SECTION 23 34 00
HVAC FANS

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work of this Section shall include, but is not limited to, the following:

B. Centrifugal Fans:

1. Scroll
2. Cabinet
3. Tubular Centrifugal
4. Plug (Unhoused Centrifugal)

C. Axial Fans:

1. Propeller

D. Backdraft Dampers for vaneaxial fans

E. Discharge Cones for axial fans

F. Roof Exhaust Fans

G. Variable Speed Dryer/Flue Vent/Combustion Fans

H. Ceiling/Wall Fans (Panasonic)

1.02 RELATED DOCUMENTS

A. Section 23 05 01 – HVAC General Provisions

B. Section 23 05 13 – Electric Motors for HVAC Equipment

C. Section 23 05 14 – Variable Frequency Drives for HVAC

D. Section 23 05 29 – Hangers and Supports for HVAC

E. Section 23 05 48 – Vibration and Seismic Controls for HVAC

F. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

G. Section 23 31 00 – HVAC Ducts and Casings

H. Section 23 33 13 – Dampers

I. Section 23 33 19 – Acoustics

J. Section 23 73 13 – Modular Indoor Central-Station Air-Handling Units

K. Section 23 74 13 – Packaged Outdoor Central-Station Air-Handling Units

1.03 REFERENCE STANDARDS

Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:

A. Construct all fans, except vaneaxial adjustable blade, to comply with the requirements of the latest editions of the Air Moving and Conditioning Association (AMCA) Standards and Bulletins. Certify these fans by AMCA for performance and sound ratings and provide the AMCA Performance and Construction Seal for Air and Sound.

B. AMCA – Air Movement Control Association

1.	AMCA 99	Standards Handbook
2.	AMCA 203	Field Performance Measurement of Fan Systems
3.	AMCA 204	Balance Quality and Vibration Levels for Fans
4.	AMCA 210	Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
5.	AMCA 300	Reverberant Room Method for Sound Testing of Fans

C. ABMA – American Bearing Manufacturers Association

1.	ABMA Std. 9	Load Ratings and Fatigue Life for Ball Bearings
2.	ABMA Std. 11	Load Ratings and Fatigue Life for Roller Bearings

D. NFPA – National Fire Protection Association

1.	NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems
2.	NFPA 96	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

E. UL – Underwriters Laboratories Inc.

1.	UL 705	Standard for Power Ventilators
2.	UL 762	Adhesives

F. OSHA – Occupational Safety and Health Administration

1.	OSHA 1910.212	General Requirements for All Machines
2.	OSHA 1910.219	Mechanical Power-Transmission Apparatus

1.04 QUALITY ASSURANCE

A. For each fan, provide a multi-speed fan performance curve with multiple horsepowers on a single sheet. Single-speed fan curves are not acceptable.

B. Provide a full two-year parts and labor warrantee for all fan-mounted control air compressors.

C. All components of exhaust fans used in smoke control systems shall be UL Listed and certified by the manufacturer for the probable temperature rise to which the components may be exposed, or a minimum of **[375]** degrees F continuous operation.

D. All components of exhaust fans used in grease hood exhaust systems shall comply with NFPA 96 and be listed under UL 705 – Standard for Power Ventilators (UL motor, wiring components, UL approved guarding), and UL 762 – Power Ventilators for Restaurant Exhaust.

E. The maximum allowable fan vibration shall be 0.15 inches per second peak velocity, filter-in as measured at the fan RPM.

1.05 SUBMITTALS

A. Submit construction details, gauges of fan wheels and housing components and certified dimensioned drawings.

B. Submit manufacturer's latest published data for weights, materials, accessories and installation details.

C. Submit full technical rating data based on tests in accordance with current AMCA standards and in an AMCA-approved laboratory. Fan curves shall indicate the relationship of airflow to static or total pressure for various fan speeds. Brake horsepower, recommended selection range, and limits of operation shall also be indicated on the curves. Indicate operating point on the fan curves at design air quantity and indicate the manufacturer's recommended drive loss factor for the specific application. Tabular fan performance data is not acceptable.

1. Include manufacturer's certified fan volume-pressure performance curves, from shut-off to free delivery. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.
2. Include certified sound power ratings based on tests performed in accordance with AMCA 300. Correct all ratings and curves for altitude and temperature where applicable.

D. Motor construction and efficiencies.

E. Bearing life calculations based on maximum design speed for the class of each fan scheduled on the Drawing(s).

F. Fan shaft critical speed at scheduled performance.

G. For variable air volume application, include data that indicates the effect of capacity control devices, such as inlet vanes, on performance.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Edit list as applicable for project.

B. Centrifugal Fans: Twin City, Chicago, Howden, Loren Cook, Greenheck

C. Propeller Fans: Twin City, Bayley, Woods, Loren Cook, Greenheck

D. Roof Exhaust Fans: Penn, Loren Cook, Greenheck

E. Cabinet Fans: Penn, Panasonic

F. Garage Transfer Fans: Howden

2.02 GENERAL – ALL FANS

A. Unless noted otherwise, provide discharge direction and drive arrangement to suit space conditions and conform as closely as possible to the layouts shown on the Drawings. Maintain clearance for service and access to all components.

B. Provide factory-fabricated, -assembled, -tested, and -finished fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Fans shall be quiet operating and non-overloading over the entire range of operation.

C. Provide fan motors in accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment. Size motor to drive its respective fan when the fan is operating at a speed 5 percent in excess of that required to meet the scheduled fan performance. Do not select motors within the service factor for this range.

D. Statically and dynamically balance fan wheels/impellers at the factory and certify balance. Design all vertically mounted fans to withstand the vertical thrust loads.

E. Provide precision self-aligning bearings designed to prevent leakage of oil or grease. Provide cups, oil chambers, Zerk or Alemite lubrication fittings in accessible locations for ease of lubrication. Provide heavy-duty split pillow block bearings with tapered, double-row spherical roller assemblies. Provide bearings with ABMA L10 service life in excess of 200,000 hours at maximum published fan operating conditions for the AMCA construction class required unless noted or specified otherwise. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, to reduce vibration, increase service life and improve serviceability. Bearings that use set screws shall not be allowed.

F. Provide copper or steel lubrication leads, for lubrication of internal motors and bearings, extending to a capped termination point external to the fan casing or air-handling unit.

G. Extend wire leads on fans driven by direct motor drive from the motor junction box in air-tight rigid walled conduit, to a junction box mounted external to the fan casing.

H. On fans driven by belt drive, provide standard “V-groove” type oil-resistant, non-sparking, and non-static belts with cast iron or steel sheaves suitable for the service intended. Fan sheaves shall be non-adjustable type with removable machined bushings. Provide adjustable pitch type motor sheaves with double locking feature, to 10 percent above and below the rated fan speed. Dynamically balance sheaves with over three groovesOn Fans used in some control / life safety provide sufficient quantity of belts and sheaves capable of carrying the entire load with one belt broken.

I. Provide pre-formed expanded metal and sheet metal belt guards at the fan and motor shafts, for all exposed sheaves and belts. Guard shall comply with OSHA and SMACNA requirements; 0.1046 inch thick, ¾ 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.

J. For motors in the airstream, provide TEFC type motors, unless other types are required,

and as specified in Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

K. Provide solid hot-rolled steel drive shafts, machined and polished to a close tolerance where in contact with bearings. Secure fan wheels/impellers to the drive shaft by a key and keyway assembly. Shafts shall be sized for first critical speed and at least 1.43 times maximum speed for AMCA fan class. Shaft length shall allow wheel adjustment of 4 inches.

L. Manufacture fans of materials and paint finishes suitable for the service intended.

M. Construct wheels/impellers exposed to normal atmospheres of cast aluminum or hot-dip galvanized steel and finished with two layers of factory-applied non-scaling paint.

N. Construct fans exposed to corrosive atmospheres using all-welded construction of corrosion-resistant materials suitable for intended use, and factory-finished with epoxy or other approved corrosion-resistant coatings.

O. Provide fans exposed to elevated temperatures with components rated for high temperature service. Do not use belt drive assembles exposed to the airstream. Use direct drive motors certified for high temperature service.

P. Use AMCA Type A spark-resistant construction for all fans handling flammable or grease-laden vapors, and use explosion-proof motors.

Q. Electrically ground all fans and drives to prevent accumulation of static charge. Indicate grounding method in fan submittals.

R. Provided threaded drain plugs at fan housing low points.

S. Completely house fan assemblies exposed to weather in weather-proof enclosures including motor and drive.

T. Fan wheels/impellers and housings shall be relieved of residual stresses produced in the forming process.

U. Provide fans used to exhaust grease-laden vapors with motor drive and bearings completely external of airstream, and fan housings continuously welded inside and outside.

V. Provide housings with integral inlet and discharge flanges, complete with bolt holes for flexible or hard duct connections. Shop-fabricate any companion flanges required for connections to sound attenuators. Companion flanges shall be rolled angles matched to both fan housing and sound attenuators.

W. Provide variable frequency drives as specified in Section 23 05 14 – Variable Frequency Drives for HVAC.

X. Provide gasketed access doors to permit routine maintenance and inspection of motor and internal components. Inside surface of access door shall be flush with the inside surface of the fan housing.

2.03 CENTRIFUGAL FANS

A. Scroll Type:

1. Provide backward inclined (BI), backward curved (BC), airfoil (AF), forward curved (FC) fan wheels, and single width single inlet (SWSI), or double width double inlet (DWDI), as specified or indicated on the Drawings, enclosed in a scroll-shaped fan housing with shaped cut-off and doors or panels to allow access to internal parts and components.
2. Weld or securely rivet fan blades to the hub plate and rim.
3. Fan housings:

    a. Heavy-gauge construction, continuously welded inside and outside.
    b. Housings shall be suitably braced to prevent vibration or pulsation and have spun, aerodynamically designed spun inlet cones or inlet venturis for smooth air entry into the wheels.
    c. Fabrication Class: AMCA 99, Class I, or as shown on the Drawings.
    d. Rotatable through eight discharge orientations.

4. All fan wheels shall have tapered spun wheel cones or shrouds providing stable flow and high rigidity. Housing with lock seam construction or partial weld shall not be acceptable unless for smaller fan sizes (12 inch wheel diameters or less) where it is standard construction for models listed on the Drawings.

B. Tubular Type:

1. Construct housing of welded rolled plate steel with reinforcing to prevent distortion. Provide each housing with a bolted and gasketed access door for inspection of drive and fan wheel.
2. Provide brackets suitable for horizontal or vertical mounting. Externally mount motors on an adjustable base.
3. Furnish with streamlined inlet cones and straightening vanes downstream of the fan wheel to minimize noise, reduce turbulence and to impart unidirectional airflow.
4. Match the wheel inlet ring to a close tolerance with integral deep-spun aerodynamic venturi inlets.
5. Use non-overloading airfoil blades welded to the wheel cones.
6. Continuously weld fan blades to the hub plate and rim. Backward inclined blades may be securely riveted to the hub plate and rim. Fan wheels shall be precision aluminum castings with machine finish.
7. Bearings shall be grease-lubricated, self-aligning ball bearing type with grease seal and external grease fitting. Unless a special coating is scheduled, paint fans with a prime coat after metal cleaning and surface preparation. Apply a second coat of paint to all exterior surfaces.
8. Isolate belt drives from airstream with a belt tube.

C. Cabinet Type:

1. Provide scroll type centrifugal fans, factory-installed within a cabinet enclosure, and comply with the requirements of Scroll Type Centrifugal Fans.
2. Internally isolate fan and motor assemblies from the cabinet.
3. Provide gasketed access doors and panels for inspection and routine maintenance of the internal components.

4. Provide solid state variable speed controllers for small ceiling-mounted direct driven exhaust and transfer fans.

D. Plug Type:

1. Single width, single inlet air foil type fan blades.
2. Plug fans shall have self-aligning pillow block bearings with minimum ABMA L10 life of 400,000 hours.
3. Plug fan plenums and inlet plenums shall be provided with an expanded metal door locked to prevent access to fan inlet, or a door switch hardwire-interlocked to automatically shut down fan operation.
4. An OSHA-compliant belt guard and shaft guard shall be included to completely cover the motor sheave and belts.

2.04 AXIAL FANS

A. Propeller Type:

1. Include propeller type impellers, complete with motors, and panel- or ring-mountings.
2. Vary fan blades in camber and twist from base to tip.
3. Construct impellers of die-formed steel or aluminum with a welded reinforcing gusset on the backside for added rigidity, attached to a central hub mounted on the fixed drive shaft. Fan shall be of welded and bolted construction utilizing corrosion-resistant fasteners.
4. Rotate fan hub on the fixed drive shaft using sealed ball bearings with a L10 life of 100,000 hours.
5. To eliminate overhang load on belted fans, design to apply belt load to the hub in the same plane as the bearings.
6. Direct drive fans are only acceptable where belt-driven units do not meet the performance criteria or direct drive is specified.
7. Provide panels or rings with spun venturi inlets suitable for wall-mounting and structural angle supports of welded steel construction.
8. Provide basket type fan guards for exposed inlets and discharges.
9. Provide TEFC motors on all fans.
10. Provide factory-fabricated wall sleeves.

B. Vaneaxial Fixed Blade Type:

1. Include impeller, motor, drive and cylindrical housing.
2. Replaceable fan blades shall have an airfoil cross-section, varying in camber and twist from base to tip, of die-formed steel or aluminum.
3. Fixed pitch fans shall have formed impeller blades and hub in a single precision casting, or precision-weld blades to the hub assembly.
4. Mount impeller directly on the drive shaft and secure in place with locking assembly. Design motor and impeller to be removable from the inlet side of the fan.
5. Cross brace motor support base on direct drive fans to the fan housing for structural rigidity and to prevent motor misalignment.
6. On belt drive fans, protect belts and bearings from the airstream in an air-insulated enclosure. Design to apply belt loads to the hub in the same plane as the bearings to eliminate overhang load.
7. Construct cylindrical fan housings of hot-rolled heavy-gauge rolled steel plate

with continuous-weld seams.

8. Provide venturi inlet bell and discharge cone diffuser accessories of the same gauge and material as the fan housing.

C. Vaneaxial Adjustable Blade Type:

1. Include impeller and hub, guide vanes, motor, drive and cylindrical housing.
2. Construct fan blades of die-formed aluminum, sized for the fan diameter. Blades cut down from longer sections shall not be acceptable. Provide double thickness blades with airfoil cross-section and profile, varying in camber and twist, from base to tip.
3. Provide fans designated as adjustable pitch fans with blades which can be collectively manually adjusted in the field. Provide pitch indicators at the base of each blade. Secure blades in place with set screws or locking adjustment nuts. Fan shall be designed so that an AABC-certified balancing contractor can make adjustments in the field to both the blades' pitch and the limit control, and not compromise the safe operation of the fan or the manufacturer's warrantee.
4. Provide fans designed as controllable-pitch fans with in-flight blade pitch modulation. Vary blade pitch through an external actuator, connected via linkages to an internal, lubricated thrust-bearing assembly. Vary blade pitch in response to a command from an external control signal. Indicate blade angle on an external pitch-index plate. Furnish and install all necessary linkages and accessories required for automatic control. Provide limit control factory-set to the maximum performance blade angle to prevent under/over-pressurizing ductwork or motor overload and burnout. Upon fan shut-down or power failure, pitch shall be reset to the minimum setting. A pneumatic actuator furnished and mounted on the side of the fan casing by the fan manufacturer shall vary blade pitch in the controllable-pitch rotor. The actuator shall be electrically controlled by a remote signal from an external source to an electro-pneumatic transducer.
5. For direct drive units, mount impeller directly on the drive shaft and secure in place with locking **[WP]** assembly. Design motor and impeller to be removable from the inlet side of the fan.
6. Provide an aerodynamic spinner cap over the hub face of impellers, to protect and conceal blade adjustment bearings.
7. Guide vane assembly construction shall match that of the impeller assembly. The vane shape, camber and twist shall be optimized for airflow straightening into the fan and minimum aerodynamic inlet losses.
8. Cross brace motor support base and motor bearing on direct drive fans to the fan housing for structural rigidity to prevent motor misalignment. Cross braces shall not obstruct airflow.
9. On belt driven fans, protect belts and bearings from the airstream in an air-insulated enclosure. Design to apply belt loads to the hub in the same plane as the bearings to eliminate overhang load.
10. Construct cylindrical fan housings of hot-rolled heavy-gauge rolled steel plate with continuous-weld seams.
11. Provide venturi inlet bell and discharge cone diffuser accessories of the same gauge and material as the fan housing.
12. Provide factory-mounted heavy-duty butterfly backdraft dampers manufactured by the fan manufacturer at discharge or inlet of fan or sound attenuator as appropriate to avoid interference with sound attenuators, routine maintenance and motor removal. Backdraft damper shall be suitable for continuous operation

at 6,000 feet per minute face velocity.

13. Butterfly type backdraft damper shall consist of vertically split and hinged steel plate assembly in a rolled steel flanged housing. In addition to backdraft performance, arrange mounting of hinged assembly to close by gravity when fan(s) are not operating.
14. Provide companion flanges to receive backdraft damper, sound attenuators, sheet metal duct or flexible connectors. Companion flanges shall be of the same thickness as the fan flanges and provided by fan manufacturer.

2.05 ROOF EXHAUST FANS

A. Provide roof exhaust fans of the centrifugal, belt-driven type. Construct fan housing of heavy-gauge aluminum.

B. Construct all spun parts with a rolled bead for added rigidity and spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.

C. Provide all-aluminum fan wheel of the centrifugal blower type with backward inclined blades and a tapered inlet shroud. Statically and dynamically balance wheels.

D. Provide inlet cone of aluminum centrifugal blower type.

E. Enclose motor and drives in a weather-tight compartment separate from airstream and extend motor leads in metal conduit down through support base to facilitate wiring from below roof. Air-cool the motor using air uncontaminated by exhaust fumes.

F. Provide motors of the heavy duty, permanently lubricated, sealed ball bearing type. Size drives for 150 percent of motor horsepower capabilities and of the cast iron type, keyed to the fan and motor shafts. Provide variable pitch drives, with a minimum of 2 belts.

G. Construct fan shaft of steel construction, turned, ground and polished to precise tolerances in relationship to the hub and bearings.

H. Provide drive belts of the oil-resistant, non-static, non-sparking type with an ABMA L10 life expectancy of minimum 24,000 hours.

I. Provide flanged, permanently lubricated and sealed ball or roller type bearings.

J. The entire drive and wheel assembly shall be removable as a complete unit from the support structure without disassembling the external fan housing. The assembly shall be hinged on one side with full-length weather-proof piano hinges. Mount the complete drive assembly on rubber vibration isolation.

K. Provide direct drive fans of identical construction as belt drive fans, except for drives, belts, and fan shaft bearings.

L. Construct all belt-drive fan interior and exterior parts, including wheel, wheel hub, supporting posts, fan shaft, drive assembly, and all outside fasteners, of aluminum or non-ferrous material. Include a five-year warranty.

M. Provide a sound-attenuating roof curb with backdraft damper of the same manufacture as the roof exhaust fan.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install fans in accordance with manufacturer's recommendations and as shown on the Drawings. Follow SMACNA- and AMCA-recommended procedures for fan installations, belt guards, duct connections, etc.

B. Provide flexible connections as described in Section 23 31 00 – HVAC Ducts and Casings with sufficient separation of ductwork, plenum panels, or air-handling unit casings from fan assembly to prevent metal-to-metal contact due to start-up torque or operating under specified isolator deflections.

C. Install fans and motors with proper support and vibration isolation as specified in Sections 23 05 48 – Vibration and Seismic Controls for HVAC, and 23 05 29 – Hangers and Supports for HVAC.

D. Provide sufficient clearances around fans for access and servicing of components. Install fans such that tachometer openings, access doors, motors, belts, lubrication lines, electrical connections, etc., are readily accessible and not obstructed by other installations or structures.

3.02 START UP

A. Verify thermal-overload protection is installed in motors, starters, and disconnect switches. Verify proper motor rotation direction, fan wheel free rotation and smooth bearing operation. Align and adjust belts, install belt guards and verify lubrication for bearings and other moving parts. Verify that manual and automatic volume control and fire/smoke dampers in connected ductwork systems are fully open.

B. Bump start fans to check that fan wheel/impeller has maintained static and dynamic balance and the rotation corresponds to the desired direction for airflow. Correct fans found to be rotating in a direction opposite to that desired. Unbalanced wheels shall be re-balanced by an AABC-certified test and balance contractor.

C. Tighten belt drives, taking into account the service factor and any other design of the drive. Exercise care not to over-tension belts.

D. Check all bolts and fasteners to ensure proper tightness. Do not over-tighten nuts and bolts.

E. Check bearings and motor for proper lubrication, taking care not to over-lubricate. Use only lubricants recommended by the manufacturer.

3.03 FAN ACCESSORIES

A. Provide the following accessories:

1. Inlet cone, inlet bell, inlet box, inlet screen, inlet vortex breaker
2. Outlet cone, outlet screen
3. Support legs, hanger brackets welded to housing
4. OSHA-approved belt guard
5. Weather-proof motor and drive cover

6. Shaft seal

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7. Threaded drain connection
8. Backdraft damper
9. Automatic spring-loaded belt tensioner on roof-mounted ventilators

B. Provide a drain at the bottom of the housing for fans discharging upward from the roof. Pipe drains from housings of interior fans discharging directly up through the roof indirectly to a floor drain. Pipe drains from housings of kitchen grease exhaust fans to a grease interceptor.

C. Provide 22 gauge wire mesh reinforced galvanized steel inlet and discharge guard screens for all fans or sound attenuators connected to fans without inlet or discharge ductwork.

D. Shaft Cooler: For all smoke exhaust fans, provide metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

E. Coatings: Epoxy

1. Epoxy Coatings Groups III-E Rustoleum

END OF SECTION 23 34 00