

SECTION 23 34 00
HVAC FANS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
 - a. 99, Standards Handbook.
 - b. 201, Fans and Systems.
 - c. 203, Field Performance Measurement of Fan Systems.
 - d. 204, Balance Quality and Vibration Levels for Fans.
 - e. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - f. 300, Reverberant Room Method for Sound Testing of Fans.
 - g. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
5. ASTM International (ASTM):
 - a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100 percent Relative Humidity.
 - c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - d. D3363, Standard Test Method for Film Hardness by Pencil Test.
 - e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
 - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA): 45, Standard on Fire Protection for Laboratories Using Chemicals.
8. Occupational Safety and Health Act (OSHA).

9. Society for Protective Coatings (SSPC):
 - a. SP 3, Power Tool Cleaning.
 - b. SP 5, White Metal Blast Cleaning.
 - c. SP 6, Commercial Blast Cleaning.
 - d. SP 10, Near-White Blast Cleaning.
10. UL: 507, Safety Standard for Electric Fans.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. dB: Decibel.
3. DWDI: Double Width, Double Inlet.
4. FRP: Fiberglass Reinforced Plastic.
5. hp: Horsepower.
6. ODP: Open Drip Proof.
7. SWSI: Single Width, Single Inlet.
8. TEFC: Totally Enclosed, Fan Cooled.
9. UV: Ultra Violet.
10. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide following for specified products:
 - a. Identification as referenced in Contract Documents.
 - b. Manufacturer's name and model number.
 - c. Descriptive specifications, literature, and the Drawings.
 - d. Dimensions and weights.
 - e. Fan sound power level data (reference 10 to power minus 12 watts) at design operating point.
 - f. Fan Curves:
 - 1) Performance Curves Indicating:
 - a) Relationship of flow rate to static pressure for various fan speeds.
 - b) Brake horsepower curves.
 - c) Acceptable selection range (surge curves, maximum revolutions per minute).
 - d) Static pressure, capacity, horsepower demand and overall efficiency required at duty point, including drive losses.
 - 2) For variable air volume applications, indicate operating points at 100 percent, 80 percent, 60 percent and 40 percent of design capacity on fan curves including data to indicate

effect of capacity control devices such as inlet vanes on flow, pressure, and brake horsepower.

- g. Capacities and ratings.
 - h. Construction materials.
 - i. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.
 - j. Wheel type, diameter, maximum revolutions per minute for fan class, operating revolutions per minute, and tip speed.
 - k. Motor data, including service factor and operating horsepower, as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
 - l. Fan shaft first critical speed.
 - m. Belt service factor.
 - n. Drive assembly horsepower rating.
 - o. Sheave horsepower rating.
 - p. Power and control wiring diagrams, including terminals and numbers.
 - q. Vibration isolation.
 - r. Factory finish system.
 - s. Color selection charts where applicable.
 - t. Fiberglass Material: Statement of resins and reinforcing proposed for use.
2. Or Equal Equipment:
- a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on the Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
 - b. Where submitted equipment results in change to ductwork and equipment configuration shown on the Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:

- 1. Recommended procedures for protection and handling of products prior to installation.
- 2. Manufacturer's installation instructions.
- 3. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following:
 - a. Motors specified to be premium efficient type.
 - b. FRP fans.
- 4. Test reports.
- 5. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

- A. Performance Ratings: Tested in accordance with AMCA 210.
- B. Sound Ratings: Tested in accordance with AMCA 300.
- C. Fabrication: In accordance with AMCA 99.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	Quantity
Filters	One complete set per unit.
Special tools required to maintain or dismantle	One complete set for each different size unit

- B. Delivery: In accordance with Section 01 67 00, Product Requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

- A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Article Supplement.

2.02 GENERAL

- A. Spark Resistant Construction: Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.
- B. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.
- C. Acoustical Levels: Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.
- D. Fan Drives:
 - 1. Physical Characteristics:
 - a. Belts: Oil and heat resistant, non-static type.
 - b. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.

- c. Belt and Shaft Guards:
 - 1) Easily removable and to enclose entire drive assembly, meeting federal, OSHA requirements.
 - 2) Guard faces of expanded metal having minimum 60 percent free area for ventilation.
 - 3) Bright yellow finish.
- 2. Functional Characteristics:
 - a. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
 - b. Furnish multiple drive belts where motor horsepower is 2 hp or larger.
 - c. Sheaves:
 - 1) Capable of providing 150 percent of motor horsepower.
 - 2) Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
 - d. Drive Adjustment:
 - 1) When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
 - 2) Provide trial and final sheaves, as well as drive belts, as required.
 - e. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
 - f. Provide speed test openings at shaft locations.
 - g. Motors:
 - 1) Motors 20 hp or Smaller:
 - a) Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
 - b) Final operating point shall be at approximate sheave midpoint.
 - 2) Motors Larger than 20 hp: Fixed-pitch sheaves.
 - 3) Furnish motors for V-belt drives with adjustable rails or bases.
- 3. Performance Characteristics: None.

E. Finishes:

- 1. Physical Characteristics:
 - a. Carbon Steel Parts: Factory finish as follows, unless turned, ground and polished.
 - 1) Parts cleaned and chemically pretreated with phosphatizing process.

- 2) Alkyd enamel primer.
- 3) Air dry enamel topcoat.
- b. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.
- c. Stainless Steel Parts: Finished smooth and left unpainted.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.03 CABINET FAN

A. Manufacturers and Products:

1. Greenheck; Model CSP.
2. Or equal.

B. Physical Characteristics:

1. Factory-assembled, ceiling, wall, or inline mounted, centrifugal cabinet fan; including housing, fan wheel, drive assembly, motor, and accessories.
2. Housing:
 - a. Material: Minimum 20-gauge galvanized steel.
 - b. Construction:
 - 1) Minimum 14-gauge blower and motor support frame.
 - 2) Lined with minimum 1/2-inch acoustical insulation.
 - 3) Outlet duct collar with integral reinforced aluminum backdraft damper, with polyamide bushings.
 - 4) Motor mounted on resilient vibration isolators.
 - 5) Motor and blower removable from unit without cabinet disassembly.
 - 6) Removable cabinet access panels.
 - 7) Air Inlet: Field convertible for bottom or end air inlet configuration.
 - 8) Predrilled universal mounting brackets, adjustable.
3. Wheel: Centrifugal forward curved type, galvanized steel, or plastic construction.
4. Shaft, Bearings, Drive:
 - a. Shafts: Turned, ground and polished carbon steel.
 - b. Bearings: Grease lubricated, precision antifriction ball, sealed type.
 - c. Drives:
 - 1) In accordance with Paragraph Fan Drives.
 - 2) Factory set to specified fan revolutions per minute.
 - 3) Type: Direct.

- 5. Electrical:
 - a. Integral wiring box.
 - b. Factory-installed disconnect receptacle.
- 6. Accessories: Provide as scheduled in Equipment Schedule.
- C. Functional Characteristics: None.
- D. Performance Characteristics: Bearing AMCA Certified Ratings Seal for sound and air performance.

2.04 INLINE FAN, CENTRIFUGAL, SQUARE

A. Manufacturers and Products:

- 1. Greenheck; Model BSQ (Belt); SQ (Direct).
- 2. Or equal.

B. Physical Characteristics:

- 1. Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor, and accessories.
- 2. Housing:
 - a. Construction: All aluminum.
 - b. Integral duct collars.
 - c. Removable side panels, for ease of service.
 - d. Field convertible for side air discharge configuration.
 - e. Predrilled universal mounting brackets for vertical or horizontal installation.
 - f. Inlets: Aerodynamic aluminum venturi.
 - g. Corrosion-resistant fasteners.
 - h. Drive belt and bearings separated from air stream by enclosure.
- 3. Wheel:
 - a. Centrifugal backward inclined, 100 percent aluminum construction.
 - b. Precision machined cast aluminum hub.
 - c. Die-formed airfoil or backward inclined blades.
 - d. Matched to inlet venturi.
 - e. Attached to fan shaft with split taper lock bushing.
- 4. Shaft, Bearings, Drive:
 - a. Shafts:
 - 1) Turned, ground and polished carbon steel.
 - 2) Keyed for sheave installation.

5. Bearings:
 - a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricatable or sealed type.
 - b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
6. Drives:
 - a. In accordance with Paragraph Fan Drives.
 - b. Factory set to specified fan revolutions per minute.
 - c. Type: Belt or direct, as indicated in Equipment Schedule.
7. Accessories:
 - a. Provide as follows:
 - 1) Belt Guard: Sheet metal construction, OSHA type.
 - 2) Motor and Drive Cover:
 - a) Factory fabricated, OSHA type.
 - b) Sheet metal construction, same material as fan housing.
 - c) Vented, openings sufficient size for proper motor cooling.
 - d) Fan speed controller: Refer to Section 26 24 19 Low-Voltage Motor Control.
 - 3) Gravity Backdraft Damper: Galvanized steel frame, aluminum blades, brass pivot pins, polychloroprene seals on damper blade edges, gravity operation, and adjustable counterweight.
 - 4) Motorized Damper: Galvanized steel frame, aluminum blades, polychloroprene seals on damper blade edges, 120V or 24V operator.
 - 5) Insulated Housing: Fiberglass insulation, 1-inch thick, polychloroprene coated, or foil faced, on interior of housing.
 - 6) Filter Housing:
 - a) Attached to fan inlet.
 - b) Box construction to match fan housing.
 - c) Integral duct collars.
 - d) Access Doors: Hinged and latched.
 - (1) Filter Media: 1-inch pleated disposable type.
 - 7) Inlet Screen: Removable 1-inch mesh screen, aluminum construction, overexposed inlets.
 - 8) Disconnect: Factory installed, non-fused, NEMA Type 1.
 - 9) Single Side Discharge: Package consisting of side duct connection collar and rear-discharge blank-off panel.
 - 10) Bearing Lubrication Lines:
 - a) Extended to outside of fan housing.
 - b) Terminate with zerk fittings.

- C. Functional Characteristics: None.
- D. Performance Characteristics: Bearing AMCA Certified Ratings Seal for sound and air performance.

2.05 ROOF FAN, CENTRIFUGAL UPBLAST

A. Manufacturers and Products:

- 1. Greenheck; Model CUE (Direct Drive); CUBE (Belt Drive).
- 2. Or equal.

B. Physical Characteristics:

- 1. Factory-assembled centrifugal upblast roof fan, including housing, fan wheel, drive assembly, motor and accessories.
- 2. Housing:
 - a. Construction: Spun-formed aluminum, minimum 16-gauge marine alloy.
 - b. Windband: Finish with rolled bead.
 - c. Top Cap: Motor access via quick release latches.
 - d. Motor completely sealed from exhaust air stream.
 - e. Motor cooling via air breather tubes.
 - f. Integral conduit chase for wiring.
 - g. Drain trough at lowest point of housing.
 - h. Fan Inlet:
 - 1) Full inlet cone of aluminum construction.
 - 2) Match inlet shroud.
- 3. Wheel:
 - a. Aluminum construction, backward inclined centrifugal, non-overloading type.
 - b. Machined, cast aluminum hub.
 - c. Matched to deep spun inlet venturi.
- 4. Shaft, Bearings, Drive:
 - a. Shaft:
 - 1) Turned, ground, and polished carbon steel.
 - 2) Keyed for sheave installation.
 - 3) Zinc-phosphate coated and oil emulsion-dipped.
 - b. Bearings:
 - 1) Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
 - 2) Selected for average life (ABMA 9 L50) of not less than 200,000 hours operation at maximum cataloged operating speed.
 - 3) Terminate with zerk fittings.

- c. Drives:
 - 1) In accordance with Paragraph Fan Drives.
 - 2) Factory set to specified fan revolutions per minute.
 - 3) Type: Belt or direct, as indicated in Equipment Schedule.

5. Accessories:

- a. Provide as follows:
 - 1) Gravity Backdraft Damper: Gravity operation, adjustable counterweight, and aluminum construction.
 - 2) Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with polyamide bushings, 120V or 24V operator.
 - 3) Bird Screens: Aluminum construction.
 - 4) Roof Curb:
 - a) Factory fabricated, aluminum construction.
 - b) Sloped to match roof pitch, and to provide level top.
 - c) Height Above Finished Roof: 12 inches.
 - d) Mitered continuous welded corner seams.
 - e) Pressure-treated wood nailer.
 - f) Insulation: Minimum 1-1/2 inches thick, 3 pounds per cubic foot density, rigid mineral fiberboard insulation with metal liner.
 - 5) Disconnect: Refer to Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
 - 6) Bearing Lubrication Lines:
 - a) Extended to outside of fan housing.
 - b) Type 316 stainless steel construction.
 - c) Terminate with zerk fittings.

C. Functional Characteristics: None

D. Performance Characteristics: Bearing AMCA Certified Ratings Seal for sound and air performance.

2.06 WALL-FAN, CENTRIFUGAL

A. Manufacturers and Products:

- 1. Greenheck: Model CUE (Direct Drive); CUBE (Belt Drive).
- 2. Or equal.

B. Physical Characteristics:

- 1. Factory-assembled centrifugal wall mounted fan; including housing, fan wheel, drive assembly, motor, and accessories.

2. Housing:
 - a. Construction: Spun-formed aluminum, minimum 16-gauge marine alloy.
 - b. Windband: Finish with rolled bead.
 - c. Cap: Motor access via quick release latches.
 - d. Motor completely sealed from exhaust air stream.
 - e. Motor cooling via air breather tubes.
 - f. Integral conduit chase for wiring.
 - g. Fan Inlet:
 - 1) Full inlet cone of aluminum construction.
 - 2) Match inlet shroud.
 - h. Wall Flange: Aluminum construction, with pre-punched key slot holes.
3. Fan Wheels:
 - a. Aluminum construction, backward inclined centrifugal, non-overloading type.
 - b. Machined, cast aluminum hub.
 - c. Matched to deep spun inlet venturi.
4. Shaft, Bearings, Drive:
 - a. Shaft:
 - 1) Turned, ground, and polished carbon steel.
 - 2) Keyed for sheave installation.
 - 3) Zinc-phosphate coated and oil emulsion-dipped.
 - b. Bearings:
 - 1) Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
 - 2) Selected for average life (ABMA 9 L50) of not less than 200,000 hours operation at maximum cataloged operating speed.
 - 3) Terminate with zerk fittings.
 - c. Drives:
 - 1) In accordance with Paragraph Fan Drives.
 - 2) Factory set to specified fan revolutions per minute.
 - 3) Type: Belt or direct, as indicated in HVAC Fan Schedule.
5. Accessories:
 - a. Provide as follows:
 - 1) Gravity Backdraft Damper: Gravity operation, adjustable counterweight, and aluminum construction.
 - 2) Motorized Damper: Aluminum frame, aluminum blades, aluminum hinge pins with polyamide bushings, 120V or 24V operator.
 - 3) Bird Screens: Aluminum construction.
 - 4) Disconnect: Factory installed, nonfused, NEMA Type 3R.

- 5) Bearing Lubrication Lines:
 - a) Extended to outside of fan housing.
 - b) Type 316 stainless steel construction.
 - c) Terminate with zerk fittings.
- 6) Spark Resistant Construction Classification:
AMCA 99-0401 Type B for Headworks 20-EF-01.
- 7) Corrosion Resistance Coating:
 - a) Provide factory-applied corrosion protection coating on these fan components:
 - (1) Wheel.
 - (2) Housing.
 - (3) Accessories.
 - (4) Interior surfaces in contact with airstream.

C. Functional Characteristics: None.

D. Performance Characteristics: Bearing AMCA Certified Ratings Seal for sound and air performance.

2.07 UTILITY BLOWER, CENTRIFUGAL SWSI, HEAVY DUTY

A. General:

1. Factory-assembled utility blower; including housing, fan wheel, drive assembly, motor, and accessories.
2. Suitable to convey air at temperatures up to 250 degrees F.
3. Fan Performance: AMCA 99-2408 as scheduled.
4. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Physical Characteristics:

1. Material: Aluminum.
2. Construction:
 - a. Curved scroll configuration, with continuous seam welding and side angle reinforcement.
 - b. Lifting lugs welded to housing.
 - c. Flanged and drilled outlet to permit duct connection.
 - d. Drain connection located at lowest point of fan housing.
 - e. Inlet: Spun-formed aerodynamic bell mouth.
3. Base/Pedestal: All-welded heavy gauge steel.
4. Wheel:
 - a. Centrifugal, one-piece, nonoverloading, backward inclined airfoil blade type.
 - b. Fan wheel speed not to exceed 90 percent of manufacturer's listed safe fan speed.
 - c. Material: Aluminum.
 - d. Attached to fan shaft with split taper lock bushing.

5. Shaft, Bearings, Drive:
 - a. Shafts:
 - 1) Turned, ground, and polished steel.
 - 2) Ends drilled and countersunk for tachometer readings.
 - 3) Keyed for sheave installation.
 - b. Bearings:
 - 1) Grease lubricated, precision antifriction ball, self-aligning type.
 - 2) Mounted in cast iron pillow block housing.
 - 3) Selected for average life (ABMA 9 L₅₀) of not less than 200,000 hours operation at maximum cataloged operating speed.
 - c. Drives:
 - 1) In accordance with Paragraph Fan Drives.
 - 2) Factory set to specified fan revolutions per minute.
 - 3) Type: Direct.
 - 4) Arrangement: Arrangement 4.

C. Accessories:

1. Provide as follows:
 - a. Flanged Inlet: Heavy gauge construction, factory drilled and flanged.
 - b. Shaft Seal: tetraflouroethylene construction, located at shaft penetration of housing.
 - c. Inlet Guard: Spiral wire type, OSHA approved, removable, same material as fan housing.
 - d. Spark Resistant Construction Classification: AMCA 99-0401 Type B.

D. Functional Characteristics: None.

E. Performance Characteristics: None.

2.08 CORROSION PROTECTION COATING

A. Manufacturers:

1. Phenolic resin, Heresite Protective Coatings, P403.
2. Or equal.

B. General:

1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this section.

2. Quality Control:
 - a. Verify dry film thickness before final baking.
 - b. Finished coating system shall be free from voids, checks, cracks, and blisters.
3. Surface Cleaning:
 - a. Clean parts to be coated as follows:
 - 1) Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
 - 2) Follow with immersion in potable water bath to neutralize and remove cleaning solution.
 - 3) Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.

C. Physical Characteristics:

1. Baked Phenolic:
 - a. Surface Preparation: Sandblast surface to SSPC SP 5.
 - b. Application: Standard air-pressurized spray equipment.
 - c. Curing: Oven baked at a metal temperature not to exceed 400 degrees F.
 - d. Finished Thickness: 5-mil to 7-mil dry film thickness.
 - e. Performance:
 - 1) Coating shall meet or exceed following criteria:
 - a) Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
 - b) Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
 - c) Impact Resistance: 100-inch pounds, ASTM D2794 test method.
 - d) Pencil Hardness: 2H, ASTM D3363 test method.
 - e) Service Temperature: Maximum 250 degrees F, continuous.

D. Functional Characteristics: None.

E. Performance Characteristics: See Section 23 34 00, HVAC Fans, Supplement Fans Schedule.

2.09 MOTORS

A. Physical Characteristics:

1. General:
 - a. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.

- b. Provide integral self-resetting overload protection on single-phase motors.
- c. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
- d. Motors shall not operate into service factor in any case.

B. Functional Characteristics:

- 1. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:
 - a. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
 - b. Winding Thermal Protection: None.
 - c. Space Heater: No.
 - d. Number of Speeds: Single.
 - e. Number of Windings: One.
 - f. Motor Efficiency: Premium efficient.
 - g. Shaft Type: Solid, carbon steel.
 - h. Mounting: As required for fan arrangement.
 - i. Service Factor: 1.15.

C. Performance Characteristics: None.

2.10 ACCESSORIES

A. Physical Characteristics:

- 1. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number as specified and shown.
- 2. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.11 SOURCE QUALITY CONTROL

A. General:

- 1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.

2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:

1. Each fan furnished with 5 hp or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
 - a. Belt Drive (except Vane Axial): 0.15 inch per second peak velocity.
 - b. Belt Drive Vane Axial: 0.08 inch per second peak velocity.
 - c. Direct Drive: 0.08 inch per second peak velocity.
3. Written records of run test and vibration test shall be made available upon request.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fans level and plumb.

- B. Secure roof-mounted fans to roof curbs with cadmium-plated steel or Type 316 stainless steel hardware.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Scroll Drains: Pipe drain connection through running trap to floor drain.
- E. Labeling:
 - 1. Label fans in accordance with Article Accessories.
 - 2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.
- F. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.
- G. Equipment Support and Restraints:
 - 1. Refer to Section 23 05 48, Vibration Isolation and Seismic Control for HVAC Piping and Equipment.
 - 2. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
- H. Connections:
 - 1. Refer to Section 23 31 13, Metal Ducts and Accessories, and Section 23 31 16.16, Thermoset Fiberglass-Reinforced Plastic Ducts and Accessories.
 - 2. Isolate duct connections to fans.
 - 3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.02 FIELD QUALITY CONTROL

- A. Functional Tests:
 - 1. Verify blocking and bracing used during shipping are removed.
 - 2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
 - 3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 4. Verify cleaning and adjusting are complete.
 - 5. Disconnect fan drive from motor; verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
 - 6. Reconnect fan drive system; align and adjust belts and install belt guards.
 - 7. Verify lubrication for bearings and other moving parts.

8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
 - a. Energize motor and adjust fan to indicated revolutions per minute.
 - b. Measure and record motor voltage and amperage.
2. Operational Test:
 - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
 - c. Test and adjust control safeties.
 - d. Replace damaged and malfunctioning controls and equipment.

3.03 MANUFACTURER'S SERVICES

- A. Refer Section 01 91 14, Equipment Testing and Facility Startup.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Balancing:
1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
 2. Replace fan and motor sheaves as required to achieve design airflow.
- E. Vibration Testing:
1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
 2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.
 - a. Vibration readings as measured at actual rotational speed shall not exceed the following values:
 - 1) Belt Drive, Flexibility Mounted: 0.25 inch per second peak velocity.
 - 2) Belt Drive, Rigidly Mounted: 0.16 inch per second peak velocity.

3.05 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.06 SUPPLEMENT

- A. The supplement listed below, following "End of Section," is a part of this specification:
 - 1. Fans Schedule.

END OF SECTION

