
USACE / NAVFAC / AFCEA / NASA UFGS-23 34 16.00 20 (July 2006)

Preparing Activity: NAVFAC Superseding
 UFGS-23 34 16.00 20 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 19 March 2007

Revised throughout - changes not indicated by CHG tags

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SECTION 23 34 16.00 20

AIR HANDLING UNITS

07/06

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SECTION 23 34 16.00 20

AIR HANDLING UNITS 07/06

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.

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 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).

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: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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; 2001a) 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 1060	(2005) Performance Rating of Air-to-air Heat Exchangers for Energy Recovery Ventilation Heat Equipment
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ARI 410	(2001; 2002a) Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1999) Standard for Central-Station Air-Handling Units
ARI 440	(2005) Standard for Room Fan-Coils and Unit Ventilators
ARI 445	(1987; R 1993) Room Air-Induction Units
ARI 610	(2004) Performance Rating of Central Systems Humidifiers
ARI 880	(1998; 2002a) Standard for Air Terminals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S12.53	(1999) Engineering Methods for the Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room
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AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 52.2	(1999; Errata 2001; Errata 2002; Addendum a 2006; Supp to Addenda a 2006) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 55	(1992; R 2004) Thermal Environmental Conditions for Human Occupancy
ASHRAE 62.1	(2004) Ventilation for Acceptable Indoor Air Quality
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 653/A 653M	(2006a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B 117	(2003) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(2005) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products

CSA AMERICA, INC. (CSA/AM)

CSA/AM Z21.47	(2003; A 2004, 2006) Gas-Fired Central Furnaces
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) 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	(2006) Standard for Industrial Controls and Systems Enclosures
NEMA MG 1	(2006) Standard for Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code
NFPA 90A	(2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

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

SMACNA HVAC Duct Const Stds	(1995; Addendum 1997, 2nd Ed) HVAC Duct Construction Standards - Metal and Flexible
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U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50554	(Basic; Notice 1) Filter, Air-Extended Area, Initial Installation
FS F-F-320	(Rev C) Filters, Electronic Air Cleaning Ionizing Plate Type

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)
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UNDERWRITERS LABORATORIES (UL)

UL 1995	(2005) Standard for Heating and Cooling Equipment
UL 507	(1999; Rev thru May 2006) Electric Fans
UL 586	(2004) Standard for High-Efficiency Particulate, Air Filter Units
UL 705	(2004; Rev thru Mar 2006) Standard for Power Ventilators
UL 867	(2000; Rev thru Feb 2004) Electrostatic Air Cleaners
UL 900	(2004) Standard for Air Filter Units
UL 998	(2001; Rev thru May 2006) 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: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army

projects and for Contractor Quality Control approval
for Navy 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.

Fans

Central station air handlers
Fan-coil units

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Room air-induction units

Gravity ventilators

Variable-air-volume (VAV) terminal units

Roof curbs

Filter Sections; (LEED)

[Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project. Submit documentation indicating relative dollar value of rapidly renewable materials to total dollar value of products included in project.]

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.

[Local/Regional Materials

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

[Environmental Data]

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.

1.5 ENVIRONMENTAL REQUIREMENTS

1.5.1 Indoor Environmental Quality

Maintain positive pressure within the building. Ventilation shall meet or exceed ASHRAE 62.1 and all published addenda. Meet or exceed filter media efficiency as tested in accordance with ASHRAE 52.2. Thermal comfort shall meet or exceed ASHRAE 55.

1.5.2 Natural Ventilation

Evaluate natural ventilation for appropriate spaces, and design air distribution systems to operate in the same direction as natural ventilation to reduce energy cost of pumping outdoor air.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor.

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][_____] mile [800][_____] kilometer radius from the project site, if available from a minimum of three sources.

1.6.2 Environmental Data

NOTE: ASTM E 2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the

sustainability of these products.

[Submit Table 1 of ASTM E 2129 for the following products: [____].]

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 horsepower, 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. Fan lights shall be compact fluorescent.

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 1995, or gas-fired heaters per AGA Z21.47.

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

NOTE: Designer must verify that products meeting the indicated minimum recycled content are available, preferably from at least three sources, to ensure adequate competition. If not, write in suitable recycled content values that reflect availability and competition.

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. [Air handling units shall be manufactured from a minimum of [70] [_____] percent post-consumer recycled content and [10] [_____] percent post-industrial recycled content.]

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] [zero-leakage

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 52.2. Prefilters shall be viscous or dry throw-away type, 60 percent minimum efficiency per ASHRAE 52.2; 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	-----	Dry type

type automatic
replaceable
filter media

2. Hospitals:

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

NOTE: Use of biobased materials that are rapidly renewable contributes to the following LEED credit: MR6. Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION.

[Filters shall contain a minimum of [85][95][____] percent biobased material like cotton.] [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 52.2. Filters shall have a minimum efficiency reporting value (MERV) of 13 unless otherwise indicated. [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.

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

CID A-A-50554 [, 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 and MERV 17 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 1995, or gas-fired heaters per AGA Z21.47.

2.2.8.1 Coils

NOTE: UV-C emitters improve air quality and reduce energy consumption by removing and inhibiting germicidal growth. Cleaning maintenance costs are also reduced.

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. Ultraviolet light C band (UV-C) emitters shall be incorporated downstream of all cooling coils and above all drain pans to control airborne and surface microbial growth and transfer. Applied units must be specifically manufactured for this purpose. Safety features shall be provided to limit hazard to operating staff. Units shall not produce ozone. Power output shall be [_____] watts. Power intensity shall be [_____] microwatts per square cm inch.] 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 1995. 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 CSA/AM 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

NOTE: Galvanized steel drip pans are subject to corrosion.

Provide each cooling coil section in both field-and-factory assembled casings with a [stainless or galvanized steel][plastic] drip pan not less than 18 gage with drain connections. [Pan shall have anti-microbial coating.] 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.

2.2.11 Labels

Provide labels for Central Station Air Handling Units (AHUs). Include the following information on each label:

- a. The identification number or name of the AHU.
- b. The outdoor air, supply air, return air, and exhaust or relief air connections to the AHU, each with arrows noting proper airflow direction.
- c. The access door(s) for the air filters and the minimum filter dust-spot (or MERV) efficiency.
- d. The filter pressure gauge and the recommended filter change pressure.

- e. The access door(s) for the condensate drain pan.
- f. Other pertinent access doors such as to energy recovery ventilation wheels or plates.
- g. The minimum amount of outdoor air for each AHU; indicate minimum CFM during occupied times.
- h. The outdoor air damper, with special marks noting when the damper is in the fully closed, fully opened, and minimum designed positions. If a motorized relief damper is installed, note the same positions.
- i. The access door to any outdoor air controls, including damper position adjustments, outdoor airflow measuring stations, resets, fuses, and switches.
- j. Breakers for exhaust fans, AHU, and unit ventilators.
- k. Access doors for inspection and maintenance of air ducts.
- l. Dampers and controls for air side economizers.
- m. The identification number or name of all exhaust fans, including the air quantity exhausted.

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 HEAT RECOVERY UNITS

Provide a heat recovery unit assembly consisting of a self supporting casing, heat exchanger section, defrost control damper section for defrost control with condensate drain pan and drain pan connection, and pre-filter box section with disposable filter. Heat recovery equipment shall operate at a minimum of 70% efficiency. The heat exchanger assembly shall be suitable for duct mounting.

2.5.1 Unit Casing

NOTE: Include bracketed sentences unless condensate drain is not needed or cross contamination is prevented by other methods.

Provide a self supporting unit casing constructed of minimum 1.1 mm0.04 inches thick extruded aluminum profiles and aluminum zinc sheet steel that create a double wall. [The base of the casing shall be constructed as a continuous condensate drain with a total of four connection possibilities.] The casing bottom, top, and sides shall be insulated with 50 mm2 inch thick fibrous glass insulation with a minimum density of 96 kg per cubic meter6 lb per cubic foot or another material with equivalent insulating value. [Provide a partition to isolate the exhaust and supply airstreams from each other to avoid cross contamination.] Partition shall be a minimum of [1.9] [] mm[0.075] [] inches [galvanized steel] [aluminum]. Provide stainless steel casing for corrosive air streams. The casing shall be designed for diagonal mounting of the heat exchanger access from the side for maintenance and cleaning. The casing shall be designed with an integral defrost control damper on the heat exchanger section for defrost control. Provide full size access doors for checking the heat exchanger section.

2.5.2 Heat Exchanger Section

[2.5.2.1 Heat Wheel

[Heat wheels shall be used for sensible heat recovery. Provide wheel without desiccant.] Provide [desiccant-impregnated] heat wheel with variable speed drive to control wheel speed and heat transfer. Wheels shall contain media made of a lightweight polymer that is coated with a corrosion-resistant finish. Etched or oxidized surfaces are not acceptable. [Heat transfer surfaces shall be coated with a non-migrating (permanently bonded) absorbent.] [Desiccant shall be silica gel for maximum latent energy transfer.] Wheel shall allow laminar flow but not radial, and prevent leakage, bypassing, and cross contamination by cross flow within wheel. The wheel shall have rotor seals specifically designed to limit cross-contamination, and a rotation detector. Should rotation stop, the rotation detector shall alarm the HVAC control system. Wheel shall not condense water directly or require a condensate drain for summer or winter operation. Performance rating shall be in accordance with ARI 1060.

] [2.5.2.2 Heat Pipe

For sensible heat recovery a run-around type heat pipe shall use refrigerant to absorb heat from the air stream at the air intake and reject the heat back into the air stream at the discharge of the air-handling unit. The heat transfer between air streams shall take place in a counterflow arrangement. The unit shall have no moving parts and shall be one piece construction. Tube core shall be [18] [25] [] mm [5/8] [1] [] inch OD seamless aluminum tubing permanently expanded into the fins to form a firm, rigid and complete metal pressure contact between the tube and fin collar of all operating conditions. Provide copper tubes and copper fins for corrosive air streams. Secondary surfaces shall be of continuous plate type aluminum fins, [0.18] [] mm[0.007] [] inch thick, and of corrugated design to produce maximum heat transfer

efficiencies. System shall have solenoid valve control to operate under partial load conditions.

] 2.5.2.3 Flat Plate

Provide a diagonally mounted cross flow type plate heat exchanger constructed of minimum 1.1 mm 0.04 inch thick Type 1100 aluminum plates with the required plate spacing to provide the performance characteristics as indicated on the Contract drawings. The aluminum plates shall be connected by a double fold and sealed into the corner of the casing with a plastic resin material. The heat exchanger section leakage rate shall not exceed 0.5 percent at a static pressure of 248 Pa 0.036 psi as certified by the Test Institute Arsenal in Vienna, Austria. The heat exchanger section plates shall be capable of withstanding a minimum of 1250 Pa 0.18 psi pressure differential between airstreams. An integral moisture eliminator shall be provided to remove any moisture from the exhaust airstream downstream of the heat exchanger.

] 2.5.3 Defrost Control Damper Section

Provide an integral defrost control damper section with electric damper motor for defrost control of the heat exchanger section. The defrost control dampers shall be mounted upstream of the heat exchanger section and shall be capable of preventing frost build-up on the plates of the heat exchanger. Drain pan shall be stainless steel. The damper motor shall be located outside of both airstreams.

2.5.4 Angle Filter Box

Provide a side access, galvanized steel duct mounted filter box assembly with integral holding frames suitable for accommodating [50 mm 2 inch] [_____] thick throwaway filters. Provide filter box constructed of minimum 1.3 mm 0.05 inch thick galvanized steel with extruded aluminum tracks and individual universal holding frames with polyurethane foam gaskets and positive sealing clips designed to accommodate various standard size filters in various efficiency ranges. Provide access doors with positive sealing, heavy duty quick opening half-twist latches and sponge neoprene gasking on each side of filter box for removal and replacement of filters. For each filter box provide one magnehelic gauge or inclined manometer with static pressure taps, shut-off and vent cocks, and aluminum tubing with range 50 to 1470 Pa 0.0073 to 0.21 psi.

2.5.5 Controls

Heat recovery unit shall have factory-installed DDC controls for monitoring temperatures, [wheel operation,] filter cleanliness, defrost control, and other critical conditions.

2.5.6 Disposable Air Filters

Filters shall be as specified for air handling units.

2.6 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 1995 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.

NOTE: Designer must verify that products meeting the indicated minimum recycled content are available, preferably from at least three sources, to ensure adequate competition. If not, write in suitable recycled content values that reflect availability and competition.

[ARI 440] [UL 1995] 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. [Fan-coil units shall be manufactured from a minimum of [70] [_____] percent post-consumer recycled content and [10] [_____] percent post-industrial recycled content.]

2.6.1 Coils

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

2.6.2 Style

[Vertical] [Horizontal].

2.6.3 Controls

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

2.6.3.1 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.]

2.6.3.2 Valves

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

2.6.3.3 Summer-Winter Switches

[Manual] [or] [Automatic].

2.6.3.4 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.

2.6.4 Unit Enclosures

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

2.6.5 Mounting

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

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

ANSI S12.53 maximum 54 dB.

2.7 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.

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

NOTE: Delete irrelevant information on sound power level.

ANSI S12.53. 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

2.7.2 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.

2.7.3 Water Coils and Drain Pans

2.7.3.1 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.

2.7.3.2 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.

2.7.4 Permanent Filters or Lint Screens

Room air-induction unit manufacturer's standard.

2.7.5 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.

2.7.6 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.

2.7.7 Dampers

Adjustable type for balancing primary air without removing enclosures.

2.8 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.]]

2.9 VARIABLE-AIR-VOLUME (VAV) TERMINAL UNITS

NOTE: VAV systems with full shutoff VAV boxes shall

be used for perimeter zone applications only. VAV shutoff boxes shall be used only with the perimeter air distribution systems in order to eliminate the need for reheat. VAV systems with fan-powered VAV boxes may be used for both perimeter and interior zone applications.

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.

2.9.1 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.

2.9.2 Insulation

NFPA 90A and UL Classified for 2 hour fire-rated classification with minimum [13 mm1/2 inch] [_____] [682 grams1 1/2 lb.] [_____] glass fiber. Acoustically and thermally insulate internal surfaces of units, air diffusers, and accessories. Surface coat the insulation to prevent erosion.

2.9.3 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.

The air-handling unit and associated VAV boxes shall have self-contained microprocessor controls capable of connecting to and interoperating with a [Direct Digital Control (DDC)] [_____] Building Automation System. [Provide controls in accordance with Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.]

[Provide controls in accordance with Section 23 09 23 DIRECT DIGITAL CONTROL HVAC AND OTHER LOCAL BUILDING SYSTEMS.]

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

2.9.4 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.

2.9.5 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.]

2.9.6 Reheat Coils

2.9.6.1 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.

2.9.6.2 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.

2.10 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

Motor kW	Voltage	Type Starter
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
7 1/2 to 15	208-230	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 less than 3/4 kW 1 hp shall meet NEMA High Efficiency requirements. Motors 3/4 kW 1 hp and larger shall meet NEMA Premium Efficiency requirements. Motors shall be variable speed and [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.

2.11 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.

2.12 CORROSION PROTECTION FOR MARINE ENVIRONMENTS

2.12.1 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.

2.12.1.1 Mild Steel and Factory Primed Surfaces

- a. 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.
- 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.

2.12.1.2 Nonferrous Heat Exchanger Fin Coil Surfaces

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

2.12.1.3 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.

2.12.1.4 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.

3.2.5 Building Sealing

Seal openings through walls, floor, and ceilings [with expandable foam].

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. Coordinate installation and tests with commissioning as specified in Section [01 91 00] [_____] COMMISSIONING.

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.

3.3.4 Protection

Protect air distribution system from contamination during construction.

3.4 WASTE MANAGEMENT

NOTE: Diverting waste from the landfill contributes
to the following LEED credit: MR2. Coordinate with
Section 01572 CONSTRUCTION AND DEMOLITION WASTE
MANAGEMENT.

Clean equipment, piping, strainers, ducts, and filters before occupancy.
Disposal of waste materials, including recycling, shall be in accordance
with the Waste Management Plan.

3.5 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 Operating Range	= -20 to 125 degrees F = 3 1/2 inch water gage	= -29 to 52 degrees C = 875 Pa

-- End of Section --