SECTION 233119 – CUSTOM AIR HANDLING UNITS AND ENERGY RECOVERY UNITS

Latest Edition 06-07-2022 See Underlined Text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the requirements for casings, factory fabricated and/or custom air handling units as follows:

1. Custom air handling units with fans, coils & filters.
2. Run around energy recovery systems.
3. Heat wheel energy recovery systems.

1.3 PERFORMANCE REQUIREMENTS

A. Static Pressure Classes:

1. Upstream from Fan(s): [Two (2) inch wg] <Insert value>.
2. Downstream from Fan(s): [Two (2) inch wg] [Three (3) inch wg] [Four (4) inch wg] [Six (6) inch wg] [Ten (10) inch wg] <Insert value>.

B. Acoustical Performance:

1. NRC: 1.09 according to ASTM C 423.
2. STC: 40 according to ASTM E 90.

C. Structural Performance:

1. Casings shall be fabricated to withstand 133% of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed one eighth (1/8) inch per foot of width.

    a. Fabricate outdoor casings to withstand wind load of 15 lb/sq. ft. and snow load of 30 lb/sq. ft.

D. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" [and] [ASCE/SEI 7] <Insert requirement>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [and the unit will be fully operational after the seismic event]." <Edit for Project>

1.4 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, performance data, installation instructions, wirings diagrams, power requirements, specified options, and warranty information.

B. Product Data: For each type of the following products:

1. Factory fabricated casings.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic restraint devices.
5. Unit dimensions and weight.
6. Cabinet material, metal thickness, finishes, insulation, and accessories.
7. Fans:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound power ratings.
c. Fan construction and accessories.
d. Motor rating, electrical characteristics, and motor accessories.

8. Certified coil performance ratings with system operating conditions indicated.
9. Dampers, including housings, linkages, and operators.
10. Filters with performance characteristics.

C. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that HVAC casings comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that HVAC casings comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."

4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Sheet metal thicknesses.
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Access doors including frames, hinges, and latches.
6. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
7. Locations for access to internal components.
8. Hangers and supports including methods for building attachment, vibration isolation, [seismic restraints,] and casing attachment.
9. Interior lighting, including switches.

E. Shop Drawings: For custom air handling units.

1. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
2. Product data shall indicate dimensions, weight, capacities, ratings, fan performance, motor electrical characteristics, coil capacities, psychometrics, pressure drops (water and air), vibration isolation, seismic restraints, and gages and finishes of materials. Operating characteristics shall be provided or both normal and emergency conditions as scheduled on the drawings.
3. Identify variations from contract documents and product or system limitations which may be detrimental to successful performance of the completed work.
4. Provide space for contractor and architect/engineer review stamps.
5. Revise and resubmit submittals as required, identify all changes made since previous submittal.
6. Test reports:

a. Furnish fan performance curves depicting the operating points described on schedule for each individual fan.
b. Furnish fan vibration nomograph generated during fan balance test for each individual fan. This data shall be furnished upon completion of fabrication of units.
c. Furnish sound power levels at supply connection, return connection, and casing radiation for each air handling unit. Test data shall show sound power levels, re: ten (10) to twelve (12) watts for each of the eight (8) octave band center frequencies.

7. Omission of any of the above information will cause submittal package to be immediately returned without review.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For acoustically critical casings, from manufacturer.

1. Show sound absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

C. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and manuals. Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.

B. Maintenance Material Submittals:

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
2. Filters: One (1) set(s) for each air handling unit.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to [AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports] [AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding].

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Electrical components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

G. ARI Certification: Air handling units and their components shall be factory tested according to ARI 430, “Central Station Air Handling Units,” and shall be listed and labeled by ARI.

H. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6- “Heating, Ventilating, and Air Conditioning.”

I. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Architectural Specification Sections "Cast in Place Concrete." and/or "Miscellaneous Cast in Place Concrete."

B. Coordinate sizes and locations of steel supports. Supports are specified in Architectural Specification Section "Metal Fabrications."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Architectural Specification Section "Roof Accessories."

1.9 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: HVAC casings and/or custom air handling units shall be designed, selected and assembled in accordance with the scheduled capacities on the drawings and the requirements of this specification.

B. Basis of Design: The basis of design for HVAC casings, air handling units and/or energy recovery units are units manufactured by the following: <Edit required for project>

1. Custom Air Handling Units: Buffalo.
2. Air Filtration: American Air Filter Corporation.
3. Energy Recovery Heat Wheels: Air Exchange.

C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide heating and cooling and/or heating terminal units by one (1) of the following: <Edit required for project>

1. Custom Air Handling Units:

   a. Air Enterprises Incorporated.
   b. Thermal by Nailor.

2. Air Filtration:

   a. Farr Company.
   b. Flanders Corporation

3. Energy Recovery Heat Wheels:

   a. American Energy Exchange, Incorporated.
   b. Loren Cook Company.
   c. EMCO, Incorporated.

2.2 CUSTOM AIR HANDLING UNITS

A. General: Comply with the following:

1. Provide factory assembled custom air handling units, complete with all components as specified herein. To include fan section, cooling coils, energy recovery corks, filter section, and intake module. Each unit shall include all components installed at the factory. Each unit shall be assembled, inspected and factory performance, leakage and vibration tested prior to shipment. Inspection shall be of the completely assembled unit. The Manufacturer shall ship the units in the minimum number of modular sections required by the method of shipment

or installation and rigging. The AHU Manufacturer shall provide full length perimeter angles at the floor walls and roof of shipping splits for field bolting of modular section by the Contractor. The AHU Manufacturer shall provide all necessary hardware, tape sealer, and caulk required to field join and seal the modular sections. Should space and rigging considerations require the units to be factory assembled, knocked down, and field reassembled, all sections and components shall be match marked to assure ease of reassembly. Units must be "knocked down" construction and shall be palletized and shrink wrapped with heavy mil plastic. All components shall be able to fit through existing doors. The intent is not to remove walls or roofing.

2. Equipment capacity and performance shall meet or exceed that shown on the schedule.
3. Units have been designed to provide appropriate access for service and proper operating clearances, and dimensions of the units must be strictly adhered to. Under sizing of housing is unacceptable.

B. Construction Requirements: Comply with the following:

1. Cabinet Construction: Cabinets shall be constructed in a watertight and airtight manner. The manufacturer's standard cabinet construction shall result in a unit leakage rate not exceeding 0.5% of unit capacity at 1.25 times the operating static pressure.
2. Base Channel and Floor: Each unit shall be constructed on a minimum six (6) inch x 2.83lb/ft welded, full perimeter structural aluminum C channel base with two (2) inch thick high density foam insulation (R-value of 13.6) under the floor. The under floor insulation shall be protected with a minimum 0.040" smooth aluminum cover sheet. Cover sheet shall be recessed into the underside of the base. Surface mounting of the cover sheet is unacceptable. Tubular, formed, or bolted perimeter base construction is unacceptable. The unit floor shall be constructed of minimum three sixteenth (3/16) inch thick aluminum tread plate, continuously welded, with two (2) inch turned up lip and floor drain piped to unit exterior in each section not having a drain pan.
3. Cooling Coil Section Drain Pan: The cooling coil section shall be provided with a pitched main drain pan recessed into the floor. The main drain pan shall extend a minimum of three (3) inches upstream and twenty four (24) inches downstream of the coils. The main drain pan shall be triple sloped and constructed of continuously welded, minimum 12 gauge, type 304 stainless steel. The min drain pan shall be factory piped to the unit exterior using a minimum two (2) inch diameter stainless steel pipe. Caulking of the drain pan seam is unacceptable. The underside of the drain pan shall be insulated with two (2) inch thick high density foam insulation (R value of 1.6) j and protected with a 0.40" smooth aluminum cover sheet. Cover sheet shall be recessed into the underside of the base. Surface mounting of the cover sheet is unacceptable. Where coils are stacked, triple sloped, continuously welded type 304 stainless steel intermediate drain pans shall be provided. Intermediate drain pans shall run beneath the coil

and consist of a single continuous assembly extending a minimum of three (3) inches upstream and nine (9) inches downstream of the coil. Coils shall be supported above the drain pans to allow for continuous flow of condensate and a single point of condensate collection. Each intermediate drain pan shall be piped with a minimum two (2) inch diameter stainless steel pipe directly to the main drain pan. This pipe shall terminate in close proximity of the main drain pan floor to prevent splashing. Cooling coil drain pan section shall be provided with a removable aluminum bar grate.

4. The base floor shall be constructed with adequate stiffening member to prevent oil canning. Where indicated, provide sections with drain pans constructed as noted above.
5. Panel Deflection: All panels shall be designed to that deflection is limited to no more than 1/240 of span dimension at unit operating pressures.
6. Lifting Lugs: Each base section shall include a minimum of four "bolt off" removable lifting lugs attached to the structural components of the unit base. Where units are of knocked down construction, job site conditions dictate the need for lifting lugs.
7. Exterior Panels: All exterior wall and roof panels shall be minimum two (2) inch thick double wall, injected with high density foam insulation (R-value 13.6). Exterior shall be minimum 0.050 inch unpainted stucco aluminum sheet while inner is to be minimum 0.40 inch smooth aluminum. All panel seams shall be externally caulked with sealant. Entire AHU casing shall be constructed of foam panels and aluminum extrusions with integral resin thermal break bridges. Surface applied tapes of plastic stand offs are not acceptable thermal break construction options. For the ERC Unit a slope upstanding seam roof shall be provided. The roof shall be either sloped to one side or peaked and shall slope at one quarter (1/4) inch per foot (minimum).
8. Control Openings: The Manufacturer shall provide one (1) conduit penetration in each access section for use by the BAS contractor. Conduit shall be constructed so as to maintain the thermal break properties of the unit and will terminate in a junction box on each end.
9. Access Doors: Access doors shall be provided in each section to provide access to the components. Door shall be double wall, insulated, "no through metal" thermal break type of a thickness no less than that of the walls. Doors shall be manufactured from materials matching the wall construction. Doors shall be maximum height and width allowed by the unit section served and shall open against the sections operating pressure. Hinges shall be continuous, heavy duty stainless steel piano type. A minimum of two (2) high compression, chrome plated, Ventlok 310 handles and latches, operable from both sides of the door, shall be used. To insure thermal integrity all access doors shall be double gasketed with one on each side of the thermal break. Double pane, thermally broken, nine (9) inch x nine (9) inch viewing windows shall be provided in each door.
10. Test Ports: The AHU Manufacturer shall provide each access door with a thermal break test port. Test ports shall be one (1) inch in diameter and capped. Cap to be provided with safety chain attached to conduit.

11. Fan Motor Removal: Size all fan section access doors to allow for removal of the fan motor. In addition, and all aluminum monorail spanning the entire AHU width is to be provided above the motor(s).

C. Fan Section:

1. General: Comply with the following:

   a. All fans shall meet the scheduled airflow performance specified and shall not exceed the brake horsepower specified on the mechanical equipment schedule.
   b. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating, as defined by the fan performance curve at the selected operating speed.

2. Centrifugal Fans: <Modify fan type for specific project>

   a. Fan Type: Fans shall be centrifugal plenum plug type fans.
   b. Performance: Performance ratings shall conform to AMCA Standard 205 (fan efficiency grade), 211 (air performance), and 311 (sound performance). Fans shall be tested in accordance with ANSI/AMCA Standard 210 (air performance) and 300 (sound performance) in an AMCA accredited laboratory. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air, and fan efficiency grade (FEG). Sound certification shall apply to both inlet and outlet sound power levels. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the peak efficiency to ensure quiet and stable operation. Fans shall have a non-overloading design with self-limiting horsepower characteristics and shall reach a peak in the normal selection area. All fans shall be capable of operating over the minimum pressure class limits as specified in AMCA Standard 99.

3. Construction: Fans shall be designed without scroll type housing and shall incorporate a non-overloading type backward inclined airfoil blade wheel; heavy gauge reinforced steel inlet plate and structural steel frame.
4. Insulation: Fans shall be provided with minimum two (2) inch insulation enclosure with perforated lining.
5. Frame and Inlet Panel: Inlet panels shall be of heavy gauge reinforced steel construction. The inlet panel incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel. A square, formed lip suitable for attachment of a boot connector shall surround the unit.
6. Wheel: Wheels shall have a spun non tapered style blade retaining ring on the inlet side to allow higher efficiencies over the performance range of the fan. Wheels shall have airfoil shaped extruded aluminum blades. All hollow blade wheels shall be continuously welded around all edges. Wheels shall have twelve

blades for better sound quality. All wheels shall be statically and dynamically balanced on precision electronic balancers to a Balance Quality Grade G6.3 per ANSI/AMCA 204 or better.

7. Finish and Coating: The entire fan assembly shall be thoroughly degreased and deburred before application of a rust preventative coating. Aluminum components shall be unpainted.
8. Factory Run Test: All fans prior to shipment shall be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Maximum vibration shall be within the limits of ANSI/AMCA 204 Fan Application Category BV-4. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.
9. Air Flow Sensor: Each fan shall be provided with an integral Piezometer ring air flow sensor. The differential pressure transmitters shall be furnished and installed in the field by the BAS Contractor. The AHU manufacturer shall extend all pneumatic tubing to compression fittings mounted inside the service corridor or ton the unit exterior wall. Insertion type airflow probes which obstruct the inlet of the fan in any way are unacceptable.

D. Coil Section: General Requirements:

1. Coil Section: Coil section shall be fabricated to allow for the removal and replacement of coils and to provide an in-place access for service and maintenance of coils(s).
2. Coil Construction: See Division 23 Specification Section "HVAC Air Coils" for requirements.
3. Coil Supports: Each coil shall be independently supported by a coil rack system so that any coil in a bank can be removed without disturbing the other coils in the bank.
4. Coil Support Racks: All coils shall be provided with individual coil support racks for coil removal. Coil racks shall be manufactured as follows:

    a. Galvanized Racks: Heating coils, Preheat coils, Energy Recovery coils.
    b. Stainless Steel (type 304) Racks: Cooling coils.

5. Provide removable panels sized for removal of the coils.

E. Air Filtration Section:

1. General Requirements: Comply with the following:

    a. Comply with NFPA 90A.
    b. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

c. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one (1) side or lifted out from access plenum.

d. Spare Filters: Provide two (2) sets of spare filters for each type of filter media. One (1) set of spare of filters shall be installed in the air handling unit for the testing and balancing procedure. The second set of spare filter media shall be turned over to the owner.

e. Air Handling Unit Operation during Construction: When the air handling units need to be operated during construction the contractor shall provide the filters for the air handling unit. These filters shall be separate from the specified filter media. Install specified filter media prior to final test and balance of air handling systems.

2. Filter Types: Comply with the following:

a. Disposable Pre Filter Media:

1) Filter Media: Filter media shall have an average efficiency of 25% to 30% and an average arrestance of 90% to 92% in accordance with ASHRAE Test Standard 52.2. <Select one of the below list>
   a) Four (4) inch Filter: Filter face area shall contain not less than 11 pleats per linear foot. Initial resistance at 500 fpm shall not exceed .27 inch wg.
   b) Two (2) inch Filter: Filter faced area shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm shall not exceed .28 inch wg.
   c) One (1) inch Filter: Filter face area shall contain not less than 16 pleats per linear foot. Initial resistance at 350 fpm shall not exceed .25 inch wg.
2) Media Support Grid: Grid shall be welded wire on one (1) inch centers with an open area of not less than 96%. Grid shall be bonded to the media to eliminate oscillation and pull away. The grid shall be formed to affect a radial pleat, allowing total use of media.
3) Enclosing Frame: The frame shall be a rigid, high wet-strength beverage board, with diagonal support members bonded to the air entering and exiting side of each pleat. The enclosing frame shall be chemically bonded to the filter pack.

b. Final Filter Media – Pleated Type:

1) Air filters shall be high performance, deep pleated, totally rigid and totally disposable type. Each filter shall consist of high density media, media support grid, contour stabilizers, diagonal support bracing and enclosing frame. <Select one of the below list>

a) 40% to 45% Efficient – Filter media shall be of high density micro fine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. The filter media shall have an average efficiency of 40-45% on ASHRAE Test Standard (52.2). It shall have an average arrestance of not less than 96% on that standard. Filters shall be listed by Underwriters' Laboratories as Class (2) (1). <Select Class>

b) 60% to 65% Efficient - Filter media shall be of high density micro fine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. The filter media shall have an average efficiency of 60-65% on ASHRAE Test Standard (52.2). it shall have an average arrestance of not less than 97% on that standard. Filters shall be listed by Underwriters' Laboratories as Class (2) (1). <Select Class>

c) 80% to 85% Efficient - Filter media shall be of high density micro fine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. The filter media shall have an average efficiency of 80-85% on ASHRAE Test Standard (52.2). It shall have an average arrestance of not less than 98% on that standard. Filters shall be listed by Underwriters' Laboratories as Class (2) (1). <Select Class>

d) 90% to 95% Efficient – Filter media shall be of high density micro fine glass fibers, laminated to a reinforcing backing to form a lofted filter blanket. The filter media shall have an average efficiency of 90-95% on ASHRAE Test Standard 52.2). It shall have an average arrestance3 of not less than 99% on that standard. Filters shall be listed by Underwriters' Laboratories as Class (2) (1). <Select Class>

2) Media Support Grid: The media support shall be a welded wire gird with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away. The media support gird shall be formed in such a manner that it affects tapered radial pleat design. The grid shall be designed to support the media both vertically and horizontally.

3) Contour Stabilizers: Contour stabilizers shall be galvanized steel and shall be permanently installed on both the air entering and air exiting sides of the filter media pack to insure that the tapered radial pleat configuration is maintained throughout the life of the filter. There shall be four contour stabilizers on the air entering side and six on the air exiting side. The filter shall be capable of

withstanding 10 inch wg. pressure drop without noticeable distortion of the media pack.

4) Enclosing Frame: The enclosing frame shall be constructed of galvanized steel. It shall be assembled in such a manner that a rigid and durable enclosure for the filter pack is affected. The media pack shall be mechanically and chemically bonded to the inside of the periphery of the enclosing frame, thus eliminating the possibility of air by-pass. The enclosing frame shall be equipped with galvanized steel protective diagonal support braces on both the air entering and air exiting sides of the filers. The diagonal support braces shall be mechanically fastened to each contour stabilizer.

c. Final Filter Media – Bag Type:

1) Air filters shall be high performance extended area disposable type filters. Each filter shall consist of high density glass microfiber media with a chemically bonded backer, individual pockets and a corrosion resistant galvanized steel enclosing frame. <Select from efficiencies below>

a) 35% to 45% Efficient: Filter media shall be of high density glass microfibers, reinforced with a backing to form a lofted filter blanket. The filter media shall have an average efficiency of 35-40% on ASHRAE 52.2 and shall have an average arrestance of not less than 96% on that standard. <Select one>

b) 45% to 50% Efficient: Filter media shall be of high density glass microfibers, reinforced with a backing to form a lofted filter blanket. The filer media shall have an average efficiency of 45-50% on ASHRAE 52.2 and shall have an average arrestance of not less than 96% on that standard. <Select one>

c) 60% to 65% Efficient: Filter media shall be of high density glass microfibers, reinforced with a backing to form a lofted filter blanket. The filter media shall have an average efficiency of 60-65% on ASHRAE 52.2 and shall have an average arrestance of not less than 97% on that standard. <Select one>

d) 80% to 85% Efficient: Filter media shall be of high density glass microfibers, reinforced with a backing to form a lofted filter blanket. The filter media shall have an average efficiency of 80-85% on ASHRAE 52.2 and shall have an average arrestance of not less than 98% on that standard. <Select one>

e) 90% to 95% Efficient: Filter media shall be of high density glass microfibers, reinforced with a backing to form a lofted filter blanket. The filter media shall have an average efficiency of 90-95% on ASHRAE 52.2 and shall have an average arrestance of not less than 99% on that standard. <Select one>

2) Pocket Construction: Pocket shall consist of glass microfibers chemically bonded to a reinforced UL Class 1 or Class 2 backing. <Select one> the pockets shall e quipped with a minimum of 40 support points per square foot of the filter media. All stitching points shall be completely sealed with Foam-seal adhesive. The pockets shall be chemically adhered around the periphery of the galvanized steel retainers. Retainers shall have rolled edges to reduce possible cuts to media, or lacerations to installers.

3) Enclosing Frame- Enclosing frame shall be constructed of a "J" return channel of galvanized steel. The channel shall be 7/8 inch, or optional 1-1/8 inch.

2.3 RUN AROUND ENERGY RECOVERY SYSTEM <Modify for specific project>

A. Run Around Energy Recovery System: Provide a Run Around Energy Recovery System, consisting of heat exchangers, pumps, pre-heat coils for [existing] [new] AHU's, exhaust recovery units with exhaust recovery coils, and filters and high dilution exhaust fans and control components as indicated on the contract drawing schedules for all noted conditions. The system shall be a multi-functional system, providing heat recovery and all necessary preheating for the supply air handlers in winter operation and pre-cooling in summer operation. This system uses Dowtherm SR-1 Ethylene Glycol in a 40% Glycol solution.

B. Exhaust Unit Recovery Coil: The exhaust unit recovery coil fins shall be aluminum, 0.4 mm thick, with a maximum spacing of thirteen (13) fins per inch. The tubes shall be copper with coated steel? headers of steel, coated to prohibit corrosion. Exhaust unit recovery coils size and performance shall be as indicated on the contract drawing schedule. Exhaust unit recovery coils shall be cleanable with high pressure water (up to 2,600 psi), low pressure steam, compressed air, hot water and detergent without degrading efficiency.

C. Miscellaneous System Components: System components shall include pipe distribution system, glycol feeder, expansion tank, shut-off valves, separate variable frequency drives for each pump, system controllers, control valves, strainers, and vibration isolation. See individual Division 23 specification sections for piping, glycol feeder, expansion tank, pumps, exhaust fans, shut off valves, control valves, strainers, vibration isolation, controls, and Division 26 specification section for VFD's.

D. BAS Controls: See drawings for BAS control components and specifications for sequences of operation and additional requirements.

1. BAS Control Functions: System control functions shall include but not be limited to the following:

a. Primary function: Heat (winter operation) or pre cool (summer operation) supply air to supply air set temperature.
b. Continuous measurement and recording of system operating parameters.
c. Starting/shutting down pumps and regulating flow rate (pump speed) for optimal energy recovery.
d. Minimizing pump power demand (flow rate increase only if additional pump power demand is smaller than marginal energy recovery).
e. When reaching/exceeding supply air temperature (set point provided by Building Management System), the energy recovery system shall be turned down.
f. Freeze protection at supply and exhaust air heat exchangers.
g. Complete regulation and minimization of energy loss through heat exchangers in winter operation.
h. Pre cool supply air in summer operation.

E. System Start Up: System start up shall include:

1. Review/inspection of heat exchanger and piping installation.
2. Review/inspection of sensors and valves installation.
3. Inspection/programming of pump variable frequency drives.
4. Functional testing of valves and variable frequency drives.
5. Testing of interface with Building Management System.
6. Instruction/training of owner's operating/maintenance staff for a period of eight (8) working hours at project work site.
7. Startup shall take place in cooperation with HVAC and BAS suppliers.

2.4 HEAT WHEEL ENERGY RECOVERY SYSTEM <Edit for Project>

A. Casing: Comply with the following:

1. Casing shall be constructed of galvanized steel, with manufacturer's standard paint coating.
2. Provide an integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6 inch wg and 0.20% at 4 inch wg (0.05% at 400-Pa and 0.20 percent at 1,000 Pa) differential pressure.
3. Provide casing seals on periphery of rotor, on duct divider, and on purge section.
4. Support rotor on grease lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.

<Engineer to choose paragraph 'B' or 'C' below and edit for project>

B. Rotor: Rotor shall be aluminum, segmented wheel, strengthened with radial spokes [with nontoxic, noncorrosive, silica gel desiccant coating]. Construct media for passing maximum [500] [800] [1,200] micrometer solids.

C. Rotor: Rotor shall be [glass fiber] [polymer] segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water selective, molecular sieve desiccant coating. Construct media for passing maximum [800] [1,200] micrometer solids.

D. Drive: Provide a fractional horsepower motor and gear reducer [with speed changed by variable frequency drive,] and self adjusting multilink belt around outside of rotor.

E. Controls: The following components shall be provided:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable frequency drive shall comply with the requirements of the Electrical Specification Section "Variable Frequency Drives" and be as follows: <Select a, b or c>
   a. Variable frequency drive, factory mounted and wired permitting input of field connected 4-20 mA or one (1) 10 volt control signal.
   b. Variable frequency drive, factory mounted and wired, with exhaust air sensor to vary rotor speed and maintain exhaust temperature above freezing.
   c. Variable frequency drive, factory mounted and wired, with exhaust and outdoor air sensors, automatic changeover thermostat and set point adjust, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set pint. Provide maximum rotor speed when exhaust air temperature is less than outdoor air temperature.
3. Pilot Light Indicator: Display rotor rotation and speed.
4. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

PART 3 - EXECUTION

3.1 EXAMINATION <Edit for Project>

A. Examine [concrete bases] [roof curbs] [and] [steel supports] for compliance with requirements for conditions affecting installation and performance of HVAC casings.

B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Equipment Mounting:

1. Install HVAC casings on cast in place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Architectural Specification Sections "Cast in Place Concrete." and/or "Miscellaneous Cast in Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."

C. Apply sealant to joints, connections, and mountings.

D. Field cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Support casings on floor or foundation system. Secure and seal to base.

F. Support components rigidly with ties, braces, brackets, [seismic restraints] and anchors of types that will maintain housing shape and prevent buckling.

G. Align casings accurately at connections, with one eighth (1/8) inch misalignment tolerance and with smooth interior surfaces.

H. Equipment Mounting: Install air handling units on concrete bases using elastomeric pads. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in “Architectural Specification Cast in Place Concrete.” Comply with requirements for vibration isolation devices specified in Division 23 Specification Section “Vibration and Seismic Controls for HVAC Systems.”

1. Minimum Deflection: One half (1/2) inch.
2. Install stainless steel plate to equally distribute weight over elastomeric pad.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around the full perimeter of concrete base.
4. Install epoxy coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.

I. Arrange installation of units to provide access space around air handling units for service and maintenance.

J. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

K. Install filter gage, static pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static pressure taps upstream and downstream of filters.

L. Install heat exchangers (coils) and hydraulic module in compliance with system manufacturer's installation guidelines.

M. Contractor shall provide filters used for equipment operated during construction, separate from final specified filter media. Install final filter media prior to final test and balance of air handling systems.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piing, fittings, and specialties.

B. Install piping adjacent to air handling unit to allow service and maintenance. Pipe coils for counter flow arrangement.

C. Connect piping to air handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes indirection.

E. Chilled Water Piping: Comply with applicable requirements in Division 23 Specification Section "HVAC Piping Systems and Specialties". Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air handling units with flexible connections. Comply with requirements in Division 23 Specification Section "HVAC Duct Systems and Accessories."

3.4 FIELD QUALITY CONTROL

A. Casing Tests and Inspections:

1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."

2. Test the following systems:

   a. Systems required by ASHRAE/IESNA 90.1.
   b. Supply Air: 100% of total installed duct area with a pressure class of three (3) inch wg or higher.

3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
4. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.
5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 FIELD QUALITY CONTROL FOR CUSTOM AIR HANDLING UNITS

A. Manufacturer’s Field Service: Engage a factory authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections. The manufacturer shall provide a minimum of one (1) week of field supervision for this project.

B. Perform tests and inspections.

1. Manufacturer’s Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Pressure Test: Pressurize housing to a minimum of three (3) inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks. Unit openings are to be blanked off and unit then tested. Coordinate with TAB contractor.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Comply with the manufacturers requirements for cleaning casings and units

3.7 STARTUP SERVICE

A. Engage a factory authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that face and bypass dampers provide full face flow.
7. Verify that outdoor and return air mixing dampers open and close, and maintain minimum outdoor air setting.
8. Comb coil fins for parallel orientation.
9. Verify that proper thermal overload protection is installed for electric coils.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems" for air handling system testing, adjusting, and balancing.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing air handling unit and air distribution systems and after completing startup service, clean air handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air handling units.

END OF SECTION 233119