

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and Divisions 00 and 01, apply to this Section.
- B. Related Sections:
 - 1. Division 07.
 - 2. Division 23.
 - 3. Division 26.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Utility Set Fans
 - 2. Downblast Roof Exhaust Fans
 - 3. Upblast Roof Exhaust Fans
 - 4. Wall Exhaust Fans
 - 5. Ceiling and Wall Cabinet Fans
 - 6. Cabinet Fans
 - 7. Square In-Line Fans
 - 8. Tubular In-Line Centrifugal Fans
 - 9. Mixed Flow Fans
 - 10. Propeller Wall Fans
 - 11. Vaneaxial Fans
 - 12. Centrifugal Fans
 - 13. Laboratory Fume Exhaust Fan System
- B. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Operating Limits: Classify according to AMCA 99.
- C. Fan Schedule: The following information is described in an equipment schedule on the Drawings.
 - 1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
 - 2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.4 SUBMITTALS

- A. General: See Section 23 05 00 for general requirements of Product Data, Shop Drawings, Reports and Certificates, and Operation and Maintenance data submittals.

B. Product Data: Provide submittals of the following:

1. Utility Set Fans
2. Downblast Roof Exhaust Fans
3. Upblast Roof Exhaust Fans
4. Wall Exhaust Fans
5. Ceiling and Wall Cabinet Fans
6. Cabinet Fans
7. Square In-Line Fans
8. Tubular In-Line Centrifugal Fans
9. Mixed Flow Fans
10. Propeller Wall Fans
11. Vaneaxial Fans
12. Centrifugal Fans
13. Laboratory Fume Exhaust Fan System

C. Shop Drawings: None required.

D. Reports and Certificates: Provide submittals of the following:

1. Factory authorized service representative report.

1.5 CODES AND STANDARDS

A. Codes and Standards shall be the current version adopted by the Authority Having Jurisdiction.

1.6 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled by UL.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

D. NEMA Compliance: Provide components required as part of fans that comply with applicable NEMA standards.

E. Testing Requirements: The following factory tests are required as indicated:

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.
- B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

1.8 COORDINATION AND SCHEDULING

- A. Coordinate the size and location of structural steel support members.
- B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.

1.9 EXTRA MATERIALS

- A. Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with moisture proof protective crating and covering.
- B. Lift and support units with the manufacturer's designated lifting or supporting points.
- C. Fans shall not be exposed to moisture or dust during construction or storage.

PART 2 – PRODUCTS

2.1 UTILITY SET FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Utility Set Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Aerovent, Inc.
 - c. Cook (Loren) Co.
 - d. Greenheck Fan Corp.
 - e. Twin City.
 - f. Or Approved Equal.
- B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and accessories.
- C. Construction: Minimum 14-gauge steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
 - 1. Housings Discharge Arrangement: Adjustable to 8 standard positions.

- D. 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: Steel.
 - 2. Blade Type: Die formed, backward inclined or forward curved, as scheduled.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
 - 1. [Open drip proof][Guarded drip proof].
- F. Fan Shaft: Turned, ground, and polished steel keyed to wheel hub.
- G. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor: 1.5.
 - 2. Motor Pulleys: Adjustable pitch for use with motors through 5 horsepower (HP); fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 4. Belt Guards: Fabricate of steel for motors mounted on the outside of the fan cabinet.
- I. Finish: [Baked polyester powder coating, electrostatically applied][Air dried phenolic resin].
- J. Accessories: The following accessories are required as indicated:
 - 1. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge.
 - 2. Access Doors: Gasketed doors with latch-type handles.
 - 3. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
 - 4. Spark-Resistant Construction: AMCA 99 construction, as indicated.
 - 5. Inlet Screens: Removable wire mesh.
 - 6. Drain Connections: 3/4-inch threaded coupling drain connection installed at lowest point of housing.
 - 7. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
 - 8. Drain Connection: Threaded drain connection with plug.

2.2 DOWNBLAST ROOF EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Downblast Roof Exhaust Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilation.
 - e. Twin City.

- f. Or Approved Equal.
- B. Description: Belt-driven or direct-drive downblast centrifugal fans as indicated, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, curb base, and accessories.
- C. Construction: Minimum 16-gauge spun-aluminum, removable dome top and outlet baffle, square one-piece aluminum base with welded corners; venturi inlet cone, and integral conduit chase.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
 - 1. [Open drip proof][Guarded drip proof].
- F. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
 - 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000.
 - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
 - 3. Belts: Oil and heat resistant, nonstatic type.
- G. Direct-Drive Units: Motor mounted in airstream on vibration isolators.
- H. Bird Screen: 1/2-inch wire mesh, aluminum or brass wire.
- I. Accessories: The following items are required as indicated:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [under fan housing][as indicated on plans].
 - 2. Damper: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 3. Roof Curbs: Provide roof curbs that are compatible with the roof type. Refer to general construction drawings and specifications for roof types. Minimum 0.08-inch aluminum, welded corners, rigid fiberglass insulation, minimum [12][18]-inch high, and wood nailer. Size as required to suit roof opening and fan base.
 - a. Configuration: Provide roof curbs that are compatible with the roof type. Refer to general construction drawings and specifications for roof types.

2.3 UPBLAST ROOF EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Upblast Roof Exhaust Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilation.

- e. Twin City.
 - f. Or Approved Equal.
- B. Description: Belt-driven or direct-drive upblast centrifugal fans as indicated, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, curb base, and accessories.
- C. Construction: Minimum 16-gauge, spun-aluminum, two-piece top including windband, square one-piece aluminum base with welded corners; venturi inlet cone, and integral conduit chase.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
- 1. [Open drip proof][Guarded drip proof].
- F. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
- 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000.
 - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
 - 3. Belts: Oil and heat resistant, nonstatic type.
- G. Direct-Drive Units: Motor mounted in airstream on vibration isolators.
- H. Bird Screen: 1/2-inch wire mesh, aluminum or brass wire.
- I. Accessories: The following items are required as indicated:
- 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [under fan housing][as indicated on plans].
 - 2. Damper: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 3. Grease Trough: Continuously welded aluminum trough and removable lid.
 - 4. Roof Curbs: Provide roof curbs that are compatible with the roof type. Refer to general construction drawings and specifications for roof types. Minimum 0.08-inch aluminum, welded corners, rigid fiberglass insulation, minimum [12][18]-inch, and wood nailer. Size as required to suit roof opening and fan base.
 - 5. Vent Extension: Provide vent extension for minimum 40-inch discharge height.

2.4 WALL EXHAUST FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Wall Exhaust Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilation.
 - e. Twin City.
 - f. Or Approved Equal.

- B. Description: Belt-driven or direct-drive centrifugal fans as indicated, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, curb base, and accessories.
- C. Construction: Minimum 16-gauge, spun-aluminum, two-piece cap including windband, wall flange; inlet cone, and integral conduit chase.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
 - 1. [Open drip proof][Guarded drip proof].
- F. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
 - 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000.
 - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
 - 3. Belts: Oil and heat resistant, nonstatic type.
- G. Direct-Drive Units: Motor mounted in airstream on vibration isolators.
- H. Bird Screen: 1/2-inch wire mesh, aluminum or brass wire.
- I. Accessories: The following items are required as indicated:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [under fan housing][as indicated on plans].
 - 2. Damper: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

2.5 CEILING AND WALL CABINET FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceiling and Wall Cabinet Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Jenn Industries Inc.
 - e. Penn Ventilation.
 - f. Twin City.
 - g. Or Approved Equal.
- B. Description: Centrifugal fans designed for installing in ceiling or wall applications.
- C. Construction: 22-gauge galvanized steel lined with acoustical insulation, complete with backdraft damper.

- D. Fan Wheel: Centrifugal forward curved wheel directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Motor: Open drip proof type with permanently lubricated sealed bearings and include impedance or thermal overload protection.
- F. Grille: Aluminum, coated with baked enamel, white.
- G. Accessories: The following items are required as indicated:
 - 1. Variable Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [on fan housing][as indicated on plans].
 - 2. Roof or Wall Caps: Complete with integral flashing, backdraft damper, and birdscreen. Refer to general construction drawings and specifications for roof and wall types.

2.6 SQUARE IN-LINE FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square In-Line Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilation.
 - e. Twin City.
 - f. Or Approved Equal.
- B. Description: Square in-line, belt-driven or direct-drive centrifugal fans as indicated, consisting of housing, wheel, fan shaft, bearings, drive assembly, motor, mounting brackets, and accessories.
- C. Construction: Minimum 18-gauge steel with integral duct collars. Bolted access doors on three sides, sealed with closed cell neoprene gasketing.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
 - 1. [Open drip proof][Guarded drip proof].
- F. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
 - 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000.
 - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
 - 3. Belts: Oil and heat resistant, nonstatic type.
- G. Direct-Drive Units: Motor mounted in airstream on vibration isolators.

- H. Finish: [Baked polyester powder coating, electrostatically applied][Air dried phenolic resin].
- I. Accessories: The following accessories are required as indicated:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [on fan housing][as indicated on plans].
 - 2. Insulated Housing: Fan housing and motor cover lined with fiberglass duct liner.
 - 3. Inlet/Discharge Guards: Minimum 16-gauge 1/2-inch by 1-inch screen, complete with mounting frame.

2.7 PROPELLER WALL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Propeller Wall Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilation.
 - e. Twin City.
 - f. Or Approved Equal.
- B. Description: Belt-driven or direct-drive propeller wall fans, as indicated, consisting of fan blades, hub, housing, orifice ring, motor, drive, and accessories.
- C. Construction: Minimum 14-gauge steel, bolted and welded construction.
- D. Propeller: Cast aluminum airfoil design with cast aluminum hub.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
 - 1. [Open drip proof][Guarded drip proof].
- F. Belt-Driven Units: Motor mounted out of airstream on vibration isolator with the following features:
 - 1. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
 - 2. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
 - 3. Belts: Oil and heat resistant, nonstatic type.
- G. Direct-Drive Units: Motor mounted in airstream on vibration isolators.
- H. Finish: [Baked polyester powder coating, electrostatically applied][Air dried phenolic resin].
- I. Accessories: The following accessories are required as indicated:
 - 1. Backdraft Damper: Aluminum blades in aluminum frame, interlocked blades with nylon bearings.

2. Motor-Side Back Guard: Steel, conforming to OSHA specifications, removable for maintenance.
3. Wall Sleeve: Steel to match fan and accessory size.
4. Weathershield Hood: Steel to match fan and accessory size.
5. Weathershield Front Guard: Steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [on fan housing][as indicated on plans].

2.8 CABINET FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cabinet Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilation.
 - e. Or Approved Equal.
- B. Description: Duct mounted, belt-driven centrifugal cabinet fans as indicated, consisting of housing, wheel, fan shaft, bearings, drive assembly, motor, mounting brackets, and accessories.
- C. Construction: Minimum 18-gauge galvanized steel with integral duct collars, two removable access panels, and mounting brackets.
- D. Fan Wheel: Steel scroll fan, double-width, double-inlet (DWDI), forward curved centrifugal type mounted on internal vibration isolators.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
1. [Open drip proof][Guarded drip proof].
- F. Bearings: Permanently lubricated, sealed ball type, minimum L50 life in excess of 200,000 hours.
- G. Drives: Precision machined cast iron type, sized for 150 percent of motor horsepower.
- H. Belts: Oil and heat resistant, nonstatic type.
- I. Finish: [Baked polyester powder coating, electrostatically applied][Air dried phenolic resin].
- J. Accessories: The following accessories are required as indicated:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to 50 percent, mount [on fan housing][as indicated on plans].
 2. Insulated Housing: Fan housing and motor cover lined with 1/2-inch fiberglass duct liner.
 3. Inlet/Discharge Guards: 1/2 by 1/2-inch galvanized welded wire on a galvanized frame.

2.9 VANEAXIAL FANS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. Vaneaxial Fans:
 - a. Barry Blower.
 - b. Chicago Blower Corp.
 - c. Joy Mfg. Corp.
 - d. Wood.
 - e. Greenheck Fan Corp.
 - f. Twin City.
 - g. Or Approved Equal.
- B. **Description:** Vaneaxial fans, belt-driven or direct-drive as indicated, consisting of fan wheel and housing, straightening vane section, factory-mounted motor, an inlet bell and outlet cone section, and accessories.
- C. **Construction:** Minimum 12-gauge steel with inlet bell and diffuser sections.
1. **Inlet Bell and Outlet Cone Connections:** Outer mounting frame and companion flanges; inlet bell and outlet cone shall be bolted to the fan housing.
 2. **Guide Vane Section:** Integral guide vanes downstream from the fan wheel designed to straighten the airflow.
- D. **Fan Hub and Blade-Bearing Assemblies:** Cast aluminum, machined and fitted with threaded bearing wells to receive blade-bearing assemblies.
1. **Blades:** Replaceable, cast aluminum; factory mounted and balanced to the hub assembly.
 2. **Fan Shaft:** Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.
 3. **Manually adjustable rotor blade.**
- E. **Motor:** Heavy duty type with permanently lubricated sealed ball bearings.
1. [Open drip proof][Guarded drip proof].
- F. **Shaft Bearings:** Heavy duty regreasable ball or roller type, minimum L50 life in excess of 200,000 hours.
- G. **Direct-Drive Units:** Direct-driven motor located downstream of the rotor.
- H. **Belt-Driven Units:** Factory mounted, with final alignment and belt adjustment made after installation.
1. **Service Factor Based on Fan Motor:** 1.4.
 2. **Pulleys:** Cast iron with split, tapered bushing, dynamically balanced at factory.
 3. **Motor Pulleys:** Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
 4. **Belts:** Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

5. Belt Guards: Fabricate of steel for motors mounted on the outside of the fan cabinet.
6. Motor Mount: Adjustable base.
- I. Controllable Pitch Blades: Designed to automatically change pitch while fan is running. Pitch control actuator contained in machined aluminum rotor.
- J. Finish: [Baked polyester powder coating, electrostatically applied][Air dried phenolic resin].
- K. Accessories: The following accessories are required as indicated:
 1. Companion Flanges: Rolled-steel flanges.
 2. Inlet and Outlet Screens: Wire mesh screen on fans not connected to ductwork.
 3. Flow Measurement Port: Pressure measurement taps installed in the inlet of the fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in other Division 23 Sections.

2.10 CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Centrifugal Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Aerovent.
 - c. Barry Blower.
 - d. Cook (Loren) Co.
 - e. Greenheck Fan Corp.
 - f. Trane Co. (The).
 - g. Twin City.
 - h. Or Approved Equal.
- B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- C. Construction: Minimum 12-gauge steel, bolted and welded construction, continuously welded seam around fan housing, spun-metal inlet bell, and doors or panels to allow access to internal parts and components. Use aluminum or stainless steel to fabricate fans downstream from humidifiers.
 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Fabrication Class: AMCA 99 Class I, Class II, or Class III.
 3. Horizontal Flanged Split Housing: Bolted construction.
 4. Plug Fans: Fabricate without fan scroll and volute housing, with steel cabinet.
- D. Fan Wheels:
 1. Backward Inclined: Steel or aluminum construction with curved inlet flange, back plate, backwardly inclined blades welded or riveted to flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.
 2. Forward Curved: Black-enameled or galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, me

- chanically secured to flange and back plate; cast-steel hub swaged to back plate and fastened to shaft with set screws.
3. Airfoil Wheel: Steel construction with smooth curved inlet flange; heavy back plate; hollow die-formed airfoil-shaped blades continuously welded at tip flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
1. [Open drip proof][Guarded drip proof].
- F. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at the maximum rated fan speed and motor horsepower (HP), with final alignment and belt adjustment made after installation.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of the first critical speed at the top of the fan's speed range.
- G. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor: 1.5.
 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
 3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch-thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 6. Motor Mount: Adjustable for belt tensioning.
- I. Finish: [Baked polyester powder coating, electrostatically applied][Air dried phenolic resin].
- J. Accessories:
1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 2. Companion Flanges: Galvanized steel, for duct connections.
 3. Fixed Inlet Vanes: Steel, with fixed cantilevered vanes welded to inlet bell.
 4. Variable Inlet Vanes: Steel, with blades supported at both ends with 2 permanently lubricated bearings. Variable mechanism terminating in single control lever with control shaft for double-width fans.

5. Adjustable Inlet Vanes: Steel, with blades cantilevered with 2 permanently lubricated bearings. Variable mechanism out of air stream terminating in single control lever with control shaft for double-width fans.
6. Discharge Dampers: Heavy-duty steel assembly with [parallel][opposed] blades constructed of 2 plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
7. Inlet Screens: Galvanized steel welded grid screen, mounted inside shaft bearings.
8. Scroll Drain Connection: 1-inch steel pipe coupling welded to low point of fan scroll.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Spark-Resistant Construction: AMCA 99 construction, as indicated.
11. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
12. Weather Cover: Heavy-gage steel sheet with ventilation slots, bolted to housing.

2.11 TUBULAR IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Tubular In-Line Centrifugal Fans:
 - a. ACME Engineering & Mfg. Corp.
 - b. Aerovent.
 - c. Barry Blower.
 - d. Cook (Loren) Co.
 - e. Greenheck Fan Corp.
 - f. Twin City.
 - g. Or Approved Equal.
- B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- C. Construction: Minimum 11-gauge marine alloy aluminum, bolted and welded construction with inlet and outlet flanges.
 1. Straightening vanes.
 2. Brackets suitable for horizontal or vertical mounting.
- D. Fan Wheel: Aluminum airfoil wheel welded to spun aluminum dome, bolted to aluminum hub assembly, hub keyed and locked to fan shaft.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.
 1. [Open drip proof][Guarded drip proof].
- F. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 1. Service Factor Based on Fan Motor: 1.5.

2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch-thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Companion Flanges: Galvanized steel, for duct connections.
3. Fixed Inlet Vanes: Steel, with fixed cantilevered vanes welded to inlet bell.
4. Inlet Screens: Galvanized steel welded grid screen, mounted inside shaft bearings.
5. Scroll Drain Connection: 1-inch steel pipe coupling welded to low point of fan scroll.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Spark-Resistant Construction: AMCA 99 construction, as indicated.
8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
9. Weather Cover: Heavy-gage steel sheet with ventilation slots, bolted to housing.
10. Split pillow block bearings selected for a minimum of 400,000 hours average life at the maximum RPM of each pressure class.

2.12 MIXED-FLOW IN-LINE FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Mixed Flow Fans:
 - a. Twin City.
 - b. Cook (Loren) Co.
 - c. Greenheck Fan Corp.
 - d. Or Approved Equal.
- B. Description: Belt driven, tubular mixed-flow in-line blower.
- C. Construction: Minimum 14-gauge marine alloy aluminum, bolted and welded construction with inlet and outlet collars.
1. Straightening vanes.
 2. Brackets suitable for horizontal or vertical mounting.
- D. Fan Wheel: Steel, non-overloading, high efficiency mixed-flow type with contoured single thickness blades and inlet cone to provide maximum performance and efficiency.
- E. Motor: Heavy duty type with permanently lubricated sealed ball bearings.

1. [Open drip proof][Guarded drip proof].
- F. Bearings: Heavy duty regreasable ball type, pillow block cast iron housing, minimum L50 life in excess of 200,000 hours.
- G. Belt Drives: Factory-mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor: 1.5.
 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.
 3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so pitch adjustment is at the middle of the adjustment range at fan design conditions.
 4. Belts: Oil resistant, nonsparking, and non-static.
 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements; 0.1046-inch thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Access Door: [Bolted][Hinged] configuration.
 2. Motor cover.
 3. Belt tunnel.
 4. Drain: Drain coupling attached to bottom of housing for threaded 3/4-inch connection.
 5. Mounting rail where motor center of gravity is offset.
 6. Inlet/Outlet safety guards.
 7. Extended Life Bearings: L10 life in excess of 200,000 hours.
 8. Shaft seal constructed of aluminum and nitrile rubber.
 9. Rub ring construction of aluminum.

2.13 LABORATORY FUME EXHAUST FAN SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by Strobic Air or approved equal.
- B. Description: Packaged fume exhaust system with intake plenum, main and standby fans, fan isolation dampers, outside air bypass dampers, air entrainment wind band discharge section, and integral control system with all wiring required.
- C. Plenum: Double wall fan inlet plenum suitable for roof curb mounting, capable of supporting entire assembly. Outer wall shall be steel construction with powder coated surfaces and inner wall 18-gauge stainless steel. Provide access door and safety screens at fan inlet.
- D. Fans: Direct drive, single width, single inlet, mixed flow type fan with welded steel impellor and non-ferrous fan inlet bell. Motor isolated from the primary exhaust air stream and accessible from the fan exterior for inspection and service.
- E. Motor: TEFC mill and chemical duty.

- F. Disconnect Switch: Located in NEMA 3R weather enclosure serving each fan.
- G. Discharges: FRP construction, chemically and UV resistant.
- H. Bypass Dampers: Opposed-blade low leakage air-foil aluminum construction dampers with extended shaft and actuator. Rain hood weather protection.
- I. Isolation Dampers: Opposed-blade low leakage air-foil aluminum construction dampers with epoxy coating. Two-position spring return damper operators.
- J. Finish (general): Baked polyester powder coating, electrostatically applied.
- K. Controller: Furnish Strobic Air Smart System 120V/1Ph controller with touch screen to be mounted indoors. Controller shall be capable of the following functions:
 - 1. Maintain system duct static pressure setpoint.
 - 2. Cycle fans every 30 days, or upon failure of operating fan.
 - 3. Control of each fan isolation dampers.
 - 4. Control of bypass dampers.
 - 5. Adjust minimum outlet velocity based on wind speed and direction.
 - 6. Automatically rotate back-up fan.
 - 7. Measures and records system performance.
 - 8. Communicate with the building DDC system via BACnet interface.
- L. Accessories: The following accessories are required as indicated:
 - 1. Roof Curb: Provide 18-inch high roof curb to match unit.
 - 2. Shaft ground kit.

PART 3 – EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install fans according to manufacturer's written instructions.
- B. Support units using the external vibration-control devices as indicated. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Support floor mounted fans on concrete housekeeping bases or roof supports using housed spring isolators. Secure units to anchor bolts installed in housekeeping base.
 - 2. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
 - a. Installation of roof curbs is specified in Division 07 Sections.

3. Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.
 4. Ceiling Units: Suspend units from structure using steel wire or metal straps.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.3 HOUSEKEEPING BASES

- A. Coordinate size of housekeeping bases with actual unit sizes provided.

3.4 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Electrical: Conform to applicable requirements in Division 26 Sections.
- C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

3.6 ADJUSTING

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

3.7 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.8 START-UP PROCEDURES

- A. Final Checks before Startup: Perform the following operations and checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 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. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
 7. Disable automatic temperature-control operators.
- B. Starting procedures for fans are as follows:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 2. Measure and record motor voltage and amperage.
- C. Shut unit down and reconnect automatic temperature-control operators.
- D. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.
- E. Replace fan and motor pulleys as required to achieve design conditions.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals. Refer to Division 01 Section "Closeout Procedures."
- C. Schedule [4][8][16] hours training with Owner, through Architect, with at least 7 days' advance notice.
- D. Demonstrate operation of fans. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION