

SECTION 23 3423**HVAC POWER VENTILATORS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes the following exhaust [**and supply**] fans:
 - 1. Utility set fans.
 - 2. Up-blast centrifugal roof ventilators.
 - 3. Mixed-flow In-line centrifugal fans.
 - 4. High-Plume Dilution Laboratory Exhaust Fans are prohibited.
 - 5. Kitchen equipment grease hood up-blast exhaust fan.
- B. The University prohibits new horizontal fan discharge outlets, fixed cap outlets, mushroom cap outlets and rotating cap outlets. Airstreams shall only exhaust upward.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor manufacturer, ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material thickness and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Prefabricated roof curbs.
 - 9. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

- 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. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Sound Performance: Fan sizing and selection shall include consideration of sound performance characteristics. Entire installation shall conform to project acoustic and vibration control requirements.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Exhaust fans shall comply with UL 705.

- E. ABMA 9 and ABMA 11 Standards: Ball bearing and roller bearings shall comply with ABMA Standards.
- F. Solid fan shafts shall be furnished whenever possible.
- G. Exterior mounted units shall be constructed and fasten with hot-dip galvanized or stainless steel bolts, nuts and washers.
- H. NFPA Compliance: Kitchen exhaust equipment shall comply with NFPA 96 requirements for cooking operations.
- I. UL Compliance: Fan shall meet UL 762 requirements for temperature of 375 degrees F. cleaning access door, and grease drainage.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, in accordance with manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Unusual Service Conditions
 - 1. Base fan-performance ratings on the following:
 - a. Ambient Temperature: .
 - b. Altitude: 100 feet above sea level.
 - c. Humidity: wet bulb deg F.
 - d. <Insert conditions>.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electric Code, by an NRTL, and marked for intended location and application.
- C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- E. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 23 0548 "Vibration and Seismic Controls for HVAC" for specific seismic factors to be followed.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- F. Wind Performance: Air-handling units shall withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 23 0548 "Vibration and Seismic Controls for HVAC."
- G. Capacities and Characteristics:
1. Airflow: Insert cfm.
 2. Total Static Pressure: Insert inches wg.
 3. Fan Diameter: Insert inches.
 4. Drive Type: Direct.
 5. Fan rpm: Insert number.
 6. Tip Speed: Insert fpm.
 7. Sound: Insert number sones.
 8. Curb Height: Insert inches.
 9. Damper: Backdraft, Motorized, or None.
 10. Brake Horsepower: Insert number.
 11. Motor Size: Insert number hp.
 12. Motor rpm: Insert number.
 13. Motor Enclosure: Totally enclosed, fan cooled or Explosion-proof.
 14. Electrical Characteristics:
 - a. Volts: 480 V or 208 or 120.
 - b. Phase: 3 phase or single phase
 - c. Hertz: 60.
 15. Accessories: Insert accessory description.

2.02 MANUFACTURERS

- A. Or Equal: Where products are specified by manufacturers name and accompanied by the term "or equal," comply with provisions in Section 01 2500 "Substitution Procedures." Specific procedures must be followed before use of an unnamed product or manufacturer.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Utility Set Fans:
 - a. Aerovent
 - b. AirPro Fan & Blower Company.
 - c. Chicago Blower
 - d. Cook, Loren Company.
 - e. Greenheck Fan Corp.
 - f. New York Blower Company (The).
 - g. Twin City Fan Company
 - h. Or equal.

2. Centrifugal Roof Ventilators:
 - a. Aerovent
 - b. Chicago Blower
 - c. Cook, Loren Company.
 - d. Greenheck Fan Corp.
 - e. New York Blower Company (The).
 - f. PennBarry
 - g. Twin City Fan Company
 - h. Or equal.
3. Mixed-flow In-Line Centrifugal Fans:
 - a. Aerovent
 - b. Cook, Loren Company.
 - c. Greenheck Fan Corp.
 - d. Twin City Fan Company
 - e. Or equal.

2.03 UTILITY SET FANS

- A. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories. Direct drive fans shall be furnished. Fans shall be corrosion-resistant. Furnish Arrangement 8 fans unless directed by the University.
- B. Housing: Fabricated of galvanized or painted steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
 1. Housing Discharge Arrangement: Adjustable to eight standard positions. Discharge shall be installed that provides the least resistance with the airflow. Bring to the University's attention if fan discharge is not arranged correctly.
- C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
 1. Blade Materials: Aluminum. Steel for kitchen applications.
 2. Blade Type: Airfoil
 3. Spark-Resistant Construction for fume hood and other hazardous air streams: AMCA 99, type B.
- D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- E. Shaft Bearings: Self-aligning, pillow-block-type ball bearings with calculated L10 life of 200,000 hours, minimum. Provide sealed bearings, where possible, while achieving designed life.
- F. Accessories:

1. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge for fans not operating 24 hours per day. Not required for continuous operating fans.
2. Access Doors: Gasketed doors with bolts. Latch-type handles are prohibited for fume hood and other hazardous type exhaust air streams.
3. Drain Connections: NPS $\frac{3}{4}$ threaded coupling drain connection installed at lowest point of housing.
4. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

G. Coatings: Epoxy, Phenolic, or Powder-baked enamel as require for use.

2.04 CENTRIFUGAL ROOF VENTILATORS

- A. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, electronically commutated motor (ECM) and exterior mounted disconnect switch, drive assembly, curb base, and accessories. The weather-proof disconnect may be factory-installed, or a field-installed item. This safety device shall be mounted externally and accessible without removing any covers.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain drain.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined or airfoil blades.
- D. Direct-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, and self-aligning ball bearings. L10 average life for minimum of 200,000 hours.
 3. Fan and motor isolated from exhaust airstream.
- E. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 or lower percent.
 2. Disconnect Switch: Nonfusible type, NEMA 4 enclosure, with thermal-overload protection mounted outside fan housing, Provide factory wired through an internal aluminum conduit to exterior location.
 3. Bird Screens: Removable, $\frac{1}{2}$ -inch mesh, aluminum or brass wire.
 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops unless fan runs continuously 24 hours per day.
 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

- F. Roof Curbs, Self-Flashing: Galvanized steel; mitered and welded corners; 1½-inch- thick, rigid, fiberglass insulation adhered to inside walls; and neoprene rubber gasket. Size as required to suit roof opening and fan base.
1. Configuration: Built-in cant and mounting flange.
 2. Overall Height: 16 inches.
 3. Sound Curb: Curb with sound-absorbing insulation matrix where indicated.
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Burglar Bars: ½-inch diameter steel bars welded in place to form 6-inch squares.
 7. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.
 8. Mounting Pedestal: Galvanized steel with removable access panel.

2.05 MIXED-FLOW IN-LINE CENTRIFUGAL FANS

- A. Description: In-line, directly driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. Housing: Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of polyester urethane, electrostatically applied and baked. No uncoated metal fan parts will be allowed. Housing shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings. Mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge. Units up to size 27 shall incorporate a universal mounting system that allows fan mounting either vertically or horizontally. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan. An access door shall be supplied for impeller inspection and service.
- C. Direct-Driven Units: Motor encased in housing outside of airstream, factory wired to disconnect switch located outside of fan housing.
- D. Fan Impeller: Fan impeller shall be mixed flow design. The impeller shall be electronically balanced dynamically to balance grade G6.3 per ANSI S2.19. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of polyester urethane coating, electrostatically applied and baked.
- E. Accessories:
1. Companion Flanges: For inlet and outlet duct connections.

2.06 KITCHEN CENTRIFUGAL VENTILATORS - ROOF UPBLAST

- A. Configuration: Centrifugal roof upblast, grease hood kitchen ventilator. Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, electronically commutated motor (ECM) and exterior mounted disconnect switch, drive assembly, curb base, and accessories. Rate selection at temperature of cooking equipment being served.

- B. Housing Upblast: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain drains. Provide grease collector.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
 - 1. Fan and motor isolated from exhaust airstream.
- D. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 3. Spark-resistant, all-aluminum wheel construction.
 - 4. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.
 - 5. Mounting Pedestal: Galvanized steel with removable access panel.
 - 6. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust and compliant with NFPA 96.
- E. Roof Curbs, Self-Flashing: Galvanized steel; mitered and welded corners; 1½-inch-thick, rigid fiberglass insulation adhered to inside walls; and neoprene rubber gasket. Size as required to suit roof opening and fan base.
 - 1. Configuration: Built-in cant, unless roof is PVC membrane and cant not required and mounting flange.
 - 2. Overall Height: minimum 24 inches.
 - 3. Pitch Mounting: Manufacture curb for roof slope.
 - 4. Metal Liner: Galvanized steel.
 - 5. Vented Curb: Unlined with louvered vents in vertical sides.

2.07 MOTORS

- A. Refer to Section 23 0513 "Motors for HVAC" for specific requirements for factory-installed motors.
- B. Enclosure Type: Totally enclosed, fan cooled (TEFC).
- C. Minimum Standard: IEEE-841 unless motor is electronically commutated type (ECM).
- D. Motor shims for alignment shall be stainless steel.

2.08 SOURCE QUALITY CONTROL

- A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.
- B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

- C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.
- D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.
- E. Operating Limits: Classify in accordance with AMCA 99.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install exhaust fans level and plumb.
- B. Support units using restrained spring isolators having a minimum static deflection of 2 inch. Vibration- and seismic-control devices are specified in Section 23 0548 "Vibration and Seismic Controls for HVAC."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base, or equipment platform.
- C. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Secure roof-mounting fans with stainless steel hardware. Refer to Division 07 Section "Roof Accessories" for installation requirements.
- E. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in Section 23 0548 "Vibration and Seismic Controls for HVAC."
 - 1. Provide for fans over 40 pounds, seismic restrain support units.
- F. Install units with clearances for service and maintenance.
- G. Label units in accordance with requirements specified in Section 23 0553 "Identification for HVAC."
- H. Fans must be fully accessible for service and routine maintenance. Fan motors and drives shall not be located within hazardous or contaminated exhaust air streams. Fan bearings shall be serviceable outside of hazardous or contaminated exhaust air streams
- I. When fan discharge is vertical and open to the weather, a capped drain pipe shall be provided on the bottom of the fan housing.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct

connections with flexible connectors. Flexible connectors are specified in Section 23 3300 "Air Duct Accessories."

- B. Install ducts adjacent to exhaust fans to allow service and maintenance.
- C. Ground equipment.
- D. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.03 FIELD QUALITY CONTROL

- A. Equipment Startup Checks:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connection 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.
 - 5. Where belt-driven fans have been directed, align the sheaves so that the centerline of the grooves are not more than 0.01 inch per 12 inches of center distance. It is possible to align the sheaves much more closely than that. Factory alignment is never accurate after shipment. Ensure sufficient work hours are available to properly align the equipment. This is an essential function and shall not be overlooked or slighted in any way.
 - 6. For Arrangement-8 fans, align motor and fan shafts, as follows. Shims shall be stainless steel. Ensure sufficient work hours are available to properly align the equipment. This is an essential function and shall not be overlooked or slighted in any way.
 - a. Alignment shall be reverse dial indicator or laser method.
 - b. Angular and offset misalignment shall be as follows:

Maximum Speed (rpm)	Maximum Angularity (per 10 inches)	Maximum Offset (Horiz. & Vert.)
600	0.010 inch	0.005 inch
900	0.007 inch	0.003 inch
1200	0.005 inch	0.0025 inch
1800	0.003 inch	0.002 inch
3600	0.002 inch	0.001 inch
Angularity is based on the diameter of the coupling. It is valid for the types of couplings used on fans at UCI, which are flexible. For example, a 3-inch diameter coupling, would have a maximum angularity of 0.001 inch ($0.003 \times 3/10$) at 1800 rpm maximum speed. It is possible to align the shafts at much smaller offsets and angularity than listed.		

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.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Fans shall be dynamically balanced to balance grade G6.3 per ANSI S2.19. The wheel cone and fan inlet cone shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

F. Shut unit down and reconnect automatic temperature-control operators.

G. Refer to Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Lubricate bearings.

3.05 CLEANING

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

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the University's maintenance personnel to adjust, operate, and maintain exhaust fans.

1. Train the University's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 01.
3. Schedule training with the University. Refer to Division 01.

END OF SECTION