

## **SECTION 233423 – HVAC EXHAUST FANS AND POWER VENTILATORS**

First Edition 5-16-2017

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all “Underlines”.)

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

#### **1.2 SUMMARY**

- A. This section includes the requirements for centrifugal exhaust fans and power ventilators and accessories as follows: **<Edit for project>**
  - 1. Base mounted exhaust fans – utility, high capacity, and plug fans.
  - 2. Inline exhaust fans – tubular and vane axial fans.
  - 3. Laboratory exhaust fans – high plume laboratory fans.
  - 4. Smoke exhaust control fans.
  - 5. Miscellaneous exhaust fans – roof, wall and ceiling fans.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Project Altitude: Base fan performance ratings on actual project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
    - a. Certified fan performance curves with system operating conditions indicated.
    - b. Certified fan sound power ratings.
    - c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
    - d. Material thickness and finishes, including color charts.
    - e. Dampers, including housings, linkages, and operators.
    - f. Roof curbs.
    - g. Fan speed controllers.

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 2. Design Calculations: Calculate requirements for selecting vibration isolators [and seismic restraints] and for designing vibration isolation bases.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  - 1. Roof framing and support members relative to duct penetrations.
  - 2. Ceiling suspension assembly members.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- B. Field quality control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation and maintenance manual.
- B. Maintenance Material Submittals:
  - 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 2. Belts: One (1) set(s) for each belt driven unit.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

## 1.8 SOURCE QUALITY CONTROL

- A. Certify sound power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA Certified Ratings Seal.

## 1.9 COORDINATION

- A. Coordinate size and location of structural steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## 1.10 WARRANTY/GUARENTEE

- A. See Division 23 Specification Section "Basic Mechanical Requirements – HVAC" for warranty and guarantee requirements.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL PRODUCT REQUIREMENTS

- A. Equipment Design and Selection: Exhaust air fans and power ventilators shall be designed and selected in accordance with the scheduled capacities on the drawings and the requirements of this specification. All fans shall bear the AMCA Seal, and fan ratings shall be based on test and procedures performed in accordance with AMCA Publication 211, AMCA Publication 311 and comply with the AMCA Certified Ratings Program and

be UL and/or CUL listed. For supply air fans see mechanical specifications for custom AHU's and packaged AHU's.

- B. Basis of Design: The basis of design for exhaust air fans and power ventilators shall be equipment manufactured by Twin City Fans as follows: **<Edit for project>**
1. Base Mounted Centrifugal Fans:
    - a. Utility Sets – Models BCV, FCV, BAF
    - b. High Capacity Fans – Models BC-SW, BAF-SW
    - c. Plug Fans – Model BCPL
  2. Inline Type Centrifugal Fans:
    - a. Tubeaxial Fans – Models TB, TD
    - b. Vaneaxial Fans – Models TCVA, TCVX
  3. Laboratory Centrifugal Fans:
    - a. High Plume – Model TFE, QFE
  4. Smoke Control Centrifugal Fans:
    - a. Base Mount Fan – BCVSH
    - b. Tubular Fan – TBSH
  5. Miscellaneous Centrifugal Fans:
    - a. Roof Ventilators – Models BCRU/DCRU
    - b. Wall Mounted Ventilators – Models BCRW/DCRW
    - c. Ceiling Mounted Fans – T Series
- C. Other Acceptable Manufacturers: Subject to compliance with requirements, provide exhaust air fans and power ventilators by one (1) of the following: **<Edit for project>**
1. Base Mounted Centrifugal Fans:
    - a. Utility Sets: Greenheck, New York City Blower, Loren Cook, ACME
    - b. High Capacity Fans: Greenheck, New York City Blower, Loren Cook, ACME
    - c. Plug Fans: Greenheck, New York City Blower, Loren Cook, ACME
  2. Inline Type Centrifugal Fans:
    - a. Tubular Fans: Greenheck, New York City Blower, Loren Cook, ACME
    - b. Vaneaxial Fans: Greenheck, New York City Blower, Loren Cook, ACME
  3. Laboratory Centrifugal Fans:
    - a. High Plume: Strobic, Greenheck, New York City Blower, Loren Cook, ACME
  4. Smoke Control Centrifugal Fans:

- a. Base Mount Fan – Greenheck, New York City Blower, Loren Cook, ACME
  - b. Tubular Fan – Greenheck, New York City Blower, Loren Cook, ACME
5. Miscellaneous Centrifugal Fans:
- a. Roof Ventilators: Greenheck, New York City Blower, Loren Cook, ACME
  - b. Wall Mounted Ventilators: Greenheck, New York City Blower, Loren Cook, ACME
  - c. Ceiling Mounted Fans: Greenheck, New York City Blower, Loren Cook, ACME
- D. Factory Run Test: Prior to shipment all fans shall be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.
- E. Motors: Motors shall comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Specification Section "Motor Requirements for HVAC Equipment."

## 2.2 BASE MOUNTED CENTRIFUGAL FANS

- A. Utility Sets: Utility fans shall comply with the following:
1. Housing: Fan housings shall be heavy gauge, continuously welded construction. Housings with lock seams or partially welded construction are not acceptable. Housings shall be suitably braced to prevent vibration or pulsation. Housings shall have tapered spun, aerodynamically designed inlet cones or shrouds providing stable flow and high rigidity. Housings shall be of the rotatable design, convertible to eight standard discharge configurations.
  2. Fan Wheels: All fan wheels shall be statically and dynamically balanced. Fan wheels shall be single thickness type designed for maximum efficiency and quiet operation and shall be non overloading type constructed for the fan sizes and class as follows:
    - a. Fan Sizes 122 through 270: Class 1 wheels shall be constructed of aluminum with blades riveted and welded to the spun wheel and backplate.
    - b. Fan Sizes 300 through 365: Class 1 wheels and all class 2 wheels shall be constructed of heavy gauge steel with welded blades. Riveted blades are not acceptable.

3. Fan Shaft: Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.
4. Fan Bearings: Prelubricated and sealed self aligning, pillow block type ball bearings with ABMA 9, L50 of 200,000 hours.
5. Motor Drive: Belt drive assembly with belts, sheaves and pulleys for specified operation. Direct drive type assembly. <Edit for project>
6. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
7. Finish and Coating: The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust preventative primer. After the fan is completely assembled, a finish coat of paint shall be applied to the entire assembly. The fan shaft shall be coated with a petroleum based rust protection. Aluminum components shall be unpainted.
8. Accessories: Provide the following accessories as required for the project:  
<edit for project>
  - a. Inlet Flange.
  - b. Outlet Flange.
  - c. Bolted Access Door.
  - d. Disconnect Switch: Comply with the requirements indicated on the electrical CD's.
  - e. Drain Connection.
  - f. Motor Weather Guard: Provide an OSHA style belt guard removable cover.

B. High Capacity Fans: High capacity fans shall comply with the following:

1. Housing: Fan housings shall be heavy gauge, continuously welded construction. Housings with lock seams or partially welded construction are not acceptable. Housings shall be suitably braced to prevent vibration or pulsation. Housings shall have tapered spun, aerodynamically designed inlet cones or shrouds providing stable flow and high rigidity. Housings shall be of the rotatable design, convertible to eight standard discharge configurations.
2. Fan Wheels: All fan wheels shall be statically and dynamically balanced. Fan wheels shall be single thickness type designed for maximum efficiency and quiet operation and shall be non overloading type constructed for the fan sizes and class as follows:
  - a. Fan Sizes 122 through 270: Class 1 wheels shall be constructed of aluminum with blades riveted and welded to the spun wheel and backplate.

- b. Fan Sizes 300 through 365: Class 1 wheels and all Class 2 wheels shall be constructed of heavy gauge steel with welded blades. Riveted blades are not acceptable.
  3. Fan Shaft: Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.
  4. Fan Bearings: Prelubricated and sealed self aligning, pillow block type ball bearings with ABMA 9, L50 of 200,000 hours.
  5. Motor Drive:
  6. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
  7. Accessories: Provide the following accessories as required for the project: <edit for project>
- C. Plug Fans: Plug fans shall comply with the following:
  1. Plug Panel: Plug panel shall be constructed of 7 gauge steel with formed flanges to maintain flatness and rigidity and cross frame bearing support design for maximum stability and load spreading..
  2. Fan Wheels: All fan wheels shall be statically and dynamically balanced. Fan wheels shall be single thickness type designed for maximum efficiency and quiet operation and shall be non overloading type constructed for the fan sizes and class as follows:
    - a. Fan Sizes 122 through 270: Class 1 wheels shall be constructed of aluminum with blades riveted and welded to the spun wheel and backplate.
    - b. Fan Sizes 300 through 365: Class 1 wheels and all class 2 wheels shall be constructed of heavy gauge steel with welded blades. Riveted blades are not acceptable.
  3. Fan Shaft: Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.
  4. Fan Bearings: Prelubricated and sealed self aligning, pillow block type ball bearings with ABMA 9, L50 of 200,000 hours. Bearings shall be serviceable without dismantling the panel or frame.
  5. Motor Drive: Belt drive assembly with belts, sheaves and pulleys for specified operation.
  6. Motor Base: Motor base shall be constructed of heavy gauge steel, prepunched to accept the required motor and have four (4) point leveling and positive tension adjustment to insure proper drive belt alignment,
  7. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.

8. Accessories: Provide the following accessories as required for the project:  
<edit for project>
  - a. Factory installed and wired disconnect switch.
  - b. OSHA type belt guard.
  - c. OSHA shaft and bearing guard.

### 2.3 INLINE TYPE CENTRIFUGAL FANS

#### A. Tubeaxial Fans: Tubeaxial fans shall comply with the following:

1. Housing: Housings shall be constructed of heavy gauge, continuously welded steel to prevent air leakage. Housings shall include punched inlet and outlet flanges for duct mounting. Motor and bearing supports shall be constructed of heavy gauge steel and shall be suitably braced to prevent vibration and pulsation. Extended lube lines shall be supplied as standard for lubrication of the fan bearings without fan disassembly.
2. Propellers: [For belt drive application propellers shall be constructed of fabricated steel or cast aluminum blades and hubs.] [For direct drive application propellers shall be constructed of cast aluminum blades and hubs.] Propellers shall be secured to the motor shaft with a taperlock bushing. <Edit for Project>
3. Direct Drive Application: All motors shall be split phase and capacitor start single phase or three phase induction, permanently lubricated, heavy duty, ball bearing type, closely matched to the fan load and the schedules power requirements. <Delete if not required>
4. Belt Drive Application: Include the following:  
<Edit for Project or delete if not required>
  - a. Motors: All motors shall be single phase or three phase induction, permanently lubricated, heavy duty, ball bearing type, closely matched to the fan load and the schedules power requirements. Motor adjustment shall allow precise belt tensioning for optimum belt life and one-person adjustment and servicing.
  - b. Motor Drives: Motor sheaves shall be cast iron, and supplied as [variable pitch] [fixed pitch]. Drives and belts shall be rated for a minimum of 150% of the required motor HP. <Edit for Project>
  - c. Shafts: Shafts shall be AISI 1045 cold rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.
  - d. Bearings: Bearings shall be pillow block, heavy duty, anti-friction, self-aligning, grease lubricated, ball type. Each fan's bearings shall be sized with a minimum average life per AFBMA, in excess of 200,000 hours when operating at the maximum RPM of the fan size.
5. Finished Coating: The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust preventive primer.

After the fan is completely assembled, a finished coat of paint shall be applied to the entire assembly. Aluminum components shall be unpainted. The fan shaft shall be coated with a petroleum based rust protectant.

6. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
  7. Accessories: Provide the following accessories as required for the project: <Edit for project>
    - a. Mounting brackets.
    - b. Vibration isolators.
    - c. Disconnect switch.
    - d. Companion flanges.
    - e. Stamped Aluminum name plate.
- B. Vaneaxial Fans: Vaneaxial fans shall be either belt driven type (arrangement #9) or direct drive type (arrangement #4) as scheduled on the drawings and shall comply with the following:
1. Housing: Fan housings shall be heavy gauge, continuously welded construction. Housings with lock seams or partially welded construction are not acceptable. Housings shall be suitably braced to prevent vibration or pulsation. Housings shall have tapered spun, aerodynamically designed inlet cones or shrouds providing stable flow and high rigidity. Housings shall be of the rotatable design, convertible to eight standard discharge configurations. Fan housings shall be welded of 14-gauge ASTM A-569 hot rolled steel on size 12, 12-gauge hot rolled steel on sizes 15 through 21, 10-gauge hot rolled steel on sizes 24 through 36, and 7-gauge hot rolled steel on sizes 42 through 60. Inlet and outlet flanges are standard.
  2. Guide Vanes: Fan housings shall be fitted with aerodynamically designed stationary straightening guide vanes on the air discharge side of the wheel. The guide vanes shall be welded to both the inner cylinder and the fan housing interior and function to aid in the elimination of swirl and turbulence downstream thereby recovering rotational energy losses, improving efficiency and static pressure capability, and reducing fan noise generation.
  3. Fan Wheels: Fan wheels shall be a solid one (1) piece sand casting of A356 - T6 Aluminum and shall contain seven blades and an integral center hub. Wheels shall have blades of airfoil shape designed with a variable hub ratio system to allow the selected fan to operate at the highest efficiency possible. Wheels shall be machined to the proper diameter so that blade tip clearance shall be within tolerance necessary to insure certified fan performance. The wheels shall be secured to the fan/motor shaft with a Trantorque® or taperlock bushing.
  4. Fan Shaft: Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.

5. Direct Drive Motor (arrangement #4): The fan wheels shall be directly mounted to the motor shaft with the direct drive motors foot mounted, NEMA standard, totally enclosed fan cooled (TEFC), continuous duty, ball bearing type motor, with Class 'F' insulation and extended lube lines to the housing exterior. Also extend the motor wiring to an external junction box mounted on the housing exterior for a single point power connection. <edit for project>
6. Belt Drive Motor (arrangement #9): Belt drive applications include the following: <edit for project>
  - a. Motors: Motors for Arrangement 9 fans shall be manufactured in accordance with current applicable standards of IEEE and NEMA and, where applicable, shall meet current EPACT standards. Motors shall be foot-mounted, NEMA standard (ODP, TEFC, Explosion-Proof), continuous duty, ball bearing type with class (B, F) insulation and of cast iron construction when commercially available.
  - b. Drives: The fan shall be equipped with a (fixed/adjustable) pitch V-belt drive selected to operate the fan at the correct operational RPM. The V-belt drive shall consist of cast iron sheaves and anti-static conducting belts and shall be selected with a (1.2/1.5) safety factor based upon the required brake horsepower of the fan.
  - c. Bearings: Bearings shall be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for a minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum fan RPM. All bearings are provided with pre-filled factory extended lubrication lines terminating at the housing exterior.
  - d. Fan, Shaft and Bearing Assembly: The complete fan shaft and bearing assembly is mounted within a steel fabricated inner cylinder. The V-belt drive assembly is extended through a two-piece belt fairing. The belt fairing shall be an aerodynamically shaped tube designed to maximize fan efficiency. The belt fairing is welded continuously to both the inner cylinder that houses the fan shaft and bearings and the fan housing.
7. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
8. Finish: The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust preventive primer. After the fan is completely assembled, a finished coat of paint shall be applied to the entire assembly. Aluminum components shall be unpainted. The fan shaft shall be coated with a petroleum based rust protectant.
9. Accessories: Provide the following accessories as required for the project: <edit for project>
  - a. Belt Guard.
  - b. Shaft Seal.
  - c. Housing Door.

- d. Suspension Clips.
- e. Companion Flanges.

## 2.4 LABORATORY EXHAUST FANS – HIGH PLUME DILUTION FANS

### A. General Requirements:

1. Performance: Base fan performance at standard conditions (density 0.075 Lb/ft<sup>3</sup>).
2. Static and Flow: Fans selected shall be capable of accommodating static pressure and flow variations of +/- 15% of scheduled values.
3. Wind Loading: Fan assembly shall be designed for a minimum of one hundred twenty five (125) mph wind loading, without the use of guy wires.
4. Fan assemblies that use flexible connectors that can fail and cause loss of laboratory containment shall not be acceptable.
5. Fasteners: Fasteners exposed to corrosive exhaust shall be stainless steel.

B. Fan Housing: Fan housings shall be cylindrical, heavy gauge, continuously welded steel for strength and rigidity. Inlets shall be fully streamlined for maximum efficiency. Housings shall be suitably braced to prevent vibration or pulsation. Punched inlet flange shall be utilized for curb cap or mixing plenum box mounting. [Model TFE shall include outlet nozzle] [Model QFE shall include a discharge venture nozzle], windband, access door, shaft seal, and weather cover. A heavy duty, coated steel or galvanized curb cap shall be included to provide for a weather tight transition between the roof curb and the fan. A nozzle and windband combination shall be provided to efficiently increase discharge velocities to be a recommended minimum of 3,000 FPM without significantly affecting BHP requirements. The windband shall provide a minimum discharge height of eighty four (84) inches from roof surface. <Edit for Project>

C. Fan Wheel: Fan wheel diameters shall be in accordance with the standard sizes adopted by AMCA Standard 99-2414 for centrifugal tubular type fans. Fan wheel sizes 90 and 105 shall be backward inclined. Fan wheel sizes 122 and larger shall have die-formed airfoil blades designed for maximum efficiency and quiet operation. The wheel shall be specifically designed for inline fans to offer a higher and broader efficiency range. The backplate of the wheel shall be designed to offer lower resistance to the air leaving the wheel. Wheels shall be statically and dynamically balanced and the complete fan assembly including motor and drive shall be test balanced at or near the operating speed at the factory prior to shipment.

D. Fan Motors: Fan motors to be premium efficiency, standard NEMA frame, 900, 1,200 or 1,800 RPM, TEFC with a 1.15 service factor. A factory mounted NEMA 3R or 4X disconnect switch shall be provided for each fan.

E. Shafts: Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.

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- F. Bearings: Bearings shall be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for a minimum L-10 life of 200,000 hours at the maximum fan RPM. Bearings shall be equipped with extended lubrication lines with grease fittings outside of the fan housing.
- G. Motor Sheaves: Motor sheaves shall be cast iron, variable pitch on applications 10 HP and smaller, and fixed pitch on 15 HP and larger. Drives shall be sized for at least 200% of motor horsepower.
- H. Weather Cover: Provide a rain tight, easily removable weather cover shall be provided to completely enclose the motor and exposed parts of the V-belt drive.
- I. Curb Cap: A heavy duty, coated steel or galvanized curb cap shall be included to provide a weather tight transition between the roof curb and the fan while fully supporting the fan assembly.
- J. Nozzle and Wind Band: A nozzle and windband combination shall be provided to efficiently increase discharge velocities to be a recommended minimum of 3,000 FPM without significantly affecting BHP requirements. The windband shall provide a minimum discharge height of eighty four (84) inches from roof surface. The fan nozzle shall be capable of efficiently handling a nozzle velocity of up to 4,500 fpm. Nozzle shall come complete with a positive shut off backdraft damper to prevent entry of rain, snow, and other elements when fan is not in operation
- K. Mixing Plenum Box, Dampers and Curb: Mixing plenum box, dampers and curb shall comply with the following:
1. Mixing Plenum Box: Mixing plenum box shall be designed to support the fan and handle wind loads up to 125 mph. The mixing plenum box shall feature modular construction allowing for multiple fan configurations, allow for ease of shipping and installation, and allow for future expansion of the fan system. Bottom intake is standard, side intake option available upon request. Plenums shall be constructed of minimum 10 gauge steel. Plenums constructed of materials such as fiberglass or plastics that have mechanical properties less than that of steel will not be acceptable. The mixing box shall be mounted on manufacturer's supplied heavy duty roof curb.
  2. By Pass Damper: Bypass damper shall be parallel blade design and constructed of either heavy duty galvanized steel or extruded aluminum. Damper blades shall be of airfoil design with superior blade seals and stainless steel bearings. Frame shall be a one (1) piece, interlocking design. Damper shall be capable of handling a minimum of 4,000 fpm face velocity and eight and one half (8.5) inches of pressure.
    - a. Control Actuation: All dampers shall have an extended control shafts for electronic (DDC) control actuation.

3. Isolation Damper: Isolation damper shall be parallel blade design and constructed of either heavy duty galvanized steel or extruded aluminum. Damper blades shall be of airfoil design with superior blade seals and stainless steel bearings. Frame shall be a one (1) piece, interlocking design. Damper shall be capable of handling a minimum of 4,000 fpm face velocity and eight and one half (8.5) inches of pressure.
    - a. Control Actuation: All dampers shall have an extended control shafts for electronic (DDC) control actuation.
  4. Roof Curb: Roof curb shall be constructed of a minimum of 10 gauge steel with structural supports. Standard bottom intake box is open on the bottom of the box for attachment of duct. For special duct adapting plates on the bottom of plenum, contact factory prior to ordering.
- L. Finishes and Coatings: Finishes and coatings shall comply with the following:
1. All fan and system components (fan, nozzle, wind band, plenum) shall be corrosion resistant coated with a two (2) part electrostatically applied and baked, sustainable, corrosion resistant coating system; or Heresite P-413C. Standard finish color to be gray.
  2. All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.
  3. The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70% zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400°F.
  4. The coating system shall not be less than a total thickness of 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4,000 hour ASTM B117 Salt Spray Resistance.
  5. Note that 10-20 mil thick wet coating systems pollute the environment (air and water), and that these manually applied coatings are not uniform over the impeller surface and can cause fan imbalance and vibration.
- M. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
- N. Accessories:
1. NEMA 3R disconnect switch.
  2. Roof curb, eighteen (18) inches high.
  3. Stack Extension to reach ten (10) feet or higher above the roof line.

## 2.5 SMOKE CONTROL CENTRIFUGAL FANS

- A. Housing: Housings shall be constructed of heavy gauge, continuously welded steel. Housings with lock seams and/or partially welded construction are not acceptable. Additional construction requirements shall include the following: <Edit for Project>
1. Base Mounted Fans: Housings shall have tapered spun, aerodynamically designed inlet cones or shrouds providing stable flow and high rigidity. Housings shall be suitably braced to prevent vibration and/or pulsation. Housings shall be of the rotatable design, convertible to eight standard discharge configurations.
  2. Tubeaxial Fans: Housings shall include punched inlet and outlet flanges for duct mounting.
- B. Base Mounted Fans – Fan Wheels: Backward inclined wheels shall be single thickness plate type designed for maximum efficiency and quiet operation and shall be of the non-overloading type. All wheels shall be constructed of heavy gauge steel with welded (not riveted) blades on all sizes. All wheels shall be statically and dynamically balanced. <Edit for Project>
- C. Tubeaxial Fans – Propellers: Propellers shall be constructed of fabricated steel blades and hubs. Propellers shall be secured to the fan shaft with a taperlock bushing and keeper plate. <Edit for Project>
- D. Fan Bearings: Bearings are to be pillow block, heavy-duty, anti-friction, self-aligning, grease lubricated, ball type. Each fan's bearings are sized with a minimum average life, per AFBMA, in excess of 200,000 hours when operating at the maximum RPM of the fan size.
- E. Fan Shaft: Shafts shall be AISI 1045 cold rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.
- F. Fan Drive: Motor sheaves shall be cast iron, and supplied as either variable pitch or fixed pitch. Drives and belts shall be rated for a minimum of 200% of the required motor HP and shall be two-groove minimum.
- G. Fan Motor: All motors shall be single phase or three phase induction, permanently lubricated, heavy-duty, ball bearing type, closely matched to the fan load and provided at the voltage, phase, hertz, and enclosure as provided on the fan schedule.
- H. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
- I. Accessories:
1. NEMA 3R disconnect switch.

## 2.6 MISCELLANEOUS CENTRIFUGAL FANS

### A. Roof Mounted Ventilators – Up Blast Type: Roof mounted ventilators shall comply with the following:

1. Housing: Removable, spun aluminum housing; square, one (1) piece, aluminum base with a discharge baffle to direct discharge air upward, with rain and snow drains [and grease collector]. <edit for project>
2. Hinged Sub Base: Galvanized steel hinged arrangement permitting service and maintenance.
3. Fan Wheel: Aluminum hub and wheel with backward inclined blades.
4. Motor Drive: Belt or direct drive.
  - a. Resiliently mounted to housing.
  - b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - c. Shaft Bearings: Permanently lubricated, permanently sealed, self aligning ball bearings.
  - d. Pulleys: Cast iron, adjustable pitch motor pulley.
  - e. Fan and motor isolated from exhaust airstream.
5. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
6. Roof Curb: Hinged galvanized steel; mitered and welded corners; one and one half (1-1/2) inch thick, rigid, fiberglass insulation adhered to inside walls; and one and one half (1-1/2) inch wood nailer. Size as required to suit roof opening and fan base. <edit for project>
  - a. Configuration: Self flashing without a cant strip, with mounting flange.
  - b. Overall Height: Twelve (12) inches.
  - c. Sound Curb: Curb with sound absorbing insulation. <edit for project>
  - d. Pitch Mounting: Manufacture curb for roof slope.
  - e. Metal Liner: Galvanized steel.
7. Accessories: Provide the following accessories as required for the project: <edit for project>
  - a. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
  - b. Bird Screens: Removable, one (1/2) inch mesh, aluminum or brass wire.
  - c. Dampers: Counterbalanced, parallel blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  - d. Motorized Dampers: Parallel blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

### B. Wall Mounted Ventilators: Wall mounted ventilators shall comply with the following:

1. Housing: Heavy gage, removable, spun aluminum, dome top and outlet baffle; venturi inlet cone.
  2. Fan Wheel: Aluminum hub and wheel with backward inclined blades.
  3. Motor Drive: Belt or direct drive.
    - a. Resiliently mounted to housing.
    - b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
    - c. Shaft Bearings: Permanently lubricated, permanently sealed, self aligning ball bearings.
    - d. Pulleys: Cast iron, adjustable pitch motor pulley.
    - e. Fan and motor isolated from exhaust airstream.
  4. Electrical Requirements: Provide a single point connection for power. See drawings for power requirements.
  5. Accessories: Provide the following accessories as required for the project: **<edit for project>**
    - a. Variable Speed Controller: Solid state control to reduce speed from 100% to less than 50%.
    - b. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
    - c. Bird Screens: Removable, one half (1/2) inch mesh, aluminum or brass wire.
    - d. Wall Grille: Ring type for flush mounting.
    - e. Dampers: Counterbalanced, parallel blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
    - f. Motorized Dampers: Parallel blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
    - g. Mounting Bracket: Provide a mounting bracket matching the steel gauge of the fan.
    - h. Fan Switch: Provide an on/off switch with variable air speed selections white plastic cover and dial, and suitable for mounting in a single gang box.
- C. Ceiling Mounted Fans: Ceiling mounted fans shall comply with the following:
1. Housing: 20 gauge galvanized steel housing, with adjustable mounting brackets.
  2. Acoustical Liner: Liner shall be one half (1/2) inch acoustical liner insulation.
  3. Fan, Wheel and Motor Assembly: Centrifugal fan and wheel assembly shall be directly mounted on motor shaft. Motor shall be permanently lubricated type motor and mounted with resilient anti vibration isolation mounts. Fan, motor, and fan wheel shall be removable for service without disturbing the ductwork.
  4. Grille: [Stainless steel] [Aluminum], louvered grille with flange on intake and thumbscrew attachment to fan housing. **<edit for project>**

5. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug in.
6. Accessories: Provide the following accessories as required for the project: <edit for project>
  - a. Ceiling Radiation Damper: Fire rated assembly with ceramic blanket, stainless steel springs, and fusible link.
  - b. Isolation: Rubber in shear vibration isolators.
  - c. Wall Cap: Model 441, galvanized steel frame with aluminum louvers, doct collar and bird screen.
  - d. Roof Cap: Model 634M low profile galvanized steel roof cap with a built in Backdraft damper, bird screen, mounting/roof flashing collar and black electrically bonded epoxy finish.
  - e. Control Switch: Model 57W, 120 volt, 3 amp, on/off switch with variable air speed selections white plastic cover and dial, and suitable for mounting in a single gang box.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
- B. Examine roughing in for duct systems to verify actual locations of duct connections before fans are installed.
- C. Examine foundations and inertia bases for suitable conditions where fans are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 FAN INSTALLATION**

- A. Refer to and follow fan manufacturers guidelines for rigging fans to their location.
- B. Install fans level and plumb.
- C. Install fans to provide access for periodic maintenance including removing motors, fan wheels, couplings, and accessories.
- D. Independently support fans and ductwork so the weight of ductwork is not supported by the fans and weight of fans is not supported by the ductwork.
- E. Base Mounted Equipment:

1. Install base mounted fans on cast in place concrete equipment base(s) and/or structural supports as indicated on the drawings. Comply with requirements for equipment bases and foundations specified in Architectural Specification Section "Miscellaneous Cast in Place Concrete."
- F. Inline Equipment: Install inline fans in a horizontal or vertical position from the structure using hangers and supports of the size required to support weight of inline fans. Comply with requirements for hangers and supports specified in Division 23 Specification Section "Hangers and Supports for HVAC Piping Systems."
- G. Vibration and Seismic Control: Comply with requirements for seismic-restraint devices specified in Division 23 Specification Section "Vibration and Seismic Controls for HVAC Systems."
- H. Wall Fans: Position fan assembly to cover wall opening. Anchor fan assembly to wall structure and provide caulking material around the perimeter for a weather proof installation.
- I. Ceiling Fans: Suspend units from structure; use steel wire or metal straps.
- J. Label units according to requirements specified in Division 23 Specification Section "Identification for HVAC Systems and Equipment."
- K. Roof Curb: Install manufacturer's roof curb on roof structure, level and secure, according to the details on the drawings and/or the "The NRCA Roofing and Waterproofing Manual," Low Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction.

### 3.3 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Specification Section "HVAC Duct Systems and Accessories."
- B. Ground equipment according to Division 26 Specification Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Specification Section "Low Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Verify that shipping, blocking, and bracing are removed.
  2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  3. Verify that cleaning and adjusting are complete.
  4. 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 guards.
  5. Adjust belt tension.
  6. Adjust damper linkages for proper damper operation.
  7. Verify lubrication for bearings and other moving parts.
  8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  9. Disable automatic temperature control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature control operators.
  11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.
- 3.5 ADJUSTING
- A. Adjust damper linkages for proper damper operation.
  - B. Adjust belt tension.
  - C. Comply with requirements in Division 23 Specification Section "Testing, Adjusting, and Balancing HVAC Systems" for testing, adjusting, and balancing procedures.
  - D. Replace fan and motor pulleys as required to achieve design airflow.
  - E. Lubricate bearings.

END OF SECTION 233423