

## PART 1 - GENERAL

### 1.1 REFERENCES

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

#### AIR MOVEMENT AND CONTROL ASSOCIATION, INC. (AMCA)

ANSI/AMCA 210	(1990) Testing Fans for Rating
AMCA 300	(1985; R 1987) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(1990) Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500	(1991) Louvers, Dampers and Shutters

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S12.33 (ASA 91)	(1990) Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room
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#### AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 410	(1991) Forced-Circulation Air Cooling Coils
ARI 360	(1986) Commercial and Industrial Unitary Air Conditioning Equipment
ARI 880	(1994) Air Terminals

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

ASHRAE 52.1	(1992) Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ANSI/ASHRAE 68	(1986) In-Duct Sound Power Measurement Procedure for Fans
ANSI/ASHRAE 62-89	For Unit Cooling Coil Drain Pan Slope, Materials and Insulation.

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(1997; Rev. A) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A 653/A 653M	(1997) Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM B 280	(1995; Rev A) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA MG 1	(1993; Rev. 1-4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC. (SMACNA)

SMACNA DCS	(1985) HVAC Duct Construction Standards Metal and Flexible
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UNDERWRITERS LABORATORIES INC. (UL)

UL 507	(1994; R 1997) Electric Fans
UL 586	(1996) High-Efficiency, Particulate, Air Filter Units
UL 705	(1994; Bul. 1994, R 1996) Power Ventilators Eliminators
UL 109	(1997) Tube Fittings for Flammable and Combustible Fluids, Refrigeration Service, and Marine Use

## 1.2 RELATED REQUIREMENTS

Section 15050, “Basic Mechanical Materials and Methods,” applies to this section with the additions and modifications specified herein.

## 1.3 SUBMITTALS

Submit the following accordance with Section 01330, Submittal Procedures.”

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

### 1.3.1 SD-03, Product Data

- a. Packaged Roof Top Cooling Units
- b. Unit Fans
- c. Power Roof Ventilators
- d. Filter Sections
- e. Roof Curbs
- f. Variable Speed Drives
- g. Variable Air Volume Terminal Units
- h. Variable Air Volume Diffusers
- i. Include sound rating data and sound power level for all octave band center frequencies or loudness level.

### 1.3.2 SD-06, Test Reports

- a. Corrosion protection
- b. Medium Efficiency Particulate Air Filters
- c. Preliminary tests
- d. Air handling and distribution equipment tests
- e. Dampers leakage test

Include certification by the equipment manufacturer's representative.

### 1.3.3 SD-07, Certificates

- a. Packaged Rooftop Cooling Units
- b. Fans

- c. Controls
- d. Variable Speed Drives
- e. Variable-air-volume (VAV) terminal units

#### 1.3.4 SD-10, Operation and Maintenance Data

- a. Packaged Rooftop Cooling Units, Data Package 3
- b. Fans, Data Package 3
- c. Filter sections, Data Package 2
- d. Variable-air-volume (VAV) terminal units, Data Package 2
- e. Variable Speed Drives, Data Package 2

Submit operation and maintenance data in accordance with Section 01781, "Operation and Maintenance Data."

### 1.4 TESTING FOR CORROSION PROTECTION

Comply with ASTM A 123, 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 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 ROOFTOP UNIT FANS

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. Have thermal overload protection in the operating starters VFD drives, and disconnect switch serving the fan. 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 Supply and Return/ Exhaust Fans

ANSI/AMCA 210 with AMCA seal, airfoil double width or airfoil plug/plenum type, V-belt drive motors, controlled by unit mounted Factory supplied and mounted VFD. Provide threaded drain connection. 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 welded to back plate and keyed to shaft with set screws. Supply, and Return/ Exhaust fans may be in Plenum fan configuration in lieu of double inlet configuration.

### 2.1.2 Power Roof Ventilators

UL 705 with UL label and ANSI/AMCA 210 with AMCA seal, centrifugal V-belt or direct driven fans as scheduled, with spun aluminum housings. Equip motors with un-fused 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 back draft damper and cast iron or steel sheaves, dynamically balanced and bored to fit shafts and keyed.

## 2.2 PACKAGED ROOFTOP VAV COOLING UNITS

ARI 360 with sound rating in accordance with ANSI/ASHRAE 68, single zone type, sound power level, and static pressure, as indicated. Units to be completely packaged air cooled rooftop cooling units designed for VAV Service. Units to contain supply fans, return/exhaust fans, filter sections, multi-compressor DX refrigeration system, packaged operational controls except for remote temperature and pressure sensors. Units to have Single point power connection and have all protective controls required to meet UL listing.

### 2.2.1 Coils

Evaporator coils to be designed with copper tubes and aluminum or copper fins. Coils to have maximum of 10 fins per inch to reduce coil clogging. Coil to be equipped with integral drain pan designed to catch condensate from coil and headers if un-insulated. Drain pan to be designed for positive drainage and meet requirements of ASHRAE Standard 62 latest revision. Drain pan to be insulated to prevent dripping into the unit cabinet.

Condenser coils to have similar construction to the evaporator coil and inlet air to the coil shall be pre-cooled by evaporative cooling section. Condenser fans to be sized to maintain design air flow with additional pressure drop of pre-cooling section. Condensers to be designed to sub cool refrigerant liquid to 20 degrees below design condensing temperatures.

### 2.2.2 Compressors

Compressors to be of scroll or rotary screw design and be of maximum of 10 ton capacity or have unloading capacity to control refrigerant pressures for Variable air flow across the evaporator. Compressors to be of hermetic or open design as standard with the manufacturer. Reciprocating Compressors with un-loading valves are not acceptable.

### 2.2.3 Cabinet

Construct cabinets of steel, galvanized steel, or aluminum and with double wall construction. Inner liner to be solid metal. Unit Base to be structurally sound to support internal components during transport and operation without bending or excessive deflection and designed for curb mounting.

Provide double wall access doors for inspection and access to internal parts, and provide doors with lever handled cam type latches to assure air and water tight closure. Insulate casings with 1-1/2" inch semi-rigid fiberglass or 3/4" inch polypropylene sheet insulation glued to outer casing.

Provide weatherproof cabinet with gasketed joints and sloped roof. Do not depend on caulking for primary waterproofing. Coat cabinet in accordance with paragraph entitled "Testing for Corrosion Protection."

Outside air intake and exhaust louvers to be, stationary extruded aluminum louvers with bird screen, AMCA Certified Ratings Seal in accordance with AMCA 500.

### 2.2.4 Dampers

Provide with factory mounted outside, return exhaust air dampers in common economizer/mixing section. Provide smoke isolation dampers in the return and supply openings of units scheduled for 15,000 CFM or over. Provide dampers with blade and jamb seals and airfoil aluminum blades and frames and with non-slip keyed connecting rods and linkages. Permanently secure damper blades on a single shaft with self-lubricating oil impregnated bronze bearings. Position damper blades across short air opening dimension. Maximum leakage is 2 percent at 4 " inch water gage differential pressure when sized for 2000 fpm face velocity.

### 2.2.5 Vibration Isolation

For the entire fan, motor, and drive assemblies, provide 2" inch nominal deflection spring vibration isolators, internally mounted at the factory together with fan discharge flexible connection and thrust restraint springs.

### 2.2.6 Filter Sections

Provide units with integral filter bank to with space for 4" inch pleated 30 percent efficient pre-filter and 12" inch 85 percent efficient cartridge final filter based on ASHRAE 52-76 Ratings. Provide visible identification on media frames showing model number and air-flow direction. Seal filter frames to unit cabinet and provide filter seals to provide means to prevent bypass of unfiltered air. Provide inclined-type manometers for filter stations, to measure pre-filter and final filter pressure differential. Provide Manometers with 1/10" inch graduations and spirit level shall be of sufficient length to read at least 3" inch water gage. Equip with over-pressure safety traps and three-way vent valves. Provide manual gauges in addition to the BAS differential pressure sensor for field verification and viewing. Provide space to maintain pre-filters and final filters from front or rear or provide side access housing suitable for the filtration efficiencies and filters as specified.

### 2.2.7 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, throw-away frames and media, and sized to limit velocity across the filter bank to 500 FPM to reduce pressure drop and extend filter life.

### 2.2.8 Extended Media (Pleated) Air Filters

High density glass micro fibers laminated to glass woven mesh backing. The filter media shall have an average efficiency of 25-30 percent based on ASHRAE Standard 52-76. Filter to have an average Arrestance of 94-96 percent based on test standard.

- a. Pre-Filter (Type I): Farr Model 30/30 or equal.

### 2.2.9 Disposable Cartridge Air Filters

UL 900, Class 2, classification, and factory assembled. Provide 12" inch deep filter media of high-density micro fine glass fibers laminated to non-woven backing to form a lofted filter blanket. The filter media to have 80 to 85 percent average dust spot efficiencies with maximum final resistance 1.50" inch water gage and maximum face velocity 500 fpm. Filter frame to be galvanized metal frame with formed wire media support grids.

### 2.2.10 Outside-Air Intake

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

### 2.2.11 Roof Top Unit Controls

Packaged Rooftop units shall be completely factory wired with single point power connections. Unit mounted and factory installed VFD shall modulate supply fan speed to maintain ductwork pressure as measured by the remote pressure sensors. Factory mounted and installed return/exhaust fan VFD shall modulate fan speed to maintain building pressure at design set point. Cooling controls shall cycle compressors to meet cooling demand as indicated by the Building Automation System. When demand is below single compressor load hot gas bypass system shall modulate to match cooling demand. Dry Bulb Economizer Cycle shall act as first stage of cooling control and shall be integral with unit controls and be initiated by the BAS system based on outside air / return air temperature measurements. Smoke detectors located in return air and supply air streams and activation shall stop supply and return air fans and after 90 second delay close supply and return smoke dampers. Provide output Buss to match BAS system to allow interaction between unit controls and building BAS system.

## 2.3 ADJUSTABLE FREQUENCY DRIVES

The variable frequency drives (VFD's) shall be UL Listed, solid state, with a pulse width modulated output wave (VVI, six step, and current source drives are not acceptable). The VFD package shall be mounted in NEMA package suitable for the environment in which it is installed, drives mounted in face of unit cabinet or exterior to the unit shall be mounted in NEMA 4 enclosure and ventilated as required to maintain required temperature within the enclosure. The total package shall be completely assembled and tested by the manufacturer prior to shipment. The VFD shall employ full wave rectifier to prevent input line notching, DC line Reactor, Capacitors and Insulated Gate Bipolar Transistors as the output switching devices. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be .98 or higher at all speeds and loads. Drives shall be suitable for the full motor load at installed location and temperature and altitude of 3400 feet above mean sea level. Design VFD's for 460V/3PH /60HZ input voltage. Provide drives with integral or separate bypass to operate fans at full speed if drive fails. Provide VFD's shall be provided with output buss compatible with the successful BAS Manufacturers hardware and software to provide control, maintenance and fault readouts.

The VFD Manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5 percent. Input line filters shall be sized and provided as required by the

VFD Manufacturer to assure compliance with IEEE Standard 519 (latest version) Guide for Harmonic Control and Reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior to VFD installation on the Packaged Rooftop Equipment.

Warranty for VFD's shall be 24 Months after Certified Start Up. The Warranty shall include all parts, labor, travel time and expenses.

## 2.4 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. Equip units with integral air-volume control dampers. Maximum air-leak rate shall be 2 percent at static pressures from 0.4 to 3 inch water gage.

### 2.4.1 Casings

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

### 2.4.2 Insulation

NFPA 90A and UL Classified for 2 hour fire-rated classification with minimum 1/2 inch, 1/2 lb. glass fiber. Acoustically and thermally insulate internal surfaces of units. Surface coat the insulation to prevent erosion.

### 2.4.3 Controls

Provide controls in accordance with Section 15910, "Direct Digital Control Systems."

Electronic, type. All thermostatic air-volume controls shall be pressure independent type.

## 2.5 AIR DIFFUSERS (VAV)

### 2.5.1 Variable Air Volume Diffusers

Louver faced diffuser with round neck and with plate volume damper above diffuser face to adjust air flow and powerful low amperage Actuator located outside of the air stream and thermostat to modulate the damper.

Thermostats shall be Heating / Cooling type with automatic change over. Thermostat and controller shall operate on 24 VAC. See Specification section 15910 for control compatibility. Provide controls compatible with BAS system per Section 05910.

## 2.6 REHEAT COILS

### 2.6.1 Water Coils

Three-row hot water coils for mounting on the outlet of the VAV Terminal Units. Design for 30 degrees F temperature differential, with entering water temperature at 140 degrees F.

### 2.6.1.1 Condenser Evaporative Cooling Section

Provide each rooftop cooling unit with evaporative cooling section over the condenser air intakes for the units. Cooling section to consist of 4" deep "Cel-Deck" type media with stainless steel pan and supports designed for RO water to be used with the system. Provide complete with pump, temperature controlled bleed down solenoid. See specification Section 15910 for control sequence.

Cooling sections to be complete with inlet screen or louver, distribution headers, stainless steel or plastic pump and motor designed for media flow. Design cooling section for easy removal of media and for easy removal of entire section if required for maintenance access. Seal cooling sections to units with dense foam rubber or neoprene gasket. Provide condenser fans with capacity to meet design air flow capacity with evaporative cooling section on the inlet.

## 2.7 ROOF CURBS

Factory-fabricated sheet-steel structural members. Provide minimum 4 inch cants for built-up roofing, 2 by 6 inch factory-installed wood nailers, and fully mitered end sections. Provide welded 18 gage galvanized steel shell, base plate, and counter flashing and provide stiffness required to eliminating deflection. Curbs to be minimum of 16" inch height to facilitate future re-roofing operations.

## 2.8 CORROSION PROTECTION

### 2.8.1 Corrosion Protection

Provide a corrosion protection on the interior of the equipment and the exterior. Apply coating at the premises of a company specializing in such work.

#### 2.8.1.1 Galvanized Surfaces

a. Polyamide Epoxy Primer: 48 percent, plus or minus 2 percent, solids content by volume; 1 coat, 2 mils minimum dry film thickness.

b. Vinyl Copolymer: 23 percent, plus or minus 4 percent, solids content by volume; 2 coats, 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 Packaged Rooftop Cooling Units

Install assembled units on roof curbs and isolate fan section with flexible duct connections. Bolt sections together in high pressure units. Pipe drain pan to the nearest roof drain.

### 3.2.3 Power Ventilators

Secure roof exhausters with cadmium plated steel or stainless steel lag screws to roof curb. Extend ducts to roof exhausters into roof curb.

### 3.2.4 VAV Terminal Units

Support terminal units from structure with all thread rods and neoprene grommet or washers at connection points. Provide Uni-strut type structure between structural I-Beams as required to support units. Weld supports to structure or provide retained beam clamps to hold terminal unit supports.

## 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 15950, "HVAC Testing/Adjusting/Balancing".

END OF SECTION