DMM Temperature Probe

O. 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 keyway, and protectively coated with lubricating oil.

P. 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, minimum 0.008 inch thick

   c. Casing: Die formed channel frame of stainless steel/aluminum.

   d. Fins Per Inch (FPI): Minimum 8/Maximum 12

   e. Minimum Number of Rows: 8

   f. Airflow Direction: Horizontal Counter Flow

   g. Serpentine: Full Row

6. Heating 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 Sustainability, Engineering and Energy (SEE) Department. Consultant must prove to the SEE group that all acceptable means of providing heat have been considered and found to be not effective before steam heating coils are considered)
   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. Chilled Water-Cooling Coils:
   a. Headers: Cast iron, seamless copper or brass 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.

   c. Fins Per Inch (FPI): Minimum 8/Maximum 12

   d. Minimum Number of Rows: 8

   e. Airflow Direction: Horizontal Counterflow

   f. Serpentine: Full Row

Q. 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 Sustainability Energy and Engineering Department when selecting filter media

3. Magnehelic gages must be supplied for each filter bank

4. Differential pressure sensors must be supplied for each filter bank. Differential pressure sensors shall be capable of integration with the University of Delaware BAS system. Differential pressure sensor shall be Dwyer series 1800 or equal Ashcroft.

R. 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 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 phase 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 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.

8. Interlock UVC light with the access door so that the UVC light is de-energized upon opening the access door.

S. 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.

3. Return/Exhaust Damper Leakage: Maximum 2 percent at 4-inch wg differential pressure when sized for 2000 fpm face velocity.

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

a. If damper requires multiple actuators, do not mount the actuators directly on the jack shaft. Mount each damper actuator independent from each other on its own mounting bracket. The mounting bracket will be mounted to the jack shaft. The mounting bracket shall be similar to Belimo model ZG-JSL.

T. 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

4. Airflow measurement device shall be Ebtron Gold or equivalent.

U. REFRIGERANT BASED ENERGY RECOVERY COILS (University of Delaware preference for energy recovery)

1. 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 Sustainability Energy and Engineering Department for design of refrigerant based energy recovery coils

V. ENTHALPY TYPE ENERGY RECOVERY WHEEL: (The use of energy recovery wheels must be approved by the University of Delaware Sustainability, Engineering and Energy (SEE) Department. Consultant must prove to the SEE group that all acceptable means of providing energy recovery have been considered and found to be not effective or code compliant before energy recovery wheels are considered)

1. Use only where is necessary to meet building codes.

2. Do not use in laboratory, clean room, commercial kitchen, process/manufacturing

3. Applications or other high hazard applications or where there is a risk of cross contamination.

4. The enthalpy wheel shall be certified to meet the requirements of ARI Standard 1060 and shall be ARI listed.

5. The enthalpy wheel shall be constructed of corrugated aluminum media with a desiccant intimately bound and uniformly and permanently dispersed throughout

the matrix structure of the media.

6. The desiccant material shall be molecular sieve, 4 angstrom or smaller to prevent cross contamination.

7. The rotor shall be constructed of alternating layer of flat and corrugated media.

8. Wheel construction shall be fluted or formed honeycomb geometry to eliminate internal wheel bypass.

9. The wheel frames shall be evenly spaced stainless steel/aluminum spokes with a stainless steel or aluminum outer band and rigid center hub.

10. The wheel seals shall be full contact nylon brush type.

11. The wheel shall slide out of the cabinet side for service.

12. Wheel cassettes shall be constructed of aluminum/stainless steel. Cassettes shall have integral purge section.

13. The wheel bearings shall be inboard mounted, permanently sealed roller bearings or externally flanged bearings.

14. The wheel shall be driven by a fractional horsepower AC motor via multilink drive belts

15. The wheel shall have defrosted control and air bypass.

16. The wheel shall have full fixed (non-adjustable) purge.

W. AIR TO AIR PLATE HEAT EXCHANGERS

1. Use only where is necessary to meet building codes.

2. Consult Sustainability Energy and Engineering prior to using air to air plate heat exchangers for approval.

3. Fabrication:
   a. Plates corrugated diamond embossed aluminum/304L/316L stainless steel

   b. Bedding: Thermosetting reinforced resin. Provide plate seal-off and passage separation at top, bottom and center divider. Resin shall be self-extinguishing type in accordance with ASTM D635.

c. Casing and End Strips: Casing shall be 16 gage aluminum/304L/316L stainless steel. End strips of the same material as heat exchanger plates. End plates shall be sealed with high temperature silicone sealant prior to installation of end strip. Provide welded end strips in corrosive air streams to avoid cross contamination. Casings shall have flanged connections for duct connections.

4. Filter Assembly:
   a. Location: Outside air and exhaust air inlets of heat exchanger.

   b. Filter Holding Frame: Constructed of aluminum//304L/316L stainless steel and arranged in either flat or angular configuration.

   c. Filter Material: 1" thick 30% efficient pre-filter/ and 6" thick 95% efficient final filter.

5. Accessories:
   a. Face and Bypass Dampers: Manufacturer's standard with factory installed winter and summer control.
   b. Defrost System: Factory installed and capable of maintaining performance down to 0 degrees Fahrenheit.

X. HUMIDIFIER SECTION

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

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

3. Stainless Steel Construction

4. Reference University of Delaware Standard 23 84 00 Humidity Control for further humidifier requirements.

Y. GAS-FIRE HEATING SECTION:

1. Heat exchanger: Constructed of stainless-steel primary combustion chamber, stainless steel header, stainless steel tube bundles within stainless steel secondary tubes. Furnish heat exchanger with condensate drain.

2. Control: modulating with 4 to 1 turndown ratio.

3. Burner: Induced draft type with pre-purge timing, flame supervision, combustion air proving switch, and spark ignition.

4. Gas Train: Furnish with the following: redundant gas valves, pressure regulator, shutoff valve, pilot gas valve, pilot pressure regulator, and pilot valve.

5. Factory test and adjust burner.

6. Location: Upstream of fan section.

7. Sustainability Energy and Engineering (SEE) shall approve any use of gas fired heating equipment. Gas fired heaters shall be avoided if the campus has a central heating district. Consult SEE prior to specifying/designing gas fired heaters into the air handling unit.

8. Fuel: natural gas (Wilmington & Newark Campuses)/propane (Dover, Lewes & Georgetown Campuses).

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 storm drain.

F. All penetrations through casing (installation of freeze stat control wiring, differential pressure sensor tubing, etc.) shall use rubber grommets to protect wire/tubing and utilize proper sealing materials and methods to ensure a leak proof installation.

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.

C. A refrigeration pump shall be considered if required to achieve energy recovery in all seasons

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.

F. All chilled water piping installed in the airstream shall be stainless steel.

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 filters prior to start up and commissioning 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