

University of Houston Master Specification

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SECTION 23 7313 - MODULAR INDOOR AIR-HANDLING UNITS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Maintain Section format, including the UH master spec designation and version date in the center columns of the header and footer. Complete the header and footer with Project information.

This Section uses the term "Engineer." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:
 - 1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
 - 2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction*.

1.2 DESCRIPTION OF WORK

- A. Section Includes: Provide factory-assembled air handling units and components as shown, scheduled, and indicated on the Drawings.
- B. Types: 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. Multi-zone indoor air handling units.

1.3 QUALITY ASSURANCE

- A. Coil Certification: Coils shall be designed and rated in accordance with AHRI Standard 410.
- B. AMCA Seal: Fans shall be designed and rated in accordance with AMCA Standards and shall bear the AMCA Seal for air and sound.
- C. Vibration Testing: Factory-vibration testing shall be provided as specified.
- D. Pressure Leakage Testing: Coils shall be factory leak tested as specified.
- E. **[Damper Leakage: Dampers shall be factory-certified per AMCA Standard 500D.]**

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1.4 ACTION SUBMITTALS:

- A. 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 ½ inch 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 AHRI 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 0400 "Motors and Controllers."
 12. Additional information as specified in Section 23 0100 "Mechanical General Provisions."

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.

1.6 WARRANTY

- A. Warranty: The entire air-handling unit(s) shall have a minimum **[one]** **[Insert duration]** year warranty from date of **[Substantial Completion]** **[Insert start date]**.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provided products produced by one the following:

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1. Carrier.
2. Daikin.
3. Thermal.
4. Trane.

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2.2 PERFORMANCE

- A. Casing Deflection: [**L/240**] [**Insert deflection**] when tested at a pressure of [**6 inches w.c.**] [**Insert pressure**].
- B. Casing Leakage: [**One percent**] of design airflow when tested at a pressure of [**6 inches w.c.**] [**Insert pressure**].
- C. Casing Thermal Requirements: Minimum R-value [**8**] [**Insert value**].
- A. Access: Unit components shall be accessible through access doors. Where components are larger than the access doors or cannot reasonably be removed through an access door, provide removable sections to facilitate component removal. Disassembly of cabinet or cabinet structure is not an acceptable method of component removal.

2.3 GENERAL

- A. Draw-thru Type Air Handling Units: Provide draw-thru type air handling units complete with fan section, [**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, [**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 (multi-zone 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.

2.4 HOUSING:

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- A. General: Casing 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 casing. Casing 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 304 stainless steel inner pan. 304 stainless steel intermediate condensate drip pan shall be provided on all coils over 48 inches 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.
Access Doors: Locate doors to allow inspection and service on internal components regardless of mounting arrangement. Door size must be at least **[24][Insert width]** inches wide and full panel height up to 72-inches tall. For units above 72 inches tall, provide 72-inch high doors. Access door construction shall equal or exceed the quality of air-handler casing materials. Access doors shall open against positive air pressure, unless they are the outer doors of the air lock entrances or approved by the Owner in writing.
- E. Insulation:
1. Casings for double wall units shall be thermally and acoustically insulated.
 2. Insulation shall be minimum two inch thick.,
 3. Insulation R-value shall not be less than **[R-8][Insert Requirement]**.
 4. 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.
 5. Insulation shall be installed to allow panel removal without disturbing insulation.
 6. Insulation shall be installed between the panel walls to prevent air flow over the insulation and to allow removal without disturbing the insulation.
 7. All insulation shall have a composite fire and smoke hazard rating complying with NFPA 90A.
 8. When exposed to the airstream the combustion rating of insulation and adhesives shall not exceed a flame spread ration of 25 and a smoke development rating of 50 when tested in according to ASTM E84 and NFPA 255.

2.5 COILS:

- A. General: Coils shall have capacities and ratings as scheduled and shall be rated by the manufacturers in accordance with AHRI Standard 410.
- B. Core Construction: Coils shall be constructed of copper tubes with **[aluminum]**plate fins with a maximum of **[eight] [twelve]** fins per inch and shall be arranged for counterflow operation. Fins shall be bonded to the tubes by means of mechanical expansion of the tubes. Supply and return connections shall be on the same end of the coil. Tubes shall be ½ inch or 5/8 inch OD spaced

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approximately 1-1/2 inch apart, with a minimum wall thickness of **[0.020 inch]**. Flat fins shall have a minimum wall thickness of 0.0055 inch.

- 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 casing components shall be joined with stainless steel bolts to create a rigid 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 304 stainless steel **[for all cooling coils] [and preheat coils] [and] [galvanized steel]** for all **[heating]** coils.
- E. Miscellaneous Requirements:
1. Minimum tube velocity at design flow rate shall be **[3] [Insert velocity]** feet per second.
 2. Coils installed in series shall have a minimum of **[12 inches] [_____ inches]** between the faces with provisions for access between the faces for cleaning.
 3. Provide drain and air vent connections, except where the coil header piping is designed to be self-venting.
 4. 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' feet per second and the water pressure drop through the coil shall not exceed **[10 feet] [15 feet]**, 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. 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 feet per second and water pressure drop shall not exceed 10 feet, unless lower maximums are scheduled.

2.6 MOTORS

- A. General: Motors shall be open drip proof (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 ½ inch below or rises to ½ inch 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 23 0400 "Motors and Controllers" for additional motor requirements.

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2.7 FANS AND DRIVES

- A. Centrifugal Fans: Provide double width, double inlet, multi-blade 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.
 - 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. Non-typical 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.
- E. Shafts: Provide one piece solid design shafts. 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 L-10 life as defined by AFBMA of **[100,000] [200,000] [Insert value]** 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.

2.8 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 inches in diameter for checking fan and motor speeds. Openings shall be centered on shafts to allow checking speed.

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2.9 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 4000 "Filters and Accessories."

2.10 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 inches wide.
 2. Leakage: Leakage rate for dampers and damper section shall not exceed leakage allowed by ASHRAE 90.1.
 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. Mixing Dampers: Provide a mixing section with ganged vertical, low leakage, opposed blade dampers. 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.

2.11 [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 26 2923 "Variable Speed Drives",] [magnetic variable speed drives] .]**

[OR]

- B. **[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**

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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.]

- C. [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.]
- D. [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.]

2.12 AIR HANDLING UNIT SPECIALTIES

- A. Ultra-Violet (UV) Germicidal Irradiation (UVGI) Systems

[NOTE: SCHEDULE UVGI LIGHTS FOR RECIRCULATION/MIXED AHU'S ONLY. NOT FOR 100% OUTSIDE AIR AHU'S]

1. Where scheduled on the Drawings for recirculation/mixed AHUs only, provide factory installed UVGI lamps. Lamps shall provide a minimum irradiance of 9 Watts per square foot or 96.54 Joules per square meter at the cooling coil surface and at the coil leaving air temperature scheduled on the Drawings.
2. UV lamps shall be located:
 - a. Downstream of cooling coils
 - b. Above condensate drain pans
 - c. Upstream of final filtration sections on blow-through units only
3. UV Lamps and ballasts shall be UL listed for application in air handling systems.
4. UV lighting systems shall be moisture resistant with electronic ballasts and shall be wired using moisture resistant conduit.
5. UV lamps shall be capable of being switched ON and OFF at the respective AHU section access door.
6. UV lamps shall be interlocked with access door position limit switches such that they are de-energize when the doors open.

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7. UV lamps shall be installed on a stainless steel grid using stainless steel fasteners in accordance with the manufacturer's installation instructions.
8. Air-handling units with view port windows from which the lamps can be seen shall be labeled to warn of possible eye damage.
9. Replacement lamps for UV systems shall be standard types which are not proprietary and are available from multiple sources.
10. All penetrations through AHU walls shall be thoroughly sealed to ensure no leakage. All UV susceptible materials in the AHU shall be shielded from line of sight UV. Installer shall remove all foreign matter such as dirt and metal shavings upon completion of installation.
11. UV lamp life shall be 9000 hours with no more than a 20 % output loss at the end of one year of continuous use.

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 0300 "Basic Materials and Methods."
- C. Vibration Isolators: Air handling units shall be installed with vibration isolators as specified under Section 23 0548 "Vibration Isolation" 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.

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- 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 Pre-filters: Provide blanket insulation or roll filter media over the pleated pre-filters 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, ADJUSTING AND BALANCING:

- A. General: Refer to Section 23 0593 "Testing, Adjusting and Balancing for HVAC" for air handling unit testing, adjusting and balancing.
- B. Vibration Testing: Provide field vibration testing as specified.

3.4 IDENTIFICATION:

- A. Refer to Section 23 0300 "Basic Materials and Methods" for applicable painting, nameplates, and labeling requirements.

END OF SECTION 23 7313