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USACE / NAVFAC / AFCEC / NASA UFGS-23 73 13.00 40 (May 2014)  
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Preparing Activity: NASA Superseding  
UFGS-23 73 13 (February 2011)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2016

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

05/14

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### SECTION 23 73 13.00 40

#### MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS 05/14

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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 items(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).

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#### PART 1 GENERAL

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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 00 00 AIR SUPPLY, DISTRIBUTION,  
VENTILATION, AND EXHAUST SYSTEMS

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

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## 1.1 REFERENCES

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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 are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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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	(2013; Rev 2015) Certified Ratings Programme - Product Rating Manual for Air Fan Performance
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 99	(2010) Standards Handbook

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 430 (2009) Central-Station Air-Handling Units  
AHRI 880 I-P (2011) Performance Rating of Air Terminals

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

ASHRAE 51 (2007) Laboratory Methods of Testing Fans  
for Aerodynamic Performance Rating  
ASHRAE 52.2 (2012; Errata 2013; INT 1 2014; ADD A,  
B, AND D SUPP 2015; INT 3 2015; Errata 2  
2015; ADD C 2015) Method of Testing  
General Ventilation Air-Cleaning Devices  
for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M (2015) Standard Specification for Steel  
Sheet, Zinc-Coated (Galvanized) or  
Zinc-Iron Alloy-Coated (Galvannealed) by  
the Hot-Dip Process  
ASTM B117 (2011) Standard Practice for Operating  
Salt Spray (Fog) Apparatus

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1 (2003; Cor 2005) Mechanical Vibration -  
Balance Quality Requirements for Rotors in  
a Constant (Rigid) State - Part 1:  
Specification and Verification of Balance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2014) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (2015) Standard for the Installation of  
Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900 (2015) Standard for Air Filter Units

1.2 SUBMITTALS

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**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.**

**The Guide Specification technical editors have  
designated 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 submittals requiring Government approval on Army projects, use a code of up to three characters within the submittal tags 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.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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

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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 reviews the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. 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[, [\_\_\_\_]]]

SD-04 Samples

[ Coating Specimen[; G[, [\_\_\_\_]]]

] SD-06 Test Reports

Final Test Reports[; G[, [\_\_\_\_]]]

## SD-07 Certificates

Listing of Product Installations[; G[, [\_\_\_\_]]]

Certificates of Conformance[; G[, [\_\_\_\_]]]

Unit Cabinet[; G[, [\_\_\_\_]]]

Fan[; G[, [\_\_\_\_]]]

Drain Pans[; G[, [\_\_\_\_]]]

Insulation[; G[, [\_\_\_\_]]]

Plenums[; G[, [\_\_\_\_]]]

Multizone AHU[; G[, [\_\_\_\_]]]

Blow-Through AHU[; G[, [\_\_\_\_]]]

Spare Parts[; G[, [\_\_\_\_]]]

## SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals[; G[, [\_\_\_\_]]]

## SD-11 Closeout Submittals

Warranty[; G[, [\_\_\_\_]]]

## 1.3 QUALITY ASSURANCE

Submit listing 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 a minimum period of 5 years. Provide list that includes 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 equipments and accessories in a manner that prevents damage or deformity. Provide temporary skids under units weighing more than [\_\_\_\_\_] kilogram pounds.

### 1.5 WARRANTY

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

## PART 2 PRODUCTS

### 2.1 SYSTEM DESCRIPTION

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NOTE: Ensure fan and motor balance conform to ISO  
1940-1 - (1986) Balance Quality Requirements of  
Rigid Rotors - Determination of Permissible Residual  
Unbalance unless otherwise noted. Ensure motor  
vibration levels conform to NEMA Specification MG-1,  
Motors and Generators, Part 7 unless otherwise noted.  
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Submit equipment and performance data for air handling units. Provide data that consists of 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 prior to the start of work detailed on these drawings.

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

## 2.2 COMPONENTS

### 2.2.1 Air Handling Unit (AHU)

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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.

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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.

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Provide a central-station type, factory fabricated, and [sectionally] [fully] assembled air handling unit (AHU). Provide AHU that includes components and auxiliaries in accordance with AHRI 430. Balance AHU fan and motor to ISO 1940-1-2005.

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

Fans with enlarged outlets are not permitted.

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

### ]2.2.2 Unit Cabinet

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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.

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NOTE: Select the following paragraph for AMCA Class

**A and Class B cabinets.**

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Provide AHU cabinet that is suitable for pressure class shown and that has leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly during starting and stopping of fans and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.004167 of unsupported span prior to acceptance. Stiffen pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, to raise natural frequency to an easily attenuated level. Fabricate enclosure from continuous hot-dipped galvanized steel no lighter than 0.91 millimeter 20 gage thickness, to match 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 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 floor as well as ceiling unit hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

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

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Provide AHU cabinet suitable for pressure class indicated with leaktight joints, closures, penetrations, and access provisions. Provide a cabinet that does not expand or contract perceptibly during starting and stopping of fans and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.002778 of unsupported span prior to acceptance by the Contracting Officer. Stiffen pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, to raise natural frequency to an easily attenuated level. Provide enclosure that is fabricated from mill-galvanized or primed and painted carbon steel sheet of required thickness. 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 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 entire floor as well as ceiling unit 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, strengthen cabinet floor to permit entry without damage to any component. Hinge and latch access doors and panels at a spacing sufficiently close 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 lapped contacting surfaces, with a corrosion-protective coating.
- b. Certify coating as passing a 500-hour exposure salt-spray fog test in accordance with ASTM B117.
- c. Immediately after completion of 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 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 prior to expiration of guarantee.

Interior surfaces of cabinets 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 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.

Ensure fan wheels are dynamically and statically balanced at the factory. Provide fan with RPM that is 25 percent less than the first critical speed. Provide 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 air handling units that are provided with variable frequency drives, have their fans balanced over the entire range of operation (20 percent - 100 percent RPM). Balancing fans of only 100 percent design of RPM is not 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. Install flexible canvas ducts or a vibration absorbent fan discharge seal between fan and casings to ensure complete isolation. Provide flexible canvas ducts that 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.

Provide heavy duty, open drip-proof, 3-phase fan motors, operable at 460

volts, 60 hertz. 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 100 watt service light that is wired to an individual switch. Light requires 115 Volt, single phase, 60 Hertz service that is separate from the main power to the AHU. Provide a single 115 volt outlet at the light switch.

### 2.2.3 Fan

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

[ Provide single-wheel fans.

] Locate fan inlet where it provides not less than one-half fan-wheel diameter clearance from cabinet wall or adjacent fan inlet where double wheels are permitted.

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**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.**  
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Mount AHU fan drive external to casing.

Install AHU fan motor and drive inside fan cabinet. Provide motor that conforms to NEMA MG 1 and is installed on an adjustable base. Provide an access door of adequate size for servicing 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

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

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

Extend integral cabinet drain pan under all areas where condensate is

collected and make watertight with welded or brazed joints, piped to drain. Provide corrosion protection in condensate collection area, and insulate against sweating. Provide minimum 2.0 millimeter 14-gage sheet metal, except that 1.6 millimeter 16-gage double-drain-pan construction is acceptable.

Provide cooling coil ends that are enclosed by 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 drain and drain substantially dry by gravity alone when 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 unit that is internally fitted at the factory with a sound-attenuating, thermal-attenuating, fibrous-glass material not less than 50.8 millimeter 2-inch thick. Ensure insulation effectiveness precludes any condensation on any exterior cabinet surface under conditions normal to the unit's installed location. Provide acoustic treatment that attenuates fan noise in compliance with specified noise criteria. Apply material to the cabinet with waterproof adhesives and permanent fasteners on 100 percent coverage basis. 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:

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

#### ][2.2.7 Multizone AHU

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

][Add a balancing plate to the heating coil when required to equalize resistance in airstreams of multizone units.

### ]]2.2.8 Blow-Through AHU

Fit blow-through AHU with pressure equalizing baffles.

### ]2.2.9 Coils

#### 2.2.9.1 Coil Section

Provide 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 connections extended through the cabinet.

#### 2.2.9.2 Coil Pressure and Temperature Ratings

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

<u>SERVICE</u>	<u>PRESSURE</u>	<u>TEMPERATURE</u>
Hot Water	289 Pa	121 degrees C
Chilled Water	289 Pa	4 degrees C

<u>SERVICE</u>	<u>PRESSURE</u>	<u>TEMPERATURE</u>
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:

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

<u>SERVICE</u>	<u>PRESSURE</u>
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 prior to shipment 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 ops spring-loaded plug drains and vent petcocks. Provide automatic air vents with ball type isolation valves for each coil 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] 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 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 gage galvanized steel with assembled brazed joints. Provide easily removable eliminator sections for cleaning from side of the air handling unit without causing partial or complete disassembly of the Air Handler Unit casing.

#### 2.2.11 Filters

##### 2.2.11.1 Filter Housing

Provide factory fabricated filter section of the same construction and finish as 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 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 filters perform in accordance with ASHRAE 52.2.

##### 2.2.11.2 Replaceable Air Filters

Select filters conforming to UL 900, Class 1, and; when cleaned, 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

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 gauge 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. Ensure minimum efficiency of filter is 60 percent per ASHRAE 52.2

#### 2.2.11.4 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. Provide the extended surface type 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: 80-85 percent nominal efficiency outfitter
- b. Grade D: 25-30 percent nominal efficiency prefilter

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

Filter Efficiency and Arrestance: Determine 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)	Average Efficiency (Percent)
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, 50.8 millimeter	0.32	0.70

	<u>Initial Resistance</u>	<u>Final Resistance</u>
Grade B, Rigid Pleated	0.60	1.00
Grade D, 2-inches deep	.032	0.70

Dust Holding Capacity: When tested to 1.00 inch w.g. at 500-feet per minute face velocity, provide a dust holding capacity from each 24-inch by 24-inch (face area) filter 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 minimum net effective area in square feet for each 24-inch by 24-inch (face area) filter at 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, of solid acrylic plastic construction with built-in level vial and with an adjustable mirror-polished scale. Equip gauges with vent valves for zeroing and over-pressure safety traps. Ensure the gauge range is adequate for the particular installation. Provide gauges manufactured by Dwyer or approved equal.

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

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

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

##### 3.1.1 Coordination

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

##### 3.1.2 Temporary Construction Filters

Have temporary construction filters 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. Avoid unnecessary filter loading with construction dust, do not have final filters in place while general building construction is taking place. Clean 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.
- ] Maximum number of coil rows is four (4). Maximum number of fins per inch is ten (10).

Provide VAV terminal units that are AHRI 880 I-P certified and UL listed.

### 3.2 FIELD QUALITY CONTROL

#### 3.2.1 Vibration Analyzer

Use an 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-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 the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

#### 3.2.2 Acceptance

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

Prior to final acceptance, verify conformance to specifications using vibration analysis. Ensure maximum vibration levels are .075 in/sec at 1 times run speed and at fan/blade frequency, and .04 in/sec at other multiples of run speed.

#### 3.2.3 AHU Testing

Conduct performance test and rate AHU and components in accordance with AMCA 211, AMCA 300, and ASHRAE 51. Provide AHU ratings in accordance with AHRI 430.

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 air handling unit start-up in the presence of the Contracting Officer.

### 3.3 CLOSEOUT ACTIVITIES

#### 3.3.1 Operation And Maintenance

Submit operation and maintenance manuals prior to testing the air handling units. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

#### 3.3.2 Acceptance

With Warranty and final test reports, 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 --