SECTION 233416 - CENTRIFUGAL HVAC FANS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section Includes:

Backward-inclined centrifugal fans, including airfoil and curved blade fans.

Forward-curved centrifugal fans.

Square in-line centrifugal fans.

Tubular in-line centrifugal fans.

Plenum fans.

Plug fans.

Utility set fans.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the er-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.

Rated capacities, operating characteristics, and furnished specialties and accessories.

Certified fan performance curves with system operating conditions indicated.

Certified fan sound-power ratings.

Motor ratings and electrical characteristics, plus motor and electrical accessories.

Material thickness and finishes, including color charts.

Dampers, including housings, linkages, and operators.

* + - * 1. Shop Drawings:

Include plans, elevations, sections, and attachment details.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Include diagrams for power, signal, and control wiring.

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

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.

* + - * 1. Sustainable Design Submittals:

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. 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.

Retain "Seismic Qualification Data" paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.
			2. MAINTENANCE MATERIAL SUBMITTALS
				1. Furnish extra materials[**, from the same product run,**] that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Belts: [**One**] <**Insert number**> set(s) for each belt-driven unit.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. PERFORMANCE REQUIREMENTS
				1. Unusual Service Conditions

Base fan-performance ratings on the following:

Ambient Temperature: <**Insert deg F dry bulb**>.

Altitude: <**Insert feet**> above sea level.

Humidity: <**Insert deg F wet bulb**>.

<**Insert conditions**>.

Retain "Seismic Performance" paragraph below with "Seismic Qualification Data" paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: [**1.5**] [**1.0**].

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table, for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

If Project has more than one type or configuration of centrifugal fan, delete "Capacities and Characteristics" paragraph below and schedule fans on Drawings.

* + - * 1. Capacities and Characteristics:

Fan Type: [**Centrifugal**] [**Square in-line centrifugal**] [**Tubular in-line centrifugal**] [**Plenum**] [**Plug**] [**Utility set**].

Blade Type: [**Forward curved**] [**Backward inclined airfoil**] [**Backward inclined curved**] [**Backward inclined flat**].

Airflow: <**Insert cfm**>.

External Static Pressure: <**Insert inches wg**>.

Class: AMCA 99, [**I**] [**II**] [**III**].

See AMCA 99 for arrangement numbers. Include numbers in "Drive Arrangement" subparagraph below.

Drive Arrangement: <**Insert AMCA arrangement number**>.

Drive Type: [**Belt**] [**Direct**].

Discharge Arrangement: <**Insert discharge arrangement configuration**>.

Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**].

Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] <**Insert manufacturer's name and trade name**>.

Wheel Size (Diameter): <**Insert inches**>.

Wheel Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**].

Wheel Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

Brake Horsepower: <**Insert number**>.

Fan rpm: <**Insert value**>.

Outlet Velocity: <**Insert fpm**>.

Motor:

Verify motor enclosure types with manufacturer of specified equipment.

Motor Enclosure Type: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**] <**Insert motor enclosure type**>.

Efficiency: [**Insert number**] percent.

Service Factor: [**100**] <**Insert number**> percent.

Suitable for Use with Variable-Frequency Drive: [**Yes**] [**No**].

Retain "Electrical Characteristics" subparagraph below if characteristics are not indicated on Drawings.

Electrical Characteristics:

Horsepower: <**Insert horsepower**>.

RPM: <**Insert number**>.

Volts: [**120**] [**208**] [**230**] [**460**] <**Insert number**>.

Phase: [**Single**] [**Poly**].

Hertz: 60.

Full-Load Amperes: <**Insert number**> A.

Minimum Circuit Ampacity: <**Insert number**> A.

Maximum Overcurrent Protection: <**Insert number**> A.

Discharge Sound Power:

1st Octave: <**Insert dB**>.

2nd Octave: <**Insert dB**>.

3rd Octave: <**Insert dB**>.

4th Octave: <**Insert dB**>.

5th Octave: <**Insert dB**>.

6th Octave: <**Insert dB**>.

7th Octave: <**Insert dB**>.

8th Octave: <**Insert dB**>.

Inlet Sound Power:

1st Octave: <**Insert dB**>.

2nd Octave: <**Insert dB**>.

3rd Octave: <**Insert dB**>.

4th Octave: <**Insert dB**>.

5th Octave: <**Insert dB**>.

6th Octave: <**Insert dB**>.

7th Octave: <**Insert dB**>.

8th Octave: <**Insert dB**>.

Vibration Isolators:

Type: [**Spring**] [**Restrained spring**] <**Insert type**>.

Static Deflection: [**1 inch**] <**Insert inches**>.

Spark-Resistance Class: Classified according to AMCA 99, [**Type A**] [**Type B**] [**Type C**].

* + - 1. BACKWARD-INCLINED CENTRIFUGAL FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Acme Engineering & Manufacturing Corp.

Loren Cook Company.

New York Blower Company (The).

Approved equivalent.

* + - * 1. Description:

Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**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.

Factory-installed and -wired disconnect switch.

* + - * 1. Housings:

Retain one option in "Housing Material" subparagraph below. If housing material varies with specific fan selection, retain last option, delete insert note, and schedule specific housing material on schedule for each fan.

Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.

Retain one option in "Housing Coating" subparagraph below. If housing coating varies with specific fan selection, retain last option and schedule specific housing coating on schedule for each fan.

Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**].

Housing Assembly: Sideplates[**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].

Formed panels to make curved-scroll housings with shaped cutoff.

Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

Split housings in first subparagraph below are an optional configuration.

Horizontally split, bolted-flange housing.

Spun inlet cone with flange.

Outlet flange.

Discharge Arrangement: Fan scroll housing is field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

* + - * 1. Wheels:

Wheel Configuration: [**SWSI**] [**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.

Retain one option in "Wheel and Blade Material" subparagraph below. If wheel material varies with specific fan selection, retain last option and schedule specific wheel material on schedule for each fan.

Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

And Retain "Spark-Resistant Construction" subparagraph below for spark-resistant construction and coordinate with "Wheel and Blade Material" subparagraph above.

Spark-Resistant Construction: Classified according to AMCA 99, [**Type A**] [**Type B**] [**Type C**].

Retain one option in "Wheel and Blade Coating" subparagraph below. If wheel coating varies with specific fan selection, retain last option and schedule specific wheel coating on schedule for each fan.

Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**].

Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

Retain either "Backward-Inclined Airfoil Blades" or "Backward-Inclined Curved Blades" subparagraph below. If blade type varies with specific fan selection, retain both subparagraphs and schedule specific blade type on schedule for each fan.

Backward-Inclined Airfoil Blades:

Aerodynamic design.

Heavy backplate.

Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

Backward-Inclined Curved Blades:

Curved design.

Heavy backplate.

Single-thickness blades continuously welded at tip flange and backplate.

Retain "Shafts" and "Bearings" paragraphs below if any fans are belt driven or are direct driven and have shafts. If all fans are direct driven and have no separate shaft, delete both paragraphs.

* + - * 1. Shafts:

Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

* + - * 1. Bearings:

Retain "Prelubricated and Sealed Shaft Bearings," "Grease-Lubricated Shaft Bearings, Tapered Roller," or "Grease-Lubricated Shaft Bearings, Ball or Roller" subparagraph below, or retain more than one type. If retaining more than one type, indicate specific type to be associated with each fan in the centrifugal HVAC fan schedule. Verify availability with manufacturers; other bearing types may be available.

Prelubricated and Sealed Shaft Bearings:

Self-aligning, pillow-block-type ball bearings.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Grease-Lubricated Shaft Bearings, Tapered Roller:

Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Grease-Lubricated Shaft Bearings, Ball or Roller:

Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Retain "Belt Drives" paragraph below if any fans are belt driven.

* + - * 1. Belt Drives:

Factory mounted, with adjustable alignment and belt tensioning.

Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].

Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

Five-hp limit in "Motor Pulleys" subparagraph below is standard with many manufacturers but is designer's choice.

Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> 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 [**5**] <**Insert number**> hp.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> 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.

Motor Mount: Adjustable for belt tensioning.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" subparagraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**] <**Insert motor enclosure type**>.
				2. Accessories:

Accessories listed in subparagraphs below are optional features. Retain applicable accessories below. Verify availability with manufacturers.

Retain "Access for Inspection, Cleaning, and Maintenance" subparagraph below if applying for LEED certification. LEED Prerequisite EQ 1 requires compliance with ASHRAE 62.1, which includes requirements for equipment access for inspection, cleaning, and maintenance.

Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.

Companion Flanges: Rolled flanges for duct connections of same material as housing.

Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

Inlet Screens: Grid screen of same material as housing.

Retain "Shaft Cooler" for fans operating at elevated temperatures, generally higher than 300 deg F (150 deg C). Other materials of the fan construction also need to be reviewed and selected for high temperature use.

Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

* + - 1. FORWARD-CURVED CENTRIFUGAL FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Acme Engineering & Manufacturing Corp.

New York Blower Company (The).

Approved equivalent.

* + - * 1. Description:

Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**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.

Factory-installed and -wired disconnect switch.

* + - * 1. Housings:

Retain one option in "Housing Material" subparagraph below. If housing material varies with specific fan selection, retain last option and schedule specific housing material on schedule for each fan.

Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**].

Retain one option in "Housing Coating" subparagraph below. If housing coating varies with specific fan selection, retain last option and schedule specific housing coating on schedule for each fan.

Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**].

Housing Assembly: Sideplates [**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].

Formed panels to make curved-scroll housings with shaped cutoff.

Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

Split housings in first subparagraph below are an optional configuration.

Horizontally split, bolted-flange housing.

Spun inlet cone with flange.

Outlet flange.

Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

* + - * 1. Wheels:

Wheel Configuration: [**SWSI**] [**DWDI**] construction with a curved inlet flange, and a backplate fastened to shaft with setscrews.

Retain one option in "Wheel and Blade Material" subparagraph below. If wheel material varies with specific fan selection, retain last option and schedule specific wheel material on schedule for each fan.

Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

Retain "Spark-Resistant Construction" subparagraph below for spark-resistant construction and coordinate with "Wheel and Blade Material" subparagraph above.

Spark-Resistant Construction: Classified according to AMCA 99, [**Type A**] [**Type B**] [**Type C**].

Retain one option in "Wheel and Blade Coating" subparagraph below. If wheel coating varies with specific fan selection, retain last option and schedule specific wheel coating on schedule for each fan.

Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**.

Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.

Forward-Curved Wheels:

Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow.

Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.

Retain "Shafts" and "Bearings" paragraphs below if any fans are belt driven or are direct driven and have shafts separate from motor shaft. If all fans are direct driven and have no separate shaft, delete both paragraphs.

* + - * 1. Shafts:

Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

* + - * 1. Bearings:

Retain "Prelubricated and Sealed Shaft Bearings," "Grease-Lubricated Shaft Bearings, Tapered Roller," or "Grease-Lubricated Shaft Bearings, Ball or Roller" subparagraph below, or retain more than one type. If retaining more than one type, indicate types in equipment schedule. Verify availability with manufacturers; other bearing types may be available.

Prelubricated and Sealed Shaft Bearings:

Self-aligning, pillow-block-type [**ball**] [**roller**] bearings.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Grease-Lubricated Shaft Bearings, Tapered Roller:

Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Grease-Lubricated Shaft Bearings, Ball or Roller:

Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Retain "Belt Drives" paragraph below if any fans are belt driven.

* + - * 1. Belt Drives:

Factory mounted, with adjustable alignment and belt tensioning.

Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].

Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

Five-hp limit in "Motor Pulleys" subparagraph below is standard with many manufacturers but is designer's choice.

Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> 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**] <**Insert number**> hp.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> 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.

Motor Mount: Adjustable for belt tensioning.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" subparagraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**].
				2. Accessories:

Accessories listed in subparagraphs below are optional features. Retain applicable accessories below. Verify availability with manufacturers.

Retain "Access for Inspection, Cleaning, and Maintenance" subparagraph below if applying for LEED certification. LEED Prerequisite EQ 1 requires compliance with ASHRAE 62.1, which includes requirements for equipment access for inspection, cleaning, and maintenance.

Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.

Companion Flanges: Rolled flanges for duct connections of same material as housing.

Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

Inlet Screens: Grid screen of same material as housing.

Retain "Shaft Cooler" subparagraph below for fans operating at elevated temperatures, generally higher than 300 deg F (150 deg C). Other materials of the fan construction also need to be reviewed and selected for high temperature use.

Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

* + - 1. SQUARE IN-LINE CENTRIFUGAL FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Acme Engineering & Manufacturing Corp.

Greenheck Fan Corporation.

Loren Cook Company.

Approved equivalent.

* + - * 1. Description: Square in-line centrifugal fans.
				2. Housing:

Retain one option in "Housing Material" subparagraph below. If housing material varies with specific fan selection, retain last option and schedule specific housing material on schedule for each fan.

Housing Material: [**Reinforced steel**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.

Retain one option in "Housing Coating" subparagraph below. If housing coating varies with specific fan selection, retain last option and schedule specific housing coating on schedule for each fan.

Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**]

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.

* + - * 1. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].
				2. 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.
				3. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" subparagraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**] <**Insert motor enclosure type**>.
				2. Accessories:

Accessories listed in subparagraphs below are optional features. Retain applicable accessories below. Verify availability with manufacturers.

Retain "Access for Inspection, Cleaning, and Maintenance" subparagraph below if applying for LEED certification. LEED Prerequisite EQ 1 requires compliance with ASHRAE 62.1, which includes requirements for equipment access for inspection, cleaning, and maintenance.

Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.

Companion Flanges: For inlet and outlet duct connections.

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.

Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

* + - 1. TUBULAR IN-LINE CENTRIFUGAL FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Acme Engineering & Manufacturing Corp.

Greenheck Fan Corporation.

New York Blower Company (The).

Approved equivalent.

* + - * 1. Description: Tubular in-line centrifugal fans.
				2. Housing:

Retain one option in "Housing Material" subparagraph below. If housing material varies with specific fan selection, retain last option and schedule specific housing material on schedule for each fan.

Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.

Retain one option in "Housing Coating" subparagraph below. If housing coating varies with specific fan selection, retain last option and schedule specific housing coating on schedule for each fan.

Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**].

Housing Construction: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

* + - * 1. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].
				2. 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.
				3. Fan Wheels: [**Steel**] [**Aluminum**], airfoil blades welded to aluminum hub.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" subparagraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**] <**Insert motor enclosure type**>.
				2. Accessories:

Accessories listed in subparagraphs below are optional features. Retain applicable accessories below. Verify availability with manufacturers.

Retain "Access for Inspection, Cleaning, and Maintenance" subparagraph below if applying for LEED certification. LEED Prerequisite EQ 1 requires compliance with ASHRAE 62.1, which includes requirements for equipment access for inspection, cleaning, and maintenance.

Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.

Companion Flanges: For inlet and outlet duct connections.

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.

Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

* + - 1. PLENUM FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Loren Cook Company.

New York Blower Company (The).

Approved equivalent.

* + - * 1. Description:

Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.

Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

[**Factory-installed and -wired disconnect switch.**]

* + - * 1. Wheels:

Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.

Retain one option in "Wheel and Blade Material" subparagraph below. If wheel material varies with specific fan selection, retain last option and schedule specific wheel material on schedule for each fan.

Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

Retain "Spark-Resistant Construction" subparagraph below for spark-resistant construction and coordinate with "Wheel and Blade Material" subparagraph above.

Spark-Resistant Construction: Classified according to AMCA 99, [**Type A**] [**Type B**] [**Type C**].

Retain one option in "Wheel and Blade Coating" subparagraph below. If wheel coating varies with specific fan selection, retain last option and schedule specific wheel coating on schedule for each fan.

Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.

Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

Retain "Shafts" and "Bearings" paragraphs below if any fans are belt driven or are direct driven and have shafts. If all fans are direct driven and have no separate shaft, delete both paragraphs.

* + - * 1. Shafts:

Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

* + - * 1. Bearings:

Retain "Prelubricated and Sealed Shaft Bearings," "Grease-Lubricated Shaft Bearings, Tapered Roller," or "Grease-Lubricated Shaft Bearings, Ball or Roller" subparagraph below, or more than one type. If retaining more than one type, indicate types in schedule. Verify availability with manufacturers; other bearing types may be available.

Prelubricated and Sealed Shaft Bearings:

Self-aligning, pillow-block-type ball bearings.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Grease-Lubricated Shaft Bearings, Tapered Roller:

Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Grease-Lubricated Shaft Bearings, Ball or Roller:

Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Retain "Belt Drives" paragraph below if any fans are belt driven.

* + - * 1. Belt Drives:

Factory mounted, with adjustable alignment and belt tensioning.

Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].

Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

Five-hp limit in "Motor Pulleys" subparagraph below is standard with many manufacturers but is designer's choice.

Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> 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**] <**Insert number**> hp.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> 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.

Motor Mount: Adjustable for belt tensioning.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" subparagraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**].
				2. Accessories:

Retain applicable accessories below. Verify availability with manufacturers.

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.

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.

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.

Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.

Retain "Shaft Cooler" for fans operating at elevated temperatures, generally higher than 300 deg F (150 deg C). Other materials of the fan construction also need to be reviewed and selected for high temperature use.

Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

* + - 1. PLUG FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Loren Cook Company.

New York Blower Company (The).

Approved equivalent.

* + - * 1. Description:

Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.

Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

Factory-installed and -wired disconnect switch.

* + - * 1. Wheels:

Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.

Retain one option in "Wheel and Blade Material" subparagraph below. If wheel material varies with specific fan selection, retain last option and schedule specific wheel material on schedule for each fan.

Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

Retain "Spark-Resistant Construction" subparagraph below for spark-resistant construction and coordinate with "Wheel and Blade Material" subparagraph above.

Spark-Resistant Construction: Classified according to AMCA 99, [**Type A**] [**Type B**] [**Type C**].

Retain one option in "Wheel and Blade Coating" subparagraph below. If wheel coating varies with specific fan selection, retain last option and schedule specific wheel coating on schedule for each fan.

Wheel and Blade Coating: [**None**] [**Themoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**

Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

Retain "Shafts" and "Bearings" paragraphs below if any fans are belt driven or are direct driven and have shafts. If all fans are direct driven and have no separate shaft, delete both paragraphs.

* + - * 1. Shafts:

Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

* + - * 1. Bearings:

Retain "Prelubricated and Sealed Shaft Bearings," "Grease-Lubricated Shaft Bearings, Tapered Roller," or "Grease-Lubricated Shaft Bearings, Ball or Roller" subparagraph below, or more than one type. If retaining more than one type, indicate types in equipment schedule. Verify availability with manufacturers; other bearing types may be available.

Prelubricated and Sealed Shaft Bearings:

Self-aligning, pillow-block-type ball bearings.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Grease-Lubricated Shaft Bearings, Tapered Roller:

Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Extended Lubrication Lines: Extend lines to accessible location.

Grease-Lubricated Shaft Bearings, Ball or Roller:

Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" subparagraph below. Common bearing life typically provided by manufacturers is either 50,000 or 120,000 hours.

Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours .

Extended Lubrication Lines: Extend lines to accessible location.

Retain "Belt Drives" paragraph below if any fans are belt driven.

* + - * 1. Belt Drives:

Factory mounted, with adjustable alignment and belt tensioning.

Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].

Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

Five-hp limit in "Motor Pulleys" subparagraph below is standard with many manufacturers but is designer's choice.

Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> 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.

Motor Mount: Adjustable for belt tensioning.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" paragraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**].
				2. Accessories:

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.

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.

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.

Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.

Retain applicable accessories below. Verify availability with manufacturers.

Retain "Shaft Cooler" for fans operating at elevated temperatures, generally higher than 300 deg F (150 deg C). Other materials of the fan construction also need to be reviewed and selected for high temperature use.

Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

* + - 1. UTILITY SET FANS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Loren Cook Company.

New York Blower Company (The).

S & P USA Ventilation Systems, LLC.

Approved equivalent.

* + - * 1. Description:

Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

* + - * 1. Housings:

Retain one option in "Housing Material" subparagraph below. If housing material varies with specific fan selection, retain last option and schedule specific housing material on schedule for each fan.

Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.

Retain one option in "Housing Coating" subparagraph below. If housing material varies with specific fan selection, retain last option and schedule specific housing coating on schedule for each fan.

Housing Coating: [**None**] [**Themoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**].

Formed panels to make curved-scroll housings with shaped cutoff.

Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

* + - * 1. Wheels:

Wheel Configuration: SWSI, with hub keyed to shaft.

Retain wheel material and blade materials in "Wheel and Blade Materials" subparagraph below. Not all materials or sizes are available from all manufacturers.

Wheel and Blade Materials: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

Retain "Spark-Resistant Construction" subparagraph below for spark-resistant construction and coordinate with "Wheel and Blade Materials" subparagraph above.

Spark-Resistant Construction: Classified according to AMCA 99, [**Type A**] [**Type B**] [**Type C**].

Retain wheel and blade coating in "Wheel and Blade Coating" subparagraph below. Not all coatings or sizes are available from all manufacturers.

Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**].

Retain blade configuration from following subparagraphs.

Backward-Inclined Airfoil Blades:

Aerodynamic design.

Heavy backplate.

Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

Backward-Inclined Curved Blades:

Curved design.

Heavy backplate.

Single-thickness blades continuously welded at tip flange and backplate.

Backward-Inclined Flat Blades:

Flat design.

Heavy backplate.

Single-thickness blades continuously welded at tip flange and backplate.

Forward-Curved Blades:

Curved design.

Heavy backplate.

Single-thickness blades continuously welded or riveted at tip flange and backplate.

Retain "Shafts" and "Bearings" paragraphs below if any fans are belt driven or are direct driven and have shafts. If all fans are direct driven and have no separate shaft, delete both paragraphs.

* + - * 1. Shafts:

Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

* + - * 1. Bearings:

Heavy-duty regreasable ball or roller type in a cast iron pillowblock housing.

Ball-Bearing Rating Life: ABMA 9, [**L(50) of 200,000 hours**] [**L(10) of 80,000 hours**] <**Insert life**>.

Roller-Bearing Rating Life: ABMA 11, [**L(50) of 200,000 hours**] [**L(10) of 80,000 hours**] <**Insert life**>.

Extend grease fitting to accessible location outside of unit.

Retain "Belt Drive" paragraph below if any fans are belt driven.

* + - * 1. Belt Drive:

Factory mounted, with final alignment and belt adjustment made after installation.

Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].

Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

In "Motor Pulleys" subparagraph below, the 5-hp limit is standard with many manufacturers but is a designer's choice.

Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert value**> hp; fixed pitch for use with motors larger than [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> 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.

Verify motor enclosure types with manufacturer of specified equipment. Delete "Motor Enclosure" paragraph below if included in schedule on Drawings or in "Capacities and Characteristics" paragraph in "Performance Requirements" Article.

* + - * 1. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**] <**Insert motor enclosure type**>.
				2. Accessories:

Accessories listed in subparagraphs below are optional features. Manufactures' catalogs list many other accessories for specialized applications.

Inlet and Outlet: Flanged.

Companion Flanges: Rolled flanges for duct connections of same material as housing.

Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.

Access Door: Gasketed door in scroll with latch-type handles.

Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.

Inlet Screens: Removable wire mesh.

Outlet Screens: Removable wire mesh.

Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.

Retain "Shaft Cooler" subparagraph for fans operating at elevated temperatures, generally higher than 300 deg F (150 deg C). Other materials of the fan construction also need to be reviewed and selected for high temperature use.

Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.

Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.

Grease Collection Trough and Receiver: For restaurant exhaust application.

Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

* + - 1. MOTORS

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

* + - * 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Variable-frequency drive for variable-speed fans is specified in Section 262923 "Variable-Frequency Motor Controllers."

* + - * 1. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.
			1. SOURCE QUALITY CONTROL
				1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

The majority of manufacturers identified are AMCA members. However, these or other manufacturers may produce a specific fan design that does not bear AMCA certification. Retain "AMCA Compliance" paragraph below to require AMCA compliance.

* + - * 1. AMCA Compliance: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

Sound-power rating information may only be available from manufacturers on request. See discussion on sound and vibration control in the Evaluations.

* + - * 1. Fan Sound Ratings: Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
				2. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
				3. Operating Limits: Classify fans according to AMCA 99.
1. EXECUTION
	* + 1. INSTALLATION OF CENTRIFUGAL HVAC FANS
				1. Install centrifugal fans level and plumb.
				2. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
				3. Lift and support units with manufacturer's designated lifting or supporting points.
				4. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

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."

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."

Retain one of two subparagraphs below. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration-isolation and seismic-control device type and minimum deflection in supported equipment schedule on Drawings.

Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

. Retain "Curb Support, Prefabricated" if prefabricated rail-type curbs are to be provided for roof-mounted fans by the fan manufacturer.

* + - * 1. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.
				2. Unit Support: Install centrifugal fans level on structural [**curbs**] [**pilings**]. Coordinate wall penetrations and flashing with wall construction.[**Secure units to structural support with anchor bolts.**]

Retain "Isolation Curb Support" paragraph below for units mounted on isolation curbs.

* + - * 1. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation[**and seismic-control**] devices.

Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

Comply with requirements in [**Section 230548 "Vibration and Seismic Controls for HVAC"**] [**Section 230548.13 "Vibration Controls for HVAC"**] for vibration-isolation[**and seismic-control**] devices.

* + - * 1. Install units with clearances for service and maintenance.
				2. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
			1. DUCTWORK AND PIPING CONNECTIONS

Coordinate duct installations and specialty arrangements with Drawings and with requirements specified in duct systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. 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."
				2. Install ducts adjacent to fans to allow service and maintenance.

Retain first paragraph below if fans have scroll drains. Show and size all scroll drain piping on Drawings. Detail trap dimensions on Drawings.

* + - * 1. 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.

Retain paragraph below if scroll drain piping or trap are located in an area subject to freezing. Indicate on Drawings all piping to be heat traced.

* + - * 1. 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."
			1. ELECTRICAL CONNECTIONS
				1. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				2. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
				3. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

Retain one of two subparagraphs below. First subparagraph cross-references Section 260553 "Identification for Electrical Systems" and should be retained for consistent electrical identification. Second subparagraph is an abbreviated version of the product specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

* + - 1. CONTROL CONNECTIONS
				1. Install control and electrical power wiring to field-mounted control devices.
				2. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."
			2. FIELD QUALITY CONTROL

Retain one of first four paragraphs below. Retain first "Testing Agency" paragraph below if Director’s Representative will hire an independent testing agency.

Retain "Testing Agency" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" paragraph below to require a Company Service Advisor to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a Company Service Advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspections, and retain optional text to require Contractor to arrange for the assistance of a Company Service Advisor.

* + - * 1. Perform tests and inspections[**with the assistance of a Company Service Advisor**].

Retain test requirements below with any combination of paragraphs above.

* + - * 1. Tests and Inspections:

Verify that shipping, blocking, and bracing are removed.

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.

Verify that there is adequate maintenance and access space.

Verify that cleaning and adjusting are complete.

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.

Adjust belt tension.

Adjust damper linkages for proper damper operation.

Verify lubrication for bearings and other moving parts.

Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.

Remove and replace malfunctioning units and retest as specified above.

* + - * 1. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. ADJUSTING
				1. Adjust damper linkages for proper damper operation.
				2. Adjust belt tension.
				3. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
				4. Replace fan and motor pulleys as required to achieve design airflow.
				5. Lubricate bearings.
			2. DEMONSTRATION
				1. [**Engage a Company Service Advisor to train**] [**Train**] Director’s Representative's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416