SECTION 23 76 13 - PACKAGED AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 01 00, "Mechanical General Provisions", govern this Section.

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide field or factory-assembled air handling units and components as shown, scheduled, and indicated on the Drawings.

B. Types: The types of air handling units required for this project include:

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1. Single-zone constant volume indoor air handling units.
2. Single-zone variable air volume indoor air handling units.
3. Multizone indoor air handling units.

1.3 QUALITY ASSURANCE:

A. Manufacturer: Provide products complying with these specifications and produced by the following:

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1. Carrier.
2. McQuay (part of Daikin Industries).
3. Thermal.
4. Trane.
5. York.

B. Coil Certification: Coils shall be designed and rated in accordance with ARI Standard 410.

C. AMCA Seal: Fans shall be designed and rated in accordance with AMCA Standards and shall bear the AMCA Seal.

D. Vibration Testing: Factory-vibration testing shall be provided as specified in Paragraph 2.01/C.

E. Pressure Leakage Testing: Coils shall be factory leak tested as specified in Paragraph 2.03/A.

F. [Damper Leakage: Multizone dampers shall be factory-certified per AMCA Standard 500-74.]

1.4 SUBMITTALS:

A. Shop Drawing submittals shall include, but not be limited to, the following:

1. Certified drawings showing overall dimensions of complete assembly, weights, support requirements, sizes, location of connections, accessories, and parts list.
2. Cut sheets on all air handling equipment, clearly marked to show sizes, configuration, construction, features, accessories and other pertinent information.
3. Curves showing fan performance and system operating point plotted on curves. Data to substantiate that fan can operate in a stable range with a static pressure 1/2" above that schedule, and that the fan motor is sized accordingly.
4. Coil performance selection data showing all criteria identified on equipment schedule. Certify the coils will meet performance criteria on equipment schedules.
5. **[Complete information on the Variable Air Volume modulation method to be furnished.]**
6. Required torque for all motor-operated dampers **[and inlet vanes]** information on shaft sizes and location in unit and amount of space available for motor operators.
7. Performance certifications based on applicable ARI Standards and prototype unit test reports.
8. Product warranties and guarantees.

9. Wiring diagrams.
10. Written instructions for installation including assembly where not factory-assembled.
11. Motor data as required in Section 23 04 00.
12. Additional information as specified in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air handling units in factory-fabricated water-resistant wrapping.
B. Handle air handling units carefully to avoid damage to material components, enclosure, and finish.
C. Store air handling units in a clean, dry space and protect from the weather.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Draw-thru Type Air Handling Units: Provide draw-thru type air handling units complete with fan section, **[inlet vanes] [magnetic variable speed drives] (variable air volume units only),]** adjustable blower drive for balancing, and fixed drive for permanent installation with motor mounted on resilient base, V-belt drive with guard, air filter section, **[heating coil section,]** cooling coil section, condensate drain pan, and other attached sections indicated on Drawings, specified herein or required to accomplish the specified control sequences.

B. Blow-thru Type Air Handling Units: Provide blow-thru type air handling units complete with fan section, **[inlet vanes] [magnetic variable speed drives] (variable air volume units only),]** adjustable blower drive for balancing, and fixed blower drive for permanent installation with motor mounted on resilient base, V-belt drive with guard, air filter section, cooling coil section, air distribution grid, **[bypass section with equalizing baffles,]** condensate drain pan, **[custom low leakage zone mixing damper section (multizone units only),]** and other attached sections indicated on the Drawings, specified herein or required to accomplish the specified control sequences.

C. General Construction: Fans, sheaves, motors, and belts shall be factory-assembled and balanced with the fan section casing. Air handling unit fans, bearings, and fan sheave shall be balanced to a maximum of 2 mil in all axes and shall be so certified by the manufacturer prior to installation. The manufacturer shall conduct vibration tests on all units after they have been installed in the field. Vibration shall not exceed 2 mils in all axes and shall be so certified by the manufacturer in writing prior to the Contractor placing the unit in service. Replace all components that cannot meet these balance and vibration requirements.

D. Capacity: Unit characteristics, size, type, capacity, and arrangement shall be as scheduled and shown on the Drawings. Unit shall be capable of stable operation at a static pressure 1/2" above that scheduled and the fan motor shall be sized accordingly.

2.2 HOUSING:

A. General: Housing shall be airtight, of sectionalized design with suitable gaskets between sections. Materials shall be phosphatized, bonderized or galvanized steel of lock-forming quality. Steel angle framework shall be designed to provide maximum rigidity, prevent pulsation and shall be of the same finish as the housing. Housing shall include fan section and coil sections with drain pan.

B. Finish: Galvanized metal shall not be painted. Phosphatized or bonderized metal shall be finished with rust-inhibiting paint.

C. Coil Section: All connections, coil headers, and return bends shall be completely enclosed. Coil frames shall not be used as reinforcing for the housing. Construction shall be such that the coils can be removed through access panels without affecting the structural integrity of the casing.

D. Drain Pan: Provide a rigid and watertight drain pan with pipe drain connection under the complete coil section on horizontal units and under the fan and coil section on vertical units. Drain pan shall be of the double pan insulated type with a **[316L stainless *(preferred)*] [galvanized] s**teel inner pan and a galvanized or painted steel outer pan. **[The inner pan shall be coated with corrosion resistant elastomeric material.]** Insulation shall be one inch (1") thick, high density fiberglass cemented and vapor sealed between the inner and outer pan. Foamed in place, closed cell insulation is not allowed.

[An] [A 316L stainless steel] intermediate condensate drip pan shall be provided on all coils over 48" high. Intermediate drain pans shall be factory-piped to main condensate drain pan. Drain pans shall be positively sloped internally to external drain connections as shown on the Drawings.

E. Access Doors: Provide access doors a minimum of 3/4 of a square foot, but no larger than 6 square feet in size, in the fan and coil sections for inspection and/or access to internal parts. Doors with one dimension 12" or less, shall be equipped with Ventlok Style 100 latch. All other doors shall be equipped with Ventlok Style 140 latch and Ventlok Style 150 hinges. Locate door to allow inspection regardless of mounting arrangement. Door insulation shall be separate from unit insulation and shall be secured and sealed to the door.

F. Insulation: Housings shall be internally insulated with minimum one inch (1"), 3 pound density Manville "Lina-Coustic", "Exact-O-Mat", "Tuf-Skin", or "Aeroflex 200B". All exposed parts such as angles, braces, and similar items in contact with exterior surfaces shall be covered with insulation to prevent condensation on the exterior casing. Insulation shall be installed to allow panel removal without disturbing insulation. Insulations shall be secured to the casing surfaces and framework with adhesive over entire surface and stick clips, grip nails, or weld pins with fasteners on approximate 24" centers. The insulation shall be protected from delamination or fretting by coating exposed edges with adhesive or mastic. All insulation shall have a composite fire and smoke hazard rating as specified in Section 15200, "System Insulation".

2.3 COILS:

A. General: Coils shall have capacities and ratings as scheduled and shall be rated by the manufacturers in accordance with ARI Standard 410. Noncertified coils will not be acceptable.

B. Core Construction: Coils shall be constructed of copper tubes with **[aluminum] [or] [copper]** plate fins **w**ith a maximum of **[eight] [twelve]** fins per inch and shall be arranged for counterflow operation. Spiral fins are not allowed. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes **[or by spiral welding under tension]**. Supply and return connections shall be on the same end of the coil. Tubes shall be 1/2" or 5/8" OD spaced approximately 1-1/2" apart, with a minimum wall thickness of **[0.020"] [0.035"]**. Flat fins shall have a minimum wall thickness of 0.0055". Tapered smooth fins shall taper in thickness from 0.01" at point of contact to 0.005" at the periphery.

C. Headers: Coil headers and connections shall be constructed of heavy wall copper or IPS brass. Joints between core tubing and headers shall be of a recessed swage design to provide a large mating area for brazing. Supply and return connections shall be terminated NPT threaded connections with wrench flats.

D. Casings: Coil casings shall be constructed with structural angle shapes bolted with stainless steel bolts and rigidly supporting the coil assembly. Casing frame members shall extend over the ends and edges of the coil and shall have formed holes for tubes, permitting free expansion and contraction of coil components. Intermediate tube supports shall be provided such that maximum unsupported tube length does not exceed 48". Casings, including all supports and frames, shall be constructed of **[316L stainless steel] [for all cooling coils] [and preheat coils] [and] [galvanized steel]** for all **[heating]** coils.

E. Miscellaneous Requirements:

1. Coils installed in series shall have a minimum of **[12"] [_____"]** between the faces with provisions for access between the faces for cleaning.
2. Provide drain and air vent connections, except where the coil header piping is designed to be self-venting.
3. Test coils by air pressure under water at 1-1/2 times the pressure classification indicated on the Plans. The test pressure shall in no case be less than 250 psig, nor more than 500 psig.

F. Chilled Water Cooling Coils: Coils shall be a minimum of **[six] [eight]** rows deep. Cooling coil capacity, maximum face velocity, and maximum air pressure drop shall be as scheduled. Water velocity in the tubes shall not exceed 5' per second and the water pressure drop through the coil shall not exceed **[10'] [20']**, unless lower maximums are scheduled. All cooling coils shall be installed in a vertical position (perpendicular to airflow) to minimize condensate carry over. Coils shall be designed

and certified by the manufacturer to operate at the scheduled face velocity plus 10% without moisture carry over.

G. Hot Water Heating Coils: Coils shall be furnished in the unit where scheduled and shall have a minimum of two rows. Heating coil capacity, maximum face velocity and maximum air pressure drop shall be as scheduled. Coils shall be installed in the bypass or heat position, except in outside air units where the coils shall be in the preheat position. Water velocity in the tubes shall not exceed 5'per second and water pressure drop shall not exceed 10', unless lower maximums are scheduled.

2.4 MOTORS:

A. General: Motors shall be open dripproof (ODP), 3-phase, 1750 rpm, unless noted or scheduled otherwise. All motors shall be high efficiency, energy efficient type. Motor selection shall be such that the motor will not overload if the static pressure drops 1/2" below or rises to 1/2" above the specified value. Motors shall be mounted on the coil connection side, unless indicated otherwise and the motor shall be mounted on an adjustable base rigidly supported to the unit. The motor shaft shall accommodate an adjustable pitch motor sheave. Refer to Section 15140 for additional motor requirements.

2.5 FANS AND DRIVES:

A. Centrifugal Fans: Provide double width, double inlet, multiblade type fans with air foil, forward curved or backward inclined blades, as scheduled. All fans shall be statically and dynamically balanced and tested after being installed on properly sized shafts. Fan shafts must not pass through their first critical speed as unit comes up to rated rpm. Fan wheels and scrolls shall be constructed of galvanized steel, all aluminum or fabricated steel protected with two coats of rust-inhibiting paint. Wheels and scrolls of fans used for outside air service shall be coated with two coats of fire resistant epoxy paint.

B. Drives: Select drives for a minimum belt horsepower capacity of 150% of the motor nameplate horsepower. Provide selection calculations with the drive submittal. The selection calculations shall include the correction factor for arc of contact.

C. Sheaves: Permanent fan sheaves shall be nonadjustable with removable machined bushings, machined on all contact surfaces. Sheaves with over three grooves shall be dynamically balanced and so designated on each sheave. Fan sheaves with three grooves or less shall be statically balanced and if weights are required, they shall be welded to the sheave. Sheaves shall be manufactured by Browning, Eaton Yale and Towne, Dodge Manufacturing Company or Fort Worth Steel and Machinery Company.

1. Typical Floor Air Handling Unit: Provide a nonadjustable type sheave selected for the rated fan rpm as determined. Provide variable sheaves as required to determine correct fan rpm as established by tenant requirements. Furnish additional fixed sheaves as required after correct speed has been determined. All unused fixed sheaves shall become the property of the Owner.
2. Nontypical Air Handling Unit: Provide Browning Type LVP, MVP, or approved equal, adjustable-type with double locking feature. Motor sheave shall be selected for the fan rpm determined by the fan capacity scheduled and shall be adjustable to as close as 10% above and below the rated fan speed. Furnish and install fixed sheaves on units that require more than two belts, after correct speed has been determined with the variable sheave.

D. Belts: Provide "V-groove" type suitable for the service intended with the capacities specified. Belts shall be closely matched and tagged for use prior to shipment. Recheck belts for proper match during operation and if necessary, replace with closely matched belt sets. Belts shall be Gates, Durkee-Atwood, Goodyear, Uniroyal or Browning.

E. Shafts: Provide one piece design shafts, either solid or hollow tube with solid stub. Hollow tube with solid stub shafts shall be hot-formed, stress relieved, and manufactured by Pittsburgh Tubular Shafting, Inc. Fans and shafts shall not pass through their first critical speed as the unit comes up to rated rpm.

F. Shaft Bearings: Provide externally or internally mounted grease lubricated, self-aligning ball or roller bearings on each end of the shaft. Bearings shall have an average B-10 life as defined by AFBMA of **[100,000] [200,000] [_____]** hours at design operating conditions. All bearings shall be the same size. Internally mounted bearings shall have grease lines extended so as to be readily

accessible from the drive side of the unit. In addition, the bearing on the drive end of the shaft shall have grease line extended beyond the belt guard. All grease lines shall terminate in a zerk fitting. Bearings shall be by SKF, Sealmaster, Timken, or Fafnir.

2.6 BELT GUARDS:

A. General: Provide belt guards for all fan drives mounted outside the unit housing. The finish of the guard shall be similar to that of the unit housing. Brace and fasten guards to prevent objectionable vibration. Provide tachometer openings at least 2" in diameter for checking fan and motor speeds. Openings shall be centered on shafts to allow checking rpm.

2.7 FILTERS:

A. General: Provide, as a part of the factory package, filter sections to accommodate the filters of the type and style scheduled and specified at maximum filter face velocity of 500 fpm. Filters shall be as scheduled and specified in Section 23 41 13, "Filters and Accessories".

3.1 DAMPERS:

A. General: Provide dampers capable of being motor operated as required under the applicable temperature control section.

B. Construction: Dampers shall be galvanized steel and mounted as a single assembly locked securely to a galvanized steel rod that rotates on nylon or teflon bushings. Dampers shall be sectionalized to limit blade length to 50" maximum to prevent excessive blade warping. Closed cell neoprene, vinyl polyester or polyurethane blade edging shall be installed to assure tight closure.

C. Multiple Zone Dampers:

1. General: Provide low leakage zone dampers with aluminum or galvanized steel blades, galvanized steel or brass shafts, brass or teflon end bearings, and galvanized steel or aluminum frames. Blades shall be a maximum of 8" wide.

2. Leakage: Leakage rate for dampers and damper section shall not exceed **[10 cfm] [_____ cfm]** per square foot of damper face area at 3" WG static pressure, with a maximum closing torque of 4 inch-pound/square foot of damper face area. Certified AMCA laboratory test data in accordance with AMCA Test 500, shall be submitted to Engineer for review.

3. Linkage: Provide factory-customized linkage, factory-mounted and adjusted, with one operator rod per zone extended for field-connection of a motor operator.

4. Submittals: Damper construction, linkage hardware, zoning arrangements, and provisions for motor operation connections shall be submitted for review.

D. Inlet Mixing Dampers: Provide a mixing box section with ganged vertical, low leakage, opposed blade dampers positioned across the short dimension of each air opening. Each set of dampers in either air inlet shall be offset with respect to the dampers in the other air inlet to provide high efficiency mixing through generation of relative velocity between the merging narrow air streams at different temperatures.

E. Face and Bypass Dampers: Provide low leakage coil face and bypass dampers for **[heating] [cooling]** coils as scheduled.

2.8 **[VAV MODULATION:]**

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A. [General: Air handling unit variable air volume (VAV) modulation shall be via [solid state variable speed drives as specified in Section 23 04 10, "Electronic Variable Speed Drives",] [magnetic variable speed drives *(preferred)*] [[variable fan inlet vanes] mechanical variable speed drives] [pneumatically controlled dump dampers].]

B. [Inlet Vanes: Provide controllable steel inlet vanes in the inlet of variable air volume fans to vary air volume from full volume to full shut-off. The inlet vane edges shall be form fit to the fan inlet cone circumference. Inlet vanes shall be operated from a center or perimeter controlling mechanism with [machined bronze] [roller] bearings through a control linkage suitable for motor operation.]

[OR]

C. [Magnetic Variable Speed Drive (VSD): Provide Magna-Speed IKV series or approved equal magnetically controlled VSD's for fan speed modulation. Drive shall consist of a fan-armature assembly mounted directly on the motor shaft and a V-belt sheave assembly on support bearings. Application of dc voltage via slip rings to the armature coil shall magnetically couple the two components causing the V-belt sheave assembly to rotate at a speed which varies with the applied dc voltage and resultant magnetic field strength. A "frequency" signal proportional to the speed of the V-belt sheave assembly shall provide feedback to the drive controller for speed control.]

D. [Drive Controller: The magnetic VSD controller shall be a MPS, Inc. ED 450-C/ED 900-C series or approved single unit controller containing all components required for operation of the drive in response to an external 4-20 mA analog control signal. The controller shall include, but not be limited to, the following features and options:

1. **NEMA 12 enclosure with labeled manual/off/auto selector switch, manual speed control potentiometer and digital speed display on the cover.**
2. **120 volt, ac input, 45 or 90 volt dc output power supply, as required.**
3. **Status monitor LED's for controller setup.**
4. **Speed meter drive card.**
5. **[4-20 mA current] [pneumatic] input follower card.**
6. **Digital frequency (speed) feedback from drive.**
7. **Adjustable minimum and maximum speed.**
8. **Adjustable torque limit.**
9. **Independently adjustable (0-40 seconds) acceleration and deceleration ramp speeds for "soft" start and stop.]**

E. [Fan Drive Sheave: Fan drive sheave shall be selected to allow fan operation at 110% of design fan speed with magnetic VSD operating at 100% drive speed.]

[OR]

F. [Mechanical Variable-Speed Drives: shall be a factory-installed variable-speed drive system which is capable of fan speed reduction to approximately 40% of design rpm. Drive design shall provide a service factor of 1.4. The drive assembly shall consist of a fan motor mounted on a movable base, a spring loaded variable pitch drive pulley, two fixed-pitched jackshaft pulleys and a fixed pitch fan shaft pulley. The jack-shaft shall be solid steel and shall be supported by regreasable pillow block bearing, selected for an average life of 200,000 hours at design condition. All drive belts shall be factory-furnished. The movable motor base shall be fitted with permanently lubricated bronze bearing which shall ride on polished chrome rails. The motor base shall be chain driven by a 1/10 hp reversing type gear motor. Control shall be via a factory-furnished, field mounted electric control panel. The panel shall contain control relays, a manual fan speed switch, a fan starter auxiliary contact, a mode switch, control transformer, gear motor start capacitor and terminal block. The control shall be activated by a duct mounted pneumatic static pressure sensor furnished under Section 23 06 00, "Building Control and Automation (BCAS)". Mechanical variable-speed drives shall be Carrier Modudrive, McQuay (part of Daikin Industries) Max-E-Drive or an approved equal.]

[OR

G. [Pneumatic Dump Dampers: Dampers and controls shall be as specified in Section [_____, "_____"].]

PART 3 - EXECUTION

3.1 AIR HANDLING UNIT INSTALLATION:

A. General: Install air handling units in accordance with the manufacturer's written recommendations and as detailed on the Drawings.

B. Housekeeping Pads: Install floor mounted air handling units on reinforced concrete housekeeping pads as specified in Section 23 03 00.

C. Vibration Isolators: Air handling units shall be installed with vibration isolators as specified under Section 23 05 48, and separated from ductwork with flexible duct connections.

D. Drain Connections: Pipe condensate **[directly to a primed floor drain via a P-trap for blow-through units and]** via a P-trap to a primed floor drain **[for draw-through units]**. Provide P-traps on air handling unit condensate drain connections with seal depths at least equal to the total static pressure of the unit as installed. P-traps shall be constructed of pipe and tees as detailed on the Drawings. Elbows shall not be used. All unused openings of tees shall be closed with removable plugs which shall serve as cleanouts.

E. Coil Pull Space: Air handling units shall be installed with adequate space to allow unit coils to be removed **[without demolition of building construction]**. Coil pull space **[and any required demolition of building construction]** shall be clearly indicated on As-built Drawings. The Contractor shall insure that all field-piping, valves, ductwork, and other obstructions are not in the way or can be easily removed with flanges to facilitate coil removal.

F. Vents and Drains: Provide **[manual] [automatic]** air vents and drain **[plugs] [valves with hose connections and caps]** for each coil section.

3.2 AIR FILTERS:

A. General: Unit shall be furnished and installed all filters as required for start-up.

B. Filters and Accessories: Install filter racks, housings, and filters in accordance with the manufacturers' written installation instruction.

C. Filter Sizes: In all cases, filters shall be of the proper size and installed in filter racks in such a manner that there will be no leakage of air around filters. Filters which have been torn, distorted, or damaged in any other way will not be acceptable.

D. Temporary Prefilters: Provide blanket insulation or roll filter media over the pleated prefilters as temporary filter.

E. Spare Filters: Furnish one complete stock of replacement filters and media, sufficient to replace all filters on each of the unit, to the Owner for maintenance use. Filters shall be delivered in their original, unopened containers, and stored as directed by the Owner.

3.3 TESTING AND BALANCING:

A. General: Refer to Section 23 05 93 for air handling unit testing and balancing.

B. Vibration Testing: Provide field vibration testing as specified in Paragraph 2.01/C.

3.4 IDENTIFICATION:

A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 76 13