



## **MAU SPECIFICATION**

### **SECTION 15822**

#### **CLEANROOM MAKE UP AIR HANDLING UNITS**

#### **PART 1 GENERAL**

##### **1.01 DESCRIPTION OF WORK**

- A. Packaged custom make up air handling units as specified.

##### **1.02 REFERENCES**

- A. AMCA 99 - Standards Handbook.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- D. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- E. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.
- F. AMCA 801 - Industrial Process/Power Generator Fans.
- G. ANSI/AFBMA 9 - Load Ratings/Fatigue Life for Ball Bearings.
- H. ANSI/AFBMA 11 - Load Ratings/Fatigue Life for Roller Bearings.
- I. ARI 410 - Forced-Circulating Air-Cooling and Air Handling Coils.
- J. ARI 430 - Standard for Central Station Air Handling Units.
- K. ARI 435 - Standard for Application of Central Station Air Handling Units.
- L. ASHRAE 62-89 - Ventilation for Acceptable Indoor Air Quality.
- M. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- N. UL 508 - Standard for Industrial Control Panels.
- O. UL 900 - Test Performance of Air Filter Units.
- P. UL 1995 - Standard for Safety - Heating and Cooling Equipment.

##### **1.03 QUALITY ASSURANCE**

- A. Construction Standards and Criteria:
  - 1. The following are to be used as selection criteria and are to be as specified: air flow rates, external static pressures, water flow rates. The following are to be equaled or bettered: coil face velocities,

Text shown in **bold** is an optional feature.

filter face velocities. The following are to be met within 5% of specified values: water pressure drops.

2. Fans shall be centrifugal type with extruded aluminum "Air Foil" blades, as required to suit service and capacity ratings and as delineated on drawings. All fans shall be tested in accordance with AMCA Standard 210.
3. Fan wheels shall be constructed to AMCA Class I, Class II, or Class III as delineated on drawings.
4. Coil capacity ratings shall be certified in accordance with ARI Standard 410.

B. Source of Quality Control:

1. VIBRATION - DIRECT DRIVE - Fan wheel shall be factory dynamically balanced and shall meet or exceed guidelines in AMCA 801-92 for dynamic balancing requirements. Following fan assembly, the complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 Axial). The maximum allowable velocity shall not exceed 0.075 inches per second peak amplitude (filter in) on any of 5 readings and shall not exceed [.8 mils @ 1800 rpm][1.2 mils @ 1200 rpm][1.6 mils @ 900 rpm]. Vibration measurements using Root Mean Square (RMS) values are unacceptable, peak amplitude must be measured. A copy of the Vibration test report (Vibration Nomograph) shall be provided with the Operation and Maintenance Manual upon request. The fan assembly shall also be vibration tested at design RPM with the spring isolators at the specified deflection, with the tunable filter utilized and frequencies from 500 cpm to 50,000 cpm shall be scanned to detect misalignment, bearing defects, mechanical looseness or foundation weakness.
2. FAN PERFORMANCE - Curves shall be based on tests in accordance with current AMCA Standards. Tests shall be conducted in a registered AMCA laboratory.
3. SOUND POWER LEVEL - Data shall be based on actual tests of fan sizes being furnished. Tests shall be conducted in a certified AMCA approved laboratory. Sound power levels of equipment submitted shall not exceed those scheduled on the drawings.
4. COILS -shall be factory tested to 350 psig (24.6 kg/cm<sup>2</sup>) compressed air under clear water. Coils shall also be tested after assembly in the air handler. This final pneumatic coil leak test shall hold 30 psig (2.1 kg/cm<sup>2</sup>) for 2 minutes.
5. **Unit manufacturer shall provide a test to verify CASING LEAKAGE. Casing leakage test shall verify that unit casing leakage is less than 1% of design air flow at 1.25 times the design static pressure or 1.1 times the fan's Peak static pressure at design RPM. Duct openings in positive pressure section shall be sealed. This section shall be connected to a fan developing 1.25 times design positive static pressure and CFM of this fan shall be read using an approved air flow measuring device. CFM shall be considered casing leakage. Duct openings in negative pressure section shall be sealed. This section shall be connected to a fan developing 1.25 times design negative static pressure and CFM of this fan shall be read using an approved air flow measuring device. CFM shall be considered casing leakage. Casing leakage must be less than 1% of unit design air flow. All tests shall be witnessed by Owner's representative and a formal written report including test results shall be submitted to Engineer.**

- C. Requirements of Regulatory Agencies: All insulation, coating, and adhesive exposed to plenum airstream of air handler shall meet a flame spread rating not over 25 and a smoke developed rating no higher than 50 as required in NFPA-90A.

- D. All major components used to assemble air handling unit, with exception of electrical devices, drives, bearings, and controls, shall be manufactured by air handling unit manufacturer. Primary fans and coils not manufactured by air handling unit manufacturer is not considered single source responsibility and shall not be acceptable.
- E. **Air handler shall be designed and manufactured in strict accordance with UL 1995, Standard for Heating and Cooling Equipment. Air handler shall be ETL or UL listed in accordance with UL 1995, and shall carry the ETL or UL label. If manufacturer cannot provide ETL/UL sticker on air handler, it will be the sole responsibility of the contractor to arrange for local, on-site, ETL or UL approval and labeling.**

**1.04 SPECIAL REQUIREMENTS**

A. Particulate and Off-Gassing

- 1. Particulate generation and off-gas control is of critical importance. All materials and components exposed to the airstream shall meet the particulate and off-gas specification.

Total Mass Loss	TML=1.0%
Volatile Condensable Materials	VCM=0.1%

- 2. Acceptable materials downstream of the humidifier are as follows (partial guide):

304 or 316 Stainless Steel	Aluminum
Teflon	Butyl Rubber
EPDM Gasket	
Dry Powder Epoxy	
Silicone Sealants	
Heresite 403 and 413	

- 3. Unacceptable materials include (partial guide):

Plywood, hardboard, pressboard  
 Dioctylphthalate (DOP) test smoke  
 Acetone and acetic acid adhesives and sealants  
 Painted Unistrut

- 4. Specific material exceptions to the off-gas specification are to be submitted to the owner for review. Where off-gassing is unavoidable, select products with an alcohol base where possible.

B. Cleaning

- 1. Degrease and wipe down both sides of perforated liners thoroughly prior to installation.
- 2. After final assembly, vacuum all interior surfaces from the top toward the bottom. Vacuum shall be cleanroom compatible HEPA-filtered type, or house vacuum with exhaust outside the cleaning area.
- 3. Prior to shipping, all interior surfaces shall be wiped down using 10% isopropyl alcohol (IPA) and 90% distilled water. Using lint-free wipes, wipe all interior surfaces until surface is clear of all oil, grease, residue and dust.

**1.05 SUBMITTALS**

- A. Submit shop drawings and product data including outside vendor data sheets and drawings.

- B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
- C. Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, coil capacities, psychrometrics, pressure drops (water and air), vibration isolation, seismic restraints, and gauges and finishes of materials.
- D. Identify variations from contract documents and product or system limitations which may be detrimental to successful performance of the completed work.
- E. Provide space for contractor and architect/engineer review stamps.
- F. Revise and resubmit submittals as required, identify all changes made since previous submittal.
- G. Test reports:
  - 1. Furnish fan performance curves depicting the operating point described on the schedule for each individual fan.
  - 2. Furnish fan vibration nomograph generated during fan balance test for each individual fan. This data shall be furnished upon completion of fabrication of units.
  - 3. Furnish sound power levels at supply connection, return connection, and casing radiation for each air handling unit. Test data shall show sound power levels, re: 10-12 watts for each of the eight octave band center frequencies.
  - 4. Furnish coil performance.
- H. Omission of any of the above information will cause submittal package to be immediately returned without review.

**1.06 OPERATION, MAINTENANCE AND PARTS DATA**

- A. Submit installation, start-up, operation and maintenance data.
- B. Include instructions for rigging, lifting, bearing lubrication, filter replacement, motor replacement, and wiring diagrams.
- C. Include customized Parts list with MAU tag number, serial number, OEM part numbers and description for motor, coils, filters, filter gages, bearings, fan shaft and other commodity components.

**1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Unit shall ship with all openings securely covered with wood and/or nylon reinforced plastic wrap and be watertight. Entire unit is to be securely covered with a reinforced plastic covering and sealed. The wrapping shall provide protection so that the unit can be transported and stored without contamination of the cleaned unit. Each unit shall be shipped with a tarp.
- B. Deliver, store, protect and handle products to site under provisions of Section \_\_\_\_\_.
- C. Store in environmentally controlled clean, dry place and protect from weather and construction traffic. Handle carefully and follow manufacturer's rigging guidelines.

**1.08 WARRANTY**

- A. Section [01700 - Contract Close-out.][01740 - Warranties and Bonds.]
- B. Provide parts **[and labor]** warranty for 12 months from date of start-up or 18 months from the date of shipment, whichever occurs first, on defective parts manufactured by CLEANPAK™. CLEANPAK™

does not offer parts or labor warranty on parts like motors, switches, controls or accessories inasmuch as they are warranted separately by their manufacturers. Filter changes are not a part of this warranty.

## PART 2 - PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. CLEANPAK™ Make Up Air Handler
- B. Substitutions: Under provisions of Division 1

### 2.02 FABRICATION

#### A. Side and Roof Panel Construction:

1. All side and roof panels shall provide a smooth, architecturally pleasing exterior surface with no exposed bolts or screws. Panels shall utilize standing seam construction on interior and are to be assembled with bolts such that each panel is individually removable. Bolted and removable panels are required for both service access and/or future air handler modifications. Casing shall be of not less than 16 gauge galvanized, and each standing seam shall be reinforced with two 16 gauge, roll formed, C channel stiffener/insulation retainers for structural integrity and to prevent oil canning. All pressure bearing side and roof panels shall be bolted construction for leak-free integrity and removability of panels. Drive (tek) screws or spot welding of pressure bearing panels is not designed for removal and reassembly, therefore unacceptable construction.

\*\*\*\*\* [OR] \*\*\*\*\*

1. **Outdoor/weatherproof construction: All side panels shall provide a smooth, architecturally pleasing exterior surface with no exposed bolts or screws. Roof panels shall utilize standing seam construction with cap strips over roof flanges. Standing seam roof shall have bowed roof with a minimum of 1/4 in/ft (20 mm/meter) slope to ensure rain and snow runoff. Roof system shall be designed for 30 lbs/ft<sup>2</sup> (146 kg/m<sup>2</sup>) snow load. Provide 1.5 in. Rain lip around perimeter of roof and provide rain gutters above each door. Side and roof panels shall utilize standing seam construction on interior and are to be assembled with bolts such that each panel is individually removable. Provide neoprene washers for roof and base bolts and nuts. Bolted and removable panels are required for both service access and/or future air handler modifications. Casing shall be of not less than 16 gauge galvanized, and each standing seam shall be reinforced with two 16 gauge, roll formed, C channel stiffener/insulation retainers for structural integrity and to prevent oil canning. All pressure bearing side and roof panels shall be bolted construction for leak-free integrity and removability of panels. Drive (tek) screws or spot welding of pressure bearing panels is not designed for removal and reassembly, therefore unacceptable construction.**
2. All walls shall be constructed of minimum [2 in. (50 mm)][**4 in. (100 mm)**] thick acoustical/thermal panels. Maximum allowable deflection of any panel shall not exceed 1/200th of any span in any direction at load of [8 in. (2 in. walls)] [**12 in. (4 in. walls)**] positive or negative pressure. Casing shall be built to exceed AMCA Class "C" plenum requirements.
3. All panels shall be assembled with minimum of 0.25 in. diameter, [zinc plated][**Stainless Steel**] bolts on maximum 10 in. (250mm) centers (drive (tek) screws are not acceptable). After completion of the unit casing and after all panel bolts have been secured, each panel seam is sealed for air and water tightness with a continuous bead of high performance polyurethane sealant which meets ASTM C-920, Type S, Grade NS, Class 25 and is USDA-approved, paintable and EPA-approved for potable water contact. [**Seal panels with silicone based, cleanroom approved caulk.**]

Comment [C1]:

4. Provide a unit housing with a minimum STC (Sound Transmission Class)(per ASTM E 90 and E413) as shown in the following tables:

Octave bands	125	250	500	1K	2K	4K	STC
2 in. wall, No Liner	23	27	35	44	50	49	39
2 in .wall, Solid Liner	21	38	44	52	51	53	45
4 in. wall, No Liner	24	29	41	50	57	62	42
4 in. wall, Solid Liner	28	39	48	55	55	60	50

5. Interior solid liner shall be fabricated from minimum of 22 gauge [G-90 galvanized steel][**304 SS**].

\*\*\*\*\* [OR] \*\*\*\*\*

5. Interior perforated liner shall be fabricated from minimum of 18 gauge [galvanized steel][**304 SS**]. The allowable free area shall be 40% - 50%.

\*\*\*\*\* [OR] \*\*\*\*\*

5. Interior perforated liner shall be fabricated from minimum of 18 gauge galvanized steel and be powder coated with 2-3 mils, high gloss, white polyester-epoxy paint and baked at 400°F (204°C) . The allowable free area shall be 40% - 50%.

\*\*\*\*\* [OR] \*\*\*\*\*

5. Interior liner shall be fabricated from minimum of 16 gauge galvanized steel and be coated with Polyurethane primer and Polyester-Hybrid semi-gloss top coat. Paint shall be baked at 450°F (232°C) for superior adhesion and uniformity. All panels are primed and top coated on both sides. Paint color shall be ANSI 61 Gray Paint system shall pass a minimum of 1000 hr salt spray test per ASTM B-117. Test documentation shall be available upon request.

6. For greater structural integrity, unit shall have header channel at perimeter of roof. Header channel shall be insulated and be accessible for wall or roof panel disassembly.

- 7. Bellmouth fittings shall be factory installed on cabinet where specified on unit drawings. Bellmouth fittings shall be installed so that fitting is flush on unit interior walls and ceilings. Mounting bellmouth on exterior of cabinet is unacceptable and contractor will modify bellmouth mounting if done incorrectly.**

B. Base and Unit Floor:

1. Unit base shall be constructed of welded structural steel around the perimeter of unit, with intermediate channel and angle iron supports. Units less than or equal to 20 ft (6.1 meters) long shall have a minimum of 4 in. (100 mm) channel, and units greater than 20 ft (6.1 meters) shall have a minimum 6 in. (150 mm) channel. Bolted or formed C channel bases are not acceptable.
2. The unit floor is to be covered with [16 gauge galvanized and painted (78 in. wide units or smaller)][12 gauge galvanized and painted steel (79 in. wide units or larger)][**10 gauge painted steel**][**3/16 in. galvanized and painted steel tread plate**][**16 gauge 304 Stainless Steel**], welded to base channel (no drive screws acceptable). The floor is to overhang the base by 1.5 in. (38 mm) to allow for bolting of the side panels to the overhung portion of the floor. All floor seams shall be supported underneath by intermediate channel and welded to supports. All seams shall be further sealed with a continuous bead of high performance polyurethane sealant which meets ASTM C-920, Type S, Grade NS, Class 25 and is USDA-approved, paintable and EPA-approved for potable

water contact. **[All seams shall be sealed with a continuous bead of silicone based, cleanroom approved caulk.]**

3. Removable type lifting lug assembly shall be welded to structural steel base. Provide a minimum of 4 lugs per section to insure proper rigging. Rigging and lifting safety instructions shall be attached to unit.
4. **All duct connections (larger than 12 in. x 12 in.) (300 mm x 300 mm) or control dampers in the floor of the unit shall be covered with painted heavy gauge steel [aluminum] "walk-on" safety bar grating bolted in place, to prevent people and large objects from passing through the unit floor into the ductwork. Bar grating shall be designed for a maximum deflection of ¼ in (6 mm) under a concentrated load (C) of 300 lb. (136 kg) at mid span. If safety grating does not meet this spec, it is the installing contractors responsibility to replace non-conforming grating.**
5. **Curb mounted units shall come complete with roof curb support angle welded on interior side of welded base assembly. Curb support shall be concealed on interior of base to help prevent possibility of roof leakage. Units which perimeter base rests on roof curb is not permitted.**
6. **Roof curbs assembly shall be [Welded and shipped as a complete assembly][Bolted assembly] and manufactured with 11 gauge galvanized and painted steel designed to insure that each unit is level, compensating for roof pitch. Each air handling unit shall be supported by a single common roof curb designed to accommodate the entire assembly. Roof curbs shall have a 2 in. x 4 in. nailer strip along the outside edge of the entire perimeter to allow the contractor to attach the roofing material to the curb, therefore ensuring a weatherproof seal between the curb and the roof. The curbs shall be provided with a self adhesive gasketing material (to be installed by the contractor) to provide the seal between the air handling unit assembly and the roof curb.**
7. **Bellmouth fittings shall be factory installed on unit floor where specified on unit drawings. Bellmouth fittings shall be installed so that fitting is flush on unit floor. Mounting bellmouth on exterior cabinet is unacceptable and contractor will modify bellmouth mounting if done incorrectly.**

C. Access Doors:

1. Provide full height (through 77 in. (2 m) tall doors), 2 in. (50mm) thick, double wall, insulated, thermal-break type, access doors where specified on unit drawings. Exterior and interior door skin shall be constructed from minimum of 16 gauge galvanized and painted steel (interior door skin will be unpainted 304 SS in all sections that have SS interior liners). Door insulation shall be 2 in.- 1.5 pcf (51 mm - 24 kg/cu m) density. Door frames are to be one piece, heavy gauge aluminum extrusion with high performance knife edge and closed cell, replaceable neoprene gasket seal. In addition, access doors are to have an aluminum extrusion perimeter frame with high performance knife edge and closed cell, replaceable neoprene gasket seal as well. Therefore, door assembly shall have double knife edge/perimeter gasket system (one system on frame and one system on door) for superior leakage and thermal performance.
2. Door hinges and latches shall be easily adjustable to allow for a tighter seal between the door and the unit. Door hinges, latches and handles are to be bolted to the unit and made with corrosion resistant materials. Bolts, nuts and shafts for door latches, handles and hinges shall be made of [zinc plated][**304 stainless**] steel. Hinge shall have stainless steel removable pin to allow door to be easily removable. Door latch and pawl assembly shall be industrial quality and corrosion resistant with a handle on both the inside and outside of door. Latch and pawl assembly shall be

one piece and bolted together (no set screws allowed). Ventlock 260 latches, or equal, that utilize "set screw" fasteners, which typically work loose, are NOT acceptable.

3. All doors with access to moving parts shall have provisions for padlocking and meet UL 1995 mechanical protection guidelines. Safety "Lockout" capable latches allow owner provided padlocks to lock doors in closed position where applicable.
4. All access doors shall open against unit operating pressure where delineated on drawings.
5. Provide view window in access doors where specified on unit drawings. View window shall be 8 in. x 8 in. (200 mm x 200 mm) with [single pane, ¼ in. (6 mm) wire reinforced safety glass][**double thermal pane, ¼ in. (6 mm) wire reinforced safety glass with a glazing code exceeding R-0.40**]. View window is UL listed and has a 1 hour fire rating.

D. Insulation:

1. The wall and ceiling panels shall be insulated with 2 in. - 2.25 pcf (51 mm - 36 kg/cu m) duct board insulation secured in place with insulation retainers and Grip-Nail fasteners welded in place when necessary. Insulation shall have WHITE mat facing which will not promote microbial growth per ASTM C 655. Insulation shall be tested and NFPA-90A rated. Insulation shall have thermal conductivity K factor of 0.24 Btu/hr. sq ft. °F @ 75°F (1.36 W/sq m.°C @ 24°C) mean and the following sound attenuation characteristics ( per ASTM C423-84a and E795-83):

Octave bands	125	250	500	1K	2K	4K	NCR
Absorption Coefficient	.13	.64	1.02	1.04	1.03	1.03	0.95

\*\*\*\*\* [OR] \*\*\*\*\*

1. The wall and ceiling panels shall be insulated with 2 in. - 3 pcf (51 mm - 48 kg/cu m) duct board insulation entirely covered with FSK (Foil/Scrim/Kraft) facing (front and back). Insulation "panel" shall be taped and ironed to completely encapsulate fiberglass insulation "panel". Complete insulation "panel" shall then be installed into air handler and secured with insulation retainers. This insulation system shall shed "absolute 0" fiberglass in airstream and can be alcohol wiped down for easy cleaning. insulation shall be tested and NFPA-90A rated. Insulation shall have thermal conductivity (K) of 0.23 Btu/hr. sq ft. °F @ 75°F (1.31 W/sq m.°C @ 24°C) mean and the following sound attenuation characteristics ( per ASTM C423-90a and E795-83):

Octave bands	125	250	500	1K	2K	4K	NCR
Absorption Coefficient	.42	.74	.84	.70	.48	.26	.70

2. All penetrations through the insulation material shall be sealed.
3. The under side of air handler floor shall be insulated with [1 in, R value = 7][**2 in, R value = 14**] polyurethane foam. Insulation shall have a thermal conductivity K factor of 0.14 Btu/hr.sq ft. °F @ 75°F ( 0.79 W/sq m. °C @ 24 °C) mean. Insulation shall completely cover all intermediate supports and channel on interior of base. Since insulation meets a flame spread rating of 25 and a smoke developed rating of 260, base shall not be used as a plenum. Base must be lined when bottom side of base will be used as plenum.

\*\*\*\*\* [OR] \*\*\*\*\*

3. **The underside of the air handler floor shall be insulated with 1 in. - 1.5 pcf, (25 mm - 24 kg/cu m) (R value = 4) fiberglass insulation. Insulation shall have a thermal conductivity K factor of 0.25 Btu/hr-sq ft· °F @ 75°F (1.42 W/sq m· °C @ 24 °C) mean.**

E. Painting:

1. All panels (wall and ceiling) shall be coated with Polyurethane primer and Polyester-Hybrid semi-gloss top coat. Paint shall be baked at 450°F (232°C) for superior adhesion and uniformity. All panels are primed and top coated on both sides. Paint color shall be ANSI 61 Gray Paint system shall offer excellent color retention, low fade characteristics, excellent UV resistance, very good resistance to solvents, chemical fumes, acids and alkalis, and very good abrasion resistance. Paint system shall pass a minimum of 1000 hr. salt spray test per ASTM B-117. Test documentation shall be available upon request.

\*\*\*\*\* [OR] \*\*\*\*\*

1. All panels (walls and ceiling) shall be painted with Gray, [4][6] mils, 2 part, polyamide activated, epoxy. **[Unit panels manufactured with Stainless Steel or Aluminum will not be painted].**
2. Entire structural steel base and unit floor shall be painted with ANSI 61 Gray alkyd enamel. Industrial grade alkyd enamel red oxide primer shall be applied by air brush to 2 mils thickness and alkyd enamel top coat shall be applied by air brush to 2-3 mils thickness, for a total dry thickness of 4-5 mils. **[Unit floors manufactured with Stainless Steel or Aluminum will not be painted].**

\*\*\*\*\* [OR] \*\*\*\*\*

2. Entire structural steel base and unit floor shall be painted with Gray, [4][6] mils, 2 part, polyamide activated epoxy. **[Unit floors manufactured with Stainless Steel or Aluminum will not be painted].**

\*\*\*\*\* [OR] \*\*\*\*\*

2. Entire structural steel base and unit floor shall be painted with Gray, 4 [6] mils, 2 part, polyamide activated, epoxy. Prior to shipment, a non-Slip, 30 mil, 2 part gray epoxy shall be rolled onto interior floors in all accessible sections. This coating shall have excellent non-slip texture, very good impact and abrasion resistance and meet MIL-D-24483A Type 1 performance criteria. Non-slip surface shall meet or exceed UL and OSHA minimum coefficient of friction for slip resistant surfaces.
3. Components of fan assembly that are not G-90 shall be painted with [ANSI 61 Gray][Wet White] alkyd enamel. Industrial grade alkyd enamel red oxide primer shall be applied by air brush to 2 mils thickness and industrial alkyd enamel top coat shall be applied by air brush to 2-3 mils thickness, for a total dry thickness of 4-5 mils.

\*\*\*\*\* [OR] \*\*\*\*\*

3. Entire fan assembly shall be powder coated with 2-3 mils, high gloss, white polyester-epoxy paint and baked at 400°F (204°C). Fan assembly paint system shall be acceptable for Cleanroom applications.

\*\*\*\*\* [OR] \*\*\*\*\*

3. Entire fan assembly shall be coated with 4 [6] mils gray, 2 part polyamide activated epoxy paint.

F. Fan Assembly:

1. Fan performance shall be based on tests run in an AMCA certified laboratory as administered in accordance with AMCA Standard 210. All fan performance shall be available in manufacturer's published catalogs. Each fan shall be sized to perform as indicated for the equipment shown on the equipment schedule. The wheel diameter shall not be less than that scheduled and shall be constructed to AMCA Class Standards as applicable for the scheduled duty.
2. Fan and motor shall be mounted on a fully welded, rigid steel base. Unpainted or galvanized, bolted-together fan/motor bases are not acceptable. Base shall be free-floating at all four corners on spring type isolators. **[Inertia base construction shall have concrete fill (installed by contractor at job site) sized for a minimum of 150% of rotating mass (wheel, shaft, motor). Spring isolators must be sized to support to final fan assembly weight.]** The structure supporting the motor shall be fabricated from formed steel and welded or bolted to fan base. The fan assembly shall be isolated by painted, color coded, steel springs with [2 in. deflection - wheel sizes 12 in. - 24 in][2.5 in. deflection - wheel sizes 27 in. - 36 in.][3 in. deflection - wheel sizes 40 in. - 73 in.]. The springs shall be free-standing, unhooused, stable steel springs, with leveling bolts and neoprene isolation pad, selected to a minimum efficiency of 98% to 99% depending on the fan RPM. Vibration isolation base shall have earthquake restraints capable of containing the fan in all directions with up to 1/2 g of force applied. Fan thrust restraints shall be provided to prevent the spring isolator system from grounding against the floor, walls, seismic restraints, or tearing the fan flexible connection.
3. The fans shall be SWSI, [horizontal Arrangement 4 (Direct Drive)] **[vertical, Arrangement 4 (Direct Drive)]** (as shown on the drawing) centrifugal, airfoil blade, plenum "plug" type and shall be designed to operate at cataloged performance without an involute housing. The air foil blades shall be fabricated from heavy gauge extruded aluminum. The airfoil blades shall be continuously welded to the back plate and inlet shroud except a one inch area on the low pressure side of each airfoil blade. This area acts as a weep hole which allow any condensate in airfoil blade to drain out. No other form of blade attachment is acceptable. Inlet cones shall be configured and designed so that wheel inlet efficiency and stall-free performance is insured. Arrangement 3 plug fans are NOT acceptable due to bearing located in inlet of fan. This inlet bearing is difficult to service, increases inlet noise and reduces performance of plug fans.
4. Provide mechanical protection from moving parts for the fan section per UL 1995 and OSHA guidelines. If not provided by manufacturer, contractor shall modify fan section access with appropriate mechanical protections (inlet screens, full screen enclosures and/or "limited access" access doors).
5. Motors shall be [high] **[premium]** efficiency, [TEFC][TEFC-SD][TEAO], [1800] **[3600],[1200],[900]** RPM. Motors shall be suitable for direct drive application **[and shall be rated for VFD duty]**. **Where VFDs are being provided, the motor and VFD shall be provided by the same manufacturer.** Motors shall be provided with insulated bearings (plastic fiberglass-reinforced thermoset polyester Grade 1412-A.) or with a factory mounted shaft grounding device manufactured by Shaft Grounding Systems, Inc.
6. Provide motor removal trolley rail in fan section with the structural I-Beam rail mounted directly over motor and extended to access door. Welded I-Beam structure shall be vertically supported by 4 in. (102 mm) tubular steel columns and mounted to floor of air handler. I Beam selection (4 in. min.) shall be based on motor weight (safety factor > 3) and maximum allowable deflection shall not exceed 1/400th of the span.
7. Fans shall be supplied with a factory mounted complete air flow measuring system and shall consist of total and static pressure pick-ups at various positions around the fan inlet cone throat and intake wall. The flow measuring station shall not obstruct the inlet to the fan and shall not have any effect on fan performance (flow or static pressure) or fan sound power levels. The flow measuring station

shall be PACE P-CONE®. Traverse type velocity probes in the air handling unit measuring the full inside height and width of the unit is an acceptable alternate. Traverse probes located in the fan inlet will not be acceptable due to increased noise levels and decreased fan efficiency. Provide a CFM gage on the external side of the fan section that indicates flow (CFM) through the fan and is calibrated for correct elevation.

**7a. Flow measuring station shall be supplied with a flow transmitter that produces a 4 to 20 ma output signal that is scaled to air flow. The flow measuring system shall consist of a flow measuring station and a flow transmitter, both factory mounted and plumbed.**

\*\*\*\*\* [OR] \*\*\*\*\*

**7a. Flow measuring station shall be supplied with an electronic flow transmitter mounted on the exterior of the fan section. It shall be capable of receiving signals of total and static pressure from the flow station, amplifying the signal if necessary, extracting the square root, and scaling to produce a 4-20 mADC or 0-5VDC output signal linear and scaled to air volume or velocity. The flow transmitter shall be capable of the following performance and application criteria: Calibrated spans from 0 to 896 FPM, in eight flow range increments. Output signal 4-20 mADC or 0-5 VDC standard. Integral zeroing (3-way zeroing valve with manual switch). Temperature effect + or - 2.0% of full span from 40°F to 120°F. The transmitter shall not be damaged by over pressurization up to 200 times greater than span, and shall be furnished with a factory calibrated span and integral zeroing means. The transmitter shall be housed in a NEMA 4 enclosure with external signal tubing, power, and output connections. The electronic differential pressure transmitter shall be Air Monitor VELTRON Series 1500 or equal.**

8. Plenum "plug" fans shall be supplied complete with PACE Econo-Disk® (as shown on the drawing); an energy saving, modulating, mechanical volume control device. The device shall provide immediately adjustable volume control for 100% to 0% of flow at design fan speed with no "full load" horsepower or acoustical penalty. Device shall be capable of 100% shutoff and have factory mounted and tested [manual][pneumatic] [electric] actuator. The variable cone shaped disk shall be supported in the center of the fan with a non-rotating, solid chrome plated, 1045 cold drawn steel shaft and 2 permanently sealed and greased linear motion ball bearings. The disk and fan assembly shall be vibration free through the entire operating range. The device shall be completely independent of the fan assembly such that removal of the fan assembly can be done without disturbing the device. The operating linkage shall be maintenance free and accessible for routine inspection. The device shall be manufactured and installed by the fan manufacturer. Due to full and part load inefficiencies and increased sound levels, inlet guide vanes are not acceptable on air foil bladed fans. Use of a variable speed drive (VFD) is acceptable.

8.a. Air handling unit manufacturer to mount and pre-wire VFD to motor. Mount VFD in a ventilated compartment which is an integral part of the air handling unit. A single manufacturer of both motor and VFD shall provide, coordinate and start-up a drive package to ensure motor and drive compatibility. Provide 2 years parts and labor on motor and drive combination. The VFD together with all options and modification shall mount within a standard NEMA-1 enclosure and shall be UL/ETL approved and labeled. The VFD shall have 3 critical frequency avoidance bands and an input line reactor. Manual contactor bypass shall be provided with all the circuitry necessary to safely transfer the motor from the line to the controller or from the controller to the line while the motor is at zero speed. Motor overload protection is to be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. Provide two input disconnects. One input disconnect shall provide a positive disconnect between the controller/bypass and all phases of the incoming A-C line. The other disconnect shall provide the ability to safely troubleshoot and test the VFD, both energized and de-energized, while operating in the "bypass" mode.

#### G. Coils:

1. [Chilled water][Hot water][Chilled Glycol][Hot Glycol][Steam] coils shall be of the plate fin extended surface type and ARI 410 certified. The primary surface shall be a minimum of 5/8 in (16 mm) outside diameter seamless copper [0.020 in. (0.5 mm)] [.025 in.][.035 in.] minimum wall thickness, and shall be expanded into the fin collars to provide a permanent mechanical bond: no metallic or thermal bonded materials shall be used. **[Steam coil shall be steam distributing type.]** The secondary surface shall be flat or formed of 0.008 in. (0.2 mm)[0.010 in.] aluminum **[0.008 in. copper]** fins and shall be spaced not closer than 12 fins per inch with integral spacing collars that cover the tube surface. **[Aluminum .008 in. fins shall be acrylic coated for added corrosion protection and is a cost competitive alternate to copper fins for sea coast applications. Acrylic coated fins shall pass a minimum of 1000 hr. salt spray test per ASTM B-117. Test documentation shall be available upon request.]** All coils shall be constructed with 0.025 in. (0.64 mm)[0.049 in.] thick brazed replaceable return bends. Same end connections are required. [Headers shall be non-ferrous seamless copper (cast iron headers are not acceptable), and provided with tobin bronze brazed [steel][brass] male pipe connections and separate 3/8 in. (9.5 mm) diameter pipe vent and drain connections extended through unit casing. All coils shall be fully drainable with no trapped tubes by design.] All coils shall be counterflow construction, with connections left or right hand as specified on the drawings. The use of internal restrictive devices "Turbs" to obtain turbulent flow will not be accepted. Due to moisture carry-over problems, spiral fin coils are not acceptable on any dehumidification coils unless face velocity is kept under 350 fpm (1.78 m/s). All copper to copper joints shall be made with high temperature brazing material: no pressure bonding or roller expanded bonding shall be used.
2. Coil casings shall be minimum [16 gauge G-90 galvanized steel] **[304 Stainless Steel][316 Stainless Steel]** with double formed 3/4 in. (11 mm) flange on all sides of coil with tube sheets having extruded tube holes. Coil casing reinforcements shall be furnished so that the unsupported casing length is not over 60 in. (152 cm). Reinforcements shall be made of the same material as the coil casing.
3. All tubes shall be tested at a minimum of 1500 psig (105 kg/cm<sup>2</sup>) and all assemblies tested under water at 350 psig (2413 kPa) and rated for 180 psig (1241 kPa) working pressure. Provide large enough condensate drain pan to ensure that any condensate drip from the coil headers or return bends shall flow into the drain pan.
4. The coils shall be arranged for easy removal and cooling coils are supported above drain pan by 12 gauge support channels and are fabricated from the same material as the drain pan. Coils shall be carefully blanked off with 16 gauge G-90 galvanized steel **[304 Stainless Steel]** to insure no air bypasses the coil. Intermediate condensate pans are to be furnished on stacked coil units to prevent upper coil condensate from passing over the lower coil. Intermediate drain pans are to be fabricated from the same material as the primary drain pan. [Stainless steel intermediate drain pans shall have 1in. (25 mm) copper downspouts]. The coil headers shall be located inside the cabinet casing with only the male pipe connections extending through the cabinet and cabinet penetration sealed air tight.

#### H. Double Sloped Condensate "IAQ" Drain Pans:

1. Provide a condensate drain pan for chilled water coils of deep, double sloping design which slopes in 2 directions (downstream from cooling coil and also toward the drain connection). This "IAQ" Drain-Dry, drain pan shall slope 0.125 in. per foot toward drain connection and be placed under the entire coil section and extend in the direction of air flow a minimum of [6 in.][12 in.][18 in.] beyond the leaving edge of the coil. Entire drain pan shall be easily accessible for annual inspection and cleaning. Mastic coated drain pans are not acceptable due to their non-cleanable nature. IAQ drain pan shall meet the requirements of ASHRAE 62-89 for both positive draining and cleanability.

2. The pan shall be of welded 16 gauge [G-90 galvanized steel] **[304 Stainless Steel][316 Stainless Steel]** construction.
3. The unit shall have a single 1.25 in. (32 mm) M.P.T. drain connection on same side of unit as coil connections (unless otherwise specified). The drain connection shall be fabricated with same material as main drain pan and connection shall be installed below the bottom of the drain pan to insure positive condensate drainage.
4. **Stacked coils shall be supported independently to allow removal on one coil without removing the other coils.**

I. Humidifier Section:

1. Provide atomizing humidifier system **[control valves and controls by others]** to deliver a proportionally controlled flow of ultrapure humidification into the airstream using deionized water.
2. Atomizing Heads and Manifolds
  - a. Manifold shall be a factory assembled unit consisting of air and water piping and atomizing heads. Materials used are based on water quality. For deionized water applications, all **[316][316L]** SS fittings and interconnecting tubing, and isolating each manifold is recommended. **All manifold fittings shall be Swagelock 316 SS fittings.**
  - b. Air and water consumption shall not exceed the values shown on the data sheet.
  - c. Atomizing heads shall be of materials not adversely affected by the purity of the water, easily be disassembled for servicing with self cleaning and purging feature to provide a complete drip free operation. Average water droplet size produced by the heads will not exceed \_\_\_\_\_ microns at 100% output and vary down to sub-micron with modulation of the system. Documentation of droplet size shall be available upon request.
  - d. Manufacturer shall be responsible for design of the humidifier nozzles and manifold for optimal distribution of water droplets into the airstream. This includes selection of nozzle capacity, calculation of total nozzles and manifolds required, and positioning of nozzles and manifold(s) within the MAU.
3. All manifold support brackets and fittings to be **[304][316]** Stainless Steel.
4. Length of cabinet section to be sufficient to allow for complete absorption of the vapor trail prior to coming in contact with the component downstream.
5. Provide an access plenum upstream of the humidifier manifold bank for maintenance.
6. Interior liners to be **[304] [316]** Stainless Steel flush mounted. Entire section base skin to be a 2 in. (51 mm) deep recessed, sloped **[304][316]** stainless steel floor with drain connections to one side.
7. PVC-coated RGS conduit shall be provided for electrical lighting circuits. Light fixture shall be corrosion-resistant, suitable for DI water spray atmospheres. All electrical boxes, fixtures, and fittings located inside the humidifier section shall be waterproof.
8. **Humidifier manufacturer to provide start up services at the job site.**

\*\*\*\*\*[OR]\*\*\*\*\*

1. Provide steam injection humidifier system.
2. Packaged steam-injection-type humidifier panel shall be factory installed.
  - a. Each panel shall consist of a steam supply header/separator, a condensate collection header, and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers.
  - b. Each tube shall be fitted with two rows of steam discharge tublets inserted into the tube wall, centered on the diametric line and equally spaced. These tublets shall be made of a non-metallic material designed for high steam temperatures.
  - c. The two rows shall discharge in diametrically opposite directions. Each tublet shall contain a steam orifice sized for its required steam capacity.
  - d. The humidifier shall provide absorption characteristics that preclude water accumulation on any component downstream within 24 inches (610 mm) while maintaining the specified conditions.
  - e. All tubes and headers shall be 304 stainless steel.
  - f. The humidifier shall be furnished with appropriate steam valve, steam strainer and steam traps, all shipped loose for installation at the job site by others.

J. Prefilter Section:

1. Filters shall be arranged for upstream loading into positive sealing "Type 8" [galvanized steel] **[Stainless Steel]** filter frames. Frames shall be welded together, structural supports weld to frames and then the filter rack assembly mounted in air handler.
2. Filters shall be 4 in. deep and rated at 30 to 35% efficiency per ASHRAE Test Standard 52-76.
3. Air handling unit manufacturer shall provide and flush mount (for each filter section), a Dwyer 2001 (or approved equal) magnehelic air filter gage [with adjustable signal flag]**[with weatherproof housing]**.
4. Provide walk-in filter access sections upstream of filter rack with adequate space available for filter service.

K. Hi-Efficiency Filter Section:

1. Filter section shall be factory fabricated as part of air handling unit. Filters shall be arranged for upstream loading into positive sealing "Type 8" [galvanized steel] **[Stainless Steel]** filter frames. Frames shall be welded together, structural supports weld to frames and then the filter rack assembly mounted in air handler. Filter rack shall be thoroughly caulked and sealed to minimize filter bypass.
2. Provide filter frames compatible with the filters shown on the schedule.
3. Air handling unit manufacturer shall provide and flush mount (for each filter section), a Dwyer 2001 (or approved equal) magnehelic air filter gage [with adjustable signal flag]**[with weatherproof housing]**.

4. Provide walk-in filter access sections upstream of filter rack with adequate space available for filter service.

L. Chemical Filter Section:

1. Chemical filter section shall include a complete frame assembly. Housings shall be minimum [16 gauge, galvanized steel **][304 SS]**, universal 24 in. x 24 in. (600 mm x 600 mm) type suitable for front loading of the media. The non access side of the housing shall include vertical support members to provide structural integrity and a sealing face for the removable filter panels. Internal runners shall act as guide for proper alignment. Housings shall be precision prepunched for easy assembly.
2. Bonded adsorbent panels shall be one inch thick and made of bonded activated carbon, covered on both sides with a spun bonded scrim and framed in a 304 stainless steel channel. A gasket shall be affixed to the panel frame. The bonded carbon configuration shall not settle, shall not particulate and shall not allow channeling through the bed. The panels shall be self supporting and when installed in the housing, shall provide a continuous seal around its periphery.
3. The panels shall be filled with a chemical media type suitable for the appropriate application **[organic solvents, acid gases, alkaline gases, mixed contaminants]**. Activated media fill shall be 4 x 8 mesh.
4. Air handling unit manufacturer shall provide and flush mount (for each filter section), a Dwyer 2002 (or approved equal) magnehelic air filter gage [with adjustable signal flag]**[with weatherproof housing]**.
5. Provide walk-in filter access sections upstream of filter rack with adequate space available for filter service.

M. HEPA Filter Section:

1. Filter media shall be single-layered fire retardant, all-glass Boron Silicate micro-fiber media, treated with a wet strength water resistant binder. The filter element shall be constructed, without the use of separators of any kind, by pleating a continuous sheet of formed, corrugated media back and forth upon itself so that it is self supporting.
2. The filter element shall be permanently bonded to a [16 gauge galvaneal steel frame] **[or a 0.063 aluminum frame]** with a solid urethane sealant. The filter face shall be double turned flanged (both sides) and a closed cell neoprene sealing gasket is to be mounted on one filter frame face (upstream or downstream).  
  
\*\*\*\* **[OR]** \*\*\*\*
2. **The filter side frame shall be 0.063 mill finished aluminum with a continuous channel, factory filled with silicone gel fluid sealant (upstream or downstream), located to mate with the knife-edge on the holding frame. The opposite side of the filter face is to have a double turned flange.**
3. Testing 99.97% efficient filters - Each filter shall be tested for resistance to airflow and penetration at the nominal rated capacity listed herein. The penetration shall not exceed 0.03% of the upstream aerosol challenge. The HEPA filters shall be certified to have a minimum removal efficiency of 99.97% on 0.3 micron particle size as specified IES-RP-CC-001.3 for Type A filters. Each filter and filter carton shall bear identical labels indicating the filter model number, compliance with IES-RP-

CC-001.3, the serial number and the resistance and penetration readings taken for the filter on the manufacturer's Q-107 Penetrometer. In addition, the manufacturer shall provide a filter test and certification of compliance report for the buyer's record when required.

\*\*\*\*\* [OR] \*\*\*\*

3. **Testing 99.99% efficient filters - Each filter shall be certified to have minimum removal efficiency of 99.99% on 0.3 micron particle size as specified by IES-RP-CC-001.3 for Type C filters. The face and perimeter of each filter shall also be scan tested to ensure freedom from leaks greater than 0.01% of the test challenge. The scan test flow rate will be at 100 FPM.**
4. Filter holding frames shall be constructed of [14 ga. Galvanized steel] **[0.080 aluminum] [14 ga. 304 SS]** with continuously welded joints and seams. All holding frames will have locking arms manufactured from 20 gauge stainless steel. The gasket sealing surface or knife-edge sealing area joints are continuously welded to prevent any contaminate air bypass, the other joints/seams are intermittently welded. The welds shall be ground or wire brushed so that the welds are free from all burrs and sharp edges and will not prevent the attachment of frame to frame or frame to duct. The gasket sealing surface shall be ground flush with the adjacent base metal. Pre-drilled mating round/oblong holes shall be provided in the frames to facilitate aligning the frames and fastening them together to make up filter banks. Guide channels shall be formed in the sides and the bottom of the frames to help center the filter in the holding frame.
5. Air handling unit manufacturer shall provide and flush mount (for each filter section), a Dwyer 2002 (or approved equal) magnehelic air filter gage [with adjustable signal flag]**[with weatherproof housing]**.
6. Provide walk-in filter access sections upstream of filter rack with adequate space available for filter service.
7. Filters shall be packaged separately for storage until installation in unit prior to startup.

#### N. Mixing Box

1. Dampers shall be [parallel] **[opposed]** blade type. Inlet sizes shown are minimum allowable, in order to keep damper pressure drop and noise to a minimum. Section shall be factory assembled and tested before shipment. Furnish access doors in section for damper, linkage, and actuator service.
2. Low leak aluminum dampers shall be constructed with [16 gauge galvanized steel]**[extruded aluminum]** frames, jamb seals constructed of stainless steel and heavy extruded aluminum airfoil dampers with replaceable extruded vinyl blade edge seals. Dampers shall be provided with 0.5 in. (13 mm) plated steel axles and stainless steel bearings. All dampers shall be AMCA certified for leakage of less than 6 cfm (10 cmh) per square foot at 4 in. wg. (102 mm wg) of differential pressure.

\*\*\*\*\* [OR] \*\*\*\*\*

2. Low leak steel dampers shall be constructed with 16 gauge galvanized steel frames, jamb seals constructed of stainless steel, and heavy-duty galvanized steel airfoil dampers with blade edge seals. Dampers shall be provided with 0.5 in. plated steel axles and stainless steel bearings. All dampers shall be rated for leakage of less than six (6) cfm per square foot at 4 in. wg. of differential pressure.

3. **Factory mounted and tested, two position pneumatic or spring return electric actuators shall be provided on all dampers.**
4. Provide louvers where shown on drawings. All intake and exhaust louvers shall be fabricated with 16 gauge galvanized steel frame and blades. Louver shall have ½ in. (13mm) mesh, 19 gauge galvanized bird screen. Louver shall be flush mounted to unit panels and provide smooth exterior look. Louver paint finish shall be baked enamel the same color as unit. Outdoor intake louvers shall be fabricated with drainable blades and shall be mounted above a sloped drain pan. Drain pan shall be the width of the louver and be a minimum of 8 in. behind the louver. The pan shall be of welded 16 gauge [G-90 galvanized steel] **[304 Stainless Steel][316 Stainless Steel]** construction. Louvers shall be AMCA certified for water penetration and air performance.
5. Provide weatherhoods where shown on drawings. All weatherhoods shall be fabricated with 16 gauge galvanized steel and painted to match unit exterior. Weatherhood shall have ½ in. (13 mm) mesh, 19 gauge galvanized bird screen. Weatherhood shall be 60 degree design and sized at a maximum of 600 fpm. Weatherhoods will not extend beyond the horizontal envelope of unit dimensions by more than 40 inches and requires a minimum of 3 feet clearance for proper performance.

O. Electrical Requirements:

1. Provide an externally **[flush]** mounted, single point power panel (SPPP) including all necessary [NEMA][**IEC**] starters, control power transformer, and main **[fused]** disconnect factory wired to all factory furnished electrical devices such as fan motors, **[lights],[switches]and [convenience outlets]**. Each fan motor shall be provided with a H-O-A switch on the door of the power panel. The power panel shall be constructed according to NEC regulations and contain a UL 508 label. Enclosure shall be NEMA 4 and be weathertight.
2. The electrical contractor shall wire main power to the single source power panel.
3. Provide [1][**2**] vaportight 150 watt marine pendant type lights in each access section as detailed in unit drawing, and factory wired to a single [NEMA 1][**weatherproof**] switch located on exterior of [unit][**SPPP**]. [Lights shall have its own circuit breaker disconnect in SPPP.][All lights shall be wired to a [NEMA 1][NEMA 3R] connect switch.] All internal wiring to lights shall be in conduit and internal to unit. No external conduit runs for lights and entire unit shall only have 1 exterior wall penetration for lights.
4. Provide weatherproof, 15 amp, GFCI receptacle in a flush mounted, single point power panel. Control panel shall have separate circuit breaker for receptacle.
5. Air handler manufacture shall provide a minimum of 1.5 in. (38 mm) clearance above entire width of each interior bulk head (filter, coil, fan, etc.). In addition, provide a minimum of 3 knockouts for 0.5 in. conduit in this 1.5 in. electrical clearance area. This will allow wiring 110v or 24v to be run internally and help prevent controls contractor from penetrating exterior panels multiple times with conduit.
6. If the unit requires splitting, junction boxes shall be furnished on each section to allow the electrical contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections.
7. **All sensors located inside of unit will be furnished by Division 17 Contractor for factory mounting by unit manufacturer. Provide all necessary wiring and conduit inside of unit and terminal strip at unit wall for Division 17 Contractor's connection. Refer to Division 16 and 17 for wiring/conduit and other electrical/control requirements.**

P. Sound Power Levels:

1. The sound power level at the air handling unit discharge, return air inlet, fresh air inlet and/or casing radiated shall not exceed the values given in the schedule below, when operating at the maximum design airflow and static pressure conditions.

Maximum Octave Band Sound Power Level, in dB RE 10E-12 watts

TAG: MAU-1							
Octave bands center Freq.	125	250	500	1K	2K	4K	NCR
Unit inlet							
Unit Outlet							
Casing Radiated							

2. It shall be the option of the contractor to provide a quieter fan, acoustical lining, sound traps and/or other sound attenuating devices within the air handling unit to supplement the design in order to comply with the sound power levels specified above.
3. Air handling unit sound power level data shall be submitted to the mechanical and acoustical engineers for approval. The submitted data shall be based on sound power measurements on similar units. The submittal shall include a complete description of the methods and procedures used to develop the sound power levels being submitted and the submitted sound power level will be verified (for a limited number of units described below by measurement of the sound power).
4. All sound power level measurements and calculations shall be in complete accordance with the latest (at time of bid) version of AMCA standard 300, Test Code for Sound Rating, AMCA standard 301, Method for Calculating Fan Sound Ratings from Laboratory Test Data. Test and calculation procedures based on sound intensity measurements may be substituted for the above procedures, if approved in advance by the acoustical engineer.
5. **The submitted inlet and outlet sound power levels shall be verified through actual measurements and calculations in accordance with AMCA standards 300 and 301 test procedures or the sound intensity technique for a minimum of 2 units, to be chosen by the mechanical engineer. These measurements will be conducted in the presence of an independent acoustical consultant who shall certify that the measurements have been conducted in accordance with the required procedure. The cost of testing and certification by the acoustical consultant shall be borne by the manufacturer.**
6. In the event the sound power level data measured or being submitted exceeds the specified level shown on the schedule, the contractor shall provide, if approved by the mechanical engineer, additional sound traps or other sound attenuating devices to supplement the design in order to comply with sound power level specifications. The cost for the additional noise control and any increase in motors and increase in electrical service shall be borne by the contractor. Calculations or measurement results will be submitted for approval by the mechanical and acoustical engineer, which substantiate that sound power level produced by the submitted equipment and any required sound attenuating devices do not exceed the specified sound power levels.

Q. Unit Performance Testing:

1. **Air handling fan performance shall be tested per the latest version of AMCA 210 - Laboratory Method of Testing Fan for Ratings.**
2. **Air volume, fan RPM, static pressure and fan BHP shall be tested and results shall fall within 2.5% of specified performance.**

## **PART 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Air handling units shall be assembled complete with internal vibration and seismic restraints for all fan assemblies.
- B. Transport air handling units in sections only where field conditions and/or transportation requirements do not allow installation as a single unit. Sealing and fastening hardware shall be supplied by the air handling unit manufacturer. Include written instructions needed to complete field assembly of the sections.
- C. **Air Handler manufacturer shall inspect units upon delivery at the job site, supervise the installation of the units, and provide initial start-up services.**