

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Centrifugal fans.
2. Laboratory exhaust fans.
3. Axial fans.
4. Mixed flow fans.
5. Propeller fans.
6. Downblast centrifugal roof fans.
7. Upblast centrifugal roof fans.
8. Inline ceiling fans.
9. Duct blowers or cabinet fans.
10. Centrifugal square inline fans.
11. Combination kitchen hood supply and exhaust fans.
12. Roof ventilators.

B. Related Sections:

1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 05 48 - Noise and Vibration Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
4. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
5. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
6. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.

7. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
8. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 1. AMCA 99 - Standards Handbook.
 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. American Refrigeration Institute:
 1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
- D. National Electrical Manufacturers Association:
 1. NEMA MG 1 - Motors and Generators.
 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. Underwriters Laboratories Inc.:
 1. UL 705 - Power Ventilators, Smoke Control File No. MH17511.
 2. UL 762 Grease Removal File No. MH11745.

1.03 SUBMITTALS

- A. Division 01 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Submit motor data in accordance with 23 05 13.

1.04 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: All fans shall be UL listed and labeled, designed, manufactured, and tested in accordance with UL 705. Fans used for smoke control shall comply with UL 705 File No. MH17511. Fans used for grease removal shall comply with UL 762 File No. MH11745.
- D. Balance Quality: Conform to AMCA 204.
- E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.
- F. Perform Work in accordance with IBC-NJ.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three (3) years documented experience approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Division 01 - Product Requirements: Product storage and handling requirements.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 WARRANTY

- A. Division 01 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five (5) year manufacturer's warranty for fans.

1.10 MAINTENANCE SERVICE

- A. Division 01 - Execution and Closeout Requirements: Requirements for maintenance service.

1.11 EXTRA MATERIALS

- A. Division 01 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two (2) sets of belts for each fan.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
 - 1. Greenheck Corp.
 - 2. New York Blower
 - 3. Twin Cities.
 - 4. Substitutions: Division 01 - Product Requirements.
- B. Performance:
 - 1. Performance Base: Sea level conditions.
 - 2. Temperature Limit: Maximum 300 degrees F (150 degrees C) for non-smoke control systems and 600 degrees F (300 degrees C) for smoke control systems.
 - 3. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

C. Wheel and Inlet:

1. Backward Inclined: Steel construction with smooth curved inlet flange, back plate, backward curved blades welded to flange and back plate; cast steel hub riveted to back plate and keyed to shaft with set screws.
2. Forward Curved: Galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, welded to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
3. Airfoil Wheel: Steel construction with smooth curved inlet flange, back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast steel hub riveted to back plate and keyed to shaft with set screws.
4. Wheels shall be continuously welded construction.

D. Housing:

1. Steel continuously welded, braced and designed to minimize turbulence with spun inlet bell and shaped cut-off.
2. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, furnish two additional coats of paint.
3. Bolted construction with horizontal flanged split housing, where indicated.
4. Fabricate plug fans without volute housing, in lined steel cabinet.

E. Bearings and Sleeves:

1. Bearings: Pillow block type, self-aligning, grease-lubricated roller bearings, or ABMA 11, L-10 life at 120,000 hours.
2. Shafts: Hot rolled steel, ground and polished, with key way, protectively coated with lubricating oil, and shaft guard.
3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 kW) and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp (15 kW) and over or fan controlled by VFD, matched belts (minimum 2 belts), and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
4. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch (2.6 mm) thick, 3/4 inch (20 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

F. Accessories:

1. Inlet/Outlet Screens: Galvanized steel welded grid.

2. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
3. Scroll Drain: 1/2 inch (13 mm) steel pipe coupling welded to low point of fan scroll.

2.02 AXIAL FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
 1. Woods
 2. New Philadelphia
 3. Twin Cities
 4. Substitutions: Division 01 - Product Requirements.
- B. Product Requirements:
 1. Performance Base: Sea level conditions.
 2. Temperature Limit: Maximum 300 degrees F (150 degrees C) for non-smoke control systems and 600 degrees F (300 degrees C) for smoke control systems.
 3. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.
- C. Hub and Impeller:
 1. Airfoil Impeller Blades: Adjustable die cast aluminum alloy or welded steel die formed blades with belt drive. The number of blades shall suit the operation required to prevent fan stalling at low flow.
 2. Hub: Die cast aluminum alloy or cast iron hub or with belt drive of spun, welded steel, bored and keyed to shaft; to facilitate indexing of blade angle with manual adjustment stops.
 3. Controllable Pitch Assemblies: Incorporate ball bearing counterbalanced blade and variable pitch assembly into hub with mechanical link to casing exterior mounted actuator, or pneumatic or electric actuator incorporated within hub. The assemblies shall have positive return mechanism.
 4. Cast Components: X-ray components after fabrication and statically and dynamically balance assembly before attachment to motor or shaft.
- D. Casing:
 1. Fabricate casing of 1/4 inch (6 mm) steel for fans 40 inch (1000 mm) in diameter and smaller and 3/8 inch (17 mm) steel for larger fans.

2. Continuously weld, with inlet and outlet flange connections, and motor or shaft supports. Incorporate flow straightening guide vanes for fans specified for static pressures greater than 1.5 inch wg (375 Pa).
 3. Finish with one coat enamel applied to interior and exterior.
- E. Bearings and Drives:
1. Bearings: Pillow block type, self-aligning, grease-lubricated roller bearings, or ABMA 11, L-10 life at 120,000 hours.
 2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil.
 3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
 4. Belt Guard: Fabricate to SMACNA Standards; 0.106 inch (2.6 mm) thick, 3/4 inch (19 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 5. Lubrication: Extend lubrication fittings to outside of casing.
- F. Accessories:
1. Guide Vanes: Welded steel construction with airfoil vanes and casing flanges, finished to match casing.
 2. Adjustable Inlet Vanes: Steel construction with blades supported at both ends with two permanently lubricated bearings, variable mechanism out of air stream terminating in single control lever with control shaft for double width fans and locking quadrant.
 3. Inlet Bell: Bell mouth inlet fabricated of steel with flange.
 4. Outlet Cones: Fabricated of steel with flanges, outlet area/inlet area ratio of 1.5, with center pod as recommended by manufacturer.
 5. Inlet Screens: Galvanized steel welded grid to fit inlet bell.
 6. Dampers: Welded steel construction, consisting of two semi-circular vanes pivoted on oil-retaining bearings in short casing section, finished by hot dip galvanizing. Furnish motor actuation; refer to Section 23 09 00 and 23 09 23.
 7. Access Doors: Shaped to conform to casing with quick opening latches and gaskets.
 8. Blade Pitch Actuator: Factory mounted and calibrated, electric actuator requiring single phase power and accepting electric input. Refer to Section 23 09 00 and 23 09 23.

9. Stall Alarm Probe: Factory installed sensing probe to detect fan operation in stall.
10. Vibration Detector: Factory installed vibration switch to stop fan with extra set of contacts.
11. For direct driven fans, motor shall be total enclosed air-over type.

2.03 MIXED FLOW FANS

- A. Inline mixed flow fans shall have capabilities as indicated on Contract Drawings when tested to AMCA Standard 210-74.
- B. The housing shall be constructed of welded heavy gauge steel to assure no air leakage. Housing shall have inlet and outlet collars for slip fit duct connections. The housing and bearing supports shall be constructed of structural steel members to prevent vibration and rigidly support the shaft and bearings. Welded steel vanes shall straighten the flow of air from the fan discharge and support bearings and drives.
- C. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90-degree increments. Bearing life shall not be reduced below specified level in different configurations. Units size 30 and larger shall allow for field rotation of motor positions. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
- D. The wheel shall be of the mixed flow type. Wheels shall have a wheel cone, spherical back plate and single thickness cambered blades. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19. The wheel cone and fan inlet cone shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.
- E. Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25% over the maximum operating speed. Close tolerances shall be maintained where the shaft makes contact with the bearings.
- F. Bearings shall be heavy duty, grease lubricated, self-aligning ball or roller flange mounted bearings with extended lubrication lines. Bearings shall be selected for a minimum life (L-10) of 200,000 hours at maximum operating speed and horsepower.
- G. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three planes; horizontal, vertical and axial. The maximum allowable fan vibration shall be 0.15 in/sec. peak velocity, filter-in reading as measured at the fan RPM. This report shall be provided at no charge to the customer.
- H. Inlet and outlet sound power levels shall be provided for each of the eight (8) octave bands at the point of operation in accordance with AMCA Standard 300.
- I. Fans shall bear the AMCA Seal for sound and air performance.

- J. Mixed flow fans shall be Model QEI as manufactured by Greenheck Fan Corp., Woods or Trane 'Q' fans.

2.04 PROPELLER FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
 - 1. Greenheck Corp.
 - 2. Loren Cook Company.
 - 3. Substitutions: Division 01 - Product Requirements.
- B. Construction:
 - 1. Impeller: Shaped steel or steel reinforced aluminum blade with hubs, statically and dynamically balanced, keyed and locked to shaft, directly connected to motor or furnished with V-belt drive.
 - 2. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.
- C. Accessories:
 - 1. Damper: Multiple blade with offset hinge pin, blades linked, line voltage motor drive, power open, spring return.
 - 2. Safety Screens: Expanded galvanized metal over inlet, motor, and drive and outlet; to comply with OSHA regulations.
 - 3. Hood: Weather shield, to exclude rain and snow.
 - 4. Fan speed controller.

2.05 LABORATORY EXHAUST AIR FANS

- A. References:
 - 1. Fans shall have been tested under AMCA 210-85, "Laboratory Methods of Testing Fans for Rating, or British Standard 848, Part I, "Methods of Testing Performance", 1980, and shall have been witnessed by an independent agency.
 - 2. Documented aspiration tests shall have been performed in conjunction with the fan performance test. Test shall incorporate AMCA 210 testing standards and physically measure the air volume entering and exiting the fan. This test can be used as an alternative to AMCA 260 testing and shall have been witnessed by an independent agency.
 - 3. Sound testing shall be in accordance with AMCA 300.
 - 4. Fans shall be UL and CUL listed per UL 705 safety standard.

5. Fans shall meet the criteria of NFPA-45.
- B. Acceptable Manufacturers:
1. The plans and specifications for the laboratory fume hood exhaust system are based on systems and equipment manufactured by Strobic Air Corporation. Alternate manufacturers include Greenheck or approved equal.
 2. In strict accordance with this specification, alternative laboratory exhaust systems and equipment shall only be considered for approval provided that the equipment be equal in every respect to the operational characteristics, capacities, and intent specified herein. Approval to bid does not relieve the alternate exhaust system supplier from complying with the minimum requirements or intent of this specification.
 3. The engineer and owner shall be the sole judges of quality and equivalence of equipment, materials, methods, and life cycle cost.
- C. Submittals:
1. Submit shop drawings and product data sheets including performance data, fan flow performance curves, system total flow performance curves at the stack/windband exit and sound power levels.
 2. Fan manufacturer shall furnish a certificate of guarantee stating that the fan, mixing plenum, outlet nozzle, acoustical silencer nozzle, stack extension if any, and all related accessories specified herein have been pre-tested at the factory and that the curves supplied in paragraph 2.06 B.1 have been de-rated for any and all system effects created by the accessories.
- D. Mixed-Flow Induced Dilution Fans:
1. Impellers shall be mounted directly to the motor shaft to provide a direct drive arrangement 4 type fan. Motors shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.
 2. Mixed flow impellers shall consist of combination axial/backward curved blades and shall be of welded steel construction. The impellers shall have non-stall and non-overloading performance characteristics with aerodynamically stable operation at any point on the fan curves. The use of centrifugal or axial style fans is not acceptable.
 3. Fan Performance shall be as stated on the schedule. The Static Pressure stated on the schedule shall be at the inlet to the "Fan System" and does not include any losses of equipment provided by the fan manufacturer (ie: HRU, filters, silencers, drives, etc.). All losses for the equipment provided by the fan manufacturer shall be detailed in the fan manufacturers technical proposal and or submittal.
 4. Maintenance shall only be required on a minimum of 18 month intervals. This maintenance shall be limited to re-greasing of the motor bearings.

5. Stationary discharge guide vane sections shall be provided to increase fan efficiencies.
6. Fan dynamic balance not to exceed 0.5 mil, peak-to-peak for nominal 900RPM, 1200RPM, and 1800RPM fans, or 0.055 in/sec -peak for 1800 RPM, 0.035 in/sec – peak for 1200 RPM, and 0.030 in/sec-peak for 900 RPM fans measured at the blade pass area when operating at fan frequency. Vibration isolation shall be limited to rubber-in-shear pad type isolators unless otherwise specified.
 - a. Factory test reports detailing vibration levels at the blade pass area shall be provided. Vibration levels shall be reported in both the axial and radial direction.
 - b. If fan vibration is greater than 0.5 mils peak-to-peak at the blade pass area, fan manufacturer shall be responsible for reducing the vibration levels as specified above. The use of spring isolators as a method of reducing the level of vibration to the specified level is not acceptable.
 - c. All balancing weights shall be permanently welded to the wheel section and coated as specified. The use of screws or clips to attach the weights. is not acceptable.
7. Fan manufacturer shall provide a 7 year warranty from time of purchase to include fan, motor and all drive mechanisms including pillow blocks, sheaves, shafts and couplings.
8. Fan assemblies shall be designed for mounting on conventional roof curb without the need for guy wire supports to withstand 120 mph wind.
9. Discharges shall include twin FRP nozzles with passive third central stacks that are capable of generating aspiration. The FRP shall be chemically and UV resistant.
10. Entrainment windbands shall provide secondary induction of outside air. Induction shall take place downstream of the fan impeller and shall not influence BHP or static pressure requirements. Windbands shall discharge up to 270% of the design flow rates. The manufacturer shall publish discharge volumes for all fans at specified primary exhaust flow.
11. Fan shall be constructed to AMCA "C" standards with a non-ferrous inlet bell, provided in order to reduce sparking in the event of a motor bearing failure.
12. Fans shall be modular construction and capable of being assembled on the roof.
13. Chemical resistant gaskets shall be provided at all companion flanged joints.
14. Fasteners shall be 316 stainless steel.
15. A bolted access door shall be provided for impeller inspection on each fan.
16. Fans and accessories shall have internal drain systems to prevent rain water from entering building duct system.

17. Electric motors shall be TEFC Mill & Chemical duty with a 1.15 service factor and an L₁₀ bearing life of 364,000 hours. Premium Efficient motors shall have re-greasable bearings with grease relief fittings in every NEMA frame. Fan motors shall be C-Face and foot mounted. All motors shall comply with efficiencies listed in U.S. Energy Policy Act of 1992. Motors shall be warranted by the fan manufacturer for a period of seven (7) years from shipment.
18. Extended motor lube lines of Teflon tubing covered with braided stainless steel shall be provided. Extended lube lines shall be mounted to a bracket located on the fan housing with grease relief fittings on each line.
19. A NEMA 3R non-fused disconnect switch shall be provided, mounted and wired to the motor.
20. Coatings-All steel and aluminum surfaces shall be prepared for coating by blasting or chemical etching. Coating will be Epoxy (10 mils DFT) for protection against weather, chemical vapors and splashes. All steel components exposed to sunlight shall have a secondary urethane top coat of 2-3 mils DFT applied over epoxy paint for protection to the elements. Coating shall pass salt spray test of a minimum 7000 hours. Coating shall be custom color as selecting Architect.
21. The fan supplied must meet the system exhaust CFM and the motor BHP shall not be larger than that shown on the fan schedule. If the BHP is larger than that shown then the fan manufacturer shall provide money for the additional energy cost for a seven (7) year period. The cost shall be \$7,530.00 per BHP greater than that shown in the schedule. The fan manufacturer shall also provide any additional money required for wiring changes or any other changes required for installation of the equipment. These additional charges shall be detailed on the proposal and include in its total value.
22. Fan and Mixing Box systems supplied by the manufacturer must have a foot print as shown on the drawings / schedule. Exhaust systems with larger footprints shall not be acceptable.
23. The static pressure shown on the schedule is based on the static pressure requirements at the inlet to the mixing box. Any system deviating from the basis of design shall include and detail in their proposal additional losses for flexible connectors, fan losses, elbows, mixing box, etc. that are not included in their fan curves. In addition any deviation from the basis of design shall be subject to requirements stated in paragraphs 2.06 C.2, D.7, and D.18.
24. Provide drain outlets to prevent water collection. Contractor to provide 304 stainless steel Schedule 40 piping with traps for each connection and terminate 6" above roof line.

E. Accessories:

1. Custom inlet mixing plenums shall be provided by the fan manufacturer. Each plenum shall be sized to support the weight and performance requirement of the number of fans listed on the schedule. Multiple fan plenums shall be insulated double wall construction with structural stiffeners. Double wall plenums shall have an overall minimum wall

thickness of 1.5", and the insulation shall have a minimum R value of 4.34. Outer skin of double wall plenums shall be coated 12Ga Galvaneal steel. Inner skin shall be uncoated 18Ga Type 304 stainless steel. Multiple fan plenums shall be able to withstand a minimum of 12 in. w.g. of negative pressure. All plenums shall be capable of supporting the fan(s) without guy wires or supports. The plenums shall include hinged access doors and safety screens over fan inlets. The primary air inlets shall be located on the bottom or side as noted on construction drawings. Unless otherwise specified, plenums shall be suitable for mounting on roof curbs.

2. Safety screens shall be supplied over inlet of fan.
3. Bypass dampers shall be provided with all mixing plenums for outside air with primary exhaust. Dampers will be:
 - a. Opposed blade low leakage airfoil control dampers with extended shaft for connection to an operator. The dampers shall be all aluminum construction. In addition, acoustical louvers shall be provided on the inlet side of each bypass damper. Rain hoods and inlet silencers shall be provided with each damper. The dampers shall be controlled by (24V electric) operators. Acoustical properties of the louver shall be:

Model	OCTAVE BAND CENTER FREQUENCY (Hz)							
	63	125	250	500	1000	2000	4000	8000
High Frequency	8	7	9	10	14	16	16	18
Low Frequency	12	14	12	12	9	11	13	15

4. Low leakage isolation dampers shall be constructed of aluminum air foil extrusions and epoxy coated 10 mils DFT. Operators shall be 2-position, spring return and shall be 24V/110V electric. Since variable frequency drives are specified, damper operators should be wired to a separate 120V/24V power source or wired to the fan power source before passing through the VFD.
5. Vortex breakers shall be provided on all side inlet and multiple fan plenums.
6. A galvanized steel roof curb shall be provided to support the fans/plenums. The curb shall be minimum 14 gauge and canted for rigidity in wind loads. The curb shall include a rigid fiberglass liner and a wood nailer.
7. Acoustical Silencer Nozzle shall be designed as an integral component of the exhaust fan discharge nozzle and shall not increase the height of the overall assembly.
 - a. The maximum air pressure drop shall be 0.1" W.C. when installed and all associated losses shall be included in the fan performance curve.
 - b. The Acoustical Silencer Nozzle shall provide the attenuation values as specified in the following schedule. The published insertion loss values shall be obtained from an AMCA 300 test with the silencer installed on the fan specified. Ratings based on separate silencer and fan testing is not acceptable.

OCTAVE BAND CENTER FREQUENCY (Hz)									
FAN SIZE / SILENCER MODEL	LENGTH	63	125	250	500	1000	2000	4000	8000
TS-2	64"	0	4	9	11	12	13	9	4
TS-3	88"	8	7	12	15	15	13	10	6
TS-4	89"	5	8	9	11	12	12	10	6
TS-5	93"	3	14	15	17	18	13	8	6

- c. The silencer shall be constructed with an outer shell of fiber reinforced plastic with a minimum of 3/16" wall thickness. The inner liner shall be perforated corrosion resistant steel. The silencer should be colored to match the fans. Acoustic media shall be 3lb. density fiberglass isolated from the air stream by a tedlar film, non-fibrous acoustical media.

8. Maximum permissible noise levels (in dB 'A' re 20 micropascals) at 10' from discharge of each exhaust fan stack under design operating conditions shall be as follows:

	OCTAVE BAND FREQUENCY							
	1	2	3	4	5	6	7	8
	OCTAVE BAND NOISE LEVEL (dBA)							
LEF-1,2,3	59	60	64	67	70	66	64	60
LEF-4,5,6	49	57	63	65	65	66	62	65
LEF-7,8	32	46	52	55	55	55	54	47

9. Provide Vortex shedding airflow measurement station for each exhaust fan. All components of devices shall be corrosion resistant. Airflow measuring devices shall be of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. A VorTek airflow sensor shall be provided in each chamber of the airflow control valve. Airflow measuring devices shall be capable of measuring velocity over the full range of 400 to 5000 FPM. Pitot or Thermal Airflow sensors shall not be acceptable.
10. Laboratory Exhaust Static Pressure Control Package:
- The control package shall be capable of maintaining the laboratory exhaust system static pressure at a predetermined level regardless of laboratory activity (i.e. opening/closing of laboratory hoods). This shall be accomplished without any user input.
 - The outlet velocity of each fan in the exhaust system shall be maintained at a minimum of 3000 fpm at all times.
 - The static pressure at which the system is required to be maintained shall be capable of being set manually at the control package interface. The control package shall also be capable of receiving the static pressure set point from the building control system.
 - Fans running simultaneously shall run at the same speed.

- e. The control package shall stage the fans in the system so that no one fan is idle for more than 30 days.
 - f. The control package shall respond to a failure of one fan by energizing an unused fan (if present) automatically and annunciate fan failure alarm.
 - g. Communication card shall be included which will allow information to be sent from the control package to the building control system. This information shall include the measured system static pressure, the frequency at which the VFDs are running, fault status, and any other parameters required on the job.
 - h. Wiring shall be done in the factory so as to minimize field wiring. Control wiring shall be brought to a single point in both the rooftop exhaust unit and VFD/mechanical room equipment.
 - i. The controller shall be powered separately from any other component in the system.
11. Manufacturers providing inline fans, other than the Strobic Air Tri-Stack, shall include the following items:
- a. 2" deflection all directionally restrained, seismic rated spring vibration isolators. Isolators must be installed on each individual fan with a minimum of four per fan. Isolation of the fan mixing plenum is not acceptable.
 - b. 1/4" thick neoprene inlet and outlet flexible connectors on the fan inlet and discharge.
 - c. A welded structural steel mounting frame fabricated of 2" x 2" x 3/8" steel angle designed to allow the fans to be suspended from the framework and separated from the plenum and building structure with the spring isolators and the flexible connectors.
 - d. Modular welded structural steel roof base with 8" perimeter channels and 6" and 4" cross members and gussets to support discharge sound attenuators. Top plate to be 3/16" plate steel. Provide 3" x 3" perimeter angle on inside face of perimeter channel to make weather tight seal at roof curb. The structural steel base and sound attenuators shall be rated for a 120 mph wind load without supplemental structural supports or guide wires. The overall height of the assembly with the support structure and discharge attenuators shall not exceed the dimensions shown on the plans.
 - e. Silencer and framework shall be rated for 120 mph windload without supplemental structural supports or guide wires.
 - f. The overall height and the footprint of the assembly with the plenum, fans, support structure and discharge attenuators shall not exceed the dimensions and weight shown on the plans.

F. Heat Recovery Unit:

- 1. Strobic Air, Model Heat Recovery Plenum is the basis of design and specification for this project will be considered as an alternate equipment

manufacturer for review by the mechanical engineer with regard to approval or disapproval. The naming of such alternate equipment does not imply that they are approved. Such manufacturers are required to meet all details of this specification without exception. Manufacturers other than those named will not be considered and are not acceptable.

2. Side and Roof Panel Construction:

- a. Outdoor/weatherproof construction: All sections shall be double wall, insulated and painted. All side panels shall provide a smooth, architecturally pleasing exterior surface with no exposed bolts or screws. Roof panels shall utilize standing seam construction with cap strips over roof flanges. Standing seam roof shall have a bowed roof with a minimum of 1/4 in/ft (20mm/meter) slope to ensure rain and snow runoff. Roof system shall be designed for 30 pounds/ft² snow load. Provide 1.5" rain gutters above each door. Side and roof panels shall utilize standing seam construction on interior and are to be assembled with bolts such that each panel is individually removable. Bolted and removable panels are required for both service access and/or future air handler modifications. Casing shall be of not less than 16 gauge galvanized steel. All pressure bearing side and roof panels shall be bolted construction for leak-free integrity and removability of panels. Drive (tek) screws or spot welding of pressure bearing panels is not designed for removal and reassembly, therefore unacceptable construction.
- b. All exterior walls shall be constructed of minimum 2" (50mm) thick acoustical/thermal panels. Maximum allowable deflection of any panel shall not exceed 1/200th of any span in any direction at unit design CFM. Casing shall be built to exceed AMCA Class "C" plenum requirements as outlined in AMCA 99 - Standards Handbook.
- c. All panels shall be assembled with minimum of 1/4" diameter, zinc plated bolts on maximum 10" centers (drive (Tek) screws are not acceptable). After completion of the unit casing and after all panel bolts have been secured, each panel seam is sealed for air and water tightness with a continuous bead of high performance polyurethane sealant which meets ASTM C-920, Type S, Grade NS, Class 25 and is USDA-approved, paintable and EPA-approved for potable water contact.
- d. Provide a unit housing with a minimum STC (Sound Transmission Class)(per ASTM E 90 and E413) as shown in the following tables:

Octave bands	125	250	500	1K	2K	4K	STC
2" wall, No Liner	23	27	35	44	50	49	39
2" wall, Solid Liner	21	38	44	52	51	53	45
4" wall, No Liner	24	29	41	50	57	62	42
4" wall, Solid Liner	28	39	48	55	55	60	50

- e. Interior liner shall be fabricated from minimum of 20 gauge 304 S.S.

G. Base, Unit Floor:

1. Unit base shall be constructed of welded structural steel around the perimeter of unit, with intermediate channel and angle iron supports. Bolted or formed C channel bases are not acceptable.

A.H. UNIT/LENGTH	MINIMUM / CHANNEL SIZE
UP TO 10'	4" X 1-5/8" (5.4lbs/Lin.Ft.)
11' TO 20'	6" X 2" (8.2lbs/Lin.Ft.)
21' TO 30'	8" X 2-1/2 (11.5lbs/Lin.Ft.)
31' TO 50'	12" X 3" (20.7lbs/Lin Ft.)

2. The unit floor shall be covered with 16 gage 304 stainless steel, welded to base channel (no drive screws acceptable). All floor seams shall be supported underneath by intermediate channel and welded to supports. All seams shall be further sealed with a continuous bead of high performance polyurethane sealant which meets ASTM C-920, Type S, Grade NS, Class 25 and is USDA-approved, paintable and EPA-approved for potable water contact.
3. Removable type lifting lug assembly shall be welded to structural steel base. Provide a minimum of 4 lugs per section to insure proper rigging. Rigging and lifting safety instructions shall be attached to unit.
4. All duct connections (larger than 12" x 12") or control dampers in the floor of the unit shall be covered with heavy gauge steel "walk-on" safety bar grating bolted in place, to prevent people and large objects from passing through the unit floor into the ductwork. Bar grating shall be designed for a maximum deflection of 1/4" under a concentrated load(C) of 300# at mid span. If safety grating does not meet this spec, it is the installing contractors' responsibility to replace non-conforming grating.
5. Curb mounted units shall come complete with roof curb support angle welded on interior side of welded base assembly. Curb support shall be concealed on interior of base to help prevent possibility of roof leakage. Units which perimeter base rests on roof curb is not permitted.
6. Roof curbs assembly shall be manufactured with 12 gauge galvanized steel designed to insure that each unit is level, compensating for roof pitch. Each air handling unit shall be supported by a single common roof curb designed to accommodate the entire assembly. Roof curbs shall have a 2" x 4" nailer strip along the outside edge of the entire perimeter to allow the contractor to attach the roofing material to the curb, therefore ensuring a weatherproof seal between the curb and the roof. The curbs shall be provided with a self-adhesive gasketing material (to be installed by the contractor) to provide the seal between the air handling unit assembly and the roof curb.

H. Access Doors:

1. Provide full height (thru 77") tall doors, 2" thick, double wall, insulated access doors where specified on unit drawings. Exterior and interior door skin shall be constructed from minimum of 16 gauge galvanized and painted steel (interior door skin will be unpainted 304 S.S. in all sections that have S.S. interior liners). Door insulation shall be 2" 3.0 lb/cu ft density.

2. Hinged, double wall, insulated, man size access doors shall be provided in all sections requiring access for maintenance or service. Access doors shall be fully gasketed with a closed cell, replaceable neoprene gasket. The gasketing material shall be installed to allow for easy removal and replacement. Access door must not leak more than 25 CFM @ 6" static pressure.

Door hinges and latches shall be easily adjustable, without the use of shims or special tools, to allow for a tight seal between the door and the doorframe as the gasketing material compresses over time. The door hinge design shall allow for field modification of door swing and doors shall be easily removable. Provide door detail drawing with submittal package.

Latches shall utilize knurled knobs. The latch assembly shall incorporate a built-in safety catch to release cabinet operating pressure prior to opening the door.

Doors entering into any section of the air handler that contains rotating fans shall be provided with zinc-plated nuts in lieu of knurled knobs. The nuts shall limit access to personnel with proper tools.

I. Insulation:

1. The wall, ceiling and floor panels shall be insulated with 2" – 1 1/2# duct board insulation secured in place with insulation retainers and Grip-Nail fasteners welded in place when necessary. Insulation shall be NFPA-90a rated. Insulation shall have thermal conductivity K factor of .24 (Btu in./hr. sq ft °F) (@75°F mean) (R value = 7.8).

J. Painting:

1. All panels (wall and ceiling) shall be coated with Polyurethane primer and automotive grade polyurethane semi-gloss top coat. Paint color shall be custom color selected by Architect. Industrial grade primer shall be applied by air brush to 2 mils thickness and polyurethane top coat shall be applied by air brush to 6 mils thickness, for a total dry thickness of 8 mils. Paint system shall offer excellent color retention, low fade characteristics, excellent UV resistance, very good resistance to solvents, chemical fumes, acids and alkalis, and very good abrasion resistance. Paint system shall pass a minimum of 1000 hr. salt spray test per ASTM B-117. Test documentation shall be available upon request. Unit panels manufactured with Stainless Steel will not be painted.
2. Structural steel base and unit floor shall be coated with Polyurethane primer and automotive grade polyurethane semi-gloss top coat. Paint color shall be Gray. Industrial grade primer shall be applied by air brush to 2 mils thickness and polyurethane top coat shall be applied by air brush to 6 mils thickness, for a total dry thickness of 8 mils. Unit floors manufactured with Stainless Steel will not be painted.

K. Coils:

1. Heat recovery coils shall be of the plate fin extended surface type and ARI 410 certified. The primary surface shall be a minimum of 5/8" outside diameter seamless copper 0.020" minimum wall thickness, and shall be

expanded into the fin collars to provide a permanent mechanical bond: no metallic or thermal bonded materials shall be used. The secondary surface shall be flat or formed of 0.006" aluminum fins and shall be spaced not closer than 12 fins per inch with integral spacing collars that cover the tube surface. All coils shall be constructed with .025" thick brazed replaceable return bends. Same end connections are required. [Headers shall be non-ferrous seamless copper (cast iron headers are not acceptable), and provided with bronze brazed [steel] male pipe connections and separate 3/8" diameter pipe vent and drain connections extended through unit casing. All coils shall be fully drainable with no trapped tubes by design]. All coils shall be counterflow construction, with connections left or right hand as specified on the drawings. The use of internal restrictive devices "Turbs" to obtain turbulent flow will not be accepted.

2. Coil casings shall be minimum 16 gauge Stainless steel with double formed 1 1/4" flange on all sides of coil with tube sheets having extruded tube holes. Coil casing reinforcements shall be furnished so that the unsupported casing length is not over 60". Reinforcements shall be made of same material as coil casing.
3. All tubes shall be tested at a minimum of 1500 PSIG and all assemblies tested under water at 350 psig and rated for 180 psig working pressure.
4. The coils shall be arranged for easy removal and coils shall be supported by 12 gauge stainless steel support channels. Coils shall be carefully blanked off with 16 gauge 304 stainless steel to insure no air bypasses the coil. The coil headers shall be located inside the cabinet casing with only the male pipe connections extending through the cabinet and cabinet penetration sealed air tight.
5. Coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from .08 - 1.2 mil on all surface areas including fin edges. Superior hardness characteristics of 2H per ATSM D3363-92A and a cross-hatch adhesion of 4B-5B per ASTM B3359-93. Humidity and water immersion resistance shall be up to a minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 5,000 hours salt spray per ASTM B117-90.

L. Hi-Efficiency Filter Section (Up/Downstream Loading):

1. Filter section shall be factory fabricated as part of air handling unit. Filters shall be 65% efficient arranged for upstream loading into positive sealing stainless steel filter frames. Frames shall be welded together, structural supports welded to frames and then the filter rack assembly mounted in air handler. Filter rack shall be thoroughly caulked and sealed to minimize filter bypass.
2. Provide with positive sealing stainless steel filter frames compatible with the filters shown on the schedule.
3. Air handling unit manufacturer shall provide and flush mount (for each filter section), a Dwyer 2000 (or approved equal) Magnehelic air filter gage with weatherproof housing.

M. Hi-Efficiency Side Access Filter Section:

1. Filter section shall be factory fabricated as part of air handling unit. The side access filter rack shall accept 2" medium efficient pre-filters. Filter rack shall be thoroughly caulked and sealed to minimize filter bypass.
2. Air handling unit manufacturer shall provide and flush mount (for each filter section), a Dwyer 2000 (or approved equal) Magnehelic air filter gage with weatherproof housing.
3. Provide access door on side of unit per drawings.

N. Mixing Box Section:

1. Mixing box section shall be complete with opposed blade type dampers and linkage. Inlet sizes shown are minimum allowable, in order to keep damper pressure drop and noise to a minimum. Opposed blade low leakage air foil control dampers with extended shaft for connection to an operator. The dampers shall be all aluminum construction. Rain hoods shall be provided with each damper. The dampers shall be controlled by a 24V electric operators
2. Low leakage isolation bypass dampers shall be constructed of aluminum air foil extrusions and epoxy coated 10 mils DFT. Operators shall be 2 position, spring return and shall be 24V/110V electric unless variable frequency drives are specified. Electric operators shall be factory wired (via a transformer when required) to the fan disconnect switch to open when the fan is energized and close via a spring return when de-energized. When the fan ships separate from the plenum, all wiring and conduit shall be factory supplied for easy connection in the field.
3. Provide weather hoods where shown on drawings. All weather hoods shall be fabricated with 16 gauge galvanized steel and painted to match unit exterior. Weather hood shall have 1/2" (13mm) mesh, 19 gauge galvanized bird screen. Weather hood shall be 60 deg design and sized at a maximum of 600 fpm. Weather hoods will not extend beyond the horizontal envelope of unit dimensions by more than 40" and requires a minimum of 3' clearance for proper performance.

2.06 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:

1. Greenheck Corp.
2. Loren Cook Company
3. Twin Cities.
4. Substitutions: Division 01 - Product Requirements.

B. Fan Unit: Downblast type. V-belt drive, with spun aluminum with baked-on enamel housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Open drip proof or TEFC suitable for application.
- E. Roof Curb: 24 inch (600 mm) high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch (25 mm) insulation and curb bottom, interior baffle with acoustic insulation, curb bottom and factory installed nailer strip.
- F. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 250 Type 3R enclosure.
- G. Accessories:
 - 1. Motor Operated Damper: Aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return.
 - 2. Fan speed controller.
- H. Electrical Characteristics and Components as scheduled.

2.07 UPBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
 - 1. Greenheck Corp.
 - 2. Loren Cook Company
 - 3. Twin Cities.
 - 4. Substitutions: Division 01 - Product Requirements.
- B. Fan Unit: Upblast type. V-belt drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Open drip proof or TEFC to suit application.
- E. Roof Curb: 24 inch (600 mm) high galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch (25 mm) insulation and curb bottom and factory installed nailer strip.

- F. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.
- G. Accessories:
 - 1. Motor Operated Damper: Aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open, spring return, except kitchen hood exhaust fans.
 - 2. Fan speed controller.
- H. Fans used for grease removal (kitchen hood exhaust) shall have UL 762 label.
- I. Provide roof curb extension to raise fan discharge for code compliance.

2.08 INLINE CEILING FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
 - 1. Greenheck Corp.
 - 2. Loren Cook Company
 - 3. Twin Cities.
 - 4. Substitutions: Division 01 - Product Requirements.
- B. Configuration: Inline.
- C. Centrifugal Fan Unit: Direct driven or belt driven as scheduled, with galvanized steel housing lined with 1/2 inch (13 mm) acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral inlet and outlet duct collar. Provide insulated hood over motor and drive.
- D. Disconnect Switch: Fan-mounted toggle switch for thermal overload protected motor.
- E. Wheel: Double width, double inlet Centrifugal forward curved type constructed of injection molded or polypropylene resin.
- F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection, mounted on vibration isolators.

2.09 DUCT BLOWER OR CABINET FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
 - 1. Greenheck Corp.

2. Loren Cook Company
 3. Twin Cities.
 4. Substitutions: Division 01 - Product Requirements.
- B. Product Description: V-belt drive with galvanized steel housing lined with 1inch (25 mm) acoustic glass fiber insulation, removable side panel for access, inlet and outlet duct collar horizontal hanging brackets.
- C. Fan Wheel: Double width-double inlet backward inclined forward curved centrifugal type.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- E. Motor and Drive Mounting: Out of air stream.
- F. Motor: Open drip proof or TEFC mounted on vibration isolators to suit the application.
- G. Bearings: ABMA 9 life at 200,000 hours.
- H. Accessories:
1. Belt guard.
 2. Disconnect Switch: NEMA 250 Type 1, heavy duty enclosure.
 3. Slide out filter box with throwaway type filter.
 4. Wall-mounted fan speed switch.

2.10 CENTRIFUGAL SQUARE INLINE FANS

- A. Manufacturer: Subject to requirements of the specification, provide the following manufacturer's products by one of the following or approved equal:
1. Greenheck Corp.
 2. Loren Cook Company.
 3. Twin Cities.
 4. Substitutions: Division 01 - Product Requirements.
- B. Product Description: V-belt drive with galvanized steel housing lined with 1 inch (25 mm) acoustic glass fiber insulation, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.

- C. Fan Wheel: Backward inclined centrifugal type, aluminum construction.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- E. Motor and Drive Mounting: Out of air stream.
- F. Motor: Open drip proof or TEFC to suit the application
- G. Bearings: ABMA 9 life at 200,000 hours.
- H. Accessories:
 - 1. Belt guard.
 - 2. Motor cover with insulation.
 - 3. Inlet safety screen.
 - 4. Outlet safety screen.
 - 5. Flexible duct connector.
 - 6. Filter box with throwaway type filter.
 - 7. Flanged inlet and outlet.
 - 8. Inlet and Outlet ductwork companion flange.
 - 9. Disconnect Switch: NEMA 250 Type 1, heavy duty enclosure.
 - 10. Fan speed controller.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Division 01 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.02 PREPARATION

- A. Install roof curbs and connect to roof structure.

3.03 INSTALLATION

- A. Secure roof and wall fans with cadmium plated steel lag screws to structure.

- B. Suspended Cabinet Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
- C. Install motorized dampers on inlet to roof and wall exhaust fans.
- D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.
- E. Install safety screen where inlet or outlet is exposed.
- F. Pipe scroll drains to nearest floor drain.
- G. Provide adjustable sheaves required for final air balance. Replace adjustable sheave with fixed sheaves after balancing as required.
- H. Each fan shall be factory painted inside and out with high grade machinery grey enamel paint.
- I. Fans with wheel diameters up to 27 inches shall have overhung wheel and pulley, Arrangement 2. Fans with larger diameter wheels shall have overhung pulley, Arrangement 3. Fans with wheels 24 inches and larger shall have cleanout door in scroll, with wedge type latches.
- J. Fans too large to pass through available doorways may be split in halves along center of shaft, with hubs, etc., arrange to bolt together when erected. Such bolts shall have double nuts and cotter pins to prevent same from loosening. Provide scroll drains in all fans.
- K. Fan wheel diameters shown are minimum diameter. Fan BHP indicated for each duty shall not be exceeded over its entire operating range.
- L. Exhaust fans exposed to outdoor weather shall have two coats of chlorinated rubber base paint applied in the factory.
- M. Insulated fans: Cleanout doors shall be raised type to finish flush with outside of insulation covering.
- N. Provide galvanized angle supports, steel, rods and isolators for support of fans to be supported from structure above.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Division 01 - Quality Requirements: Requirements for manufacturer's field services.
- B. Before start-up, factory technician shall be on site to certify the alignment in a written report.

- C. Furnish services of factory trained representative for minimum of one (1) day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.05 CLEANING

- A. Division 01 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of fan cabinet.

3.06 DEMONSTRATION

- A. Division 01 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate fan operation [and maintenance procedures].

3.07 PROTECTION OF FINISHED WORK

- A. Division 01 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION