Preparing Activity: NASA Superseding
UFGS-23 73 13 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

05/17

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SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
05/17

****
NOTE: This guide specification covers the requirements for 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.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****

NOTE: Include in drawings or schedules 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.

Include the following sections when applicable:

Section 23 05 15 COMMON PIPING FOR HVAC

Section 23 82 16.00 40 AIR COILS

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

Section 23 37 13.00 40 DIFFUSERS, REGISTERS, AND GRILLS

Section 23 41 13.00 40 PANEL FILTERS

Section 26 60 13.00 40 LOW-VOLTAGE MOTORS

****

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 Reference Identifier (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 are automatically 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, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 211	(2013; Rev 2017) Certified Ratings Program Product Rating Manual for Fan Air Performance
AMCA 300	(2014) Reverberant Room Method for Sound

Testing of Fans

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 430 I-P	(2014) Performance Rating of Central Station Air-handling Unit Supply Fans
AHRI 431 SI	(2014) Performance Rating of Central Station Air-handling Unit Supply Fans
AHRI 880 I-P	(2011) Performance Rating of Air Terminals
AHRI 881 SI	(2011) Performance Rating of Air Terminals

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

ASHRAE 51	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
ASHRAE 52.2	(2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 21940-11	(2016) Mechanical vibration -- Rotor balancing -- Part 11: Procedures and Tolerances for Rotors with Rigid Behavior

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit

the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification 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; G[, [____]]

Fabrication and Connection Drawings; G[, [____]]

SD-03 Product Data

Equipment and Performance Data; G[, [____]]

Sample Warranty; G[, [____]]

Air Filter Gauges; G[, [____]]

SD-04 Samples

[Coating Specimen; G[, [____]]

] SD-06 Test Reports

Final Test Reports; G[, [____]]

SD-07 Certificates

List of Product Installations

Certificates of Conformance; G[, [____]]

Unit Cabinet

Fan

Drain Pans

Insulation

Plenums

Multizone AHU

Blow-Through AHU

Spare Parts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

SD-11 Closeout Submittals

Warranty

1.3 QUALITY CONTROL

Submit a list of product installations for air-handling units showing a minimum of five installed units, similar to those proposed for use, that have been in successful service for at least 5 years. Provide a list that includes the purchaser, address of installation, service organization, and date of installation.

1.3.1 Certification of Conformance

Submit certificates of conformance for the following items, showing conformance with the referenced standards contained in this section:

a. Unit Cabinet

b. Fan

c. Drain Pans

d. Insulation

e. Plenums

f. Multizone AHU

g. Blow-Through AHU

h. Spare Parts

1.3.2 Sample Warranty

Submit samples of warranty language concurrently with Certificates for review and approval by the Contracting Officer.

Submit a sample warranty for the following items:

a. Unit Cabinet

b. Fan

c. Drain Pans

d. Insulation

e. Plenums

f. Multizone AHU

g. Blow-Through AHU

[h. Spare Parts

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, handle, and store equipment and accessories in a manner that prevents damage or deformity. Provide temporary skids under units weighing more than [_____] kilogram pounds.

1.5 WARRANTY

****

NOTE: The Systems Engineer/Condition Monitoring Office/Predictive Testing Group needs to know the warranty expiration date, if there is a warranty, in order to perform the inspections within the prescribed time frame.

****

Final acceptance is dependent upon providing the warranty, based on approved sample warranty, to the Contracting Officer, along with final test reports. Ensure that the warranty is valid for at least [2] [5] [_____] years from the date of project closeout, showing [Government] [_____] as the warranty recipient.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Ensure that the fan and motor balance conform to ISO 21949-11 Mechanical vibration -- Rotor balancing -- Part 11: "Procedures and tolerances for rotors with rigid behavior" unless otherwise noted. Ensure that the motor vibration levels conform to

NEMA Specification MG-1, Motors and Generators, Part 7 unless otherwise noted.
****

Submit equipment and performance data for air-handling units, including use life, total static pressure and coil face area classifications, and performance ratings.

Submit all required fabrication and connection drawings and obtain approval from the Contracting Officer before the start of work shown on these drawings.

Submit drawings and manuals that include a spare parts data sheet, with manufacture's recommended stock levels.

2.2 COMPONENTS

2.2.1 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.
****

Provide a central-station type, factory-fabricated, and [sectionally] [fully] assembled AHU. Provide AHU that includes components and auxiliaries in accordance with AHRI 431 SI AHRI 430 I-P. Balance the AHU fan and motor according to ISO 21940-11.

Ensure that the total static pressure and coil face area classification conforms to AMCA 99.

Fans with enlarged outlets are not permitted.

[Provide a double-width, double-inlet, centrifugal scroll type AHU fan.

]2.2.2 Unit Cabinet

****
NOTE:
Class A total static pressure to 75 cm 3 inches water gauge.

Class B total static pressure of 75 to 137 cm 3 to 5.5 inches water gauge.

Class C total static pressure over 137 cm 5.5 inches water gauge.

****

2.2.2.1 Class A and Class B Cabinets

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

Provide an AHU cabinet suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.004167 of unsupported span before acceptance. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Fabricate the enclosure from continuous hot-dipped-galvanized steel no lighter than 0.91 millimeter 20 gauge thickness, to match the industry standard. Provide mill-galvanized sheet-metal that conforms to ASTM A653/A653M and that is coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of a two-sided surface. Provide mill-rolled structural-steel that is hot-dip-galvanized or primed and painted. Corrosion-protect cut edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

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

2.2.2.2 Class C Cabinets

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

Provide an AHU cabinet that is suitable for the pressure class shown and has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly when the fans are starting or stopping and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.002778 of unsupported span before acceptance by the Contracting Officer. Stiffen pulsating panels, which produce low-frequency noise due to diaphragming of unstable panel walls, to raise the natural frequency to an easily attenuated level. Provide the enclosure that is fabricated from mill-galvanized or primed and painted carbon sheet steel. Provide mill-galvanized sheet metal that conforms to ASTM A653/A653M and that is coated with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of a two-sided surface. Provide mill-rolled structural steel that is hot-dip galvanized or primed and painted. Corrosion-protect edges, burns, and scratches in galvanized surfaces. Provide primed and painted black carbon steel cabinet construction that complies with this specification.

Provide removable panels to access the interior of the unit cabinet.

Provide seams that are welded, bolted, or gasketed and sealed with a rubber-based mastic. Make the entire cabinet floor and ceiling hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

2.2.2.3 Cabinet Construction

Where the cabinet size is such that personnel access is possible, strengthen the cabinet floor to permit entry without damaging any component. Hinge and latch the access doors and panels sufficiently close together to preclude leaks caused by distortion, and effectively gasket.

[Make all door handles operable from inside the casing.

] Black carbon steel cabinet construction is acceptable when the following conditions are met:

a. Coat all interior and exterior surfaces, including the lapped contacting surfaces, with a corrosion-protective coating.

b. Certify the coating as passing a 500-hour-exposure salt-spray fog test in accordance with ASTM B117.

c. Immediately after completing the test, provide a coating specimen that shows no signs of wrinkling, cracking, or loss of adherence and no signs of rust creep beyond 3 millimeter 1/8 inch on either side of the scratch mark.

d. Ensure that inspection of interior and exterior cabinet surfaces will pass examination for the same defects as the salt-spray fog test specimen, after 11 months of service and before the guarantee expires.

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

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

Provide cabinets and casings that are double-walled with[25 mm 1 inch][50 mm 2 inch] [_____] insulation. Provide a [stainless steel] [galvanized] [non-absorbent coating] [_____] interior wall.

Weigh the fan and motor assembly at the AHU manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies, including 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.

Provide heavy-duty, open drip-proof, three-phase fan motors, operable at 460 volts (V), 60 hertz (Hz). Provide high-efficiency motors. Refer to specification Section 26 05 70.00 40 HIGH VOLTAGE OVERCURRENT PROTECTIVE DEVICES and Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide a marine-type, vapor-proof service light in the fan segment. Provide a 100 watt (W) service light that is wired to an individual switch and operates on 115 V, single-phase, 60 Hz service that is separate from the main power to the AHU. Provide a single 115 V outlet at the light switch.

2.2.3 Fan

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

Mount fans on isolation bases. Internally mount motors on the same isolation bases and internally isolate fans and motors. Install flexible canvas ducts or a vibration absorbent fan discharge seal between the fan and casings to ensure complete isolation. Provide flexible canvas ducts that comply with NFPA 90A.

Provide an overall fan-section depth that is equal to or greater than the manufacturer's free-standing fan.

[Provide single-wheel fans.

] Locate the fan inlet where it provides not less than one-half fan-wheel diameter clearance from the cabinet wall or the 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.

****

Mount the AHU fan drive external to the casing.

Install the AHU fan motor and drive inside the fan cabinet. Provide a motor that conforms to NEMA MG 1 and is installed on an adjustable base. Provide an access door of adequate size for servicing the motor and drive. Provide a belt guard inside the cabinet or interlock the access door with the supply fan so that power to the fan is interrupted when the access door is opened.

2.2.4 Drain Pans

****

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

****

Provide intermediate-coil, 80 millimeter 3 inch deep drip pans for each tiered coil bank.

Extend the top pan 300 millimeter 12 inches beyond the face of the coil, and extend the bottom pan not less than 600 millimeter 24 inches beyond the face of the coil. Where more than two pans are used, make the pan extension proportional. Make adequate supports from the same type of material as the pans or from hot-dip galvanized angle iron with isolation at the interface. Use 0.85 millimeter 22-gauge, AISI Type 304, corrosion-resistant steel for pan material, with silver-soldered joints. Minimum size of the drain opening is 32 millimeter 1-1/4 inches. Pipe the pan to the drain.

Extend the integral cabinet drain pan under all areas where condensate is collected and make it watertight with welded or brazed joints, piped to the drain. Provide corrosion protection in condensate collection areas, and insulate against sweating. Provide minimum 2.0 millimeter 14-gauge sheet metal; however 16-gauge double-drain-pan construction is also acceptable.

Provide cooling coil ends that are enclosed by the cabinet and are factory insulated against sweating or drain to a drain pan.

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

Provide pans that have a double slope to the drain point.

[Plastic drain pan material is allowed.

][2.2.5 Insulation

Provide a unit that is internally fitted at the factory with a sound-attenuating, thermal-attenuating, fibrous-glass material not less than 50.8 millimeter 2 inches thick. Ensure that the insulation precludes any condensation on any exterior cabinet surface under conditions that are normal to the unit's installed location. Provide acoustic treatment that attenuates fan noise in compliance with specified noise criteria. Apply material to the entire cabinet with waterproof adhesives and permanent fasteners. Provide adhesive and insulating material in accordance with NFPA 90A.

[Provide insulated plenums and bypasses.

]][2.2.6 Plenums

Provide plenums in the following minimum widths:

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

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

c. 600 millimeter 24 inches for access sections

][2.2.7 Multizone AHU

Provide multizone unit delivery dampers that are part of the manufacturer's standard unit construction and that meet the requirements specified in the paragraph POWER-OPERATED DAMPERS of Section 23 09 33.00 40 ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC.

[Provide face and bypass dampers and multizone unit delivery dampers that are part of the manufacturer's standard unit construction and that meet the requirements specified in the paragraph POWER-OPERATED DAMPERS of Section 23 09 33.00 40 ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC.

][When required, add a balancing plate to the heating coil to equalize resistance in airstreams of multizone units.

]][2.2.8 Blow-Through AHU

Fit the blow-through AHU with pressure-equalizing baffles.

]2.2.9 Coils

2.2.9.1 Coil Section

Provide a coil section that encases cooling coils and drain pipes. Arrange coils for horizontal air flow. Provide intermediate drain pans for multiple-coils installation. Completely enclose coil headers with the insulated casing with only the connections extending through the cabinet.

2.2.9.2 Coil Pressure and Temperature Ratings

Ensure that the coils are designed for the following fluid operating pressures and temperatures:

SERVICE	PRESSURE	TEMPERATURE
Hot Water	289 Pa	121 degrees C
Chilled Water	289 Pa	4 degrees C

SERVICE	PRESSURE	TEMPERATURE
Hot Water	200 PSI	250 degrees F
Chilled Water	200 PSI	40 degrees F

Provide coils that are air-pressure-tested under water at the following minimum pressures:

SERVICE	PRESSURE
Water (hot and chilled)	289 Pa

SERVICE	PRESSURE
Water (hot and chilled)	250 PSI

2.2.9.3 Coil Casings

Provide coils that are factory-tested, dehydrated, vacuum-tested, purged with inert gas, and sealed before shipped to the job site.

Provide stainless-steel casings. Provide cast iron, brass, or copper coil headers. Fit water coil headers with 6.35 millimeter 0.25 inch ips spring-loaded plug drains and vent petcocks. Provide automatic air vents with ball-type isolation valves for each coil that is piped to the drain pan.

2.2.9.4 Chilled Water Coils

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

2.2.9.5 Hot Water Coils

Provide heating coils that have copper tubing [aluminum] [copper] fins.

2.2.9.6 Drainable Coils

[Provide drainable coils that are capable of being purged free of water with compressed air.

][Provide self-draining coils that have a drain point at the end of every tube and are pitched to that point. Drain provisions include drained headers, U-bends with integral plugs, or nonferrous plugs in cast-iron headers. Provide tubes that drain substantially dry by gravity alone when the drains and vents are open.

]2.2.10 Eliminators

Provide eliminators that are SMACNA three-break, hooked-edge design, constructed of reinforced 1.52 millimeter 16 gauge galvanized steel with assembled brazed joints. Provide easily removable eliminator sections for cleaning from the side of the AHU without requiring partial or complete disassembly of the AHU casing.

2.2.11 Filters

2.2.11.1 Filter Housing

Provide factory-fabricated filter sections of the same construction and finish as the unit casings. Provide filter sections that 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 the model number and airflow direction. Where a filter bank is indicated or required, provide a means of sealing to prevent bypass of unfiltered air. Ensure that the filters perform in accordance with ASHRAE 52.2.

2.2.11.2 Replaceable Air Filters

Select filters conforming to UL 900, Class 1. Ensure that when clean filters are exposed to flame, the filters do not contribute fuel when attacked by flame and emit only negligible amount of smoke. Provide permanent frames with replaceable media, 25.4 millimeter 1 inch thickness, size as indicated.

2.2.11.3 Disposable Cartridge Air Filters

Provide UL 900, Class 2, UL-classified, and factory-assembled filters. Provide media of ultra-fine glass fibers having 50 to 55 percent average dust spot efficiencies with a maximum final resistance 19 millimeter 0.75-inch water gauge, and maximum face velocity of 152.4 meter 500 feet per minute. Construct filter frames of 1.21 millimeter 18 gauge galvanized steel or aluminum with welded or riveted joints. Caulk or gasket the entire assembly to prevent air leakage around the frames. Ensure that the minimum efficiency of the filter is 60 percent per ASHRAE 52.2.

2.2.11.4 Outside Air Filters

Provide an extended-surface, factory-assembled air filters with supported cartridges. Provide extended surface filter units 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:

a. Grade B: 80 to 85 percent nominal efficiency outfitter

b. Grade D: 25 to 30 percent nominal efficiency prefilter

Filter Media: Grade B Supported (Rigid Pleated) Type: Provide media that is composed of high-density glass fibers[or [_____] fibers]. Use fastening methods to maintain pleat shape, seal aluminum separators in a proper enclosing frame to ensure that there is no air leakage for the life of filter. Staples and stays are prohibited.

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

Filter Efficiency and Arrestance: Determine the efficiency and arrestance of filters in accordance with ASHRAE 52.2 Standard Atmospheric dust spot efficiency and synthetic dust weight arrestance that is not less than the following:

	Initial Efficiency (Percent)	Average Efficiency (Percent)	Final Efficiency (Percent)
Grade B	58	79	98
Grade D	Less than 20	22	89

Maximum initial and final resistance and inches of water gauge for each filter cartridge when operated at 152.4 meter a face velocity of 500-feet per minute are as follows:

	Initial Resistance	Final Resistance
Grade B, Rigid Pleated	0.60	1.00
Grade D, 50.8 millimeter	0.32	0.70

	Initial Resistance	Final Resistance
Grade B, Rigid Pleated	0.60	1.00
Grade D, 2-inches deep	0.32	0.70

Dust-Holding Capacity: When tested to 1.00 inch w.g. at 152.4 meter 500 feet per minute face velocity, provide a dust-holding capacity from each 61 by 61 centimeters 24 inch by 24 inch (face area) filter that is at least equal to the values listed below. For other filter sizes, provide a dust-holding capacity that is proportionally higher or lower.

Grade B, Rigid Pleated 175 grams
Grade D, 50.8 millimeter Deep 150 grams
Grade D, 100.16 millimeter 300 grams

Grade B, Rigid Pleated 6.17 ounces
Grade D, 2 inches Deep 2.29 ounces
Grade D, 4 inches Deep 10.58 ounces

Minimum Media Area: Provide a minimum net effective area in square feet for each 61 by 61 centimeters 24 inch by 24 inch (face area) filter at 152.4 meter 500 feet per minute face velocity of at least the values listed below. For other filter sizes, provide a net effective media that is proportionally higher or lower.

Grade B, Rigid Pleated 57.0
Grade D, 2-inches Deep 14.8

2.2.11.5 Air Filter Gauges

Provide manometer air filter gauges of the inclined tube differential type that have solid acrylic plastic construction with a built-in level vial and with an adjustable mirror-polished scale. Equip gauges with vent valves for zeroing and over-pressure safety traps. Ensure that the gauge range is adequate for the particular installation.

Provide one air filter gauge at each filter bank.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

Install equipment in accordance with the manufacturer's recommendations.

Provide installation drawings in accordance with referenced standards in this section.

3.2.1 Temporary Construction Filters

Have temporary construction filters in place during normal building construction whenever the AHUs are run for general ventilation, building dehumidification, or other purposes during construction. Install two layers of blanket filter at a time. Replace temporary construction filters as required during construction and after duct system cleaning is completed.

After systems have been cleaned and temporary construction filters are removed, and before test and balance operations are started, install a set of final filters. Avoid loading the filter with construction dust; do not have final filters in place while general building construction is taking place. Clean the permanent filter bank before testing and balancing.

[Perform operation tests on each fire damper in the presence of the Contracting Officer by removing the fusible link and demonstrating the operation of the damper.

] The maximum number of coil rows is four. Maximum number of fins per inch is ten.

Provide variable air volume (VAV) terminal units that are certified by AHRI 881 SI AHRI 880 I-P and UL-listed.

3.3 FIELD QUALITY CONTROL

3.3.1 Vibration Analyzer

Use an Fast Fourier Transform (FFT) analyzer to measure vibration levels. The following characteristics are required: A dynamic range greater than 70 dB; a minimum of 400-line resolution; a frequency response range of 5 Hz to 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.

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

3.3.2 Acceptance

Before final acceptance, use dial-indicator gauges to demonstrate that the fan and motor are aligned as specified.

Before final acceptance, verify conformance to specifications using vibration analysis. Ensure that the maximum vibration levels are 0.19 cm per second 0.075 inches per second at 1 times run speed and at fan/blade frequency, and 0.10 cm per second 0.04 inches per second at other multiples of run speed.

3.3.3 AHU Testing

Conduct performance test and rate the AHU and components in accordance with AMCA 211, AMCA 300, and ASHRAE 51. Provide AHU ratings in accordance with AHRI 431 SI AHRI 430 I-P.

Provide final test reports to the Contracting Officer. Provide reports with 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."

Perform AHU start-up in the presence of the Contracting Officer.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Operation And Maintenance

Submit operation and maintenance manuals before testing the AHUs. Update and resubmit data for final approval no later than 30 calendar days before contract completion.

3.4.2 Acceptance

With the warranty, provide a cover letter/sheet clearly marked with the system name, date, and the words "Equipment Warranty" - "Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --