

SECTION 23 74 13
PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

SPEC WRITER NOTES:

1. Delete between //----- // if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. Provide the year of latest edition to each publication given in Paragraph APPLICABLE PUBLICATIONS.
3. References to pressure in this section are gauge pressure unless otherwise noted.
4. The spec writer shall review the Physical Security Design Manual for VA Facilities to determine and include any Mission Critical or Life Safety requirements called out.
5. For major new and renovation construction projects, outdoors (located on roof or grade) air-handling units are prohibited for the high-humidity locations, identified in VA HVAC Design Manual. Outdoors air-handling units are also prohibited in the hurricane locations for the Mission Critical Facilities, identified in the Physical Security Manual.
6. For NRM (Non-Recurring Maintenance) and minor construction projects, if outdoors air-handling units are permitted due to space constraints, the corrosion treatment specified below should be used for high-humidity locations.
7. VHA is prohibited from allowing roof top units for any type of critical area such as SPS, pharmacy, etc.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Roof top air-handling units including integral components specified herein.
- C. Definition of Roof Top Air-Handling Units (RTU): A factory-fabricated assembly consisting of fan, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying,

and mixing of air. Design capacities of units shall be as scheduled in the contract documents.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. //Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//
- E. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. //Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.//
- H. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- I. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- J. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- K. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- M. Section 23 21 13, HYDRONIC PIPING.
- N. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
- O. Section 23 31 00, HVAC DUCTS AND CASINGS.
- P. Section 23 34 00, HVAC FANS.
- Q. Section 23 40 00, HVAC AIR CLEANING DEVICES.
- R. //Section 23 82 16, AIR COILS.//
- S. Section 23 84 00, HUMIDITY CONTROL EQUIPMENT.
- T. Section 26 29 11, MOTOR CONTROLLERS.

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTES:

1. Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project unless the reference applies to all HVAC systems. Publications that apply to all HVAC systems may not be specifically referenced in the body of the specification but shall form a part of this specification.
2. Insert the year of approved latest edition of the publications between the brackets // // and delete the

brackets if applicable to this project.

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.
- B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
- 260-//2017//.....Sound Rating of Ducted Air Moving and Conditioning Equipment
 - 410-//2001//.....Forced-Circulation Air-Cooling and Air-Heating Coils
 - 430-//2020//.....Performance Rating of Central Station Air-Handling Unit Supply Fans
- C. Air Moving and Control Association (AMCA):
- 99-//2016//.....Standards Handbook
 - 210-//2016//.....Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
 - 801-//2001(R2008)//.....Industrial Process/Power Generation Fans: Specification Guidelines
- D. American Bearing Manufacturers Association (ABMA):
- 9-//2015//.....Load Ratings and Fatigue life for Ball Bearings
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
- 51-//2016//.....Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
- F. American Society for Testing and Materials (ASTM):
- A653/A653M-//2020//.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - B117-//2019//.....Standard Practice for Operating Salt Spray (Fog) Apparatus
 - C1071-//2019//.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
 - D1654-//2008(R2016)e1//.Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

D1735-//2014//.....Standard Practice for Testing Water Resistance
of Coatings Using Water Fog Apparatus

D3359-//2017//.....Standard Test Methods for Rating Adhesion by
Tape Test

E84-//2021a//.....Standard Test Method for Surface Burning
Characteristics of Building Materials

G. Energy Policy Act of 2005 (P.L.109-58)

H. Military Specifications (Mil. Spec.):

MIL-P-21035B-//2003//...Paint, High Zinc Dust Content, Galvanizing
Repair

I. National Fire Protection Association (NFPA):

90A-//2021//.....Standard for the Installation of
Air-Conditioning and Ventilating Systems

J. Sheet Metal and Air Conditioning Contractors National Association
(SMACNA):

016-//2012//.....HVAC Air Duct Leakage Test Manual, 2nd Edition

1.4 SUBMITTALS

SPEC WRITER NOTES:

1. For larger projects involving more than 5 air-handling units, the A/E shall select a few typical AHUs, in different configurations, for an initial submission. The suggested different configurations are: 100 percent outside air AHUs with or without heat recovery coils; and re-circulating type of variable air volume AHUs with minimum outside air and economizer cycle features.
2. The remaining submission shall be received only after the initial submission is approved with satisfactory resolution of all comments made during the review and approval process.

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 XX XX, SECTION TITLE", with applicable paragraph identification.

C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights,

materials, applications, standard compliance, model numbers, size, and capacity.

1. Submittals for RTUs shall include fans, drives, motors, coils, //humidifiers, // //sound attenuators//, mixing box with outside/return air dampers, filter housings, //blender sections, // and all other related accessories. The contractor shall provide custom drawings showing total air-handling unit assembly including dimensions, operating weight, access sections, //diffusion plates//, flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc.) and rigging points.
2. Submittal drawings of section or component only, will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details; if the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VA at the time of submission.
3. Submit sound power levels in each octave band for fan and at entrance and discharge of RTUs at scheduled conditions. Include sound attenuator capacities and itemized internal component attenuation. Internal lining of supply air ductwork with sound absorbing material is prohibited. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
4. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of operation and at maximum design Liters/Second (cubic feet per minute) and 110 percent of design static pressure.
5. Submit total fan static pressure, external static pressure, for RTU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air-handling unit schedule in contract documents.

SPEC WRITER NOTE: Coordinate O&M Manual and commissioning requirements with Section 01 00 00, GENERAL REQUIREMENTS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS. O&M Manuals shall be submitted for content review as part of closeout documents.

- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.
 4. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare part lists.
- E. Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.
- F. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.
1. Units shall be shipped in one (1) piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.
 2. If not shipped in one (1) piece, provide manufacturer approved shipping splits where required for installation or to meet shipping and/or job site rigging requirements in modular sections. Indicate clearly that the shipping splits shown in the submittals have been verified to accommodate the construction constraints for rigging as required to complete installation and removal of any section for replacement through available access without adversely affecting other sections.
 3. If shipping splits are provided, each component shall be individually shrink wrapped to protect the unit and all necessary hardware (e.g. bolts, gaskets etc.) will be included to assemble unit on site in accordance with paragraph ROOF TOP AIR-HANDLING UNITS.
 4. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each

unit will have to be broken into to meet shipping and job site rigging requirements.

- G. //Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician, and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- H. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

1.5 QUALITY ASSURANCE

- A. Refer to paragraph QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Air-Handling Units Certification:
 - 1. Air-Handling Units with Housed Centrifugal Fans: The air-handling units shall be certified in accordance with AHRI 430 and tested/rated in accordance with AMCA 210.
 - 2. Air-Handling Units with Plenum Fans:
 - a. Air-handling units with a single plenum fan shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
 - b. Air-handling units with multiple fans in an array shall be tested and rated in accordance with AHRI 430 and AMCA 210.
- C. Heating, Cooling, and Air-Handling Capacity and Performance Standards: AHRI 410, AHRI 430, ASHRAE 51, and AMCA 210.
- D. Performance Criteria:
 - 1. The fan BHP shall include all system effects for all fans and v-belt drive losses for housed centrifugal fans.
 - 2. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
 - 3. Select the fan operating point as follows:
 - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point.
 - b. Air Foil, Backward Inclined, or Tubular Fans Including Plenum Fans: At or near the peak static efficiency but at an appropriate distance from the stall line.
 - 4. Operating Limits: AMCA 99 and manufacturer's recommendations.

- E. Units shall be factory-fabricated, assembled, and tested by a manufacturer, in business of manufacturing similar air-handling units for at least five (5) years.
- F. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- G. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

1.6 AS-BUILT DOCUMENTATION

- A..Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

SPEC WRITER NOTES:

1. Use of the blow-through air-handling units, with cooling coils and after-filters located on the downstream side of the supply air fans.
2. Capacity of a single air-handling unit shall not exceed 23,600 Liters/Second (50,000 Cubic Feet per Minute - CFM).

2.1 ROOF TOP AIR-HANDLING UNITS

A. General:

1. Roof top units (RTU) shall be fabricated from insulated, solid double-wall galvanized steel without any perforations in draw-through configuration. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90). Aluminum constructed units shall be provided subject to VA approval and documentation that structural rigidity is equal or greater than the galvanized steel specified.
2. The contractor and the RTU manufacturer shall be responsible for ensuring that the unit will not exceed the allocated space shown in the contract documents, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the

responsibility of the contractor at no additional cost to the Government.

3. RTUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown in the contract documents. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.
4. The RTU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted in the contract documents. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local representative cannot be provided, the manufacturer shall provide a factory representative.
5. Gaskets: All door and casing and panel gaskets and gaskets between air-handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections shall use a more permanent gasketing method provided they are not disassembled.
6. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 2000 Pa (8 inches WG) or higher.
7. Corrosion Protection:

SPEC WRITER NOTE: Outdoor air-handling units in the high-humidity locations (VA HVAC Design Manual) require corrosion-resistant treatment for the coils and the

casing surfaces, exterior and interior, exposed to ambient air.

a. Epoxy Immersion Coating-Electrically Deposited Coil Treatment:

The multi-stage corrosion-resistant coating application comprises of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. The coating thickness shall be maintained between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, they are treated to permeate immersion rinse and spray. Where the coils are subject to UV exposure, UV protection spray treatment comprising of UV-resistant urethane mastic topcoat shall be applied. Provide complete coating process traceability for each coil and minimum five (5) years of limited warranty. The coating process shall be such that uniform coating thickness is maintained at the fin edges. The quality control shall be maintained by ensuring compliance to the applicable ASTM Standards for the following:

- 1) Salt Spray Resistance (Minimum 6,000 Hours)
- 2) Humidity Resistance (Minimum 1,000 Hours)
- 3) Water Immersion (Minimum 260 Hours)
- 4) Cross-Hatch Adhesion (Minimum 4B-5B Rating)
- 5) Impact Resistance (Up to 160 Inch/Pound)

b. Casing Surfaces (Exterior and Interior): All exposed and accessible exterior and interior metal surfaces shall be protected with a water-reducible acrylic with stainless-steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness shall be 2-4 mils and provide minimum salt-spray resistance of 1,000 hours (ASTM B117) and 500 hours UV resistance (ASTM D4587).

SPEC WRITER NOTE: Contractor need not supply supplemental steel if drawings call for additional structure to mount the unit high to accommodate cooling coil condensate trap.

B. Base:

1. Provide a heavy duty steel base for supporting all major RTU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 127 mm (5 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as

required for lateral stability. //Contractor shall provide supplemental steel supports as required to obtain proper operation heights for cooling coil condensate drain trap// and steam coil condensate return trap// as shown in the contract documents.//

2. RTUs shall be completely self-supporting for installation on //roof curb or// //steel support pedestals//.
3. The RTU bases not constructed of galvanized material shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.

C. Casing (including wall, floor and roof):

1. General: RTU casing shall be entirely double wall insulated panels, integral of or attached to a structural frame. Construction shall be such that removal of any panel shall not affect the structural integrity of the unit. All casing and panel sections shall be tightly butted and gasketed. No gaps of double wall construction will be allowed where panels bolt to air-handling unit structural member. Structural members, not covered by the double wall panels, shall have equivalent insulated double wall construction.
2. Double wall galvanized steel panels, minimum 50 mm (2 inches) thick, constructed //of minimum 1.3 mm (18 gauge) outer skin and 1.0 mm (20 gauge) solid or perforated inner skin// to limit wall, roof and floor deflection to not exceed an L/240 ratio when the unit casing is pressurized to ± 1245 Pa (± 5 inch WG). Deflection shall be measured at the midpoint of the panel height. Total housing leakage shall not exceed 1 percent of rated CFM when the unit casing is pressurized to ± 1245 Pa (± 5 inch WG). The outer (skin) and inner panels shall be solid.
3. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.
4. Insulation: Insulation shall be injected CFC free //polyurethane// foam encased in double-wall casing between exterior and interior panels such that no insulation can erode to the air stream. Insulation shall be 50 mm (2 inch) thick, and 48 kg/m^3 (3.0 lb/ft^3) density with a total thermal resistance (R-value) of approximately 2.3 m.K/W ($13.0 \text{ hr-ft}^2 \text{ }^\circ\text{F/BTU}$). Units with less than 50 mm (2 inch) of insulation in any part of the walls, floor, roof or drain pan shall not be acceptable. The insulation shall comply with NFPA 90A

for the flame and smoke generation requirements. Also, refer to Section 23 07 11, HVAC and BOILER PLANT INSULATION.

Outer Panel	0.8 mm (22 Gauge) Minimum
Inner Panel	0.8 mm (22 Gauge) Minimum
Insulation	Foam
Thickness	50 mm (2 inch) Minimum
Density	48 kg/m ³ (3.0 lb/ft ³) Minimum
Total R Value	2.3 m ² .K/W (13.0 ft ² .°F.hr/Btu) Minimum

5. The thickness of insulation, mode of application, and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU.
6. Casing panels shall be secured to the support structure with stainless-steel or zinc-chromate plated screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are prohibited.
7. Access Doors: Provide in each access section and where shown in the contract documents. Show single-sided and double-sided access doors with door swings on the floor plans. Doors shall be a minimum of 50 mm (2 inches) thick with same double wall construction as the unit casing. Doors shall be a minimum of 610 mm (24 inches) wide, unless shown of different size in the contract documents, and shall be the full casing height up to a maximum of 1829 mm (6 feet). Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, mixing box, //humidifier// coil section shall include a minimum 152 mm x 152 mm (6 inch x 6 inch) double thickness, with air space between glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.
 - a. Hinges: Manufacturer's standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 pound) weight hung on latch side of door.

- b. Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require approximately 0.785 radian (45-degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 2000 Pa (8 inches WG).
 - c. Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
8. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.
9. Roof of the unit shall be sloped to have a minimum pitch of 6 mm (1/4 inch) per foot. The roof shall overhang the side panels by a minimum of three inches to prevent precipitation drainage from streaming down the unit side panels.
- SPEC WRITER NOTE: The paragraph below is applicable where the corrosion treatment is not required.
10. Casing finished shall meet ASTM B117, 500-hour salt spray test, using 20 percent sodium chloride solution. Immediately after completion of the test, the coating shall show no sign of blistering, wrinkling, or cracking, no loss of adhesion, and the specimen shall show no sign of rust creepage beyond 3.2 mm (1/8 inch) on either side of scratch mark.
- D. Unit floor shall be level without offset space or gap and designed to support a minimum of 488 kg/square meter (100 pounds per square foot) distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in

service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.

- E. Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double wall construction, Type 304 stainless-steel, a minimum of 50 mm (2 inch) insulation and shall be sloped to drain. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
1. An intermediate condensate drip pan shall be provided on stacked cooling coils and shall be constructed of Type 304 stainless-steel with copper downspouts factory piped to main condensate pan. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
 2. Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
 3. Installation, including frame, shall be designed and sealed to prevent blow-by.

SPEC WRITER NOTES:

1. In this section, housed centrifugal fans and plenum fans (not more than 4 fans in an array) are specified. Before selecting one type or another for a specific application, multiple selections comparing both types of fans should be made. Selection of the fan type and arrangement would be dependent upon the specific priority involving such factors as power input, overall dimensions, acoustics, and percentage redundancy requirement.
2. Use of the housed forward curve centrifugal fans should be considered only for low static pressure applications, typically 950 Pa (3-3/4 inch WG) or less.

F. Housed Centrifugal Fan Sections:

1. Fans shall be minimum Class II construction, double width, double inlet centrifugal, //air foil or backward inclined// //or forward curved// type as indicated in the contract documents, factory balanced and rated in accordance with AMCA 210 or ASHRAE 51. Provide self-aligning, pillow block, regreasable ball-type bearings selected for a B(10) life of not less than 40,000 hours and an L(50) average fatigue life of 200,000 hours per ABMA 9. Extend bearing grease lines to motor and drive side of fan section. Fan shall be located in airstream to assure proper air flow.
2. Provide internally vibration isolated fan, motor and drive, mounted on a common integral bolted or welded structural steel base with adjustable motor slide rail with locking device. Provide vibration isolators and flexible duct connections at fan discharge to completely isolate fan assembly. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT, for additional requirements. Allowable vibration tolerances for fan shall not exceed a self-excited vibration maximum velocity of 0.005 m/s (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. After field installation, compliance to this requirement shall be demonstrated with field test in accordance with Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT and Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC. Following fan assembly, the complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 axial).

G. Fan Motor, Drive, and Mounting Assembly (Housed Centrifugal Fans):

1. Motors shall be premium energy efficient type, as mandated by the Energy Policy Act of 2005, with efficiencies as shown in the Specifications Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT, in the contract documents and suitable for use in variable frequency drive applications on AHUs where this type of drive is indicated. Refer to Section 23 05 11,

COMMON WORK RESULTS FOR HVAC, for additional motor and drive specifications. Refer to Section 26 29 11, MOTOR CONTROLLERS.

2. Fan drive and belts shall be factory mounted with final alignment and belt adjustment to be made by the Contractor after installation. Drive and belts shall be as specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide additional drive(s) if required during balancing, to achieve desired airflow.

H. Plenum Fans - Single and/or Multiple Fans in an Array:

1. Fans shall be Class II (minimum) construction with single inlet, aluminum wheel and stamped air-foil aluminum bladed. The fan wheel shall be mounted on the directly-driven motor shaft in AMCA Arrangement 4. Fans shall be dynamically balanced and internally isolated to minimize the vibrations. Provide a steel inlet cone for each wheel to match with the fan inlet. Locate fan in the air stream to assure proper flow. The fan performance shall be rated in accordance with AMCA 210 or ASHRAE 51.
2. Allowable vibration tolerances for fan shall not exceed a self-excited vibration maximum velocity of 0.005 m/s (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions. After field installation, compliance to this requirement shall be demonstrated with field test in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT and Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC. The fan wheel shall meet or exceed guidelines in AMCA 801 for dynamic balancing requirements. The complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 axial).
3. The plenum fans shall be driven by variable speed drives with at least one back-up drive as shown in the design documents. Use of a drive with bypass is prohibited.
4. Multiple fans shall be installed in a pre-engineered structural frame to facilitate fan stacking. All fans shall modulate in unison, above or below the synchronous speed within the limits specified by the manufacturer, by a common control sequence. Staging of the fans

is prohibited. Redundancy requirement shall be met by all operating fans in an array and without the provision of an idle standby fan.

5. Fan Accessories:
 - a. Fan Isolation: Provide //an actuator-controlled damper// //a manual blank off plate// //an automatic back draft damper// to isolate the fan not in operation due to failure.
 - b. Fan Airflow Measurement: Provide an airflow measuring device integral to the fan to measure air volume within +/- 5 percent accuracy. The probing device shall not be placed in the airflow path to stay clear of turbulence and avoid loss of performance.
6. Fan Motor, Drive and Mounting Assembly: Fan Motors shall be premium energy efficient type, as mandated by the Energy Policy Act of 2005, with efficiencies as shown in the Specifications Section 23 05 12 GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT, in the contract documents and suitable for use in variable frequency drive applications. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC, for additional motor and drive specifications. Refer to Section 26 29 11, MOTOR CONTROLLERS.
- I. //Multi-zone damper blades shall be galvanized steel or aluminum type. Dampers shall have metal compressible jamb seals and extruded vinyl or metal blade edge seals. Dampers shall rotate on stainless-steel bearings or bronze bushings. Leakage rate shall not exceed 2.5 cubic meters/minute/square meter (8 cfm per sq. foot) at 250 Pa (1 inch water). Dampers and operators shall be furnished and factory-installed by RTU manufacturer. Damper operators shall be of the same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//
- J. //Mixing Boxes: Mixing box shall consist of casing and outdoor air and return air dampers in opposed blade arrangement with damper linkage for automatic operation. Coordinate damper operator with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Dampers shall be of ultra-low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless-steel sleeve bearings or bronze bushings. Leakage rate shall not exceed 1.6 cubic meters/min/square meter (5 cfm per square foot) at 250 Pa (1 inch WG) and 2.8 cubic meters/min/square meter (9 CFM per square foot) at 995 Pa (4 inches WG) //Electronic// //Pneumatic// damper operators shall be furnished and mounted in an accessible and easily serviceable

location by the air-handling unit manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//

- K. //Blenders: Construction of the blender section shall be of welded aluminum 2 mm (0.08 inch) thick framing and turbulators. The mixer shall have no moving parts and shall contain a primary set of directional changing vanes, a secondary set of turbulator vanes, and a cone design for mixing of air streams. Certify blender performance to achieve no greater than a 5 degree F variation across the cross section of the AHU measured 305 mm (12 inches) downstream of the blender over a face velocity range of 1-4 m/s (200-800 FPM).//

SPEC WRITER NOTE:

For air-handling units equipped with plenum fans and requiring after-filters to be located on the downstream side of the supply air fans, follow manufacturer's recommendations to establish the distance between the supply air fan and after-filters.

- L. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
1. Filters including 1 complete set for temporary use at site shall be provided independent of the RTU. The RTU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The RTU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown in the contract documents) required for RTU testing.
 2. Factory-fabricated filter section shall be of the same construction and finish as the RTU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in accordance with side service or holding frame housing requirements in Section 23 40 00, HVAC AIR CLEANING DEVICES.

SPEC WRITER NOTE: Diffuser section is required for the housed centrifugal fan and not for the plenum fan, where the plenum is pressurized and provides uniform velocity distribution.

- M. //Diffuser Section: Furnish a diffuser segment with perforated diffuser plate immediately downstream of supply fan to assure uniform distribution of leaving air across the face of the downstream after-filters to create uniform velocity profiles across the entire opening.

Bolt or weld diffuser plate to a sturdy steel support frame so that it remains rigid. Manufacturer shall include any diffuser section pressure loss in excess of diffuser plate and this value shall be included in unspecified internal losses when selecting fan.//

- N. Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils //and glycol-water exhaust heat recovery coils// shall be designed and installed to ensure no condensate carry over. Provide factory-installed extended supply, return, drain, and vent piping connections. //For air-handling units serving surgical suites, provide copper fins for all coils.// Refer to contract documents and Section 23 82 16, AIR COILS, for additional coil requirements.

1. Water coils//, including glycol-water//.

SPEC WRITER NOTE: Pneumatic damper operators may be used in paragraph below only when connecting to any existing pneumatic control system.

2. //Integral Face and Bypass Steam Coils: Provide integral vertical face and bypass dampers. //Electric// //Pneumatic// damper operators shall be furnished and mounted by the RTU manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//

3. //Steam distributing tube coils//

- O. Humidifier: When included in design, coordinate the humidification requirements with Section 23 84 00, HUMIDITY CONTROL EQUIPMENT. Provide humidification section with stainless-steel drain pan of adequate length to allow complete absorption of water vapor. Provide stainless-steel dispersion panel or distributors as indicated, with stainless-steel supports and hardware.

- P. Sound Attenuators: Refer to contract documents, Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT, and Section 23 31 00, HVAC DUCTS AND CASINGS, for additional unit mounted sound attenuator requirements. RTU sound attenuators shall be factory-installed as an integral part of RTU.

- Q. Discharge Section: Provide aerodynamically designed framed discharge openings or spun bellmouth fittings to minimize pressure loss.
- R. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
1. Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, //humidifier,// and any section over 305 mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment access door. Wiring between switches and lights shall be factory-installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box.
 2. Install compatible LED bulb in each light fixture.
 3. Provide a convenience duplex //weatherproof// receptacle next to the light switch.
 4. Disconnect switch and power wiring: Provide factory or field mounted disconnect switch. Coordinate with Division 26, ELECTRICAL.
 5. Provide single point power connection. Coordinate with Division 26, ELECTRICAL.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.
- B. Install rooftop unit in conformance with ARI 430.
- C. Assemble rooftop unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. MIL-P-21035B. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- D. //Install seismic restraints for rooftop units. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- E. Leakage and test requirements for rooftop units shall be the same as specified for ductwork in Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class (C_L) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design

static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.

- F. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- G. Seal and/or fill all openings between the casing and RTU components and utility connections to prevent air leakage or bypass.

3.2 STARTUP AND TESTING

- A. The air-handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- B. After the air-handling unit is installed and tested, provide startup and operating instructions to VA personnel.
- C. An authorized factory representative should startup, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.
- D. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- E. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- F. //The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.//

3.3 //COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.//

3.4 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //4//
// // hour//s// to instruct each VA personnel responsible in
operation and maintenance of the system.
- B. //Submit training plans and instructor qualifications in accordance
with the requirements of Section 23 08 00, COMMISSIONING OF HVAC
SYSTEMS.//

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