

SECTION 23 73 10 - MODULAR AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The following Specification Section apply this specification section:
 - 1. Bidding Requirements, Contract Forms and Conditions of the Contract.
 - 2. Division 1 - General Requirements.

1.2 SUMMARY

- A. This Section includes constant-volume and variable volume modular air handling units with coils, filters and other components and accessories, designed for interior and exterior installations. Refer to the contract drawings for unit configurations and required components.

1.3 SUBMITTALS

- A. Submit product technical data for each unit to include the following information:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound power ratings.
 - 3. Certified coil performance ratings with system operating conditions indicated.
 - 4. Motor ratings and electrical characteristics plus motor and fan accessories
 - 5. Filters with performance characteristics.
- B. Exceptions: Shop drawing submittals are required to include a listing of any and all exceptions to the requirements indicated in this specification and on the drawings. If no exceptions are taken the lead sheet of the submittal shall indicate this. Submittals that do not have this information will be returned without review.
- C. Provide manufacturer's shop drawings detailing dimensions, operating weight, required clearances, all components, and location and size of each field connection.
- D. Provide wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Provide Operation and Maintenance data for all units.
- F. Provide warranty information.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain all modular air handling units through one source from a single manufacturer, regularly engaged in production of air handling units.
- B. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

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- C. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard 430.
- D. Air handling units with fan sections utilizing multiple fans shall be rated in accordance with AHRI standard 430 for airflow, static pressure, and fan speed performance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Each section shall have lifting lugs for field rigging and final placement of AHU sections.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.7 WARRANTY

- A. Provide written warranty indicating all air handling units and components will be warranted for a period of 1 year from the date of substantial completion. The warranty will include all parts, materials and labor for replacement of any of the unit's components that fail in materials and/or workmanship within the warranty period.

1.8 EXTRA MATERIALS

- A. In addition to the equipment and materials furnished with the air handling units, furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing the contents:
- B. Filters: Two complete sets of each type filter for each handling unit.
- C. Fan Belts: Two matched sets for each belt drive fan on each air handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide modular air handling units manufactured by Carrier. Subject to review, equipment meeting the full requirements of the specifications and project installation limitations (i.e., physical size and weight) and manufactured by one of the following will be considered by alternate bid:
 - 1. The Trane Co.
 - 2. York/Johnson Controls.

- B. Manufactures other the basis of design manufacturer shall carefully review the contract drawings, prior to bidding to verify the equipment will meet all requirements, including installation clearances, electrical power, and structural support. Any change in cost required for alternate bid manufacturers shall be included in the alternate bid price.

2.2 GENERAL

- A. Refer to the contract drawings for unit configurations and required components of the air handling units.

2.3 UNIT CASINGS

- A. The entire air handler shall be constructed of galvanized steel with insulated double wall construction. Indoor air handling unit casing finish to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage.
- B. Where required the manufacturer shall ship each unit with separate segments so unit can be broken down for ease of installation in tight spaces.
- C. Casing air leakage shall not exceed 1% of design airflow at the specified casing pressure. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
- D. The entire unit casing shall be able to withstand up to 1.5 times design static pressure up to +8" w.g. in all positive pressure sections and -8" w.g. in all negative pressure sections, whichever is less, and shall not exceed 0.0042" per inch of panel span.
- E. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042" per inch of panel span.
- F. Unit casing panels shall be 2" double-wall construction with solid galvanized construction for all exterior panels and solid galvanized interior for all unit components except for fan sections and discharge plenum sections which shall be provided with an interior perforated liner.
- G. Unit casing panels and doors shall be fabricated with insulation to provide a minimum thermal resistance (r value) of 13. All casing panels shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- H. Access panels and/or access doors shall be provided on both sides of all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

2.4 ACCESS DOORS

- A. Access doors shall be 2" double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

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- B. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- C. Handle hardware shall be designed to prevent unintended closure. Access doors shall be hinged and removable without the use of specialized tools. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
- D. All doors shall be a minimum of 15" wide and 60" high when sufficient height is available, or the maximum height allowed by the unit height and shall be located on each side of all units. Where access doors are provided in sections with a positive pressure the doors shall be hinged so as to open in an inward direction.

2.5 DRAIN PANS

- A. All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan. The drain pan shall be designed in accordance with ASHRAE 62.1 and be of sufficient size to collect all condensation produced from the coil. The pan shall be sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. Refer to other specification sections requirements on intermediate drain pans between cooling coils.
- B. The drain outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. All drain pan threaded connections shall be visible external to the unit. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2" beyond the base to ensure adequate room for field piping of condensate traps.

2.6 FANS

- A. Provide supply, return and/or exhaust fans of the types and capacities as scheduled or indicated on the drawings.
- B. Fans shall be designed to accommodate a 10 percent future increase in air flow or total static pressure without requiring a fan wheel replacement. The equivalent fan selection shall not increase motor horsepower, fan RPM and tip speed by more than 10 percent and shall not increase inlet or discharge velocity by more than 10 percent from the specified amount. Include with the shop drawing submittal multiple RPM fan curve with the operating points plotted on the curve.
- C. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. Fan wheels shall be keyed to fan shafts to prevent slipping.
- D. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.

- E. All fans shall be mounted on spring isolation bases. Internally-mounted motors shall be on the same isolation base. Isolator bases and springs shall be designed and provided to totally eliminate vibration. Isolation bases shall have factory installed tie-down bolts provided to secure the isolation base to the unit. A flexible connection (e.g., canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements.
- F. Fan sections containing multiple fans shall be provided as indicated on the schedule and drawings. Each fan shall operate in parallel to the other fan in the array. The fans shall be SWSI plenum type with high efficient AF blades. Fan wheels shall be aluminum. The Hp characteristic of the fans shall be non-overloading. Fan sections containing multiple fans shall be controlled using a common control signal, such as the duct static control signal, to modulate the fan speed. The manufacturer shall supply a blank-off plate, for field installation, to prevent air circulation in the event one of the fans is disabled.
- G. For belt drive fans provide belt guards as required by OSHA standard 29 CFR 1910 to protect worker from accidental contact with the belts and sheaves.
- H. Fan sections shall have an access door located on each side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

2.7 MOTORS AND DRIVES

- A. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change.
- B. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
- C. Belt-driven fan sections with single fans shall use 4-pole (1800 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads.
- D. Direct-driven fan sections shall use 2-pole (3600 rpm), 4-pole (1800 rpm), or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads. Multiple fan selections utilizing 8-pole (900 rpm) motors are unacceptable due to motor inefficiency, cost, and replacement lead times.
- E. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
- F. V-Belt Drive shall be variable pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs shall be fixed pitch.
- G. All fans with fixed-pitch drives and motors 15 hp and larger shall be equipped with multiple belt drives.
- H. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in start-up and service personnel in maintenance:
 - 1. Fan and motor sheave part number
 - 2. Fan and motor bushing part number
 - 3. Number of belts and belt part numbers
 - 4. Number of belts and belt part numbers
 - 5. Belt tension and deflection

2.8 COILS

- A. Coils section side panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
- C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity.
- D. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle shall be degreased and cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
- F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the primary drain pan.
- G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
- H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
- I. Hydronic Coils:
 - 1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
 - 2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
 - 3. Headers shall be constructed of round copper pipe or cast iron.
 - 4. Tubes shall be minimum 5/8 inch O.D. and minimum 0.024 inch thick copper. Fins shall be aluminum with a maximum of 12 fins per inch.
 - 5. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

2.9 FILTERS

- A. Filter MERV rating and arrangement shall be provided as defined on the project drawings.
- B. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall be provided with filter frames. Filter holding frames shall be continuously welded for heavy-duty construction, long-term reliability, minimal maintenance, and minimal air bypass such that filtration efficiency is that of the scheduled filters. Frames shall be equipped with filter fasteners of the same material as the filter frame. Filter holding frames shall be of the universal type to accommodate standard filters as well as appropriate fasteners. Hinged access door(s) shall be provided on each side of the section to facilitate filter removal.

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- C. Pre-Filters: provide 2" pleated media filters made with 100 percent synthetic fibers capable of operating at face velocities of up to 625 f.p.m. without loss of efficiency. The filters shall have MERV 8 rating in accordance with ANSI/ASHRAE Standard 52.2.
- D. High Efficiency Filters: The filters shall be constructed with a continuous sheet of fine-fiber media made into closely spaced pleats. The filters shall be capable of operating up to 625 fpm face velocity without loss of filter efficiency and holding capacity. The filters shall be sealed into a metal frame assembled in a rigid manner. A gasket material shall be installed on the metal header of the filter to prevent filter bypass where the metal headers meet on the side-access racks. The manufacturer shall supply a side-access filter rack capable of holding high efficiency filters and pre-filters. High Efficiency filters shall have a MERV 13 rating when tested in accordance with the ANSI/ASHRAE Standard 52.2.

2.10 DAMPERS

- A. All dampers, with the exception of external bypass, shall be internally mounted. Dampers shall be premium ultra-low leak and located as indicated on the schedule and plans. Blade arrangement shall be opposed. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D.

2.11 AIRFLOW MEASURING STATIONS

- A. Airflow measuring stations shall be provided and located in the outside and/or return air paths where indicated on the drawings. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage. The airflow measurement station shall measure up to 100 percent of the total outside air and/or return air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior.

2.12 ACCESS SECTIONS

- A. Access sections shall be provided where indicated in the schedule and plans. Access sections to be of the same construction and finish as the unit casings. Provide access doors on each side of the access section. Refer to preceding paragraphs for access door requirements.

2.13 AIR BLENDER SECTIONS

- A. Air blender sections shall be provided where indicated on the drawings. Sections to be of the same construction and finish as the unit casings. Mixers shall incorporate fixed blades, with no moving parts. Mixer panels shall be sized and installed in the unit with manufacturer's recommended distances both upstream and downstream to ensure a minimum mixing effectiveness of 70% at 25% outside air. The pressure drop rating for static air mixers installed with the unit shall include the pressure loss due to the mixer design and the mixer-to-plenum area ratio.

2.14 DISCHARGE PLENUM SECTIONS

- A. Plenums shall be provided where indicated on the drawings. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs.
Discharge plenum panels shall include an acoustical liner. The liner shall be fabricated from stainless steel perforated material to prevent corrosion and designed to completely encapsulate fiberglass insulation. The perforation spacing and hole size shall be such as to prevent insulation breakaway, flake off, or de-lamination when tested at 9000 fpm, in accordance with UL 181 or ASTM C1071. Insulation material must be resistant to fungi in accordance with ASTM C1338.

2.15 ENERGY RECOVERY SECTIONS

- A. Total energy recovery wheels shall be provided where indicated on the drawings. Wheels shall be integral parts of the AHUs and shall be sized per the ventilation requirement of the units. Additional outside air units, or other field assembled and ducted energy recovery devices, are not acceptable. Mixed air units with economizing shall be constructed with internal bypass dampers such that the pressure drop across the wheel does not increase during economizing. External bypass and multiple duct connections are not acceptable.
- B. The air handling unit shall be certified by AHRI to contain a rotary energy recovery wheel certified to ANSI/AHRI Standard 1060 and bears the AHRI 1060 label. The air handling unit and wheel must be AHRI 1060-certified as a package. Proof of compliance shall be that the air handling unit brand name and specific wheel being used be listed on the AHRI website within the Directory of Certified Product Performance for Commercial Air-to-Air Energy Recovery Ventilators under the Packaged Program Type.
- C. Performance characteristics of the energy wheel shall be provided as defined by AHRI 1060 definitions. The energy wheel shall be a total energy wheel, with the sensible and latent effectiveness reported and within 5% of each other. The calculated total net effectiveness of the recovery wheel shall not be less than 70% when the specified ventilation flow rate equals the exhaust flow rate. The energy wheel's EATR shall be less than the value indicated in the schedule and drawings. Wheel face velocity and pressure drop shall not exceed performance as defined on schedule. The energy recovery cassette shall be an Underwriters Laboratories (UL) Recognized Component certified for mechanical, electrical, and fire safety in accordance with UL Standard 1812.
- D. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belts. The total energy recovery wheel shall incorporate a desiccant without the use of binders or adhesives, which may plug the desiccant aperture. The adsorbent shall not be applied as a glued on surface coating and not susceptible to erosion, abrasion, or delamination. Coated segments shall be washable using standard detergent or alkaline-based coil cleaners. The adsorbent shall be selected for its high affinity for water vapor and shall not dissolve or deliquesce in the presence of water or high humidity. The rim shall be continuous rolled stainless steel to form an even concentric circle to prevent leakage around the rim and to minimize wear of components. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting; diameter seals shall be adjustable. Seals shall be factory set
- E. Wheel drive motor shall be provided mounted in the cassette frame. Wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall not require belt tensioners. On units that require drive belt tensioners for the wheel belt/motor assembly, the unit manufacturer shall provide at no additional charge to the customer a visual inspection every four months, and adjustment if necessary, of the recommended belt tension during the unit warranty period. Wheel motors shall be of the voltage, phase, frequency, and Hp indicated on the schedule and drawings.
- F. Wheel bearings shall be permanently sealed and lubricated and have a minimum L-10 life of 400,000 hours.

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- G. Access doors shall be provided on both sides of the section for the removal of wheel segments. Doors shall be located on all air entering and air leaving sides of wheel to allow access to the entire upstream and downstream face of each wheel. Adequate space and access shall be provided for energy wheel motor, bearing and belt removal.
- H. Energy recovery wheels shall be designed with variable effectiveness control, to vary the wheel's recovery capacity. Variable effective control shall be done by an internal bypass damper provided by the AHU Manufacturer. The wheel's variable effectiveness control shall have the ability to modulate the total energy recovery ability down to at least 40% of the initial recovery capacity. Variable frequency speed control is not an acceptable method for controlling variable effectiveness.
- I. Frost prevention shall be achieved by outside air bypass, return air preheat, or outside air preheat, depending upon design conditions. Frost set point temperatures based on the scheduled design air conditions shall be provided by the AHU Manufacturer. Variable frequency speed control is not an acceptable method of frost control. Winter design supply and exhaust air conditions leaving the energy wheel shall be provided by the AHU Manufacturer and shall include any de-rate in performance due to frost prevention measures.
- J. Control of energy wheels shall be incorporated and an integral part of the AHU control systems and shall be as described under the AHU control specifications. Secondary independent wheel controllers are not acceptable.

2.16 VARIABLE FREQUENCY DRIVES (VFD)

- A. Where indicated on the drawings variable frequency drives shall be provided. Refer to specification section 238900 for VFD requirements. Variable frequency drives shall NOT be supplied with bypass capabilities on air handling units that serve systems with variable air volume terminal units.

2.17 OUTDOOR AIR HANDLING UNITS

- A. In addition to all other details specified within for air handling units, units that are installed outdoors shall also comply with the following specification.
- B. Outdoor air handling units shall have only single door handles for each door linking multiple latching points necessary to maintain the specified air leakage integrity of the unit and ease of maintenance. Outdoor AHUs shall be shipped with all openings covered to protect unit interior from in-transit debris.
- C. Unit Paint: External surfaces of all outdoor unit casings shall be prepared and painted with a minimum 1.5 mil thick enamel finish or equal. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Paint shall be AHU Manufacturer's standard color, unless otherwise indicated in the schedule and drawings.
- D. Unit Base: Outdoor units shall have a 6-inch welded base and steel cross members for structural rigidity and supports the full perimeter of the air handling unit. AHU panels must overhang the primary unit base such that no ledge exists for water to pool. The entire AHU perimeter shall be sealed for additional water management protection. Unit base shall be designed to allow the unit to be either pier-mounted or rest on a roof Curb when field-installed.
- E. Unit Roof: Outdoor unit roofs shall incorporate a standing seam on the exterior to ensure a rigid roof construction and prevent water infiltration. Roof assembly shall overhang all walls by 1.5-inch minimum to prevent sheeting from roof to side panels. Rain gutters shall also be provided over all doors to direct rain away from the door assembly. Outdoor roofs shall be sloped, not less than 0.125 inches per foot, for water

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- drainage. Where outdoor units are shipped in multiple sections, provide standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by the installing contractor.
- F. External Pipe Cabinets: The manufacturer shall provide external pipe cabinet assemblies as indicated on the drawings. External pipe cabinets shall be factory assembled and shipped with the units for field mounting. Cabinet walls and doors shall be the same double-wall construction and exterior color/finish as the unit wall panels. Cabinet roofs shall be sloped away from the unit for water drainage.
 - G. Weather Hoods: Outside and exhaust air weather hoods shall be fabricated from the same material as the unit exterior. Hoods shall extend past the perimeter of the unit casing opening to ensure the hood does not obstruct the airflow path. Hoods shall be painted with the same paint requirements identified for the external casing herein. Inlet hoods for each outside damper shall be provided with a high performance sine-wave moisture eliminator to prevent entrainment of water into the unit from outside air. Wire mesh screens shall not be acceptable as a moisture eliminator. Exhaust hoods shall be provided on exhaust air openings. All hoods shall be sized for 100 percent of nominal damper capacities and furnished with bird screens or similar protection to prevent nesting and entry into AHU inlet or exhaust paths.
 - H. Roof Curbs: Roof curbs shall be provided where indicated on the plans and shall be galvanized steel. Roof curb shall support the full perimeter of the air handling unit, including pipe chases. A 2"x4" nominal wood nailing strip shall be supplied attached to the roof curb. Roof curb shall include frame work necessary to support supply and return duct installation prior to unit placement. Roof curb shall be shipped loose for field installation.
 - I. Marine Lights: Marine lights shall be provided throughout all Outdoor Air Handling units. Lights shall be instant-on, LED type and shall produce 1200 lumens. LED lighting shall provide instant-on, white light and have a minimum 50,000 hr life. Light fixture shall be weather-resistant, enclosed and gasketed to prevent water and dust intrusion. Fixtures shall be designed for flexible positioning during maintenance and service activities for best possible location providing full light on work surface of interest and not being blocked by technician. All lights shall be wired in the factory to a single on-off switch. Installing contractor shall be responsible for providing 115V supply to the factory-mounted marine light circuit.
 - J. A 15-amp, 115V GFCI convenience outlet shall be provided by the AHU manufacturer. The outlet shall be separate from the load side of the equipment per NEC requirements. Installing contractor shall be responsible for providing 115V supply to the factory-mounted GFCI outlet circuit per NEC (even when single-point power is specified to be provided by AHU manufacturer).

PART 3 - EXECUTION

3.1 SHIPPING

- A. Protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.

3.2 ON-SITE STORAGE

- A. If equipment is to be stored for a period of time prior to installation, the installing contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in an area not subject to rain and/or snow.

3.3 EXAMINATION

- A. The contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents. The contractor shall verify that the proper power supply is available prior to starting of the fans.
- B. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- D. Examine roughing-in for piping, ducts and electrical services to verify actual locations of connections before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSTALLATION

- A. Install modular air-handling units level and plumb, in accordance with manufacturer's written instructions. Arrange installation of units to provide the required access space around air-handling units for service and maintenance.
- B. Provide watertight coverings over all unit openings until the final duct connections are completed.
- C. Roof curb: provide a roof curb for all roof mounted units. Where roof curbs are shipped in a knockdown fashion provide labor to assemble the curbs. Install the roof mounted air handling unit(s) on the roof curb immediately after the curb is installed. If immediate installation is not performed provide temporary watertight covering, for all curb openings, consisting of minimum 3/4" exterior grade plywood and watertight rubber or plastic cover.
- D. When spring isolation roof curbs are specified the installing contractor is required to verify factory installed tie-down bolts, located at the fan / motor isolation base(s), remain in a locked down condition.
- E. Install floor mounted air-handling units on concrete bases, where indicated on the drawings. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified.
- F. Where air handling units are to be installed in existing areas with limited access the contractor shall require the unit manufacturer to ship the units in segments that allow installation through existing construction. Provide shipping segments dimensions to the manufacture.
- G. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods.
- H. 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.
- I. 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.
- J. Where required, install exterior mounted units install roof curb on roof structure level and secure and per the manufacturer's installation instructions. Secure units to the curb.
- K. Where required, install wind and seismic restraints according to manufacturer's written instructions.

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- L. At the direction of the Owner's Representative the contractor shall remove and dispose of filters from the respective units and install a new filter obtained from the Extra Materials required in Part 1 of this specification. If additional filter installation is not required, forward filters to the owner as extra stock, at the completion of the project.

3.5 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate piping to drain pans and extend to nearest equipment or floor drain. Construct trap at connection to drain pan per the manufacturer's requirements and install cleanouts at changes in direction.
- E. Hot and Chilled-Water Piping: Install control valve, 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.

3.6 FIELD QUALITY CONTROL

- A. Engage a factory service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections and to provide start-up service.
- B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 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.

3.8 DEMONSTRATION

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

END OF SECTION 23 73 10