
USACE / NAVFAC / AFCEA / NASA UFGS-23 73 00.13 40 (April 2006)

Preparing Activity: NASA Superseding
NASA-15720S (December 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are NOT in agreement with UMRL dated 01 April 2006

Revised throughout - changes not indicated by CHG tags

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 73 00.13 40

AIR HANDLING UNITS

04/06

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SECTION 23 73 00.13 40

AIR HANDLING UNITS 04/06

NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers manufacturer's standard low- (AMCA Class A), medium- (AMCA Class B), and high-pressure (AMCA Class C), low- and high-velocity, factory fabricated and assembled, central station, air handling units.

Drawings or schedules must include configuration, all capacity conditions, coils, fans, filters, filter operating pressure range, access, drainage provisions, vibration isolation, piping, control diagrams, etc.

Identify air handling systems on the drawings, schedules, or herein by ah series numbering, location served, air flow (draw-through): cabinet type (multi-zone), and pressure and velocity class.

Supplement unit description with paragraphs which describe special requirements.

The following sections should be included when applicable:

Section 23 05 00.00 40 BASIC MECHANICAL MATERIALS AND METHODS

Section 23 82 16.00 40 AIR COILS

Section 23 73 00.00 40 AIR HANDLING

Section 23 05 48.00 40 VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT

Section 23 37 13.00 40 DIFFUSERS

Section 23 41 13.00 40 FILTERS

Section 26 18 39.00 40 MOTORS

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 211 (2005) Certified Ratings Programme - Product Rating Manual for Air Fan Performance

AMCA 99 (2003) Standards Handbook

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ANSI/ARI 430 (1999) Standard for Central-Station
Air-Handling Units

ARI 880 (1998) Standard for Air Terminals

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 51 (1999; Errata, 2006) Laboratory Methods of
Testing Fans for Aerodynamic Performance
Rating

ASHRAE 52.1 (1992) Gravimetric and Dust Spot
Procedures for Testing Air-Cleaning
Devices Used in General Ventilation for
Removing Particulate Matter

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M (2004a) Standard Specification for Steel
Sheet, Zinc-Coated (Galvanized) or
Zinc-Iron Alloy-Coated (Galvannealed) by
the Hot-Dip Process

ASTM B 117 (2003) Standing Practice for Operating
Salt Spray (Fog) Apparatus

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1 (2003) Mechanical Vibration - Balance
Quality Requirements for Rotors in a
Constant (Rigid) State - Part 1:
Specification and Verification of Balance
Tolerance - International Restrictions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA MG 1 (2003) Standard for Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (2002) Standard for the Installation of
Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900 (2004e7) Standard for Air Filter Units

1.2 GENERAL REQUIREMENTS

NOTE: If Section 23 00 00.00 40 GENERAL MECHANICAL
PROVISIONS is not included in the project
specification, applicable requirements there from
should be inserted and the following paragraph
deleted.

Section 23 00 00.00 40 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

NOTE: Fan and motor balance shall conform to ISO 1940-1 - (1986) Balance Quality Requirements of Rigid Rotors - Determination of Permissible Residual Unbalance unless otherwise noted. Motor vibration levels shall conform to NEMA Specification MG-1, Motors and Generators, Part 7 unless otherwise noted.

Equipment and Performance Data shall be submitted for air handling units in accordance with the specification. Data shall consist of use life, total static pressure and coil face area classifications, and performance ratings.

All drawings and manuals submitted shall include a spare parts data sheet, with manufactures recommended stock levels.

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the

"G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings shall be submitted for air handling units in accordance with paragraph entitled, "AHU Equipment Installation," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted for air handling units in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

- Unit Cabinet
- Fan
- Drain Pans
- Insulation
- Plenums
- Multizone AHU
- Blow-Through AHU
- Spare Parts

SD-07 Certificates

Listing of Product Installations shall be submitted for air handling units in accordance with paragraph entitled, "AHU Equipment Installation," of this section.

Certificates shall be submitted for following items showing conformance with the referenced standards contained in this section.

- Unit Cabinet
- Fan
- Drain Pans
- Insulation
- Plenums
- Multizone AHU
- Blow-Through AHU
- Spare Parts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for air handling units in accordance with paragraph entitled, "Operation and Maintenance," of this section.

PART 2 PRODUCTS

2.1 AIR HANDLING UNIT (AHU)

NOTE: Schedule packaged AHU "total AMCA fan outlet

area" refers to AMCA 99 areas. It is the sum of outlet areas for the number of fans per unit and permits a variance to accommodate the manufacturer's standard number per unit and fan type, where options are permitted, of plus or minus approximately 4 percent.

NOTE: Balanced quality Grade G6,3 includes fans and pump impellers. Higher precision Grades G2,5 and G1,0 include turbines and precision machine spindles.

Air handling unit (AHU) shall be central-station type, factory fabricated, and [sectionally] [fully] assembled. AHU shall include components and auxiliaries in accordance with ANSI/ARI 430. AHU fan and motor shall be balanced to ISO 1940-1-1986, [G6,3] [G2,5] [G1,0] [_____].

Total static pressure and coil face area classification shall conform to AMCA 99.

Fans with enlarged outlets shall not be permitted.

[AHU fan shall be double-width, double-inlet, centrifugal scroll type.]

2.2 UNIT CABINET

NOTE:

Class A total static pressure to 3 inches water gauge.

Class B total static pressure of 3 to 5.5 inches water gauge.

Class C total static pressure over 5.5 inches water gauge.

NOTE: Select the following paragraph for AMCA Class A and Class B cabinets.

AHU cabinet shall be suitable for pressure class shown and shall have leaktight joints, closures, penetrations, and access provisions. Cabinet shall not expand or contract perceptibly during starting and stopping of fans and shall not pulsate during operation. Cabinet surfaces with deflections in excess of 0.004167 of unsupported span shall be reinforced prior to acceptance. Pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, shall be stiffened to raise natural frequency to an easily attenuated level. Enclosure shall be fabricated from continuous hot-dipped galvanized steel no lighter than 0.91 millimeter 20 gage thickness, to match industry standard. Mill-galvanized sheet metal shall conform to ASTM A 653/A 653M and shall be coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of two-sided surface. Mill-rolled structural steel shall be hot-dip galvanized or primed and painted. Cut edges, burns, and scratches

in galvanized surfaces shall be corrosion protected. Primed and painted black carbon steel cabinet construction shall comply with this specification.

Provide removable panels to access the interior of the unit cabinet. All seams shall be welded, bolted or gasketed and sealed with a rubber-based mastic. Entire floor as well as ceiling unit shall be hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

NOTE: Select the following paragraph for AMCA Class C cabinets.

AHU cabinet shall be suitable for pressure class indicated and shall have leaktight joints, closures, penetrations, and access provisions. Cabinet shall not expand or contract perceptibly during starting and stopping of fans and shall not pulsate during operation. Cabinet surfaces with deflections in excess of 0.002778 of unsupported span shall be reinforced prior to acceptance by the Contracting Officer. Pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, shall be stiffened to raise natural frequency to an easily attenuated level. Enclosure shall be fabricated from mill-galvanized or primed and painted carbon steel sheet of required thickness. Mill-galvanized sheet metal shall conform to **ASTM A 653/A 653M** and shall be coated with not less than **0.38 kilogram of zinc per square meter** **1.25 ounces of zinc per square foot** of two-sided surface. Mill-rolled structural steel shall be hot-dip galvanized or primed and painted. Cut edges, burns, and scratches in galvanized surfaces shall be corrosion protected. Primed and painted black carbon steel cabinet construction shall comply with this specification.

Provide removable panels to access the interior of the unit cabinet. All seams shall be welded, bolted or gasketed and sealed with a rubber-based mastic. Entire floor as well as ceiling unit shall be hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

Where cabinet size is such that personnel access is possible, cabinet floor shall be strengthened to permit entry without damage to any component. Access doors and panels shall be hinged and latched at a spacing sufficiently close to preclude leaks caused by distortion, and shall be effectively gasketed.

[All door handles shall be operable from inside the casing.]

Black carbon steel cabinet construction shall be acceptable when the following conditions are met:

All interior and exterior surfaces, including lapped contacting surfaces, shall be coated with a corrosion-protective coating.

Coating shall be certified as passing a 500-hour exposure salt-spray fog test in accordance with **ASTM B 117**.

Immediately after completion of the test, the specimen shall show no signs of wrinkling, cracking or loss of adherence, and no signs of rust creepage beyond **3 millimeter** **1/8 inch** on either side of the scratch mark.

After 11 months of service and prior to expiration of guarantee, cabinet shall pass inspection of interior and exterior surfaces for the same defects as the salt-spray fog test specimen.

Interior surfaces of cabinets constructed of intact mill-galvanized steel shall require no further protection.

Exterior surfaces of cabinets constructed of mill-galvanized steel shall be [left unpainted] [painted] [prepared by a phosphatizing treatment, and painted with two coats of manufacturer's standard enamel finish in color selected by the Contracting Officer].

Cabinets and casings shall be double walled with [25 mm1 inch] [50 mm2 inch] [_____] insulation. Interior wall shall be [stainless steel] [galvanized] [non-absorbent coating] [_____].

Fan wheels shall be dynamically and statically balanced at the factory. Maximum fan RPM shall be 25 percent less than the first critical speed. Fan shaft shall be solid, ground and polished steel and coated with a rust inhibitor. V-belt driven fans shall be designed for 50 percent overload capacity. Variable air volume air handling units that shall be provided with variable frequency drives shall have their fans balanced over the entire range of operation (20 percent - 100 percent RPM). Balancing fans of only 100 percent design of RPM shall not be acceptable for air handling units to be used with variable frequency drives.

Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with 50.8 millimeter 2-inch. Install flexible canvas ducts or vibration absorbent fan discharge seal between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A.

Weigh fan and motor assembly at air handling unit manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions.

Factory install all motors on slide bases to permit adjustment of belt tension.

Fan motors shall be heavy duty, open drip-proof, operable at 460 volts, 60 hertz, 3-phase. All motors shall be high efficiency. Refer to specification Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

A marine-type, vapor proof service light shall be provided in the fan segment. Light shall be 100 watt service and shall be wired to an individual switch. Light shall require 115 Volt, single phase, 60 Hertz service that is separate from the main power to the AHU. A single 115 volt outlet shall be provided at the light switch.

2.3 FAN

Overall fan-section depth shall be equal to or greater than the manufacturer's free-standing fan.

[Fans shall be single-wheel.]

Location of fan inlet shall provide not less than one-half fan-wheel diameter clearance from cabinet wall or adjacent fan inlet where double wheels are permitted.

NOTE: Where open or TEFC motor and bearing noise, belt noise, and thermal load of motor located within cabinet airstream is objectionable, select or revise one of the following two paragraphs.

AHU fan drive shall be mounted external to casing.

AHU fan motor and drive shall be installed inside fan cabinet. Motor shall conform to ANSI/NEMA MG 1 and be installed on an adjustable base. An access door of adequate size for servicing motor and drive shall be provided. A belt guard shall be provided inside the cabinet, or the access door shall be interlocked with the supply fan so that power to the fan will be interrupted when the access door is opened.

2.4 DRAIN PANS

NOTE: Following coil drip-pan requirements are based on air velocities of 500 feet per minute 152 meter per second maximum, normal size coils to 38 inches 965 millimeter height, latent to total loads not in excess of 33 percent.

Intermediate-coil, 80 millimeter 3-inch deep drip pans shall be provided for each tiered coil bank.

Top pan shall extend 300 millimeter 12 inches beyond face of coil, and bottom pan shall extend not less than 600 millimeter 24 inches beyond face of coil. Where more than two pans are used, pan extension shall be proportional. Adequate supports shall be made from the same type material as pans or hot-dip galvanized angle iron with isolation at interface. Pan material shall be 0.85 millimeter 22-gage AISI Type 304 corrosion-resistant steel with silver-soldered joints. Minimum size of drain opening shall be 32 millimeter 1-1/4 inches. Pan shall be piped to drain.

Integral cabinet drain pan shall extend under all areas where condensate must be collected and shall be watertight with welded or brazed joints, piped to drain, corrosion protected in condensate collection area, and insulated against sweating. Sheet metal shall be minimum 2.0 millimeter 14-gage, except that 1.6 millimeter 16-gage double-drain-pan construction shall be acceptable.

Cooling coil ends shall be enclosed by cabinet and shall be factory insulated against sweating or shall drain to a drain pan.

All drain pans shall be double pan construction, thermally isolated from the exterior casing with 25.4 millimeter 1-inch thick fiberglass insulation. All drain pans shall slope to drain and shall drain substantially dry by gravity alone when drains are open.

All pans shall have a double slope to the drain point.

[Drain pan material may be plastic.]

2.5 INSULATION

[Unit shall be internally fitted at the factory with a sound-attenuating, thermal-attenuating, fibrous-glass material not less than [50.8 millimeter 2 inch] thick with 37.6 millimeter 1-1/2 inch density neoprene coated fiberglass. Insulation effectiveness shall preclude any condensation on any exterior cabinet surface under conditions normal to the unit's installed location. Acoustic treatment shall attenuate fan noise in compliance with specified noise criteria. Material shall be applied to the cabinet with waterproof adhesives and permanent fasteners on 100 percent coverage basis. Adhesive and insulating material shall be in accordance with NFPA 90A.]

[Plenums and bypasses shall be insulated.]

2.6 PLENUMS

[Plenums shall be provided in the following minimum widths:

150 millimeter 6 inches for mounting temperature controls and to separate two or more coils of different size mounted in series

355 millimeter 14 inches between face and bypass dampers and upstream accessories and at change in cross section

600 millimeter 24 inches for access sections]

2.7 MULTIZONE AHU

[Multizone unit delivery dampers shall be part of the manufacturer's standard unit construction and shall meet the requirements specified under paragraph entitled, "Power-Operated Dampers," of Section 23 09 33.00 40 CONTROL SYSTEMS.]

[Face and bypass dampers and multizone unit delivery dampers shall be part of the manufacturer's standard unit construction and shall meet the requirements specified under paragraph entitled, "Power-Operated Dampers," of Section 23 09 33.00 40 CONTROL SYSTEMS.]

[A balancing plate shall be added to the heating coil when required to equalize resistance in airstreams of multizone units.]

2.8 BLOW-THROUGH AHU

[Blow-through AHU shall be fitted with pressure equalizing baffles.]

2.9 COILS

2.9.1 Coil Section

Coil section shall encase cooling coils and drain pipes. Coils shall be arranged for horizontal air flow. Provide intermediate drain pans for multiple coils installation. Coil headers shall be completely enclosed with the insulated casing with only connections extended through the cabinet.

2.9.2 Coil Pressure and Temperature Ratings

Coils shall be designed for the following fluid operating pressures and temperatures:

<u>SERVICE</u>	<u>PRESSURE</u>	<u>TEMPERATURE</u>
Hot Water	200 PSI	250 degrees F
Chilled Water	200 PSI	40 degrees F
<u>SERVICE</u>	<u>PRESSURE</u>	<u>TEMPERATURE</u>
Hot Water	289 Pa	121 degrees C
Chilled Water	289 Pa	4 degrees C

Coils shall be air-pressure tested under water at the following minimum pressures:

<u>SERVICE</u>	<u>PRESSURE</u>
Water (hot and chilled)	250 PSI
<u>SERVICE</u>	<u>PRESSURE</u>
Water (hot and chilled)	289 Pa

2.9.3 Coil Casings

Coil casings shall be stainless steel. Coil headers shall be cast iron, brass, or copper. Water coil headers shall be fitted with 6.35 millimeter .25 inch ops spring-loaded plug drains and vent petcocks. Automatic air vents with ball type isolation valves shall be provided for each coil piped to the drain pan.

Coils shall be factory tested, dehydrated, vacuum tested, purged with inert gas, and sealed prior to shipment to the job site.

2.9.4 Chilled Water coils

Tubing for coils shall be copper 15.875 millimeter 0.625 inch outside diameter. Fins shall be [aluminum] [copper] mechanically bonded by tubing expansion with a maximum spacing of 12 fins per 25.4 millimeter 1 inch unless otherwise noted. Coils shall have supply and return connections on the same end. Provide a maximum of four coil rows.

2.9.5 Hot Water Coils

Heating coils shall have copper tubing [aluminum] [copper] fins.

2.9.6 Drainable Coils

Drainable coils shall be capable of being purged free of water with compressed air.

Self-draining coils shall have a drain point at the end of every tube and shall be pitched to that point. Drain provisions shall include: drained headers; U-bends with integral plugs; or nonferrous plugs in cast-iron headers. Each tube shall drain substantially dry by gravity alone when drains and vents are open.

2.10 ELIMINATORS

Eliminators shall be SMACNA three-break, hooked-edge design, constructed of reinforced 1.52 millimeter 16 gage galvanized steel with assembled brazed joints. Eliminator sections shall be easily removable for cleaning from side of the air handling unit without causing partial or complete disassembly of the Air Handler Unit casing.

2.11 FILTERS

2.11.1 Filter Housing

Provide factory fabricated filter section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double wall, hinged and removable access doors for filter removal. Provide air sealing gaskets to prevent air bypass around filters. Provide visible identification on media frames showing model number and airflow direction. Where filter bank is indicated or required, provide means of sealing to prevent bypass of unfiltered air. Performance in accordance with ASHRAE 52.1.

2.11.2 Replaceable Air Filters

UL 900, Class 1, those which, when cleaned, do not contribute fuel when attacked by flame and emit only negligible amount of smoke. Permanent frames with replaceable media, 25.4 millimeter 1-inch thickness and size as indicated.

2.11.3 Disposable Cartridge Air Filters

UL 900, Class 2, UL classified, and factory assembled. Provide media of ultra-fine glass fibers having 50-55 percent average dust spot efficiencies with maximum final resistance 19 millimeter 0.75 inch water gage and maximum face velocity of 152.4 meter 500 feet per minute. Construct filter frame of 1.21 millimeter 18 gage galvanized steel or aluminum with welded or riveted joints. Caulk or gasket entire assembly to prevent air leakage around frames. Minimum efficiency of filter shall be 60 percent per ASHRAE 52.1

2.11.4 Outside Air Filters

The factory assembled air filters of the extended surface type with supported cartridges for removal of particulate matter in air conditioning, heating, and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the dust-load limit is reached as indicated by maximum (final) pressure drop.

Filter Classification: UL approved for Class 1 or 2 conforming to UL 900.

Filter Grades, Nominal Efficiency and Application:

Grade B: 80-85 percent nominal efficiency afterfilter
Grade D: 25-30 percent nominal efficiency prefilter

Filter Media: Grade B Supported (Rigid Pleated) Type: Media shall be composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, aluminum separators shall be sealed in a proper enclosing frame to ensure no air leakage for life of filter.

Staples and stays are prohibited.

Grade D Type: Media shall be composed of synthetic/natural fibers. A metal grid backing shall be bonded to the air leaving side of the media to maintain uniform pleat shape and stability for proper airflow and maximum dust loading. The media frame shall be constructed of high strength moisture resistant fiber or beverage board. The pleated media pack shall be bonded on all four edges to ensure no air leakage of the life of the filter. Staples and stays are prohibited.

Filter Efficiency and Arrestance: Efficiency and arrestance of filters shall be determined in accordance with [ASHRAE 52.1](#) Standard Atmospheric dust spot efficiency and synthetic dust weight arrestance shall not be less than the following:

	<u>Initial Efficiency (Percent)</u>	<u>Average Efficiency (Percent)</u>	<u>Average Efficiency (Percent)</u>
Grade B	58	79	98
Grade D	Less than 20	22	89

Maximum initial and final resistance, inches of water gauge, for each filter cartridge when operated at [152.4 meter](#) [500 feet](#) per minute face velocity:

	<u>Initial Resistance</u>	<u>Final Resistance</u>
Grade B (Rigid Pleated)	0.60	1.00
Grade D (2 inches Deep)	0.32	0.70
Grade D (50.8 millimeter)	0.32	0.70

Dust Holding Capacity: When tested to 1.00 inch w.g. at 500 feet per minute face velocity, the dust holding capacity from each 24-inch by 24-inch (face area) filter shall be at least the values listed below. For other filter sizes, the dust holding capacity shall be proportionally higher or lower.

Grade B (Rigid Pleated)	6.17 ounces
Grade D (2 inches Deep)	2.29 ounces
Grade D (4 inches Deep)	10.58 ounces
Grade B (Rigid Pleated)	175 grams
Grade D (50.8 millimeter Deep)	150 grams
Grade D (100.16 millimeter)	300 grams

Minimum Media Area: The minimum net effective area in square feet for each 24-inch by 24-inch (face area) filter at 500 feet per minute face velocity shall be at least the values listed below. For other filter sizes the net effective media shall be proportionally higher or lower.

Grade B (Rigid Pleated)	57.0
Grade D (2 inches Deep)	14.8

2.11.5 Air Filter Gauges

Provide manometer air filter gauges of the inclined tube differential type, of solid acrylic plastic construction with built-in level vial and with an adjustable mirror-polished scale. Gauges shall be equipped with vent

valves for zeroing and over-pressure safety traps. Gauge range shall be adequate for the particular installation. Gauges shall be as manufactured by Dwyer or approved equal.

Provide one (1) air filter gauge at each filter bank.

PART 3 EXECUTION

3.1 AHU EQUIPMENT INSTALLATION

Equipment shall be installed in accordance with manufacturer's recommendations.

Installation drawings shall be in accordance with referenced standards in this section.

Listing of Product Installations shall be submitted for air handling units showing a minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

3.2 VIBRATION ANALYZER

Contractor shall use an FFT analyzer to measure vibration levels. It shall have the following characteristics: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5 Hz-10 KHz(300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

An accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk(or finished surface) shall be used with the FFT analyzer to collect data. The mass of the accelerometer and its mounting shall have minimal influence on the frequency response of the system over the selected measurement range.

3.3 ACCEPTANCE

Prior to final acceptance, dial indicator gages shall be used to demonstrate that fan and motor are aligned as specified.

Prior to final acceptance, vibration analysis shall verify conformance to specifications. Vibration levels shall not be more than .075 in/sec at 1 times run speed and at fan/blade frequency, and .04 in/sec at other multiples of run speed.

3.4 AHU TESTING

AHU and components shall be performance tested and rated in accordance with AMCA 211 and ASHRAE 51. AHU ratings shall be in accordance with ANSI/ARI 430.

Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Air handling unit start-up shall be performed in the presence of the Contracting Officer.

3.5 OPERATION AND MAINTENANCE

Contractor shall submit [Operation and Maintenance Manuals](#) prior to testing the air handling units. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

3.6 COORDINATION

Contractor shall coordinate the size and location of concrete equipment pads, variable frequency drives, control and electrical requirements.

3.7 TEMPORARY CONSTRUCTION FILTERS

Temporary construction filters shall be in place during normal building construction whenever the air handling units are run for general ventilation, building dehumidification, and for other purposes during construction. Install two (2) layers of blanket filter at a time. Replace temporary construction filters as required during construction and after completion of duct system cleaning.

After systems have been cleaned and temporary construction filters are removed, and before test and balance operations are started, install set of final filters. Final filters shall not be in place while general building construction is taking place, to avoid unnecessary loading with construction dust. Clean permanent filter bank before testing and balancing.

All required installation, Fabrication and Connection drawings shall be submitted and approved prior to the start of work detailed on these drawings.

[Operation tests shall be performed on each fire damper in the presence of the Contracting Officer by removing the fusible link and demonstrating the operation of the damper.]

Maximum number of coil rows shall be four (4). Maximum number of fins per inch shall be ten (10).

VAV terminal units shall be [ARI 880](#) certified and UL listed.

-- End of Section --