

SECTION 23 74 20 - CUSTOM 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:

[edit to suit project]

1. Single-zone constant volume indoor air handling units.
2. Single-zone variable air volume indoor OA pretreat air handling units.
3. Single-zone variable air volume indoor air handling units.
4. Double duct indoor air handling units.

1.3 QUALITY ASSURANCE:

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

[edit to suit project]

1. Haakon.
 2. Engineered Air.
 3. ClimateCraft.
 4. Energy Labs.
 5. Temtrol
- 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 2.1/B.
 - E. Pressure Leakage Testing: Coils shall be factory leak tested as specified in Paragraph 2.03/A.
 - F. **[Damper Leakage: Dampers shall be factory-certified per AMCA Standard 500Ä74.]**
 - G. Acoustical Testing: Provide acoustical acceptance testing in a mocked up project installation as specified in Paragraph 2.11.
 - H. **[Unit Run Test: Factory run test entire unit at design speed and simulated discharge static pressure and furnish report for housing integrity (panel deflection), leakage, acoustical acceptability, vibration, electrical system operation, module fit, workmanship and finish appearance prior to shipment from the factory. A complete vibration spectrum shall be conducted as specified in the section covering the fan described hereinbefore. Any fan, motor, drive and base assembly vibration shall be brought to within specified levels prior to unit shipment. Fan tests as conducted in the fan supplier's shop are not acceptable. Motor and drive vibration must be checked with the fan installed as a total assembly.]**

- 1.4 Ifactory-testing for vibration, acoustical performance and unit run testing shall be witnessed by the Owner's Representative. The Contractor shall pay for air fare, accommodations, and similar expenses so that two Owner's Representatives can witness the test.

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. Bearing sizing calculations for each similar size and type of unit. Fan bearing calculations shall be based on fan at maximum operating conditions. Complete information on the Variable Air Volume modulation method to be furnished.
 6. Required torque for all motor-operated dampers 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. Prototype sound power levels for each size and type of air handling unit at operation conditions specified. Sound levels shall be in all eight octave bands for: discharge off unit, inlet to unit, and radiated noise through fan section casing. Proposed test mockup layout and testing procedure for unit sound level acceptance testing. Detailed shop drawings showing all dimensional data, including, but not limited to, gauges of sheet metal, panel reinforcing, size and weight per linear foot of structural base members, floor reinforcing, base reinforcing at internal equipment supports, construction details, damper information, filter frames, etc. Information shall be complete in all respects necessary for Architect/Engineer to evaluate the complete construction of the unit.
 9. Performance certifications based on applicable ARI Standards and prototype unit test reports.
 10. Product warranties and guarantees.
 11. Wiring diagrams.
 12. Written instructions for installation including assembly where not factory-assembled.
 13. Motor data as required in Section 23 04 00.
 14. 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. Single Zone Draw-thru Type Air Handling Units: Provide draw-thru type air handling units complete with sound attenuating housing, plug fan section, adjustable blower drive for balancing and fixed drive for permanent installation with motor mounted on resilient base, V-belt drive with guard, fan intake plenum, access sections, pre-filter section, final filter air filter sections, cooling coil section, condensate drain pan, **[heating coil section,] [preheat and reheat coil sections,]** outside air damper (outside air units only) and other attached sections indicated on Drawings, specified herein or required to accomplish the specified control sequences.

- B. **Double Duct Air Handling Units:** Provide blow-thru type air handling units complete with sound attenuating housing, fan section, 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, **[heating coil section,]** air distribution grid, **[bypass section with equalizing baffles,]** condensate drain pan, and other attached sections indicated on the Drawings, specified herein or required to accomplish the specified control sequences.
- 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 placing the unit in service. Replace all components that cannot meet these balance and vibration requirements. Unit shall be constructed with the required field splits for rigging, installation and assembly on the jobsite.
- 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, double wall 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. **[Interior Perforated Liner (Downstream of Final Filters): Each unit shall be constructed with an interior perforated liner which shall protect the insulation while allowing acoustical absorption. Insulation shall have a continuous covering of Tedlar film under the perforated liner such that there is not any insulation directly exposed to the air stream downstream of final filters. Liner shall be electrically and thermally insulated from the galvanized steel housing to prevent galvanic action of the two dissimilar metals by use of an acrylic/sealant. Perforated liner shall be 0.030" thick aluminum.]**
- [Interior Perforated Liner (Except Downstream of Final Filters): Each unit shall be constructed with an interior perforated liner which shall protect the insulation while allowing acoustical absorption. Liner shall be electrically insulated from the galvanized steel housing to prevent galvanic action of the two dissimilar metal by use of an acrylic adhesive/sealant. Perforated liner shall be 0.030" thick aluminum.]**
- C. Finish: Galvanized metal shall not be painted. Phosphatized or bonderized metal shall be finished with rust-inhibiting paint.
- D. 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.
- E. Drain Pan: Provide a rigid and watertight positively sloped IAQ 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 steel inner pan and a galvanized or painted steel outer pan. Insulation shall be one inch (1") thick, high density fiberglass cemented and vapor sealed between the inner and outer pan or 1/2" thick foamed in place, closed cell insulation. 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.
- F. Access Doors: Provide windowed 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 double wall constructed door. All access doors shall include 8" x 8"

(minimum) dual pane with wire mesh observation window. Fan section access doors shall be equipped with a factory-installed and wired blower motor / access kill switch.

- G. Insulation: Housings for double wall units shall be thermally and acoustically insulated with minimum two inch (2"), 1-1/2 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. Where condensation may occur the exterior wall shall be aluminum, stainless steel or a coated metal to prevent corrosion. Insulation shall be installed between the panel walls to prevent air flow over the insulation and to allow removal without disturbing the insulation. 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. Non-certified coils will not be acceptable.
- B. Core Construction: Coils shall be constructed of copper tubes with [aluminum] [or] [copper] plate fins with a maximum of **[8] [12] []** 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 1/2" or 5/8" OD spaced approximately 1-1/2" apart, with a minimum wall thickness of **[0.020"] [0.024"] [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 admiralty 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.

Miscellaneous Requirements:

1. Coils installed in series shall have a minimum of **[12"] [18"] []** between the faces with provisions for access between the faces for cleaning.
 2. Provide internal light for each access, coil and fan section. Light shall be vaporproof with glass globe and guard. Lights shall be prewired to a 120 volt external disconnect switch. 120 volt 15 amp circuit shall be furnished by Division 16.
 3. Provide 12 ga. galvanized steel treadplate for all floor spaces of access sections and fan section.
 4. Provide drain and air vent connections, except where the coil header piping is designed to be self-venting.
 5. 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.
- E. Chilled Water Cooling Coils: Coils shall be a minimum of **[minimum] [maximum]** of **[six] [eight]** rows deep or as scheduled. **[Where more rows are required, multiple coils shall be provided.]** 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.

- F. 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.
Steam Heating Coils: Coils shall be furnished in the unit where scheduled and shall have a minimum of two rows or as scheduled. Heating coil capacity, maximum face velocity and maximum air pressure drop shall be as scheduled. Coils shall be installed in the heat position, except in outside air units where the coils shall be in the preheat and reheat positions.
- G. Bypass Deck Baffle: On dual duct units, the coil position on the neutral deck shall have a perforated stainless steel plate installed in lieu of a coil. The plate shall be rigidly mounted and shall have an air pressure drop equal to the cold duct cooling coil.
Coil Access/Pull: All hot water and chilled water coils shall include a removable cover plate mounted in the side of the unit casing for future coil repair/removal. This cover plate shall be located on the side of the unit required for coil removal with the unit installed as shown on the Drawings. The Contractor and unit manufacturer shall coordinate exactly where coil access cover must be located on each unit. All unit submittal drawings must show the access cover. The access cover shall be the same gauge as the unit housing, with gasket or sealant strips and attachment screws provided.
- H. MOTORS/ELECTRICAL:
General: Motors shall be open drip-proof (ODP), 3-phase, 1750 rpm, unless noted or scheduled otherwise. All motors shall be premium efficiency 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 23 04 00 for additional motor requirements. All motors shall be factory mounted and wired to an external junction box.
[Lighting and Power: Provide a minimum of one vapor-proof fluorescent light fixture in each module. Module light shall be controlled from a light switch. [Each module will be provided with one convenience outlet, at the inside of each door.] Wiring from lights fixture to switch shall be by unit manufacturer. Unit light fixture [and receptacles] shall be factory-wired to a single external junction box for a single circuit 120 volt, 20A power connection by Division 16.]
Wiring: All wiring shall be 600 volt rated type THHN/THWN stranded copper, enclosed in EMT or Liquidtight flexible conduit (maximum 3'). All junction boxes shall be UL-approved and gasketed.

2.4 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. Fan and fan drive shall be internally spring isolated.
- 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. 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 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.
- G. Vibration Isolation: All units shall be internally spring isolated and mounted on pipe columns with ribbed neoprene pads.

2.5 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.

2.6 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".
Frame and Support Construction: The filter housing shall be constructed of galvanized steel with support and bracing upstream and down stream to ensure rigid construction.
Filter Racks: Racks shall be provided under this Section for installation on the air handling equipment which it serves. Racks shall be equipped with gaskets and spring type positive sealing fasteners to hold filters in place. Fasteners shall be removable without the use of tools.
- B. Pleated Filters (Prefilter and Final Filters):
 - 1. General: Provide medium efficiency, pleated, disposable type filters where scheduled or shown on the Drawings.
 - 2. UL-listing: Filters shall be listed by Underwriters' Laboratories, Inc. as Class 1.
 - 3. Filter Media: Filter media shall be of the nonwoven cotton fabric type. The filter media shall have an average efficiency of 25% to 30% and an average arrestance of 90% to 92% in accordance with ASHRAE Test Standard 52-76.
 - 4. Capacity: Ratings and capacity for pleated filters shall be as follows:
 - a. Two Inch (30% Efficient Prefilter): The effective filter media shall be not less than 4.6 square feet of media per 1.0 square foot of filter face area and shall contain not less than 15 pleats per linear foot. Initial resistance of 500 fpm approach velocity shall not exceed 0.28" w.g.
 - b. Four Inch (65% efficient Final Filter): The effective filter media shall be not less than 7.0 square feet of media per 1.0 square foot of filter face area and shall contain not less than 11 pleats per linear foot. Initial resistance of 600 fpm approach velocity shall not exceed 0.35" w.g..
 - 5. Media Support Grid: The filter media support shall be a welded wire grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull away. The media support grid shall be formed in such a manner that it effects a radial pleat design, allowing total use of filter media.

- 6. **Enclosing Frame:** The filter enclosing frame shall be constructed of a rigid, heavy-duty, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exit side of each pleats, to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack, eliminating the possibility of air bypass.
- 7. **Manufacturers:** Filters shall be American Air Filter AM-AIR 300X, Farr 30-30 or an approved equal.

2.7 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. **Testing:** A representative 4 square foot damper sample shall not exceed 6ÿcfm leakage/square foot at 4"ÿwg, when tested by an independent testing laboratory in accordance with AMCAÿ500Ä74.
[Inlet [Mixing] Dampers: Provide a [mixing box] [damper] section with [ganged] vertical, low leakage, opposed blade dampers positioned across the short dimension of each [outside] 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.]
- D. **[Face and Bypass Dampers: Provide low leakage coil face and bypass dampers for [heating] [cooling] coils as scheduled.]**

2.8 VAV MODULATION:

- 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".

ACOUSTIC PERFORMANCE:

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General: The custom air handling units provided for the project shall be of a low noise design to reduce audible HVAC system noise levels in office areas and similar spaces adjacent to air handling unit rooms.

Criteria: The air handling units shall cause a maximum allowable sound power level (SPL) in dB, measured in a mocked-up office space adjacent to a simulated air handling unit room, which does not exceed NC40. The specific octave band maximum SPL valves shall not exceed the following:

| Octave Band | Frequency (Hz) | Allowable SPL (dB) |
|-------------|----------------|--------------------|
| 1 | 63 | 64 |
| 2 | 125 | 56 |
| 3 | 250 | 50 |
| 4 | 500 | 45 |
| 5 | 1000 | 41 |
| 6 | 2000 | 39 |
| 7 | 4000 | 38 |
| 8 | 8000 | 37 |

- B. **Preliminary Submittal:** Shop Drawing submittals shall include manufacturer's certified mock-up test results from previous mock-up testing to verify the manufacturers ability to meet the specified sound criteria. Tentative approval will be made based upon submitted data, subject to final approval of the mock-up test using two project air handling units.
[FACTORY ACOUSTICAL ACCEPTANCE TESTING:]
[edit to suit project]
[General: Acoustical performance of the project air handling units shall be verified by factory mock-up acoustical testing at the air handling unit manufacturer's facility or designated test

facility. All costs associated with mock-up testing shall be included in the project bid.]
[**Test Method:** A typical project office suite and adjacent air handling unit room shall be mocked-up with a single zone air handling unit, related ductwork, return air provisions, HVAC terminal unit, air devices, and lighting fixtures which will be provided on the project installed. The air handling units and terminal unit shall then be operated at specified capacities and test noise measurements shall be made and plotted on NC curves.]

- C. [**Mock-up Configuration:** The test mock-up shall construct a facsimile of air handling unit room [] and adjacent office suite rooms []. Air handling units [] and [] and HVAC terminal units [] shall be installed with related ductwork and air devices.]
- D. [**Mock-up Area:** The mock-up shall be constructed in a sound isolated area with a background noise level of NC30 or lower.]
[**Air Handling Unit Room:** The mock-up air handling unit room shall be constructed as follows:]
1. [Partitions shall be constructed using staggered 3⁵/₈" metal studs on 24" centers and two layers of 5/8" gypsum board installed with staggered joints on each side. Studs shall be staggered 4" with an acoustical blanket serpentine through the studs, filling the partition air space.]
[The room shape, dimensions, and door location shall conform to the project design. The room shall be 13' high and simulated structure shall be constructed using a minimum of two layers of 3/4" plywood. The air handling unit room partitions shall extend up to the plywood "structure".]
- E. [**Suite Test Rooms:** The mock-up test office suite rooms shall be constructed as follows:]
[Partitions shall be constructed using 3⁵/₈" metal studs on 24" centers. Perimeter partitions shall extend through the ceiling up to the plywood structure. Interior partitions shall terminate at the suspended ceiling.]
[Room shape, dimensions, and door locations shall conform to the project design. The building structure above the office areas shall be simulated by extending the two layers of 3/4" plywood which form the ceiling of the air handling room across the office mock-up area. Provide a 9' suspended ceiling, lighting fixtures and air devices in the mock-up offices per the project design.]
[**Air Handling Units:** Air handling units constructed per the project specifications shall be installed in the mock-up per the project design. Units shall be isolated on nominal 3/4" ribbed neoprene pads.]
[**Ductwork:** Ductwork shall be installed to simulate the project design.]
1. [Single duct trunk ductwork and lined return air ductwork shall be installed per the project drawings and shall extend 30' beyond the mock-up to an open discharge.]
[Opposed blade dampers shall be installed in the supply duct discharge for static pressure simulation.]
 2. [Ductwork to the HVAC terminal units and air devices shall be installed per the project drawings.]
 3. [Return air attenuator and boots shall be installed per the project drawings.]
 4. [Ductwork construction, liner, external insulation and other components shall be as specified for the project.]
 5. [Test Procedure: The mock-up set-up and test Procedure shall be as follows:]
[The ambient noise level in the mock-up test area shall be NC30 or less.]
[The single zone air handling unit shall be balanced to test cfm's and design static pressure. CFM shall be measured by air velocity traverse to the supply duct.]
 6. [The HVAC terminal units and air devices shall be balanced for cfm's shown on the project drawings. The HVAC terminal units shall be operated as a constant volume unit with 60% cold air and 40% plenum air for the duration of the test.]
 7. [The single zone unit static pressure controls specified for the project shall be installed and shall be used to vary supply fan volume during testing.]

8. **[The supply volume for the single unit shall be varied (via the supply air balancing damper) to allow testing at 100%, 90%, 75%, and 50% of design cfm.]**
[Noise measurements shall be taken at 3' above the floor in the center of each of the three test rooms and plotted on NC curves. Curves for tests at each air flow shall clearly indicate all conditions during the test.]

- F. **[Proposed Mock-up: The configuration and construction details and test procedure/reporting forms for the proposed mock-up shall be submitted to the Engineer for approval prior to construction of the mock-up.]**
[Acceptable Test Results: Test results which produce a SPL as specified in Paragraph 2.10 above and lower in each room in the suite test rooms will result in approval of the air handling unit acoustic performance.]

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 15250, and separated from ductwork with flexible duct connections.
- D. Drain Connections: Pipe condensate **[directly to a primed floor drain without a 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 74 20