SECTION 23 74 13

ROOFTOP MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the design, controls and installation requirements for packaged rooftop units providing outside make-up air to the data center building (data halls, electrical rooms, and critical back of house areas).

1.3 SUBMITTALS

A. Compliance Review: In addition to the submittal requirements of this section, preorder bidders shall provide a Compliance Review of the Specifications and Addenda. The Compliance Review shall be a paragraph-by-paragraph review of the Specifications with the following information, “C”, “D,” or “E” marked in the margin of the original Specifications and any subsequent Addenda.

1. “C”: Comply with no exceptions.
2. “D”: Comply with deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
3. “E”: Exception, do not comply. For each and every exception, provide a numbered footnote with reasons and possible alternatives.
4. The notes associated with “D” and “E” responses shall be typewritten and submitted alongside the compliance review for review by the Design Professional.
5. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Bidder is in complete compliance with the plans and Specifications. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction do not release the Bidder from being in complete compliance, unless the exception or deviation has been specifically noted in the Compliance Review submitted with the Bid.

B. Product Data / Technical Data Sheets:

1. Include rated capacities, electrical load data, physical dimensional data, weights (shipping, installed, and operating), media information, component specifications, sound data, power and control wiring diagrams, furnished specialties, and accessories.
2. Capacity and energy use data provided in the data.

C. Performance Data Sheet: Provide the manufacturer standard performance data sheet showing the performance data for the scheduled conditions.

1. Provide certified data sheets showing the coil, fan, and electrical performance data.
2. Provide computer generated fan curves for each type of fan with specific design operation range noted.
3. The performance data provided shall be within tolerance requirements.

D. Shop Drawings: Provide project specific dimensional drawings, including required service clearances and connection details.

E. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

F. Installation Procedures: Provide step by step descriptions and details for the field installation of the equipment. Include fabrication details for anchorage and attachment to the structure and to support the equipment.

G. Lead times to manufacture equipment and to deliver equipment to project site.

1.4 QUALITY ASSURANCE

A. Packaged air-cooled units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.

B. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

C. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

D. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings, except Low-Rise Residential Buildings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.

B. Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Air Filters: One spare set of filters.

2. Fan Belts: One spare set of belts where applicable.

1.7 WARRANTY

A. The Equipment Supplier shall warrant that the equipment supplied is of a proven design and can meet the requirements specified. Workmanship shall be of the best quality, free from any defects that might render the equipment unsuitable or inefficient for the purpose for which it is to be used. In the event of problems or malfunctions, the Equipment Supplier shall have qualified technicians capable of affecting the necessary repairs and restoring the system to full operation within eight hours of notification. There shall be no cost to the Owner for corrective repairs or firmware upgrades during the first twelve (12) months following successful integrated site commissioning and the project substantial completion date. Owner and Engineer shall be made aware prior to any firmware flashes after equipment has left the factory.

B. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters. The labor warranty shall align with the parts warranty. The labor warranty must be executed by the manufacturer and/or their exclusive representative. Contractor provided labor warranty will not be accepted.

C. If at any time during the first twelve (12) months of operation as defined below, the Owner shall accumulate sufficient evidence to reasonably indicate that the equipment or any part thereof, is not in accordance with the Specifications, the Owner shall so notify the Equipment Supplier in writing, and the Equipment Supplier shall repair or replace the defective components. The cost of removal, reinstallation and complete re-testing of the equipment, and any associated freight charges (via air ride truck) or service engineering charges, shall be at the Equipment Supplier's expense. The warranty for the repaired or replaced equipment shall be extended for twelve (12) months from the completion of repairs or replacement.

D. If the equipment fails to meet the specific performance guarantees, the Equipment Supplier shall recommend to the Owner adjustments or modification. Upon approval by the Owner, the adjustments or modifications shall be made, and tests shall be rerun. The cost of these adjustments or modifications and complete re-testing shall be made at the Equipment Supplier's expense. After such adjustments or modifications, should the equipment fail to achieve the guaranteed performance, an equitable settlement shall be made which may, without limitation, include an adjustment of the contract price.

E. Complete re-testing, as referred to in this Section, shall mean site acceptance testing as stipulated in testing portions of this Specification. The conditions which apply to original testing requirements, shall also apply to the re-testing of any equipment performed under the conditions of this warranty.

F. Commercial operation is defined as commencing on the date on which the equipment covered by these Specifications has successfully completed final site integrated acceptance testing and the project substantial completion date.

G. Identify any manufacturer's standard warranty periods that exceed the time frame listed above.

1.8 COMMISSIONING

A. Commissioning of equipment or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Construction Manager and the Commissioning Authority. Project Closeout is dependent on successful completion of the commissioning procedures, documentation, and issue closure.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Products shall be provided by the following manufacturers as noted.
   1. Basis-of-Design Product: Subject to compliance with requirements. Provide Trane as the base bid.
   2. Substitute manufacturers listed must meet the requirements of the specifications herein; being listed as an acceptable substitute does not absolve manufacturer from meeting full intent of the specifications.

2.2 ROOFTOP UNITS

A. General Description
   1. Packaged rooftop make-up air unit shall include compressors, evaporator coils, electric heating coils, filters, supply fans, power exhaust fan, dampers, air-cooled condenser coils, condenser fans, hot-gas reheat and unit controls.
   2. Unit shall be factory assembled and tested, including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
   3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
   4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
   5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
   6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
   7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.

8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

B. Construction

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, hot-gas reheat coil, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans, minimum 2 inches deep, and complying with ASHRAE 62.1 for design and construction of drain pans.
9. Unit shall be provided with base discharge and return air openings. The openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit base pan shall be provided with 1/2 inch thick foam insulation.

C. Electrical

1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
2. Short Circuit Current Rating: The high-voltage electrical configuration shall provide at least 65.0 kAIC SCCR and shall be labeled.

3. Unit shall be provided with a factory installed and factory wired 115V, 12 amp GFI outlet disconnect switch in the unit control panel.
4. Unit shall be provided with phase and brown out protection which shuts down the motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.
5. Unit shall be provided with single point power connection.
6. Provide unit mounted 115-volt convenience outlet.

D. Supply and Exhaust Fans
1. Unit shall include direct drive, unhoused, backward curved, plenum fans.
   a. Fan shall be selected for turndown necessary to allow data hall pressurization to be controlled by fan speed.
   b. Fan Wheel Material: Aluminum; attached directly to motor shaft.
   c. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
   d. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
   e. Fan Enclosure: Easily removable enclosure around rotating parts.
   f. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.
2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
   a. Shaft-grounding means shall be furnished, and factory installed for the motors driven by Variable Frequency Drive.
4. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
5. Supply air system shall have air-flow measuring infrastructure. The output of this infrastructure will be available to the air-handling unit as well as the building automation system.

E. Cooling Coils
1. Evaporator Coils
   a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
   b. Coils shall have interlaced circuitry and shall be standard capacity.
   c. Coils shall be hydrogen or helium leak tested.
   d. Coils shall be furnished with factory installed expansion valves.

F. Refrigeration System
1. Unit shall be factory charged with R-445B refrigerant.
2. Factory charged with refrigerant and filled with oil.
3. Refrigeration Specialties:
   a. Expansion valve with replaceable thermostatic element.

b. Refrigerant filter/dryer.
c. Manual-reset high-pressure safety switch.
d. Automatic-reset low-pressure safety switch.
e. Minimum off-time relay.
f. Automatic-reset compressor motor thermal overload.
g. Brass service valves installed in compressor suction and liquid lines.
h. Low-ambient kit high-pressure sensor.
i. Hot-gas reheat solenoid valve modulating with a replaceable magnetic coil.
j. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.
k. Liquid line sight glass.

4. Compressors
   a. Compressors shall be scroll type with thermal overload protection, internal pressure relief and crankcase heater.
   b. All compressors on every circuit shall be a modulating digital scroll. Single variable capacity scrolls with on/off modulating for the remainder is not acceptable.
   c. The variable capacity scroll compressors shall be capable of modulation from 10-100% of capacity.
   d. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
   e. Compressors shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Hot Gas Re-Heat
   a. Lead refrigeration circuit shall be provided with hot-gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal, which allows the unit to have a dehumidification mode of operation.
   b. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
   c. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   d. Suction-discharge bypass valve.
6. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
7. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
8. Each refrigerant circuit shall be equipped with a liquid line sight glass.
9. Other Refrigeration System Specialties:

a. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
b. Brass service valves installed in discharge and liquid lines.

G. Air-Cooled Condenser

1. Condenser fans shall be vertical discharge, axial flow, direct drive.
2. Outdoor coil shall be designed for use with R-454A refrigerant.
3. Outdoor coil shall be constructed of copper tubes with aluminum fins, mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
4. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
5. Coils shall be hydrogen or helium leak tested.
6. Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

H. Filters

1. Unit shall include a combo 2”/4” filter rack upstream of the main DX coil. Provide one (1) set of 2” MERV-8 filters and one (1) set of 4” MERV-13 filters for final installation and turnover.
2. Additional sets of construction filters shall be provided by the Mechanical Contractor and replaced at a frequency as agreed to with the GC.
3. Unit shall include a clogged filter switch.
4. Unit shall include a Magnehelic gauge mounted in the controls compartment.

I. Outside Air Intake

1. Unit shall include a motor operated outside air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals, and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return actuator. Unit shall include outside air opening bird screen and outside air hood.

J. Electric Resistance Heating Coil

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection.

5. Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.

K. Accessories

1. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

L. Controls

1. Control equipment and sequence of operation are specified in Section 230923 “Direct Digital Control (DDC) System for HVAC” and Section 230993.11 “Sequence of Operations for HVAC DDC”.
2. Control Valves: Comply with requirements in Section 230923.11 “Control Valves”.
3. Controls for the OAU’s shall consist of factory provided end-devices, sub-routine panels, and safeties along with a field (or factory) provided programmable DDC controller.
   a. Standard, configurable controllers, typically provided by packaged manufacturers will only be allowed if the controller is capable of executing the full sequence of operation.
   b. Custom routines written by the BAS provider and communicated over BACnet from the front-end will not be an acceptable means of meeting the sequence. The unit shall be capable of executing its sequence if communication is lost with BAS.
4. The MAU manufacturer shall include the following control scope:
   a. A programmable application specific controller (ASC) shall be provided by the MAU manufacturer. If the controller cannot be factory installed and programmed, the MAU manufacturer (or their designated representative) shall field install the controller and be responsible for the following:
      1) All wiring between factory terminal strip and ASC I/O panel.
      2) Installation and wiring of any remote mounted devices.
      3) Execution of the unit Sequence of Operation, including proper operation and safeties for mechanical components within the MAU.
      4) Any miscellaneous wiring, relays or devices required to meet intent of the Sequence of Operation.
   b. A factory installed end-device package, which shall include factory wiring to a terminal strip. The following control points shall be available on the terminal strip for control by the third party ASC, as required to meet the sequence of operation.
      1) 24 VAC Control Voltage
      2) Common
      3) Supply Fan Enable
      4) Cooling Stage / Heat Pump Stage 1 Enable
      5) Cooling Stage / Heat Pump Stage 2 Enable
      6) Cooling Stage / Heat Pump Stage 3 Enable
      7) Cooling Stage / Heat Pump Stage 4 Enable
      8) Variable Capacity Compressor 1-2 Signal
      9) Variable Capacity Compressor 3-4 Signal

10) Suction Pressor Sensor – Compressor 1
11) Suction Pressor Sensor – Compressor 2
12) Suction Pressor Sensor – Compressor 3
13) Suction Pressor Sensor – Compressor 4
14) Supply Fan Speed Signal
15) Clogged Filter Switch
16) Drain Pan High Condensate Level Switch
17) Reheat Enable
18) Reheat Supply Air Setpoint Signal
19) Preheat Enable
20) Preheat Setpoint Signal
21) Phase & Brown Out

c. Control boards with logic to safety operate the following sub-routines shall be included by the MAU manufacturer:
1) Modulating Hot-Gas Reheat
2) Head Pressure Control
3) Heat Pump Oversight/Safety
4) Air-source Heat Pump Defrost Cycle
a) Defrost cycle shall begin when outdoor coil temperature is below a fixed setpoint and have a fixed 10 minute run time, or end when the outdoor coil temperature is above a fixed setpoint.
b) Defrost timer, with 30/60/90 minute selectable defrost cycle interval time, shall be factory installed in the controls compartment. During defrost cycle the compressors shall energize, reversing valve shall energize, and auxiliary heat (if available) shall energize.

d. The following points/devices will be provided by the MAU manufacturer, but will require the BAS Contractor to field wire them directly to the ASC as required by the points list in the control documents (or if required for sequence of operation).
1) VFD Current Feedback
2) VFD Fault Status
3) Outdoor Airflow Measurement

5. Refer to the control diagrams, points list, and sequence of operation for additional details.

M. Accessories

1. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

PART 3 - EXECUTION

3.1 START-UP SERVICE

A. Engage the unit manufacturer's service representative to perform startup service.

1. Service representative shall be a factory-trained and -authorized service representative of the OAU unit manufacturer.

2. Complete startup service of each unit and provide start-up report for submission to owner.
3. Startup scope shall encompass the items required by the manufacturers IOM, along with other best practices to ensure proper set-up and operation.

3.2 INSTALLATION, OPERATION, AND MAINTENANCE

A. Installation, Operation, and Maintenance manual shall be supplied with the unit.

B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.

C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to the roof top units to allow service and maintenance.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
1. Install ducts to terminate at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to the roof top units with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

D. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 260553 "Identification for Electrical Systems."
2. Locate nameplate where easily visible.

END OF SECTION

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