SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Backward-inclined centrifugal fans, including airfoil and curved blade fans.
 - 2. Forward-curved centrifugal fans.
 - 3. Square in-line centrifugal fans.
 - 4. Tubular in-line centrifugal fans.
 - 5. Plenum fans.
 - 6. Plug fans.
 - 7. Utility set fans.

1.2 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 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. Fan speed controllers.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 5. 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.
- C. Delegated Design Submittal: For vibration isolation, supports, and seismic restraints 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, supports, and seismic restraints for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.
- 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. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Unusual Service Conditions
 - 1. Base fan-performance ratings on the following:
 - a. Ambient Temperature: 91F dry bulb.
 - b. Altitude: 4255 above sea level.
 - c. Humidity: 50% RH.
- B. 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.

- C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and System Startup."
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."
- F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports and seismic restraints including comprehensive engineering analysis by a qualified professional engineer, using performance and design criteria indicated.
- G. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.5.
- H. Capacities and Characteristics: Refer to drawing schedules.
- I. Acceptable Manufacturer's:
 - 1. Greenheck
 - 2. Loren Cook

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, belt-or direct-driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 2. Factory-installed and -wired disconnect switch.
- B. Housings:
 - 1. Housing Material: Reinforced steel.
 - 2. Housing Coating: Epoxy.
 - 3. Housing Assembly: Side plates continuously welded.
 - 4. Formed panels to make curved-scroll housings with shaped cutoff.
 - 5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 6. Horizontally split, bolted-flange housing.
 - 7. Spun inlet cone with flange.
 - 8. Outlet flange.

- 9. Discharge Arrangement: Fan scroll housing is field rotatable to any of seven discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.
- C. Wheels:
 - 1. Wheel Configuration: SWSI or DWDI construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels shall be statically and dynamically balanced, and nonoverloading.
 - 2. Wheel and Blade Material: Steel or Stainless steel.
 - a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8, as scheduled.
 - 3. Wheel and Blade Coating: Epoxy.
 - 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
 - 5. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 - 6. Backward-Inclined Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
- D. Shafts:
 - 1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 - 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Bearings:
 - 1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
 - 2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.

- c. Extended Lubrication Lines: Extend lines to accessible location.
- 3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
- F. Belt Drives:
 - 1. Factory mounted, with adjustable alignment and belt tensioning.
 - 2. Service Factor Based on Fan Motor Size: 1.5.
 - 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch pulleys for use with motors larger than 5hp.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 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 provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 7. Motor Mount: Adjustable for belt tensioning.
- G. Motor Enclosure: Totally enclosed, fan cooled .
- H. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Scroll Drain Connection: NPS 1steel pipe coupling welded to low point of fan scroll.
 - 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 4. Inlet Screens: Grid screen of same material as housing.
 - 5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 6. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
 - 7. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.3 FORWARD-CURVED CENTRIFUGAL FANS

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, belt or direct-driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 - 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 3. Factory-installed and -wired disconnect switch.
- B. Housings:
 - 1. Housing Material: Reinforced steel

- 2. Housing Coating: Epoxy.
- 3. Housing Assembly: Side plates continuously welded.
- 4. Formed panels to make curved-scroll housings with shaped cutoff.
- 5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
- 6. Horizontally split, bolted-flange housing.
- 7. Spun inlet cone with flange.
- 8. Outlet flange.
- 9. Discharge Arrangement: Fan scroll housing field rotatable to any of seven discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.
- C. Wheels:
 - 1. Wheel Configuration: SWSI construction with a curved inlet flange, and a backplate fastened to shaft with setscrews.
 - 2. Wheel and Blade Material: Steel.
 - a. Spark-Resistant Construction: Type B, Classified according to AMCA 99, Section 8, as scheduled.
 - 3. Wheel and Blade Coating: Epoxy.
 - 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.
 - 5. Forward-Curved Wheels:
 - a. Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow.
 - b. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.
- D. Shafts:
 - 1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 - 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Bearings:
 - 1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball or roller bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
 - 2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

- b. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
- c. Extended Lubrication Lines: Extend lines to accessible location.
- 3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
- F. Belt Drives:
 - 1. Factory mounted, with adjustable alignment and belt tensioning.
 - 2. Service Factor Based on Fan Motor Size: 1.5
 - 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5hp.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inchthick, 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 provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 7. Motor Mount: Adjustable for belt tensioning.
- G. Motor Enclosure: Totally enclosed, fan cooled
- H. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 - 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 4. Inlet Screens: Grid screen of same material as housing.
 - 5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 6. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
 - 7. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.4 SQUARE IN-LINE CENTRIFUGAL FANS

- A. Description: Square in-line centrifugal fans.
- B. Housing:
 - 1. Housing Material: Reinforced steel or Aluminum.
 - 2. Housing Coating: None.
 - 3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.
- F. Motor Enclosure: Totally enclosed, fan cooled
- G. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 - 4. Companion Flanges: For inlet and outlet duct connections.
 - 5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
 - 7. Discharge: As indicated on plans.

2.5 TUBULAR IN-LINE CENTRIFUGAL FANS

- A. Description: Tubular in-line centrifugal fans.
- B. Housing:
 - 1. Housing Material: Reinforced steel or Aluminum
 - 2. Housing Coating: None.
 - 3. Housing Construction: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing with swing-out service door.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Steel or Aluminum, airfoil blades welded to aluminum hub.
- F. Motor Enclosure: Totally enclosed, air over .
- G. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

- 2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
- 3. Companion Flanges: For inlet and outlet duct connections.
- 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
- 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.6 PLENUM FANS

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, belt or direct-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 - 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 3. Factory-installed and -wired disconnect switch.
- B. Wheels:
 - 1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
 - 2. Wheel and Blade Material: Steel
 - a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8, Type B as scheduled.
 - 3. Wheel and Blade Coating: Epoxy.
 - 4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
- C. Shafts:
 - 1. Statically and dynamically balanced, and selected for continuous operation at maximumrated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 - 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- D. Bearings:
 - 1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.

- 2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
 - c. Extended Lubrication Lines: Extend lines to accessible location.
- 3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.
- E. Belt Drives:
 - 1. Factory mounted, with adjustable alignment and belt tensioning.
 - 2. Service Factor Based on Fan Motor Size: 1.5.
 - 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch thick, 3/4-inchdiamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 7. Motor Mount: Adjustable for belt tensioning.
- F. Motor Enclosure: Totally enclosed, fan cooled.
- G. Accessories:
 - 1. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
 - 2. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
 - 3. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
 - 4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
 - 5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 6. Piezometer Ring: Refer to 230923.

2.7 PLUG FANS

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 - 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 3. Factory-installed and -wired disconnect switch.
- B. Wheels:
 - 1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
 - 2. Wheel and Blade Material: See schedule.
 - a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8 Type B.
 - 3. Wheel and Blade Coating: None
 - 4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
- C. Shafts:
 - 1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 - 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- D. Bearings:
 - 1. Prelubricated and Sealed Shaft Bearings:
 - a. Self-aligning, pillow-block-type ball bearings.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
 - 2. Grease-Lubricated Shaft Bearings, Tapered Roller:
 - a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000 hours.
 - c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000 hours.
 - d. Extended Lubrication Lines: Extend lines to accessible location.
 - 3. Grease-Lubricated Shaft Bearings, Ball or Roller:
 - a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

- b. Ball-Bearing Rating Life: ABMA 9, L(10) at 50,000hours.
- c. Roller-Bearing Rating Life: ABMA 11, L(10) at 50,000hours.
- d. Extended Lubrication Lines: Extend lines to accessible location.

E. Belt Drives:

- 1. Factory mounted, with adjustable alignment and belt tensioning.
- 2. Service Factor Based on Fan Motor Size: 1.5.
- 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
- 4. Motor Pulleys: Adjustable pitch for use with motors through 5hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.
- 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
- 6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch-thick, 3/4-inchdiamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- 7. Motor Mount: Adjustable for belt tensioning.
- F. Motor Enclosure: Totally enclosed, fan cooled.
- G. Accessories:
 - 1. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
 - 2. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
 - 3. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
 - 4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
 - 5. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.8 UTILITY SET FANS

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, belt or direct-driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- B. Housings:
 - 1. Housing Material: See schedule.
 - 2. Housing Coating: Epoxy.

- 3. Formed panels to make curved-scroll housings with shaped cutoff.
- 4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
- 5. Discharge Arrangement: Fan scroll housing field rotatable to any of seven discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.
- C. Wheels:
 - 1. Wheel Configuration: SWSI, with hub keyed to shaft.
 - 2. Wheel and Blade Materials: See schedule.
 - a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8 as scheduled.
 - 3. Wheel and Blade Coating: Epoxy or See schedule.
 - 4. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 - 5. Backward-Inclined Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
 - 6. Backward-Inclined Flat Blades:
 - a. Flat design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
 - 7. Forward-Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded or riveted at tip flange and backplate.
- D. Shafts:
 - 1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.
- E. Bearings:
 - 1. Heavy-duty regreasable ball or roller type in a cast iron pillow block housing.
 - 2. Ball-Bearing Rating Life: ABMA 9, L(10) of 80,000 hours
 - 3. Roller-Bearing Rating Life: ABMA 11, L(10) of 80,000 hours

- 4. Extend grease fitting to accessible location outside of unit.
- F. Belt Drive:
 - 1. Factory mounted, with final alignment and belt adjustment made after installation.
 - 2. Service Factor Based on Fan Motor Size: 1.5
 - 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5hp; fixed pitch for use with motors larger than 5hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," 0.146 inch thick, 3/4-inchdiamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- G. Motor Enclosure: Totally enclosed, fan cooled.
- H. Accessories:
 - 1. Inlet and Outlet: Flanged.
 - 2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 3. Access Door: Gasketed door in scroll with latch-type handles.
 - 4. Inlet Screens: Removable wire mesh for openings with no duct connection.
 - 5. Outlet Screens: Removable wire mesh for openings with no duct connection.
 - 6. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
 - 7. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
 - 8. Weather Hoods: When installed outdoors, weather resistant with stamped vents over motor and drive compartment.

2.9 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive. Provide pump motor variable-speed controller in accordance with Section 262923 "Variable-Speed Motor Controllers".

2.10 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. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 - 1. Install floor- or roof-mounted centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
 - 3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.
- F. Isolation Curb Support: Where indicated, install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation and seismic-control devices.
 - 1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 2. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC."
- G. Install units with clearances for service and maintenance.
- H. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK AND PIPING CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.

- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.
- D. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing according to Section 230533 "Heat Tracing for HVAC Piping."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 STARTUP SERVICE:

- A. Perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. 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.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
 - 6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 7. Adjust belt tension.
 - 8. Adjust damper linkages for proper damper operation.

- 9. Verify lubrication for bearings and other moving parts.
- 10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
- 12. Shut unit down and reconnect automatic temperature-control operators.
- 13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Fans and components will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416