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Preparing Activity: NAVFAC Replacing without change
UFGS-15720N (September 1999)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 1 April 2006

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SECTION 23 34 16.00 20

AIR HANDLING UNITS

04/06

NOTE: This guide specification covers the requirements for air handling equipment including central-station air handlers, fans, (centrifugal fan, propeller fan, vaneaxial fan, power ventilator, in-line tubular centrifugal fan, propeller ceiling fan, and air curtain), gravity ventilators, fan-coil room units, room air-induction units, variable-air-volume terminal units, and unit ventilators.

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.

NOTE: This guide specification does not cover and should not be used for local exhaust systems. It may be used for fresh air supply or make-up portion of local exhaust system. Local exhaust systems are appropriate for the containment or removal of contaminants encountered in hazardous work place atmospheres. Consult Section 11501, "Industrial Ventilation and Exhaust Systems (Ducts and Fans)," for guidance regarding local exhaust systems. Noise levels of all equipment shall not exceed 84 dBA on an 8 hour time weighed average. See OPNAVINST 5100.23B, paragraph entitled "Permissible Exposure Limit (PEL)."

NOTE: The following information shall be shown on the project drawings:

1. Arrangement plan and details for air handling equipment and accessories.
2. Equipment schedules with sound ratings or loudness level, electrical characteristics, capacities.
3. Equipment foundations, supports, and vibration isolators.

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 210	(1999) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 220	(2005) Test Methods for Air Curtain Units
AMCA 300	(2005) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2005) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(1998) Laboratory Methods of Testing Dampers for Rating

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 410	(2001; Addendum 2002) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1999) Central-Station Air-Handling Units
ARI 440	(2005) Room Fan-Coils
ARI 445	(1987; R 1993) Room Air-Induction Units
ARI 610	(2004) Central Systems Humidifiers for Residential Applications
ARI 880	(1998) Air Terminals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S12.33	(2002; Corrigendum 1 (2001)) Engineering Methods for the Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room (Note: was ASA91, but that document refers to ANSI S12.53.)
ANSI Z21.47	(2001; A 2002) Gas-Fired Central Furnaces

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

ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 653/A 653M	(2004a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(2002) Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1996; R 2004) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA MG 1	(2003; R 2004) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code
NFPA 90A	(2002) Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVAC Duct Const Stds	(1995, 2nd Ed) HVAC Duct Construction Standards - Metal and Flexible
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U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS F-F-2790	(Basic) Filter, Air-Extended Area, Initial Installation
FS F-F-320	(Rev C) Filters, Electronic Air Cleaning Ionizing Plate Type

UNDERWRITERS LABORATORIES (UL)

UL 1096	(1986; R 1988, Bul. 1994 and 1996) Electric Central Air Heating Equipment
UL 507	(1999; Rev thru Dec 2003) Electric Fans
UL 586	(1996; Rev thru Apr 2000) High-Efficiency, Particulate, Air Filter Units
UL 705	(2004) Power Ventilators
UL 867	(2000; Rev thru Feb 2004) Electrostatic Air Cleaners
UL 883	(1986; R 1989, Errata 1989, Bul. 1994 and 1996) Fan-Coil Units and Room Fan-Heater Units
UL 900	(2004) Air Filter Units
UL 998	(2001) Humidifiers

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with the additions and modifications specified herein.

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.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

NOTE: Indicate sound ratings or loudness level of equipment in the Equipment Schedule on the drawings.

Central station air handlers

Fans

Fan-coil units

Room air-induction units

Gravity ventilators

Variable-air-volume (VAV) terminal units

Roof curbs

Filter Sections

Eliminators

Drip Pans

Humidifiers

Sprayed Coil Dehumidifiers

Manometers

Include sound rating data and sound power level for all octave-band center frequencies or loudness level.

SD-06 Test Reports

Corrosion protection

High Efficiency Particulate (HEPA) Air Filters

Preliminary tests

Air handling and distribution equipment tests

Dampers leakage test

Include certification by the equipment manufacturer's representative.

SD-07 Certificates

Central station air handlers

Fans

Fan-coil units

Room air-induction units

Gravity ventilators

Variable-air-volume (VAV) terminal units

SD-10 Operation and Maintenance Data

Central station air handlers, Data Package 3

Fans, Data Package 3

Fan-coil units, Data Package 3

Room air-induction units, Data Package 2

Gravity ventilators, Data Package 2

Filter sections, Data Package 2

Variable-air-volume (VAV) terminal units, Data Package 2

Humidifiers, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 TESTING FOR CORROSION PROTECTION

Comply with [ASTM A 123/A 123M] [ASTM A 653/A 653M], or protect equipment with a corrosion-inhibiting coating or paint system that has proved capable of satisfactorily withstanding corrosion in accordance with ASTM B 117. Test 125 hours for equipment installed indoors and 500 hours for equipment installed outdoors or subjected to a marine atmosphere. Each specimen shall have a standard scratch as defined in ASTM D 1654.

1.4.1 Corrosion Criteria

Upon completion of exposure, evaluate coating or painting in accordance with ASTM D 1654. Coat or paint shall show no indication of deterioration, loss of adhesion, or indication of rust or corrosion extending further than 3 mm 1/8 inch on either side of original scratch.

1.4.2 Thickness of Coating

Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry film thickness.

PART 2 PRODUCTS

2.1 FANS

NOTE: Indicate sound ratings or loudness level of
equipment in the Equipment Schedule on the drawings.

Total sound power level of the fan shall not exceed 90 dBA when tested per AMCA 300 and rated per AMCA 301; statically and dynamically balanced, with air capacities, brake horsepowers, fan types, fan arrangement, sound power levels or loudness level, and static pressure as indicated. Fan bearing life shall have a minimum average life of 200,000 hours at design operating conditions. [Provide nominal 2 mesh 1.60 mm 0.063 inch wire diameter, [aluminum] [or] [stainless steel] bird screens for outdoor [inlets] [and] [outlets].] [Equip with automatic (backdraft) dampers where indicated.] Have thermal overload protection in the operating disconnect switches within the building. Construct housings and impellers of [aluminum] [or] [steel], except as specified otherwise. Provide non-sparking construction where indicated. For wiring terminations, provide terminal lugs to match

branch circuit conductor quantities, sizes, and materials. Enclose terminal lugs in terminal box sized to NFPA 70.

2.1.1 Centrifugal Fans

AMCA 210 with AMCA seal, [utility] [forward-curved] [radial] [backward-curved] [backward-inclined] [airfoil] [single width] [double width] type, [direct] [or] [V-belt] drive motors, and [manual] [or] [automatic] inlet vanes [as indicated]. Provide bearing cooling fan (heat slinger) [and threaded drain connection]. [Inlet and outlet duct connections shall be flanged.] Impeller shall be constructed of steel [or aluminum] with smooth curved rim, back plate, blades, and cast iron [or cast steel] hub riveted to back plate and keyed to shaft with set screws.

2.1.2 Propeller Fans

AMCA 210 with AMCA seal, [direct] [or] [V-belt] drive motors. Furnish fans with a three-conductor neoprene-covered flexible cable, (Type SO), and a three-prong attachment plug. [Provide for connection of permanent wiring.] Provide shaped steel or steel reinforced aluminum blade impeller with heavy hubs, statically and dynamically balanced, [keyed and] locked to shaft.

2.1.3 Vaneaxial Fans

NOTE: Use automatically variable speed motor or adjustable variable pitch blades for vaneaxial return fans in VAV systems.

AMCA 210 with AMCA seal, [direct-drive motors of totally-enclosed air-cooled (TEAC) type] [V-belt drive motors, adjustable, with external belt guards]. Provide with adjustable die cast aluminum alloy [or glass reinforced polyester resin] air-foil impeller blades. Die cast aluminum alloy or cast iron hub with diameter of the fan hubs at least equal to that of the motor frame. [The hubs shall be indexed for direct-driven fans, with automatically adjustable variable pitch blades to facilitate setting the angle of blades from minimum to maximum angle.] [In lieu of variable pitch blades, variable speed motor may be used.] In the fan nameplate data, include the factory blade setting and the maximum setting for the motors. Guide vanes, adjustable inlet vanes, inlet bell, and outlet cones shall be constructed of steel. [Provide galvanized steel welded grid inlet screens to fit inlet bell.]

2.1.4 Power [Roof] [and] [Wall] Ventilators

NOTE: For naval facilities at Adak, Alaska, the entire assemblies of roof top or wall equipment shall be structurally strong enough to resist 200 km/hr 125 miles per hour wind force. In the third sentence of paragraph entitled "Power [Roof] [and] [Wall] Ventilators," delete "mounted under fan housings" for wall ventilators.

UL 705 with UL label and AMCA 210 with AMCA seal, [centrifugal] [propeller] [V-belt] [direct driven] fans in [low-silhouette] [spun aluminum] housings

high-impact plastic with glass fiber reinforcement. Equip motors with unfused safety disconnect switches [mounted under fan housings] and resilient mounts. [Mount motors out of air stream.] [Provide factory-fabricated roof curbs with continuous curb gaskets and aluminum bird screen.] [Provide gravity actuated, aluminum multiple blade construction backdraft damper and cast iron or steel sheaves, dynamically balanced and bored to fit shafts and keyed.]

2.1.5 In-Line Tubular Centrifugal Fans

AMCA 210 with AMCA seal, welded tubular steel casings, [tubular centrifugal backward-inclined] [or] [axial propeller] blades, stationary discharge conversion vanes, belt guards, and adjustable motor-mounts. Provide slip-fit or flanged connections between fan casings and ductwork. Air shall enter and leave fans axially. Streamline inlet with conversion vanes [and bell-mouth]. Enclose and isolate fan bearings and drive shafts from air stream. [Furnish direct-drive TEAC motors.] [Guard V-belt drives of drip-proof motors mounted out of air stream.] Provide fan supports [and vibration isolators].

2.1.6 Air-Circulating Fans

NOTE: These fans are not allowed when local exhaust system is used in the room or space.

UL 507 and UL listed, propeller ceiling type, with size and electrical characteristics as indicated.

2.1.7 Air Curtains

AMCA 210 and AMCA 220 with AMCA seal, factory-fabricated, [insect] [thermal] control type, angle adjustment feature, minimum air velocity [3] [8] meter per second (m/s) [600] [1,600] feet per minute (fpm), measured at points one meter 3 feet above the floor, and minimum air capacities and electrical characteristics.

2.2 CENTRAL STATION AIR HANDLERS

NOTE: ARI 210, 240, or 360, unitary air conditioning equipment with direct expansion coil are covered by Section 15730, "Unitary Air Conditioning Equipment." Fan-coil units are covered in ARI 440. For other exclusions, see ARI 430. In the industry, the provision of heating and cooling sections may be added by being rated separately, with coils per ARI 410, electric heaters per UL 1096, or gas-fired heaters per AGA Z21.47.

NOTE: Indicate sound ratings or loudness level of equipment in the Equipment Schedule on the drawings.

ARI 430 with sound rating in accordance with ASHRAE 68, [[single-] [multi-] zone] [or] [double-deck] type, sound power level, and static pressure, as

indicated. Include damper section, supply blower section, filter section with mixing box section or combination filter-mixing box section, and [coil] [or] [heater] section. Filters, housing coils, and heaters must be completely removable from the unit without having to dismantle the unit or adjacent equipment.

2.2.1 Casings

Construct casings of steel, galvanized steel, or aluminum on channel base [and drain pan] coated externally with manufacturers standard paint finish.

Provide removable panels and access doors for inspection and access to internal parts. Insulate casings with manufacturer's standard materials. For outdoor roof mounted units, provide weatherproof casing in accordance with paragraph entitled "Testing for Corrosion Protection." Finish with seal joints, [stationary] [adjustable] galvanized steel louvers with birdscreen, and bearing AMCA Certified Ratings Seal in accordance with AMCA 500-D.

2.2.2 Dampers

Provide with factory mounted [outside and return air dampers in mixing boxes] [face and bypass dampers] [multi-zone dampers] of galvanized steel blades, [with vinyl bulb edging] [and edge seals] in galvanized frame, in [parallel] [opposed] blade arrangement with non-slip keyed connecting rods and linkages. Permanently secure damper blades on a single shaft with self-lubricating [nylon] [brass] [oil impregnated bronze] bearings. Position damper blades across short air opening dimension. Maximum leakage is 2 percent at 1000 Pa 4 inch water gage differential pressure when sized for 10 m/s 2000 fpm face velocity.

2.2.3 Supply Blower (Fan) Sections

[Centrifugal fan of [backward-inclined] [forward-curved] [airfoil] blades with [direct] [or] [V-belt] drive motor] [or] [vaneaxial fan with [direct-drive TEAC motor] [or] [V-belt drive motor, adjustable, with belt guards for external mounted motors. Belt guards are not required for internally mounted motors]]. Provide [manual inlet vanes] [automatic inlet vanes or variable speed motor as indicated]. Bearings shall be grease-lubricated ball-bearing type, with minimum average life of 200,000 hours at design operating conditions.

2.2.4 Vibration Isolation

For the entire fan, motor, and drive assembly, provide 50 mm 2 inch nominal deflection spring vibration isolators, internally mounted at the factory together with fan discharge flexible connection and thrust restraint springs. As an alternate, vibration isolation may be provided external to air handlers. When alternate is chosen, provide 50 mm 2 inch nominal deflection springs, pipe and duct flexible connections, thrust restraint springs, and spring type pipe hangers on pipes directly-connected to such air handlers.

2.2.5 Filter Sections

NOTE: Select air filters based on ASHRAE "Handbook, Equipment." Provide two sets of filters for application requiring high infiltration efficiency above 85 percent per ASHRAE 52.1. Prefilters shall

be viscous or dry throw-away type, 60 percent minimum efficiency per ASHRAE 52.1; after-filters shall be of dry media type, absolute, or electrostatic precipitators. The following may be used as a guide only; selection of filters should suit the project requirements.

1. General Application:

Air Handling Type	m/3 Range	Filter Type
Air Handling Type	CFM Range	Filter Type
Factory-fabricated dry type throw-away	Up to 4,000	Viscous or
Factory-fabricated automatic replaceable filter media	Above 4,000	Dry type
Field-fabricated type replaceable filter media	-----	Dry type automatic

2. Hospitals:

See NAVFACINST 11012.143A, FAC 0441A, 31 November 1981, "Design Criteria Guidance for Medical Facilities."

[Protect permanent holding frames with rust inhibitor coating.] Provide visible identification on media frames showing model number and air-flow direction. [Where filter bank is indicated or required,] provide means of sealing to prevent bypass of unfiltered air. Except extended media with self-supporting cartridge and high efficiency particulate filters, performance shall be determined in accordance with ASHRAE 52.1. [Provide inclined-type manometers for filter stations of 944 liter per second (L/s) 2,000 cfm capacity or more, including filters furnished as integral parts of air-handling units. Manometers with 3 mm 1/10 inch graduations and spirit level shall be of sufficient length to read at least 76 mm 3 inch water gage. Equip with over-pressure safety traps and three-way vent valves.]

2.2.5.1 Replaceable Air Filters

UL 900, Class [1, those which, when clean, do not contribute fuel when attacked by flame and emit only negligible amount of smoke] [2, those which, when clean, burn moderately when attacked by flame or emit moderate amount of smoke, or both], [throw-away frames and media] [permanent frames with replaceable media], [25 mm one inch] [50 mm 2 inch] nominal thickness, and size as indicated.

2.2.5.2 Cleanable Air Filters

UL 900, Class [1, those which, when clean, do not contribute fuel when attacked by flame and emit only negligible amount of smoke] [2, those

which, when clean, burn moderately when attacked by flame or emit moderate amount of smoke, or both], [adhesive coated media] [dry media], and size indicated. [Provide washing-and-charging tank for every 100 filter sections or fraction thereof.] [Furnish adhesive oil in 19 liters 5 gallon containers sufficient for 12 cleaning operations but not less than one liter one quart per filter section.]

2.2.5.3 Automatic Roll Air Filters

UL 900, Class 2 units, UL classified, renewable media type in which a roll media is unwound across the air stream by continuous media and [a differential-pressure controller] [a timer] [or] [a timer with pressure drop override]. Filter medium having a normal depth of 50 mm 2 inches when clean, shall not compress more than 8 mm 1/4 inch when subject to air velocity of 2 1/2 m/s 500 fpm. Wind dirty medium with the dirty surface inward, and reroll automatically. Each roll of medium shall be minimum 20 meters 65 feet long. Ship each roll of medium in a container which will not permit seepage of adhesive to surface of container, regardless of the position during shipment or storage. Replace stored rolls showing evidence of seepage. Fabricate filter-supporting structural members of not less than 14 gage (1.90 mm 0.0747 inch nominal thickness) steel for the base and side panels and 16 gage (1.60 mm 0.0598 inch nominal thickness) steel for top panel. Ship filters in major subassemblies or in fully assembled sections. Prewire master sections. Run wiring in rigid conduit or steel enclosed wire tunnels. Equip master section with a run-out switch to stop the media movement and operate a signal light to indicate that the medium from one of the sections has run out. Furnish a manual media-advance switch with each drive unit to advance media to the end of the roll. [Locate signal light on air handling units temperature-control panel.] Media shall have an average synthetic dust weight arrestance of minimum 75 percent efficiency, a dust holding capacity of minimum, [2 kilogram per square meter] [200 grams per square foot] [____], and an average resistance of 112 Pa 0.45 inch water gage at [the design] [2 1/2 m/s 500 fpm] face velocity.

2.2.5.4 Disposable Cartridge Air Filters

NOTE: Disposable cartridge are filters with efficiencies of 85 to 95 percent and electrostatic air filters are intended for uses only in instrument shops, hospitals, certain laboratories, and other special buildings where extreme cleanliness is required.

UL 900, Class 2, UL classified, and factory assembled. Provide filter media of [cotton and synthetic fibers] [ultra-fine glass fibers] having [35 to 40] [50 to 55] [80 to 85] [90 to 95] percent average dust spot efficiencies with maximum final resistance [188] [250] [300] Pa [0.75] [one] [1.20] inch water gage and maximum face velocity 3 m/s 625 fpm. Construct filter frame of [16] [____] gage sheet steel or aluminum with welded or riveted joints. Calk or gasket entire assembly to prevent air leakage around frames.

2.2.5.5 Extended Media (Pleated) Air Filters

FS F-F-2790 [, permanent holding frame] and [filter housing with factory-assembled [side] [or] [bottom] access]:

[a. Pre-Filter (Type I): [Externally supported] [or] [nonsupported (internally supported)] cartridge.
Efficiency: [20] [30] [40] percent rated.
Pre-Filter Track: Required.]

[b. After-Filter (Type II): [Externally supported] [or] [nonsupported (internally supported)] cartridge.
Efficiency: [85 (Grade C)] [95 (Grade D)] percent rated.]

[b. After-Filter (Type III): Self-supporting cartridge.
Efficiency: 95 (Grade E) percent rated on standard dioctyl-phthalate (DOP) Test with 0.3 micron diameter particles.]

2.2.5.6 High Efficiency Particulate (HEPA) Air Filters

NOTE: Use high efficiency particulate air filters in "white" room, dust-controlled facilities, medical facilities, and clean work stations.

UL 586 and UL classified; minimum 99.97 percent efficiency to remove 0.3-micron diameter particles. Construct filters of continuously pleated filter-media of honeycomb design or separated by corrugated inserts. Correct overall frame dimensions and squareness to zero, minus 3 mm or plus 3 mm 1/8 inch or plus 1/8 inch, respectively. Provide airtight joints with frame retainers and gaskets. Air capacity and normal depth of the filters shall be as indicated.

2.2.5.7 Filter Housing

Minimum thickness, 14 gage steel with baked finish inside and out. Joints shall be continuously welded. Flange shall have a fixed air sealing gasket with hollow cross section, closed cell rubber or resilient neoprene, suitable for repetitive reuse. Cabinets shall have flanged ends for connection to adjacent ducts. Hinged access doors on both cabinet sides. Provide access doors with fixed air sealing gaskets to be airtight at the static pressure expected in service. Provide two 10 mm 3/8 inch Society of Automotive Engineers (SAE) flare connection test ports complete with seal cap, one on each side of the filter. Weld test ports into each filter cabinet or plenum. Test port shall not penetrate to filter frame or media.

2.2.5.8 Odor Control

Factory-fabricated, charcoal type with multiple-cells of porous activated carbon. Construct each filter cell with trays to retain the activated carbon and with means to prevent the by-passing of air. Construct filter frames of rigid and corrosion resisting materials.

2.2.6 Mixing Boxes

Include equally sized openings, sized to individually handle full air flow capacity. Provide [automatic] [or] [manual] dampers.

2.2.7 Outside-Air Intake

NOTE: Delete this paragraph if the central station
air handlers are not roof top units.

Provide each roof top unit with a unit-mounted louver, built-in rain lip,
and bird screen.

2.2.8 [Heating] [and] [Cooling] Sections

NOTE: ARI 210, 240, or 360, unitary air
conditioning equipment with direct expansion coil
are covered by Section 15730, "Unitary Air
Conditioning Equipment." Fan-coil units are covered
in ARI 440. For other exclusions, see ARI 430. In
the industry, the provision of heating and cooling
sections may be added by being rated separately,
with coils per ARI 410, electric heaters per UL
1096, or gas-fired heaters per AGA Z21.47.

2.2.8.1 Coils

Provide removable coils per ARI 410 with access to both sides. Enclose
[heating] [and] [cooling] coils in a common or individual casing with
headers and return bends [exposed outside] [fully contained within] casing.
[Cooling coils shall have drain pans with piping connections to remove
condensate.] Seal coils to casing to prevent leakage of air around coils.
[Provide face and bypass dampers to regulate the proportions of conditioned
and unconditioned air delivered.]

2.2.8.2 Heaters

[Electric heaters per UL 1096. Elements shall be [nickel chromium alloy]
[_____] [manufacturer's standard]. Heater elements shall cover at least 70
percent of air outlet area to minimize bypass air and reduce surface
temperature.] [Gas-fired heater per ANSI Z21.47 with American Gas
Association (AGA) label. Construct heat exchanger of minimum 16 gage
series 300 or 400 stainless steel. Provide electric ignition type burners.]

2.2.8.3 Eliminators

Equip each cooling coil having an air velocity of over 2 m/s 400 fpm
through the net face area with moisture eliminators, unless the coil
manufacturer guarantees, over the signature of a responsible company
official, that no moisture will be carried beyond the drip pans under
actual conditions of operation. Construct of minimum 24 gage [zinc-coated
steel] [copper] [copper nickel] [or] [stainless steel], removable through
the nearest access door in the casing or ductwork. Eliminators shall have
not less than two bends at 45 degrees and shall be spaced not more than 63
mm 2 1/2 inches center-to-center on face. Each bend shall have an
integrally formed hook as indicated in the SMACNA HVAC Duct Const Stds.

2.2.8.4 Drip Pans

Provide each cooling coil section in both field-and-factory assembled
casings with a stainless or galvanized steel drip pan not less than 18 gage
with drain connections. Drip pans shall collect, confine, and dispose of
all condensate from cooling coils and attachments, including headers,

return bends, distributors, and uninsulated pipe and fittings. Where individual eliminator blades are in section (not in one piece from top to bottom of coil bank), provide auxiliary drip troughs at bottom of each section with drains to drip pans. Insulate drip pans with water impervious insulation of sufficient thickness to prevent condensate formation on the exterior at ambient conditions to be encountered.

2.2.9 Sprayed Coil Dehumidifiers

Provide assembly with reinforced, braced, and externally insulated galvanized steel casing, vertical in-line spray pump, bronze self-cleaning spray nozzles, galvanized steel pipe spray headers. adjustable float valve with replaceable neoprene seat, manufacturer's standard cooling coil, and welded black steel drain tank. Provide overflow drain, make-up, and bleed connection.

2.2.10 Humidifiers

Factory-assembled, single or multiple units as required to obtain the capacities indicated.

2.2.10.1 Evaporative Pan

UL 998. [UL listed and rated as indicated.] Units shall have submerged [steel coils] [or] [electric heating elements] to evaporate water from pans into the surrounding air. [Steam coils shall be of copper construction with pan of copper or 300 series stainless steel per ASTM A 167.] Provide low water cut-off switch.

2.2.10.2 Steam Grid

NOTE: Steam containing amines should not be
injected directly into the air stream. A dedicated
"clean steam" boilers is recommended to supply steam
to this equipment.

Units shall inject steam directly into the air stream. Factory mounted [in plenum with drain pan for draw-thru units] [in diffuser section of blow-thru units].

- a. For single grid units, equip each unit with a single [copper] [galvanized steel] distribution grid with pipe connection on one end and cap on the other end. Evenly space orifices along grid length. Provide automatic steam control valve and condensate traps. House grid in [copper] [galvanized steel] enclosures with built-in condensate drain connection for enclosed-grid type and wrap grid with wicks for exposed-grid type.
- b. For packaged units, equip each unit with provisions to trap out and reevaporate condensate and to supply dry steam for a single distribution grid. Provide modulating [electric] [electronic] [or] [pneumatic] steam-control valve, steam-jacket with condensate drain, and condensate trap.
- c. Electronic Electrode Steam Units: Self-contained, electronic steam generators with steam output as indicated and equipped with disposable tank. Provide each unit with a solid state energy

saving control circuit to control steam output and compensate for changing water conditions without chemical additives. Include an integral control and monitoring panel, with a capacity meter, a "change cylinder (container)" indicator, a capacity adjustment control adjusting from 20 to 100 percent of rated output capacity, an on-off drain switch, and an on-auto push button with indicator light. Equip each unit with double-wall insulated steam supply hose, a steam distributor, an automatic fill with cleanable strainers, or an automatic drain valve.

2.2.10.3 Mechanical Water-Spray

UL 998 and UL listed, [space] [or] [duct] units. Equip each unit with a water reservoir with float-controlled makeup valve, inlet and overflow connections, motor-driven fan, and [centrifugal atomizing-disk] [or] [water pump with atomizing breaker-device]. Distribute air steam [radially in each directions] [or] [in one or two directions]. Provide air filters of humidifier-manufacturer's standard and nonferrous parts in contact with water. Fan shall have fractional horsepower motor with stainless steel shaft.

2.2.10.4 [Atomizing] [or] [Wetted Element]

[By-pass] [or] [duct]-mounted; capacities as indicated. Do not employ fan or electric heating coil for normal operation of units. [Provide drain outlet and [manual on-off switch] [saddle (manual shut-off) valve] [remotely located] [or] [integral with each unit].] Materials shall be corrosion resistant.

- a. Atomizing Units: UL 998 and UL listed, electric power units with metered nozzle, relay, solenoid valve, sail switch, and integral humidistat. Electrical characteristics shall be as indicated.
- b. Wetted Element Units: ARI 610 rated and ARI labeled, reservoir or recirculating design units with a drain outlet, [automatic bleed] and cock valve to permit manual draining of the drain pan.

2.3 RETURN-AIR FAN SECTIONS

[Centrifugal fan] [or] [vaneaxial fan] conforming to paragraph entitled "Supply Blower (Fan) Sections."

2.4 GRAVITY VENTILATORS

NOTE: For naval facilities at Adak, Alaska, the entire assemblies of roof top or wall mounted equipment shall be structurally strong enough to resist 201 kilometers per hour 125 miles per hour wind force. In the third sentence of paragraph entitled "Power [Roof] [and] [Wall] Ventilators," delete "mounted under fan housings" for wall ventilators.

Factory-fabricated, [wind-driven rotary turbine,] minimum 24 gage [galvanized sheet steel] [or] [aluminum], storm proof and raintight, [self-flashing-prefabricated roof curbs,] [bird [and snow] screens,] [removable hoods], and maximum static pressure of 12 Pa at L/s 0.05 inch at

cfm indicated. Provide [factory-fabricated roof curbs with continuous curb gaskets] [flashing].

2.5 FAN-COIL UNITS

NOTE: Use ARI seal and ARI 440, except that fan coil units with refrigerant coils, steam coils, or electric coils shall use UL 883 and UL seal. If a dual fan-coil unit is used, provide separate access panel or guards for each unit. ARI 440 is formerly ARI 441. Older fan-coil units were rated under ARI 441. Fan-coil unit systems shall be two-pipe with zoned system change-over capability where required.

[ARI 440] [UL 883] with [ARI] [UL] seal, factory-fabricated. Provide [discharge] and [return-air] grilles, [tamperproof front panels] [, subbases] [, replaceable filters] [, unit levelers] [, grease or oil-lubricated motor bearings with minimum average life of 200,000 hours at the design operating conditions,] and vibration isolators. Conform with requirements below.

2.5.1 Coils

[Single] [and] [water] [steam] [electric].

2.5.2 Style

[Vertical] [Horizontal].

2.5.3 Controls

[Pneumatic] [or] [Electric] type as indicated.

2.5.3.1 Fans

[Manual with fan-speed switch] [Automatic with [selected speed-to-off] [high-to-low on cooling and low-to-off on heating] fan-cycled type.] [Construct fan wheels and scrolls of galvanized steel.]

2.5.3.2 Valves

[Two-way] [Three-way] [manual] [automatic [two-position] [modulating]] valves. Valves shall be [unit-mounted] [wall-mounted].

2.5.3.3 Summer-Winter Switches

[Manual] [or] [Automatic].

2.5.3.4 Air Dampers

[Manual] [or] [Automatic], [Nominal 0-25 percent outdoor air] [or] [Nominal 0-25 percent two-position outdoor air] [or] [0-100 percent modulating proportional outdoor air] dampers.

2.5.4 Unit Enclosures

[Exposed] [Recessed] [Semi-recessed], [suitable for duct connections as

indicated].

2.5.5 Mounting

[Floor (free standing)] [Ceiling] [or] [Wall-mounted].

2.5.6 Sound Power Level (Reference; 10 to the Power of -12 Watts)

ANSI S12.33 maximum 54 dB.

2.6 ROOM AIR-INDUCTION UNITS

ARI 445, factory-made and assembled, complete with enclosure, primary air plenum, water coil assembly, drain pan, filter or lint screen, air-balancing damper, primary-air nozzles, secondary coils, and discharge stack.

2.6.1 Sound Power Levels (Reference; 10 to the Power of -12 Watts)

NOTE: Delete irrelevant information on sound power level.

ANSI S12.33. Sound power level (dB) shall not exceed the following values:

Sound Power Level, (dB)					
Octave Band	3	4	5	6	7
Center-frequencies (Hz)	250	500	1000	2000	4000
a. Offices, Class Rooms, Quarters	51	49	45	44	41
b. Libraries, Hospital Rooms, Conference Rooms, Communication Facilities	49	46	43	41	41
c. Shops, Mess Halls, Factories	65	61	59	57	55

2.6.2 Enclosures

[Exposed] [Concealed] [floor (free-standing)] [ceiling], [wall-] type. Construct enclosures of minimum 18 gage galvanized steel or cold-rolled steel with baked prime finish. Provide [fixed] [adjustable] discharge and return-air metal grilles and access doors.

2.6.3 Water Coils and Drain Pans

2.6.3.1 Water Coils

ARI 410; seamless copper tubes mechanically bonded to aluminum fins. Each coil shall be tested at the factory under water at minimum 2068 kPa 300 psi air pressure and shall be suitable for 1379 kPa 200 psi working pressure.

2.6.3.2 Drain Pans

Galvanized steel pans. Insulate pans with water impervious insulation of sufficient thickness to prevent condensate formation on the exterior at ambient conditions to be encountered.

2.6.4 Permanent Filters or Lint Screens

Room air-induction unit manufacturer's standard.

2.6.5 Primary-Air Plenums

Minimum 24 gage galvanized steel, interior acoustically baffled and lined with sound absorbing materials of manufacturer's standard. Provide a supply-air duct connection at both plenum ends, and a cap for the unused connection.

2.6.6 Air Nozzles

Heat-resistant thermoplastic or polypropylene. Operating conditions range shall be minus 29 to plus 52 degrees C 20 to plus 125 degrees F and 875 Pa 3 1/2 inch water gage maximum pressure.

2.6.7 Dampers

Adjustable type for balancing primary air without removing enclosures.

2.7 ELECTROSTATIC (IONIZING) AIR FILTERS

NOTE: Do not use roll-type air filters unless specifically requested by the Government. Air filter per FS F-F-320 is for use only in non-residential air cleaning systems.

[UL 867 and UL listed, [duct] [fixed] [portable] [or] [stationary] type.] [Except as modified herein, FS F-F-320; Type [II (dry-plate type with wash water and detergent system and permanent after-filters, ionizing type)] [III dry-plate with disposable after-filter, ionizing type)] pf Style [A (roll-type filter, vertical, standard design)] [B (roll-type filter, vertical, compact design)] [C (roll-type filter, horizontal)] [D (extended media type, Stationary filter)]; Class [1 (standard efficiency, 75 percent minimum)] [2 (high efficiency, 95 percent minimum)]; Group [1 (factory-assembled)] [2 (field-assembled)]; and automatic controls. [For roll-type filter, controls may be pressure-drop, timer, or timer with pressure-drop override types. Provide runout switch to break control circuit and turn on control-panel signal light at the end of media roll. Filter media shall receive not less than 0.50 kilogram per square meter 50 grams per sq ft dust-holding capacity, with 75 percent efficiency at 2 1/2 m/s 500 fpm and average resistance of 112 Pa 0.45 inch water gage.]]

2.8 VARIABLE-AIR-VOLUME (VAV) TERMINAL UNITS

ARI 880; sound power level, capacities, static pressures, and other operating conditions as indicated. Include sound-attenuator boxes, variable-volume dampers, adjustable maximum air-volume regulators, and other items for system operation. Equip units with integral air-volume control dampers. Thermostats may be mounted in the units if room air is

induced over the thermostats. Maximum air-leak rate shall be 2 percent at static pressures from 100 to 750 Pa 0.4 to 3 inch water gage.

2.8.1 Casings

Minimum 26 gage galvanized steel or minimum one mm 0.04 inch thick aluminum, welded construction. Provide removable access panels where required for inspection, adjustment, and maintenance without disconnecting ducts.

2.8.2 Insulation

NFPA 90A and UL Classified for 2 hour fire-rated classification with minimum [13 mm 1/2 inch] [_____] [682 grams 1 1/2 lb.] [_____] glass fiber. Acoustically and thermally insulate internal surfaces of units, air diffusers, and accessories. Surface coat the insulation to prevent erosion.

2.8.3 Controls

NOTE: Select one of the following paragraph as appropriate. Direct digital controls shall only be used with the approval of the Engineering Field Division, Code 403.

[Provide controls in accordance with Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

[Provide controls in accordance with Section 23 09 54.00 20 DIRECT DIGITAL CONTROL SYSTEMS.]

[[Pneumatic], [Electric], [or] [Duct-pressure-powered] type. All thermostatic air-volume controls shall be pressure [independent] [dependent] type.]

2.8.4 Air-Volume Regulators

NOTE: For electric heat, use 30 percent for minimum regulator setting. Otherwise, use 25 percent for minimum regulator setting. In addition to regulator VAV units, there are pressure independent system-powered VAV units available. These system-powered VAV units do not require energy-consuming external controls. The system-powered VAV units can only maintain the set air flow quantity plus or minus ten percent, twice as much as permitted in Navy air leakage tests for ducts of pressure class 750 Pa or less 3 inch or less water gage. In some project locations, system-powered VAV units may be considered by the designer, if and only if economic and life cycle analysis can justify.

Static-pressure-compensated or velocity-pressure type. At any damper position, maintain constant-volume L/s cfm within plus-or-minus 5 percent of design-rated L/s cfm setting. Provide factory-fabricated and

field-adjustable set-points to set maximum and minimum L/s cfm.

2.8.5 Air Diffusers

[Fixed] [or] [Variable] type. Construct diffusers to operate without loss of Coanda effect. [Provide remote diffusers with integral boots and bellows or dampers.]

2.8.6 Reheat Coils

2.8.6.1 Water Coils

One-row or two-row hot water coils for [_____] degrees C degrees F temperature differential, with entering water temperature at [_____] degrees C degrees F. On reduction in cooling loads, the air supply quantity shall be gradually reduced to a fixed minimum setting. Then, the reheat coil shall be activated in sequence to maintain thermostat setting.

2.8.6.2 Electric Coils

UL listed, factory-fabricated, electric-resistance coils, and open-type heaters. Provide integral terminal box containing automatic reset thermal-cutout primary safety device, load carrying heat limits or manual reset thermal-cutout secondary safety device, and air-flow switch in control circuit.

2.9 MOTORS AND MOTOR STARTERS

NOTE: The motor control requirements should be coordinated with the electrical section and will depend on field conditions. The following types of motor starters should be used as a guide only. When electrical equipment is connected to heavily loaded power circuits, the starting current may cause excessive voltage drop.

<u>Motor kW</u>	<u>Voltage</u>	<u>Type Starter</u>
Up to 1/4	120	Manual
3/8 to 5 1/2	208-230	Across-the-line-magnetic
5 1/2 to 11	208-230	Across-the-line magnetic, part winding or wye-delta
11 to 22 1/2	460	Across-the-line magnetic part winding or wye-delta
Above 11	208-230	Part winding or wye-delta
Above 22 1/2	460	Part winding or wye-delta
<u>Motor hp</u>	<u>Voltage</u>	<u>Type Starter</u>
Up to 1/3	120	Manual
1/2 to 7 1/2	208-230	Across-the-line-magnetic

Motor hp 7 1/2 to 15	Voltage 208-230	Type Starter Across-the-line magnetic, part winding or wye-delta
15 to 30	460	Across-the-line magnetic, part winding or wye-delta
Above 15	208-230	Part winding or wye-delta
Above 30	460	Part winding or wye-delta

NEMA MG 1, NEMA ICS 2, and NEMA ICS 6, respectively, with electrical characteristics as indicated. Motors shall be [open] [dripproof] [totally-enclosed] [explosion-proof]. Motor starters shall be [manual] [magnetic-across-the-line] [reduced-voltage] [part-winding] [wye-delta] type with [general-purpose] [water-resistant] [watertight] [explosion-proof] enclosure.

2.10 ROOF CURBS

Factory-fabricated sheet-steel structural members. Provide minimum 100 mm 4 inch cants for built-up roofing, 50 by 150 mm 2 by 6 inch factory-installed wood nailers, and fully mitered end sections. Provide welded 18 gage galvanized steel shell, base plate, and counterflashing and provide stiffness required to eliminating deflection.

2.11 CORROSION PROTECTION FOR MARINE ENVIRONMENTS

2.11.1 Corrosion Protection for Marine Environments

NOTE: Indicate specific equipment for such special finish in the drawings. This paragraph applies only primarily to Pacific islands, Atlantic islands, or other similar marine environments.

Provide a special finish on the interior of the equipment and the exterior, where indicated. Apply coating at the premises of a company specializing in such work.

2.11.1.1 Mild Steel and Factory Primed Surfaces

- Synthetic Resin Primer: 36 percent, plus or minus 6 percent, solids content by volume; 1 coat, 0.076 mm 3 mils minimum dry film thickness.
- Vinyl Copolymer: 23 percent, plus or minus 4 percent, solids content by volume; 2 coats, 0.038 mm 1 1/2 mils minimum dry film thickness per coat.

2.11.1.2 Nonferrous Heat Exchanger Fin Coil Surfaces

Vinyl copolymer, 4 coats, 0.038 mm 1 1/2 mils minimum dry film thickness per coat.

2.11.1.3 Galvanized Surfaces

- a. Polyamide Epoxy Primer: 48 percent, plus or minus 2 percent, solids content by volume; 1 coat, 0.051 mm 2 mils minimum dry film thickness.
- b. Vinyl Copolymer: 23 percent, plus or minus 4 percent, solids content by volume; 2 coats, 0.038 mm 1 1/2 mils minimum dry film thickness per coat.

2.11.1.4 Aluminum Surfaces Other than Fin Coil Surfaces

- a. Polyamide Epoxy Primer: 48 percent, plus or minus 2 percent, solid content by volume; 1 coat, 0.051 mm 2 mils minimum dry film thickness.
- b. Vinyl Copolymer: 23 percent, plus or minus 4 percent, solids content by volume; 2 coats, 0.038 mm 1 1/2 mils minimum dry film thickness per coat.

PART 3 EXECUTION

3.1 PREPARATION

Provide storage for equipment and materials at the project site. Parts shall be readily accessible for inspection, repair, and renewal. Protect materials and equipment from weather.

3.2 INSTALLATION

Install air distribution equipment as indicated and in accordance with the manufacturer's instructions. Provide clearance for inspection, repair, replacement, and service. Electrical work shall conform with NFPA 70 and Division 16, "Electrical." Provide overload protection in the operating disconnect switches and magnetic starters. Locate air intake of air handling equipment at a minimum of 8 meters 25 feet from industrial stacks, bathroom vents, and sanitary risers. Prevailing wind direction shall not be used as justification for placing air intake closer than 8 meters 25 feet of exhaust stacks. Locate annunciator panel in maintenance office or foreman's office.

3.2.1 Fans

Install with resilient mountings, flexible electrical leads, and flexible connections between fan inlet and discharge ductwork. Provide [fixed] sheaves required for final air balance and safety screen where inlet or outlet is exposed.

3.2.2 Air Handling Units

Install assembled units on vibration isolators [and isolate fan section with flexible duct connections]. Bolt sections together in high pressure units. Pipe drain pan to the nearest floor drain.

3.2.3 Power Ventilators

Secure [roof] [wall] exhausters with [cadmium plated steel] [aluminum] [stainless steel] lag screws to [roof curb] [structure]. Extend ducts to [roof] [wall] exhausters into [roof curb] [structure]. Counterflash duct

to [roof] [wall] opening.

3.2.4 Room Air-Induction Units

Level and shim units and anchor to structure. Center units under windows. [Where multiple units occur over windows, divide element into equal segments, centered under each window.] Extend cabinet enclosure wall-to-wall unless otherwise indicated. Support cabinet enclosures from wall mounting strip or attach direct to wall and floor. For units butted against walls, provide wall angles and trim pieces. Provide radiator valves on coil supply and return piping, easily accessible manual air vent at high points, and control valves.

3.3 FIELD QUALITY CONTROL

Schedule and administer specified tests. Provide personnel, instruments, and equipment for such tests. Correct defects and repeat the respective inspection and tests. Give the Contracting Officer ample notice of the dates and times scheduled for tests and trial operations. Conduct inspection and testing in the presence of the Contracting Officer.

3.3.1 Inspection

Prior to initial operation, inspect equipment installation for conformance with drawings and specifications.

3.3.2 Preliminary Tests

For each item of air handling and distribution equipment and its components, perform an operational test for a minimum period of [4] [_____] hours.

3.3.3 Testing and Balancing

After preliminary tests, perform [air handling and distribution equipment tests](#), adjustment, and balancing in accordance with Section [23 08 00.00 20](#) HVAC TESTING/ADJUSTING/BALANCING.

3.4 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

<u>Products</u>	<u>Inch-Pound</u>	<u>Metric</u>
a. Vibration Isolators Nominal Deflection	= 2 inches	= 50 mm
b. Air Filters Nominal Thickness	= 1, 2 inches	= 25, 50 mm
c. Water Coils Working Pressure	= 200 psi	= 1379 kPa
d. Induction Unit Air Nozzles		

<u>Products</u>	<u>Inch-Pound</u>	<u>Metric</u>
Operating Range	= -20 to 125 degrees F	= -29 to 52 degrees C
	= 3 1/2 inch water gage	= 875 Pa

-- End of Section --