PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. Fans shall be dynamically balanced and factory-tested and certified in accordance with applicable AMCA test codes. All Fans shall be certified AMCA Class II or higher. Units shall arrive at the Project bearing Certification Seal.

B. Fans shall be furnished complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories required for specified performance and proper operation. Direct driven fans are preferred however for motors/assembly using V-belt drives shall be furnished with adjustable rails or heavy duty double pull style (two bolt pull) bases.

C. Fans shall be selected at design condition operating points with the design CFM falling in the range of 60 to 75%. In all cases, the professional service provider shall evaluate system conditions and select the optimum fan type and configuration based on efficiency, system curve, and fan characteristics at all anticipated design conditions. Fan motor BHP to account for drive losses and field conditions.

D. Preferred Variable Frequency Drives, the design operating point shall be at or to the right of the peak efficiency point or peak efficiency system curve. Total Efficiency (TE) of the fan selection shall equal or exceed 55 percent at the design point.

E. Air handling fan preference shall be double width, double inlet with backward inclined centrifugal airfoil blades.

F. Use OSHA approved belt guards that totally enclose the entire drive and permit easy removal for replacement of belts. Construct guards of expanded metal to allow for ventilation and provide tachometer openings at shaft locations. Fan capacity shall account for restrictions caused by protected housing/screening.

G. Provide AMCA spark resistant construction option: A, B, or C as required by project conditions for handling flammable or explosive vapors. Drive set shall be comprised of non-static belts for use in an explosive. Bearings located out of air or gas stream, fan equipped with explosion-proof motor.

H. Provide a minimum of two coats epoxy coating finish as a minimum for non corrosive applications. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

I. Fans exposed to fume and other corrosive exhaust air as required by project conditions shall be constructed of materials compatible with the chemicals being transported in the air through the fan.

J. Exhaust Stack Discharge shall be in a vertical up-draft direction at a minimum of 10 ft. above adjacent roof lines and located with respect to surrounding air inlets as to avoid contaminant re-entry. Exit velocity shall have a minimum exit velocity of 3000 fpm and a maximum velocity of 4000 fpm. Design discharge static pressure loss should strive to maintain one (1) inch water gauge or less.

K. Provide latest standard NEMA Premium Efficiency rated motor for compatibility with variable frequency drives where applicable. Select non-overloading motors at all points on the RPM operating curve. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at static pressure. Motor furnished with fan shall not operate into motor service factor in any of these cases.
1.02 SUBMITTALS

A. Product Data: Catalog sheets; include rated capacities of each unit, dimensional data, operating weights, accessories, material finishes and installation instructions.

B. Shop Drawings: Manufacturer’s detailed dimensional drawings showing equipment, assemblies, dimensions, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

C. Quality Control Submittals:
   1) Certified fan performance curves.
   2) Certified fan sound power levels of Fan in each of the 8 Octave Bands as per current AMCA Bulletin #300-67 for Sound Testing of Air Moving Devices.

D. Contract Closeout Submittals:
   1) Operation and Maintenance Data: Deliver 2 copies covering the installed products, to the Director’s Representative.
   2) Equipment vibration readings confirming vibration isolation schedule specified.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1) Each fan shall bear AMCA Seal indicating that fans comply with AMCA 211, Certified Ratings Program - Air Performance, and AMCA 311, Certified Sound Ratings Program for Air Moving Devices.
   2) Operating Limits: Classify according to AMCA 99-2408.
   3) Sound power level ratings shall comply with AMCA Standard 301, Method for Calculating Fan Sound Ratings from Laboratory Test Data.

B. Field Quality Control
   1) Provide equipment and apparatus required for performing inspections and tests.
   2) Field Inspections:
      a) Prior to initial operation, inspect the vibration isolators for conformance to drawings, specifications, and manufacturer's data and instructions.
      b) Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls.
      c) Check connector alignment before and after filling of system and during operation.
      d) Correct misalignment without damage to connector and in accordance with manufacturer's recommendations.
   3) Rebalance, adjust, or replace equipment with noise or vibration levels in excess of those given in the equipment specifications, or equipment manufacturer's data.

1.04 REFERENCES

A. ABMA: American Bearing Manufacturer’s Association
B. **AMCA:** Air Movement and Control Association.

   - AMCA 99-2408 Operating Limits for Centrifugal Fans
   - AMCA 203 AMCA Fan Application Manual – Troubleshooting
   - AMCA 204 Balance Quality and Vibration Levels for Fans
   - AMCA 210 Laboratory Method of Testing Fans for Rating
   - AMCA 300 Reverberant Room Method for Sound Testing of Fans

C. **ASHRAE:** American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.

D. **NFPA:** National Fire Protection Association

   - NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals
   - NFPA 70: National Electrical Code
   - NFPA 79: Electrical Standard for Industrial Machinery
   - NFPA 99: Health Care Facilities
   - NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems
   - NFPA 91: Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids

E. **UL Compliance:** Provide centrifugal fan electrical components which have been listed and labeled by UL.

F. **ASTM:** American Society for Testing and Materials

   - ASTM D1735 water fog
   - ASTM B117 salt spray
   - ASTM D3359 adhesion
   - ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units to the extent allowable by shipping limitations, with protective crating and coverings.

B. Disassemble and reassemble units as required for movement to the final locations in accordance with manufacturer’s printed instructions.

C. Lift and support units at the manufacturer’s designated lifting or supporting points.

### 1.06 PROJECT CONDITIONS

A. Do not operate fans until ductwork is clean, filters, if any, are in place and bearings are lubricated.

B. Field Measurements: Verify dimensions and clearances by field measurements.

### PART 2 PRODUCTS

#### 2.01 FANS

A. Provide centrifugal fans built to AMCA Standard 99-2408 Class II construction (minimum) or higher.
B. Provide factory-assembled and tested Direct Driven or Belt driven (project specific) centrifugal fans, factory fabricated, assembled, finished and tested; consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structures.

C. Equip fan unit with unitary base.

2.02 HOUSINGS

A. Materials and Fabrication: Formed and reinforced steel curved scroll housing panels, spun metal or die formed inlet cones to provide a streamlined flow into the wheel, and the doors or panels for access to internal parts and components.
   1) Bracing: Steel angle or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2) Construct inlet and outlet of fan for project connection.
   3) Scroll/Housing Drain Connection: One inch threaded steel pipe coupling welded to low point of fan scroll, with threaded steel plug and non-galling lubricant applied to threads.
   4) Provide weather covers and weather-resistant enamel finish for fans installed outdoors.

2.03 WHEELS

A. Fans to use airfoil blades welded to spun wheel cones unless otherwise indicated.

2.04 SHAFTS

A. Turned, ground, and polished hot-rolled steel with keyway and drive end counter sunk for tachometer readings. Close tolerances shall be maintained where the shaft makes contact with the bearing. Ship with protective coating of lubricating oil. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower.
   1) Size shaft so that first critical speed is at least 25 percent over maximum operating speed.
   2) Shaft heat slinger for fans handling high temperature air or gas.

2.05 BEARINGS

A. Ball, roller, or taper roller type with double locking collars and split two-piece, cast iron housing. Select bearings in accordance with ABMA Standards for Ball and Roller Bearings and for maximum operating speed and horsepower for construction level.
   1) All Bearings: Shall be “Heavy Duty” rated, grease lubricated, ball or roller self-aligning, pillow block type housing with grease seal. Bearings shall be selected for a minimum AMBA bearing rated life of not less than 200,000-hrs operation at maximum cataloged operating speed. Furnish bearings with pressure relief type external grease fittings. Bearings shall be factory lubricated. Both unit bearings shall have the same bore, type and manufacturer. At least one of the bearings shall be fixed. The bearing supports shall be removable for access to and removal of the fan wheel.
   2) In addition to respective fan type bearing criteria, provide an auto-greaser on all applications in which bearings are inaccessible due to being platform mounted or physically located in a remote location, which would otherwise require special OSHA
regulated access. Extended copper lube lines may be used to allow “line of sight” connection between bearing and auto-greaser.

3) Pillow Block type bearings to be similar to SKF Concentra ball bearing pillow block or Dodge grip tight.

2.06 BELT DRIVEN FANS

A. Unless otherwise indicated, Original Equipment Manufacturer (OEM) Serial number – matched oil resistant, non-sparking, and non-static V-belt drive set(s) shall be selected and provided. Belts shall be applied in matched sets. V-belts shall be matched multiple A, B or C belts having a rating of not less than 150 percent of the motor nameplate horsepower. (Multi-groove pulleys using 2, 3 or 4 grooves shall be provided with matching companion pulleys such that the belts are properly aligned.)

B. Service Factor:
   1) Design belt drive to operate at the horsepower equivalent to the highest BHP of the fan multiplied by service factor of 1.5.

C. Fan Pulleys: Cast iron or cast steel with interchangeable split, tapered bushing, dynamically balanced at factory prior to assembly.

D. Motor Pulleys:
   1) No adjustable pitch adjustment type, only fixed pitch type.
   2) Distance between fan shaft and motor shaft:
      a. Minimum sheave size – nothing under four inches (4”).
      b. Distance – two and a half times the largest sheave size.

E. Belt Guards: Comply with OSHA and SMACNA requirements.
   1. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

F. Motor Mount: Heavy duty double pull style (two bolt pull) adjustable for belt tensioning.

2.07 VIBRATION LIMITS

A. Each fan \ wheel shall be statically and dynamically Factory balanced to grade G6.3 per ANSI S2.19 or better. Complete fan assembly shall be factory balanced statically and dynamically in accordance with AMCA Standard 204.

B. Each Complete fan assembly shall be Field balanced statically and dynamically in accordance with AMCA Standard 204 and shall be statically and dynamically Field balanced to the equivalent balance grade based on the conditions stated as follows.
   1) Each Constant Volume fan assembly shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three planes; horizontal, vertical, and axial. The maximum allowable fan vibration shall be the lower of either that stated under this sub-paragraph entitled “Balancing Fan and Drive Assemblies” or 0.20 in./sec peak velocity, filter-out reading as measured at the fan RPM. This report shall be provided concurrently with the unit shipment.
2) Fans incorporating variable frequency drives shall be balanced for inverter duty operation. The fan shall be balanced over the entire range of fan operation i.e. 30 percent to 110 percent of design operation to the more stringent of:

a) Grade G2.5 per ANSI S2.19.

b) Complete fan assembly shall be factory balanced statically and dynamically in accordance with AMCA Standard 204.

1. Filter-in measurement (all fan assemblies) shall be taken in the horizontal and vertical planes on the drive and opposite-drive sides of the fan shaft.

a. Fans using variable frequency drives - Measurements shall not exceed 2.0 mils in any plane at or below 750 rpm and shall not exceed .0785 inches/sec in any plane beyond 750 rpm for inverter duty fans.

2. Filter-out measurements (all fan assemblies) shall be taken in the horizontal, vertical and axial planes on the drive and opposite-drive sides of the fan shaft.

a. Fans using variable frequency drives - Measurements shall not exceed 2.8 mils in any plane at or below 750 rpm and shall not exceed .110 inches/sec in any plane beyond 750 rpm for inverter duty fans.

2.08 ACCESSORIES

A. Provide accessories per the following requirements:

1) Access Doors: Provide access door in scroll housing, with latch-type handles, flush mounted for un-insulated housings, and raised-mounted for insulated housings.

2) Backdraft Dampers: Provide gravity-actuated dampers on fan discharge, counterweighted, with interlocking aluminum blades with felt edges in steel frame.

3) Drain Connections: Provide minimum 1 inch threaded coupling drain connection at lowest point of housing.

4) Extended Grease Lines: Extend grease lines from bearings to outside of inlet duct flange, terminate with grease fitting.

5) Heat Slingers: Provide metal disc between bearings and fan wheel, to dissipate heat from shaft.

6) Split Housings: Provide flanged, horizontally split housings as required by project conditions.

7) Weather Hoods: Provide protective weather hood with stamped vents over motor and drive compartment.

8) Screens: Provide manufacturer’s standard screens on fan inlet and outlet where exposed to operating and maintenance personnel for safety.

9) Fan Guards: Specify guards on inlets and outlets not connected to ductwork, constructed of expanded metal in removable frame.
PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of fans. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Fans shall be installed with the applicable NFPA standard and in accordance with manufacturer’s printed installation instructions.

B. Fans shall be located, arranged and installed with clearances for inspection and maintenance.
   1) Provide clearance for complete wheel and shaft removal as per manufacturer’s manual recommendations and structural support clearance.
   2) Provide ancillary equipment.

C. Floor Mounted Fans: Support fans on concrete mechanical equipment pads with vibration isolation devices.

D. Provide inlet screens on fans with non-ducted fan inlets. If fan has inlet bearing, install screen on inboard side of bearing.

E. Vibration Isolation Bases:
   1. Coordinate size and location of bases with the Work of related contracts.

F. Electrically connect Fan motor per latest National Electrical Safety Code and other applicable codes as a guide in establishing wiring. Provide motor disconnect box on site adjacent to motor.

3.03 FIELD QUALITY CONTROL

A. Inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Pre-start Up:
   1) Remove shipping blocking, and bracing.
   2) Verify lubrication for grease bearings and other moving parts.
   3) Set dampers in connected ductwork in proper position.
   4) Belt Driven Fans: Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guard.

C. Start Up:
   1) Energize motor, verify proper operation of drive system, and fan wheel.
   2) Belt Driven Fans:
      a) Adjust fan pulley to indicate initial rpm, further adjust pulley to obtain system design conditions if required. Align fan and motor sheaves to allow belts to run true and straight.
      b) Replace fan and motor pulleys if required to achieve design conditions.
      c) Replace variable sheaves with fixed permanent sheaves after air balance.
      d) Measure and record motor voltage and amperage.

END OF SECTION 233416