

SECTION 15834
HIGH PLUME DILUTION FANS

PART 1 - GENERAL

1.01 PROVISIONS INCLUDED

- A. The general provisions of the Contract, including General and Supplementary Conditions, and Division 1 General Requirements, apply to work specified in this Section.
- B. Requirements of Section 15050, "Basic Mechanical Materials and Methods" apply to work specified in this Section.

1.02 SUMMARY

- A. This Section includes high-plume dilution fans.
 - 1. Exhaust fans
 - 2. Heat recovery coils
 - 3. Filter section
 - 4. Fan isolation dampers with actuators
 - 5. Electric power wiring and fan disconnects
 - 5. Access doors and panels

1.03 SUBMITTALS

- A. Product data for selected models, including specialties, accessories, and the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound power ratings.
 - 3. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- C. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- D. Maintenance Data: Provide comprehensive operation and maintenance data.
- E. Submit published discharge volume for all fans at specified primary exhaust flow.

1.04 OPERATION AND MAINTENANCE MANUALS

- A. Basic O & M material requirements:
 - 1. All information must be project specific. Edit vendor O & M manuals to reflect exact equipment supplied. Cross out extraneous information not applicable to the specific equipment provided.

2. Provide complete data relative to make/model number, size, capacity data, manufacturer name and address, accessories included, etc.
 3. If equipment contains multiple subassemblies provided by different manufacturers, include make/model number, size, capacity data, etc. for each subassembly.
 4. Include fan curves and sound power levels for all fans.
 5. Include clean and dirty filter pressure drops for all filters.
- B. Include a list of recommended spare parts and a schedule of required lubricants, as recommended by the Manufacturer. Include all nameplate information and shop order numbers for each item of equipment and component part thereof. Include all data including serial numbers as well as the complete motor nameplate data of the associated motor.
- C. Provide six copies of complete and final operation and maintenance manuals, including one set, suitable for reproduction.

1.05 QUALITY ASSURANCE

- A. Testing:
1. Test and rate fans under AMCA 210-85, Laboratory Methods of Testing Fans for Rating, or British Standard 848, Part I, Methods of Testing Performance, 1980,
 2. Fans tests shall have been witnessed by an independent agency.
 3. Fans shall be tested and rated for air performance, aspiration, sound and vibration in the specified configuration with high velocity discharge nozzles and induction wind bands installed. Fan curves and fan performance de-rating based on calculated estimates are not acceptable.
 - a. Provide documented aspiration tests performed in conjunction with the fan performance test.
 - b. Sound testing shall be in accordance with AMCA 300 in a laboratory built to AMCA standards. Fans shall be guaranteed to meet specified octave band sound levels.
- B. UL compliance:
1. Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
 2. Fans and components shall be UL listed and labeled.
 3. Listing and Labeling: Provide electrically operated fixtures that are listed and labeled. The Terms "listed" and "Labeled" shall be as defined in the National Electrical Code, Article 100.
- C. AMCA compliance:
1. Standard 500, Damper leakage test procedure.
 2. Standard 210-99, Laboratory methods of testing fans for ratings,
 3. Standard 300-96, reverberant room method for sound testing of fans.
- D. NEMA Compliance: Provide motors and electrical accessories that comply with NEMA standard MG-1-1993.
- E. NFPA compliance:

1. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
2. Fans shall meet the criteria of NFPA-45.

F. Comply with USM IDAT per section 01810.

1.06 SEQUENCE AND SCHEDULING

- A. Coordinate fabrication and unit delivery with awarded contractor.
- B. Lift and support units with the manufacturer's designated lifting or supporting points.
- C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
- D. Coordinate the size and location of structural steel support members.

1.07 WARRANTY

- A. Provide seven year warranty service by the unit manufacturer's authorized representative. Warranty shall commence upon date of substantial completion of project. Date of substantial completion is the date of acceptance by the Owner or the Owner's Agent based on successful start-up and operation of the units in support of the building's load. If Manufacturer's conditions for standard warranty will not cover seven years past date of substantial completion, provide manufacturer's extended or special warranty to cover this period.

1.08 SPARE PARTS

- A. Extra Materials: Furnish the following spare parts for each High plume dilution fan / Energy recovery coil units to the owner; obtain receipt:
 1. One set of matched fan belts for each belt-driven fan.
 2. One spare set of filters of each type and size.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

Subject to compliance with requirements, provide products of one of the following:

- A. Energy recovery units:
 1. Strobic Air
 2. Cambridgeport
 3. Dynamic Air Corp
 4. Greenheck
- B. High plume dilution exhaust fans:
 1. Strobic Aire
 2. Greenheck
- C. Low leakage dampers:

1. Arrow AFD-20
 2. Ruskin CD-50
 3. Johnson D-1300 Airfoil
- D. Acoustical louvers:
1. Arrow 401-HL.
 2. Ruskin Mfg. Div, Phillips Industries, Inc.
 3. Construction Specialties, Inc.
- E. Heat recovery coils:
1. Marlo
 2. Heatcraft
 3. Aero-fin
 4. RAE Corp.
- F. Filters:
1. American Air Filter
 2. FGI
 3. Farr Co.
- G. Damper actuators:
1. Delta Controls – 480 series
 2. Belimo
 3. Johnson Controls

2.02 MIXED FLOW HIGH PLUME EXHAUST FANS

- A. Direct drive, Arr. 4 with impeller mounted directly to the motor shaft. Motor shall be isolated from the primary exhaust air stream and shall be visible and accessible from the fan exterior for inspection and service.
1. Provide modular construction fans capable of being assembled on site.
 2. Provide PTFE gaskets at all companion flanged joints.
 3. Fasteners shall be a combination of 316 stainless steel and monel to prevent binding.
 4. Provide bolted access door for impeller inspection.
 5. Provide an internal drain system for fans and accessories to prevent rain water from entering building duct systems.
 6. Coatings - All steel and aluminum surfaces of fan, roof base, attenuator and wind band shall be prepared for coating by blasting or chemical etching. Coating will be Corrosion Resistant Interzone 954 Epoxy Phenolic.
 - a. Intermediate Coat 4-5 mil
 - b. Interthane 990 Top Coat 4-5 mil – color to match existing, as selected by architect.
 7. Bearings: air handling quality, heavy duty grease lubricated, ball or roller type. Select bearings for a Basic Rating Life, (L₁₀) of 100,000 hours at maximum operating speed and horsepower for each construction level.
- B. Mixed flow impeller with combination axial-backward curve blades. Welded steel construction stationary discharge guide vane section. Non-stall and non-overloading characteristic with stable operation at any point on the fan curve. The fan shall be able to operate with the inlet isolation damper at full shutoff without any increase in vibration.

1. Provide a non ferrous inlet bell.
 2. Fan shall be spark-resistant construction per AMCA "C".
 3. Provide a vortex breaker at fan inlet.
 4. Provide stationary discharge guide vane sections.
 5. Provide fan and sound attenuator assemblies designed for mounting without the need for guy wire supports.
 6. Fan dynamic balance not to exceed 0.50 mil, peak-to-peak, at the blade pass area when operating at fan frequency. Limit isolation to rubber-in-shear pad type isolator.
- C. FRP discharge nozzle:
1. Provide two piece discharge nozzle for motor access.
 2. Provide a heavy duty fiberglass entrainment wind band to provide secondary induction of outside air. Induction shall take place downstream of the fan impeller.
 3. Size and selected fans that do not have full size induction wind bands on the discharge, and the required documented aspiration tests to induce secondary air into the inlet mixing plenum upstream of the blade fan inlet to match the specified fan discharge cfm.
- D. Electric motors shall be TEFC mill and chemical duty with a 1.15 service factor; C-Face and foot mounted.
1. Provide heavy duty grease lubricated ball or roller type motor bearings with a basic rating life, (L₁₀) of 100,000 hours. Motors shall have sealed bearings up through a 256T NEMA frame.
 2. Provide motors compatible with the drive and use of the VFD shall not adversely effect the operation, useful life, or warranty.
 3. Provide a minimum Class F or H insulation as required.
 4. Provide NEMA 3R non-fused knife type disconnect switch for each fan, mounted and wired to their respective motor. Disconnects shall be suitable for use with a VFD.
- E. Accessories: The following accessories are required :
1. Discharge attenuator: Provide a self supporting modular discharge attenuator for each fan. The silencer shall be designed as an integral component of the exhaust fan discharge nozzle.
 - a. Maximum air pressure drop shall be 0.01" W.C. when installed.
 - b. Constructed from fiberglass and all welded galvanneal steel, with a structural fiberglass outer wall and 22 ga. perforated inner wall.
 - c. Colored or coated to match the fans.
 - d. Acoustic media: 3# density fiberglass isolated from the air stream by a Mylar or tedlar film, non fibrous acoustical media, or pack less with no acoustical fill.
 - e. Provide silencer attenuation values and fan sound pressure as specified in the following schedule. The published insertion loss values shall be obtained from testing with the silencer installed on the fan in the specified configuration.

| | | Octave Band Center Frequency (Hz) | | | | | | | |
|-------------------------|--------|-----------------------------------|-----|-----|-----|------|------|------|------|
| Fan Size/Silencer Model | Length | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| TS3-DNS | 88" | 8 | 7 | 12 | 15 | 15 | 13 | 10 | 6 |

- f. The fan with the specified silencer shall have an operating sound pressure level measured at a distance of 30 Ft. from the fan as follows:

| | | Octave Band Center Frequency (Hz) | | | | | | | |
|-------------------------|--------|-----------------------------------|-----|-----|-----|------|------|------|------|
| Fan Size/Silencer Model | Length | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| TS3-DNS | 88" | 60 | 69 | 64 | 60 | 59 | 57 | 58 | 52 |

2. Maintenance davit and davit socket with socket positioned to remove each fan/motor.

F. Alternate fan arrangement: Include the following items:

1. Belt drive fans, or direct drive fans with horizontally mounted motors.
 - a. Motor Bearings: heavy duty grease lubricated, ball or roller type with a Basic Rating Life, (L₁₀) of 100,000 hours. Motors shall have sealed bearings up through a 256T NEMA frame.
 - b. Fan Bearings: air handling quality, heavy duty grease lubricated, ball or roller type. Select bearings for a Basic Rating Life, (L₁₀) of 100,000 hours at maximum operating speed and horsepower for each construction level.
2. Seismic rated spring vibration isolators compliant with Section 15070. Isolation of the fan mixing plenum is not acceptable.
3. ¼" thick neoprene inlet and outlet flexible connectors on the fan inlet and discharge.
4. A welded structural steel mounting frame fabricated of 3" X 3" X 3/8" steel angle designed to allow the fans to be suspended from the framework and separated from the plenum and the building structure with the spring isolators and the flexible connectors.
5. The structural steel framework shall also support the fan discharge Silencer and architectural screen enclosure. The framework and silencer shall be rated for a 120 mph wind load without supplemental structural supports or guide wires.
6. 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.

2.03 ENERGY RECOVERY UNIT

A. FACTORY BUILT MODULAR UNITS

1. Base shall consist of steel beams or channel for direct bearing support for components in casing, and shall be painted with Rustoleum primer and Rustoleum exterior enamel. Exterior color will be selected by Owner. Base shall have minimum of four removable ½" thick steel lifting lugs at corners of each module. Provide back-to-back channels at each shipping split.
 - a. The exhaust air handler base shall be fabricated to allow the unit to counter flash the curb by a minimum of 1.5".
 - b. Floor
 - Floor shall be of 12 gauge steel plate welded to sub-base. Provide 12 gauge thick galvanized steel flooring in exhaust section. The floor covering shall have a 2" flange turned-up on the outer perimeter of the unit to form a watertight drain pan. All seams in the floor shall be continuously welded. Pan shall be braced to support internal equipment components without sagging or pulsating. Provide drains with Type L copper piping extending through sides of unit base in each compartment. Drains to be 2" diameter, with grating material at the floor surface.

- Underside shall be insulated continuously with 2 in. thick rigid, high density fiberglass or polyisocyanurate foam insulation. For installations mounted on steel platforms the bottom of base shall be covered with min. 18 ga. galvanized sheet metal and sealed weather tight at all joints and penetrations.
 - Unit foot print: not to exceed 7'-8" X 16'-0" out to out.
2. Housing walls and roof shall be galvanized, separate frame and panel or integral frame and panel.
- a. Panel skin thickness, stiffener and frame spacing and thickness, and core density shall be designed to eliminate panel pulsation and to limit maximum deflection to 1/200 of any span at design positive or negative pressures. Design pressure shall be equal to 1.5 times fan static pressure.
 - b. Panels: double wall with interior sheet and non-perforated exterior sheet. Panels shall be 2" thick with 2" polyisocyanurate foam insulation and an overall "U" factor of .10 BTU/Hour/Square foot/Deg F. All panel seams shall be designed to ensure complete air seal.
 - c. Exterior skin: 16 gauge galvanized steel with 8-10 mil DFT Ameron 385 epoxy exterior finish factory applied – color to match existing, as selected by architect.
 - d. Interior skin in exhaust air section: 16 gauge galvanized steel. Section safing walls shall be 1 inch thick double wall insulated.
 - e. Roof panels: peaked in center - sloping to each end, with 16 gauge galvanized exterior, with a minimum pitch of 1/8" per foot. Interior skin shall be same as walls.
 - f. Access doors:
 - double wall construction as specified for panels; 2" thick with integral frame - double gasketed, tapered to allow for door swing and easy panel removal.
 - at least 54" high x 24" wide, unless noted otherwise, and shall have three hinges and three tapered latches to force door against gasket. All hinges are to be Kason #1070.
 - suction side of fan shall swing out . Latches shall operate from both sides of door.
 - g. Panels: factory-sealed, air tight at corners and seams without visible caulking on casing exterior. Modules shall be assembled with caulking and gasketing in field and shall be air tight without exterior visible caulking.
 - h. Safing panels to seal coils, filter banks and attenuator banks to casing and casing to building structure: aluminum or stainless steel for heat recovery coils and aluminum, stainless or galvanized steel otherwise.
3. Roof: slightly pitched as indicated. After complete unit assembly, cover roof with continuous rubber Hypalon membrane roofing system with 20 year warranty, such as Tremco Lexply, or standing seam roof equal to exterior panel construction. Roof membrane shall be installed by unit Manufacturer. Provide 16 gauge galvanized flashing for roof perimeter, with prime finish. Provide rain gutters over exterior access doors.
4. Fan Support Curbs
- a. Provide fan support roof curbs integral to the enclosure for each exhaust fan. Roof curbs shall be 12" high with inner skin, outer skin and insulation to match air handling unit and internal structural reinforcement.

- b. Provide a vortex breaker at fan inlet.
5. Unit Support Curbs: Provide 18" high full surround unit support roof curb. Provide roof curb shall with inner skin, outer skin and insulation to match housing with internal structural reinforcement.
 6. Duct Connections: Provide duct connections as shown on drawings, with 4" insulated duct collars.
- B. Provide exhaust heat recovery coils for 40% propylene glycol and water. Provided ARI certified coil performance ratings.
- C. Glycol heat recovery coils:
1. 5/8" O.D., 0.035" thick wall copper tubes with helically wound .01" thick aluminum fins.
 2. Casing: 16 ga. stainless steel with 1.5" punched flange.
 3. Connections: 3" Carbon Steel MPT and turned toward entering face; Same end connections.
 4. Turbulators: where required to improve heat transfer and prevent laminar fluid flow.
 5. Coil frames: 12 Ga. Stainless steel factory-fabricated frame independent of unit casing.
- D. Filter Section:
1. Provide side service tracks with gaskets
 2. Filters: 2" deep, 20-25% efficient, 3 ply link panel type; 80% efficient on particles 5 micron and larger.
 3. Provide a magnehelic pressure gauge for each filter bank.
 4. Provide hinged and latched filter service access door for each filter bank.
- E. Dampers
1. Provide aluminum, opposed blade bypass damper on each side of the plenum for mixing outside make-up air with primary exhaust. Dampers shall have a 1/2" square mesh screen on the inlet side. Dampers shall have a heavy duty manual locking quadrant.
 2. Provide heavy duty, low leakage extruded aluminum, parallel blade fan isolation dampers at the exhaust duct connection. Dampers shall have vinyl blade edge seals, stainless steel spring jamb seals, 1.5" x 8" x 1.5" extruded aluminum frame, jamb mounted concealed linkage and nylon bearings. Coat dampers with two coats of white epoxy phenolic. Provide dampers with an extended shaft projecting through the plenum sidewall for connection to a two position, spring return electric actuator. Mount actuators and linkage in weatherproof enclosures outside the plenum. Damper shaft extensions shall be provided with a support bushing at the plenum wall.
 3. Leakage characteristics: 6 CFM per sq. ft. at 4" w.c. differential pressure. Dampers shall be suitable for 9" w.c. static pressure and 6,000 FPM free velocities.
 4. Frames and blades to be minimum 12 gauge. (.081") extruded aluminum. Blades to be of single unit air foil design, 6" wide with the PIN-Lock an integral section within the blade core.
 5. Provide overlapping blades and seals to assure minimum air leakage. Provide extruded silicone seals fit into a ribbed groove insert in blades with a formed stainless steel, spring steel at the jamb.
 6. Frames: extruded aluminum channel with reinforcing bosses.

7. Pivot rods: ½" dia. extruded aluminum, PIN-LOCK design interlocking into blades section. Bearings to be Double Sealed type with Celcon inner bearing on rod riding in Polycarbonate outer bearing inserted in frame so that outer bearings cannot rotate.
 8. Rod bearings shall be designed so that there shall be no metal-to-metal or metal-to-bearing riding surfaces. Inter-connecting linkage to have separate Celcon bearing to eliminate friction in linkage.
 9. Blade linkage hardware: non-corrosive reinforced material or cadmium-plated steel. All linkage shall be concealed in damper frame.
- F. Electrical: Pre-wire energy recovery unit in the factory to require a single point connection for a weatherproof convenience receptacle on the unit base exterior and fluorescent lighting fixtures in the filter section. Wire lighting to a weatherproof switch adjacent to the primary access. Provide vapor-proof fixtures with cold start ballasts.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, roof curbs, equipment supports, and other conditions affecting performance of fans.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install roof curbs and fans level and plumb, in accordance with manufacturer's written instructions.
- B. Arrange installation of units to provide access space around fans for service and maintenance. Locate equipment with minimum service area size and location recommended by manufacturer.

3.03 CONNECTIONS

- A. Duct installations and connections are specified in other Division 15 sections. Make final duct connections with flexible connections.
- B. Electrical Connections: The following requirements apply:
 1. Provide temperature control wiring and interlock wiring are specified in Division 15 Section "Control Systems".
 3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.04 ADJUSTING, CLEANING, AND PROTECTING

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

- C. Lubricate bearings.
- D. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- E. Clean unit interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and housing.

3.05 START UP AND TESTING

- A. Perform the following operations and checks before start-up:
 1. Remove shipping blocking and bracing.
 2. Verify unit is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Verify that manual and automatic volume control and fire dampers in connected ductwork systems are in the full open position.
 7. Disable automatic temperature control operators.
- B. Starting procedures for fans:
 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
- C. Shut unit down and reconnect automatic temperature control operators.
- D. Refer to Section 15950 "Testing, Adjusting, and Balancing" for procedures for fan-system testing, adjusting, and balancing.

3.06 DEMONSTRATION

- A. Comply with USM IDAT per section 01810.
- B. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
 1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 2. Familiarization with contents of Operating and Maintenance Manuals specified in Section 01770 "Project Closeout" and Section 15050 "Basic Mechanical Materials and Methods."

- C. Schedule training with at least 7 days advance notice.

3.07 CONTROLS

- A. Provide variable frequency drives for EF-19, 20 & 21 in FEU-2 each with by-pass and Hand-Off-Auto Switch
- B. When the H-O-A switch is in the Hand position, the corresponding fan motor shall be energized and the fan shall run. When the switch is on the Off position, the fan motor shall be de-energized and the fan shall remain off. When the switch is on Auto (normal operational position), signal corresponding fan to start/stop through building DDC system.
- C. Interlock FEU-2 with AHU-4 such that the energy recovery system shall start and run when AHU-4 is started. Fans in FEU-2 shall remain off if AHU-4 is scheduled off or signaled off on safety.
- D. Indicate exhaust fan operation to the DDC system by fan motor current sensor. A variation from current draw limits on the running fan shall constitute exhaust fan failure alarm.
- E. Modulate the variable frequency drives in unison to maintain exhaust duct static pressure set point. The system is designed for one fan redundant (off). The system shall also measure general exhaust air flow.
- F. Provide a normally closed, spring return isolation damper upstream of the inlet to each exhaust fan. When the fan is commanded on, the isolation damper shall open. Damper position shall be confirmed open via an end switch. The isolation damper actuator shall be wired in series with the fan VFD through an integral transformer to ensure that fan and damper operation is interlocked, and that both start simultaneously. When the fan is commanded off, the isolation damper shall automatically close. (Note: The fan has a non-stall characteristic and can run against a fully closed damper).
- G. With the duct static pressure at its set point and the air flow measuring station indicates the discharge velocity from the operating fans is falling below 3,000 fpm the DDC controller shall modulate the outside air bypass damper(s) (*normally closed, spring return*) to maintain the minimum discharge velocity at its set-point. Upon an increase in flow rate above the set point the outside bypass dampers shall modulate closed to allow the flow rate and the static pressure control to maintain the system pressure and flow rate.

END OF SECTION 15834