

2.0 SECTION 23 82 20 - FANS, AIR INTAKES AND RELIEF VENTS

**PART 1 - GENERAL**

1.2 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 01 00, "Mechanical General Provisions", govern this Section.

1.3 DESCRIPTION OF WORK:

- A. Work Included: Provide supply and exhaust fans, air intakes, and relief vents as scheduled and indicated.
- B. Types: The types of fans, outside intakes and relief vents required for the project include, but are not limited to, the following:
1. Centrifugal roof exhaust fans.
  2. Centrifugal upblast roof exhaust fans.
  3. Sidewall propeller exhaust fans.
  4. In-line exhaust/transfer fans *[may be used for renovation only]*
  5. Utility exhaust fans.
  6. Upblast smoke exhaust fans.
  7. Vane axial supply/exhaust fans.
  8. Air intakes.
  9. Relief vents.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
1. Acme.
  2. Carnes Company, Inc.
  3. Cooke.
  4. Flakt Products, Inc.
  5. Greenheck Fan Corporation.
  6. Peerless.
  7. Penn Ventilator Company.
  8. Trane Company.
  9. Woods Fan Division.
- B. AMCA Seals: Provide fans which are rated per AMCA standards and bear the AMCA-certified rating seal.
- C. Electrical Standards: Provide electric motors and products which have been listed and labeled by Underwriters' Laboratories, Inc. (UL) and comply with National Electrical Manufacturer's Association (NEMA) standards.

1.5 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
1. Cut sheets clearly indicating fans, air intake and relief vent construction, dimensions, ratings, capacities, and accessories.
  2. Cut sheets on roof curbs clearly indicating dimensions, required roof openings, and flashing details.
  3. Fan curves with fan selection point clearly indicated.
  4. Fan drive selection calculations.

5. Motor data as required in Section 23 04 00, "Motors and Controllers".
6. Additional information as required in Section 23 03 00.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver fans, intakes, vents, and accessories carefully to avoid damage to material components, enclosure, and finish.
- B. Handle fans, intakes, vents, and accessories carefully to avoid damage to material components, enclosure and finish.
- C. Store fans, intakes, vents, and accessories in a clean, dry space, and protect from the weather.

**PART 2 - PRODUCTS**

**[REFER TO TEXT AFTER END OF SECTION FOR ADDITIONAL FAN TYPES]**

2.1 GENERAL FAN REQUIREMENTS:

- A. Ratings: Fans shall be licensed to bear the AMCA-certified ratings seal. Ratings of fans shall be not less than the values shown on the Drawings, based on 69.8°F and 29.92" of Hg atmospheric pressure.
- B. Construction: Fan construction shall be in accordance with AMCA classes of construction for the intended duty. Fan wheels, shafts, and drives shall be statically and dynamically balanced at the factory as a unit. Balancing shall be factory-certified.
- C. Motors: Fan motors shall be 1750 rpm open drip-proof (ODP) or totally-enclosed, fan-coded (TEFC) type as required for the application. Motors 5 hp and larger shall be energy efficient, high efficiency type. Motors shall be selected to be nonoverloading with the fan provided. Refer to Section 15140 for additional motor requirements.
- D. Drives: Provide drives with a minimum belt horsepower capacity of 165% of the motor nameplate horsepower. All fans requiring 1-1/2 hp or larger motor shall include the fan drive selection calculations with the submittal. The selection calculations shall include the correction factor for arc of contact. The submittal data shall identify the source of the selection data.
- E. Motor Sheaves: Motor sheaves shall be Browning Type, MVP, or approved equal, adjustable type with double locking feature. Motor sheaves shall be selected for the rated fan rpm and shall be adjustable to as close as 10% above and below the rated fan speed. Provide fixed sheaves for all motors 3 hp and larger after proper speed has been determined during system balancing.
- F. Fan Sheaves: Provide nonadjustable sheaves with removable machined bushings. Sheaves shall be machined on all surfaces. Sheaves with over three grooves shall be dynamically balanced and the manufacturer shall so designate on each sheave. Fan sheaves with three grooves or less shall be statically balanced and weights required for balancing shall be welded to the sheaves. Manufacturers shall be Browning, Eaton, Yale and Towne, Dodge Manufacturing Company, or Fort Worth Steel and Machinery Company.
- G. Belts: Provide standard "V-groove" belts suitable for the service intended with the required capacities. The belts shall be closely matched and tagged prior to delivery to the job site. If the belts do not appear to be properly matched during operation, they shall be rechecked and, if necessary, replaced. Belts shall be as manufactured by Gates, Durkee-Atwood, Goodyear, Browning, or Uniroyal.
- H. Speed Control: All single phase direct drive fans shall be provided with compatible internally mounted solid state speed controllers, unless noted otherwise.
- I. Bearings: Provide SKF, Sealmaster, Timken or Fafnir, externally or internally-mounted, grease-lubricated, self-aligning ball bearings. Bearings shall have grease type Zerk fittings and shall be selected for a minimum B-10 life as defined by AFBMA of **[200,000]** hours, unless specified otherwise.
- J. Motor Mounts: Motors shall be mounted on an adjustable base rigidly supported on the fan and shall have extended shaft to accommodate the adjustable pitch sheave.

2.2 ROOF CURBS:

- A. General: Provide prefabricated, insulated aluminum roof curbs for all roof mounted fans. Curbs shall be of welded construction and roof-over-flashing type with build-in cant and a minimum overall height of 8" above roof surface, unless otherwise noted or required to meet code requirements. Roof curbs

shall be Greenheck Model #GPS or approved equal for roof decks that are not surface insulated and Model #GPR or approved equal for roof decks that are surface insulated. Damper trays shall be provided to facilitate the mounting of the backdraft dampers, where specified or scheduled. Extended base curbs shall be provided when scheduled or required.

### 2.3 CENTRIFUGAL ROOF EXHAUST FANS:

- A. General: Provide Greenheck Model G, GB or approved equal ACME, Cook or Carnes centrifugal roof-mounted exhaust fans with capacities as scheduled.
- B. Construction: Fans shall be centrifugal, belt or direct driven as scheduled. Construction of the fan housing, fan wheel and inlet cone shall be aluminum. Wheels shall be aluminum, non-overloading backward curved, centrifugal type and shall be statically and dynamically balanced to assure smooth and vibration-free operation. The entire drive assembly shall be mounted on vibration isolators. Fans shall be constructed to withstand winds up to 150 mph.
- C. Drives: The wheel shaft on belt drive models shall be ground and polished shafting mounted in heavy duty sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. An adjustable drive shall be used for balancing and then a fixed drive shall be provided.
- D. Motors: Motor and drives shall be isolated from the exhaust airstream and mounted on vibration isolators. Motors shall be of the heavy duty type with permanently lubricated, sealed ball bearings. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]**
- E. Certification: All fans shall bear the AMCA ratings seals for both air flow and sound performance with birdscreens in place.
- F. **[Coatings: Exhaust fans used for fume hood service shall have all fan parts exposed to the air stream coated with a high temperature acid resistant epoxy coating.]**
- G. Accessories: Provide all required accessories including, but not limited to: aluminum birdscreen, **[gravity (preferred) [motorized] backdraft dampers [with end switch]**, prefabricated insulated aluminum roof curb, factory-mounted and wired **[internal NEMA 1] [external NEMA 3R]** disconnect switch and solid state fan speed controllers (direct drive units only) with a conduit through the roof curb for field wiring.

### 2.4 CENTRIFUGAL UPBLAST ROOF EXHAUST FANS: (DINING FACILITIES)

- A. General: Provide a Greenheck Model CUBE, CUBE-HP, or approved equal ACME or Cook upblast centrifugal roof-mounted exhaust fans with capacities as scheduled.
- B. Construction: Fans shall be of belt or direct drive as scheduled, upblast vertical discharge type. Construction of housing shall be heavy gauge aluminum. The windband shall have a rolled bead and additional structural members for added strength.
- C. Wheels: The fan and wheel inlet cone shall be non-sparking aluminum and of the high performance, centrifugal blower type. Wheel shall be statically and dynamically balanced. Construction shall include a built in grease drain.
- D. Motors and Drives: Motors and drives shall be isolated from the exhaust air stream and mounted on vibration isolators. Motors shall be of the heavy duty type with permanently lubricated, sealed ball bearings. Air for cooling the motor shall be taken into the motor chamber by means of an air tube from a location free of discharge contaminants. The entire drive assembly and wheel, shall be mounted on vibration isolators as a unit and shall be removable through the support structure without dismantling the fan housing. The wheel shaft shall be mounted in heavy duty ball bearings. Drives shall be sized for 165% of driven horsepower. Pulleys shall be adjustable cast iron type, keyed to the fan and motor shafts. The entire drive assembly shall be mounted on rubber vibration isolators. Motors shall be 1750 rpm open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]**
- E. Certification: All fans shall bear the AMCA Certified Ratings seal for both air and sound performance.
- F. Accessories: Provide all required accessories including, but not limited to: aluminum birdscreen, **[extended base to conform to NFPA 96 requirements for fan discharge a minimum of 40" above roof,]** fan UL-listed and labeled for grease removal (UL 762), **[grease drain connection and trap (for**

**all kitchen hood exhaust fans),] [insulated motor heat baffle (for kitchen exhaust fans).] [gravity] [motorized] backdraft dampers [with end switch (for all fans except kitchen hood exhaust fans)], prefabricated insulated aluminum roof curb, factory-mounted and wired [internal NEMA 1] [external NEMA 3R] disconnect switch and solid state fan speed controllers on direct drive units.**

## 2.5 SIDEWALL PROPELLER EXHAUST FANS:

- A. General: Provide Greenheck Model SDE, SDP, and SBP or approved equal ACME, Cook or Carnes sidewall propeller exhaust fans with capacities as scheduled.
- B. Construction: Fans shall be axial type, belt or direct driven as scheduled. Blades shall be die-formed and welded to a steel hub. A polished steel fan shaft shall be mounted in permanently-lubricated, sealed ball bearing pillow blocks. The drive frame assembly shall be formed steel. The fan panel shall have prepunched mounting holes, formed flanges with welded corners, and a deep formed venturi. Fans shall bear AMCA rating seals for air and sound performance.
- C. Motors: Motors shall be 1750 rpm open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]**
- D. Accessories: Provide all required accessories including, but not limited to: mounting collar, factory-wired and mounted NEMA 1 disconnect switch, **[gravity] [motorized] backdraft damper [with end switch]**, and motor side fan guard (except on fans with reverse air flow).

## 2.6 IN-LINE EXHAUST/TRANSFER FANS:

- A. General: Provide Greenheck Model CSP, BCF, BSQ, BSQ-HP or DSQ or approved equal Acme or Cook in-line exhaust fans with capacities as scheduled.
- B. Construction: Fans shall be belt or direct driven in-line type with square heavy gauge galvanized steel housing with duct mounting collars shall have a galvanized or thermally fused epoxy finish. One or both sides shall be hinged and shall support the entire drive assembly and wheel allowing the assembly to swing out for cleaning, inspection, or service without dismantling the unit in any way. On belt drive models the motor shall be mounted on the hinged side exterior, isolated from the airstream. The motor shall be isolated from the airstream by a motor enclosure and shall draw cooling air from outside the fan housing.
- C. Wheels: The fan inlet shall be spun venturi throat overlapped by an aluminum backward inclined centrifugal wheel with spun cone for maximum performance. The fan wheel shall be statically and dynamically balanced.
- D. Insulation: The interior of the fan housing shall have one inch (1") thick, 3 PCF density internal sound absorbing fiberglass insulation to reduce operating noise levels.
- E. Drives: Motors shall be heavy duty type with permanently-lubricated, sealed ball bearings. The wheel shaft shall be ground and polished shafting mounted in heavy duty sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. An adjustable drive shall be used for balancing and then a fixed drive shall be provided. Motors shall be 1750 rpm open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]**
- F. Wiring: Flexible wiring leads shall be installed in conduit from the fan motor to an externally mounted junction box[, **motor speed controller (single phase units only)**] and disconnect switch, permitting access for service without disconnecting field wiring.
- G. Certification: All fans shall bear the AMCA-certified ratings seal for both air and sound performance.
- H. Accessories: Provide all required accessories including, but not limited to: Duct mounted automatic acting gravity type backdraft dampers of same size as fan housing, hanging support isolators with door side perpendicular to mounting surface, solid state fan speed controllers (direct drive units only) and belt guard for belt driven fans.

## 2.7 UTILITY EXHAUST FANS:

- A. General: Provide Greenheck Model SFD or approved equal Peerless or Trane utility exhaust fans with capacities as scheduled.
- B. Construction: Fans shall be belt or direct driven, single width, single inlet centrifugal blowers with discharge arrangement as shown on the drawings. The blower housing shall be of continuously welded construction which can be adjusted for discharge position. Housing supports shall have formed flanges and prepunched mounting holes. The blower wheel shall be steel of the forward curved type and shall be statically and dynamically balanced. A polished steel fan shaft shall be mounted in ball bearing pillow blocks. Bearings shall be grease lubricated.
- C. Finish: Entire exterior of the fan assembly shall be phosphatized, primed and finished with a baked enamel. **[Laboratory exhaust fans shall have a factory applied epoxy corrosion resistant coating applied to all surfaces exposed to the air stream.]**
- D. Motors: Motors for interior mounted fans shall be open dripproof (ODP) type and motors for exterior mounted fans shall be totally enclosed fan cooled (TEFC). Motors shall be 1750 rpm type of the horsepower and voltage scheduled. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]**
- E. Accessories: Provide all required accessories including, but not limited to: Vented weather hood with expanded metal outlet guard, access doors, shaft seals, factory-mounted and wired NEMA **[1] [3R]** disconnect switch, felt tipped automatic aluminum backdraft dampers, vibration isolators, belt guard, drain connections and weather hoods (where required).

## 2.8 UTILITY EXHAUST FANS:

- A. General: Provide Greenheck Model SFB, SWB, or approved equal Peerless or Trane exhaust fans with capacities and discharge arrangement as scheduled and shown on the Drawings.
- B. Configuration: Fans shall be a belt drive, single width, single inlet utility vent set with forward curved or backward inclined centrifugal fan wheel as scheduled.
- C. Housing: The fan housing and inlet cones shall be constructed of heavy gauge steel with lock-formed seams to prevent leakage. Housing supports and drive frame shall be constructed of welded steel members to prevent vibration and rigidly support the fan shaft and bearings.
- D. Wheels: Fan wheels shall be constructed of formed steel blades securely attached to the wheel backplate and cone. Each wheel and shaft shall be statically and dynamically balanced.
- E. Fan Shafts: Fan shafts shall be precision tuned, ground and polished steel shafts, sized so that the first critical speed is a minimum of 25% over the maximum operating speed. Fan shaft shall have pillow block bearings. All fan bearings shall be factory-lubricated and equipped with standard hydraulic grease fittings. Extended lube lines shall be furnished where bearings are not accessible and shall terminate on the outside of drive end of each unit including extension to allow greasing without removal of drive guard.
- F. Drives: V-belt fan drives with variable pitch motor sheave shall be selected for 150% of motor horsepower and anti-static belts shall be furnished. Drive guards shall have accessible opening to read rpm.
- G. Motors: Fan motors shall be ball bearing 1750 rpm open dripproof (ODP) type for indoor use and shall have electrical characteristics as scheduled. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]** Motor base shall be equipped with adjustable base rails.
- H. Finish: The entire fan assembly shall be phosphatized and painted with the manufacturers standard paint finish.
- I. Certification: Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices. Fans shall be licensed to bear the AMCA Certified Rating Seal for air performance.
- J. Accessories: Provide all required accessories including, but not limited to, belt guard, access door, **[gravity] [motorized] backdraft damper [with end switch], [inlet] [discharge] guard[, drain connection] and [a motor and drive weather load].**

## 2.9 UPBLAST SMOKE EXHAUST FANS:

- A. General: Provide Greenheck Model TAUB-HT or approved equal roof-mounted upblast tube axial smoke exhaust fans capable of operating for a minimum of 4 hours at an exhaust air temperature of 500°F.
  - B. Construction: Fan housing shall be constructed of heavy gauge welded steel and shall be designed for curb mounting using a curb cap with an integral flanged venturi inlet. The fan housing shall have a reinforced steel windband and outlet screen from discharge damper protection. Bearing and motor supports shall be constructed of structural steel shapes and welded to the fan housing. A ventilated weatherproof motor cover shall be provided.
  - C. Dampers: Provide spring-loaded steel butterfly damper on the fan discharge. Damper shall be gasketed in the closed position to minimize leakage and be provided with damper stops to maintain proper damper position when the fan is operating. The damper shall be held closed by a resettable McCabe type electrothermal link which shall open the damper at 165°F ambient temperature or upon a 120 volt signal on fan start-up.
  - D. Fans: Propeller construction shall be fabricated steel, with the fan hub key locked to the fan shaft. Fans and shafts shall be statically and dynamically balanced.
  - E. Fan Shafts: Fan shafts shall be precision tuned, ground and polished steel shafts, sized so that the first critical speed is a minimum of 25% over the maximum operating speed. Fan shaft shall have pillow block bearings. All fan bearings shall have a minimum B-10 life as defined by AFBMA of 25,000 hours, factory-lubricated and equipped with standard hydraulic grease fittings. Extended lube lines shall be furnished where bearings are not accessible and shall terminate on the outside of drive end of each unit including extension to allow greasing without removal of drive guard. Heat slingers shall be mounted on the fan shaft to dissipate heat from the fan shaft and draw cooling air over the bearings, shaft, and drive.
  - F. Drives: V-belt fan drives with variable pitch motor sheave shall be selected for 150% of motor horsepower and anti-static belts shall be furnished. Drive guards shall have accessible opening to read rpm. Belt and bearing tubes shall be constructed of welded heavy gauge steel and provided with ventilation for proper cooling of belts, bearings, and drives.
  - G. Motors: Fan motors shall be ball bearing 1750 rpm open dripproof (ODP) type for indoor use and shall have electrical characteristics as scheduled. Motor base shall be equipped with adjustable base rails.
  - H. Finish: The entire fan assembly shall be phosphatized and painted with the manufacturers standard paint finish.
  - I. Certification: Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices. Fans shall be licensed to bear the AMCA Certified Rating Seal for air performance.
  - J. Accessories: Provide all required accessories including, but not limited to, an outlet screen, bolted access door, and a factory-mounted and wired heavy duty NEMA 3R disconnect switch.
- 2.10 VANE AXIAL SUPPLY/EXHAUST FANS:
- A. General: Provide Woods of Colchester Limited or approved equal belt or direct driven in-flight controllable pitch and manually adjustable fixed pitch vane axial type supply and exhaust fans of the type, size, and capacity scheduled.
  - B. Ratings: The fan shall deliver the volume and pressure specified in the fan schedule when tested in accordance with AMCA Standard 210.
  - C. Casings: The fan casing will consist of two sections, each 3/16" minimum thickness mild steel, joined with bolted flanges. The motor will be supported by the fabricated steel structure of 3/16" minimum thickness welded to one of the ducts. The other duct will be removable for access to the impeller. Drilled flanges will be provided for attachment of accessories or ductwork. The casing shall have an integral support frame and plate for mounting the motor on direct drive fans and internal bearing supports and an external motor mounts on belt drive fans. The casing and drilled flanges shall be hot dip galvanized.
  - D. Fan Impellers: The impeller hub shall be cast in high strength heat-treated aluminum alloy precision-machined and balanced. Blades shall be of aerofoil section cast from silicon aluminum alloy and mounted on thrust bearings with grease retaining features such that the bearings shall be fully

submersed in grease. All hub and blade materials shall be examined by X ray before machining. The manufacturer shall have available, laboratory evidence that impeller hubs and blades are suitable designed for normal running conditions and that fluctuating stresses in use are sufficiently low to ensure that no premature failure will occur due to metal fatigue.

- E. Fixed Adjustable Pitch Fans: The fan impeller pitch angle shall be manually adjustable in the field.
- F. In-flight Controllable Fans: The impeller blades shall be actuated in flight by an internal pneumatic actuator built into the hub and providing stepless control of the blade pitch angle. A pilot positioner shall be provided to ensure minimum control hysteresis. Where scheduled, the fan blades shall be reversible in-flight to reverse the airflow direction through the fan. A blade angle indicator shall be provided on the outside of the fan housing. The pneumatic operator shall be factory-adjustable to control fan blade angle from minimum to maximum pitch from a 3 to 15 psi pneumatic signal **[and for pitch reversing, where applicable]**.
- G. Balancing: After assembly the fan shall be dynamically balanced while on anti-vibration mountings giving over 90% isolation. The balance standard shall be in accordance with ISO 2372;1974 Quality Grade C for Class II machines. Maximum vibration velocity shall not exceed 0.14 in/sec r.m.s. on 60 Hz supplies over the full pitch angle range, when measured at the fan mounting feet.
- H. Certification: The fan manufacturer shall supply a test certificate for each fan showing the voltage, current, frequency, kilowatts input, degree of balance and control characteristic (actuator movement against control signal). The fan pitch angle for adjustable fixed pitch fans shall be adjusted at the factory to meet scheduled conditions.
- I. Characteristics: The aerodynamic design of the fan shall be such that the maximum power absorbed by the impeller occurs within the normal working range such that the fan has a non-overloading characteristic.
- J. Impeller Attachment: The impeller shall be secured to the motor or fan shaft by a key and keyway. Axial location shall be provided by a collar or a shoulder on the drive shaft together with a retaining washer and a screw fitted into a tapped hole in the end of the shaft. The screw shall be locked in position.
- K. Direct Drive Motors: Motors shall be totally enclosed fan cooled (TEFC) with Class F insulation and 1.15 service factor. Motor bearings shall be selected for a minimum L-10 life of 20,000 hours. Grease lubrication lines shall be brought to outside of the fan casing and labeled. Motor wiring shall be factory-extended to a junction box installed on the outside of the fan housing.
- L. Belt Drive Motors: Fan motors shall be ball bearing 1750 rpm open dripproof (ODP) type for indoor use and shall have electrical characteristics as scheduled. **[Motors 1 hp and larger shall be of the high efficiency, energy efficient type.]** Motor base shall be equipped with adjustable base rails.
- M. Belt Drives: V-belt fan drives with variable pitch motor sheave shall be selected for 150% of motor horsepower and anti-static belts shall be furnished. Drive guards shall have accessible opening to read rpm.
- N. Fan Shafts: Fan shafts shall be precision tuned, ground and polished steel shafts, sized so that the first critical speed is a minimum of 25% over the maximum operating speed. Fan shaft shall have pillow block bearings. All fan bearings shall be factory-lubricated and equipped with standard hydraulic grease fittings. Extended lube lines shall be furnished where bearings are not accessible and shall terminate on the outside of drive end of each unit including extension to allow greasing without removal of drive guard.
- O. Accessories: Provide all required accessories including, but not limited to:
  - 1. Inlet bell mouth fittings with guards.
  - 2. Outlet guard.
  - 3. Outlet cone.
  - 4. Inlet and outlet attenuators.
  - 5. Flange mounted flexible connections.
  - 6. Horizontal or vertical mounting brackets as required for isolated fan mounting.

## 2.11 AIR INTAKES:

- A. General: Provide ACME or approved equal Greenheck, Cook or Carnes roof-mounted air intakes with capacities as scheduled.
- B. Construction: Construction of the housing shall be aluminum. Intakes shall be constructed to withstand winds up to 150 mph.
- C. Accessories: Provide all required accessories including, but not limited to: aluminum birdscreen, gravity or motorized (as scheduled) backdraft dampers and prefabricated insulated aluminum roof curb.

2.12 RELIEF VENTS:

- A. General: Provide ACME or approved equal Greenheck, Cook or Carnes roof-mounted air relief vents of the type and capacities as scheduled.
- B. Construction: Construction of the housing shall be aluminum. Vents shall be constructed to withstand winds up to 150 mph.
- C. Accessories: Provide all required accessories including, but not limited to: aluminum birdscreen, gravity or motorized (as scheduled) backdraft dampers and prefabricated insulated aluminum roof curb.

**PART 3 - EXECUTION**

3.1 INSPECTION:

- A. General: Installer shall examine conditions under which fans, outside intakes, and relief vents are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION:

- A. General: Install fans, outside intakes, and relief vents where shown, in accordance with manufacturer's written instructions and recognized industry practices to ensure that fans, outside intakes, and relief vents comply with requirements and serve intended purposes. Comply with NEMA standards and requirements of NEC.
- B. Curb-mounted Fans: All fans mounted on roof curbs shall be securely attached to the roof curb with appropriate fasteners located 8" on center with a minimum of two fasteners per side by this Contractor. The roof curb shall be securely attached to the building structure by the General Contractor.
- C. Insulation: Refer to Section 23 05 48 for fan insulation requirements.
- D. Housekeeping Pads/Vibration Isolation: Refer to Section 23 03 00 and Section 23 05 48 for applicable requirements.

3.3 COORDINATION:

- A. General: This Contractor shall be responsible for coordinating installation requirements and provisions with the work of other Divisions and the General Contractor.
- B. Coordinate all required fan motor horsepower, voltages and locations with Electrical Contractor prior to purchase.
- C. **All fans with 2000 cfm or greater airflow shall have a firestat with manual reset set to open at 50°F, above maximum system operating temperature to interrupt electric current to the fan motor in case of fire. Firestat shall be furnished and installed by [this Contractor with wiring of firestat by the Electrical Contractor.] [the Temperature Controls Subcontractor. Refer to Section 23 06 00 for control requirements].**
- D. Coordinate all roof mounted fan curb openings with General Contractor prior to roofing installation.

3.4 START-UP SERVICES:

- A. General: The fan supplier shall provide fan checkout, start-up, testing and adjusting of system components for the vane axial fan systems. The fan supplier shall also train the Owner's Engineer in the proper operation and maintenance of these fans.

3.5 TESTING:



- A. General: Test and adjust all installed fans to verify proper operation as specified herein and as recommended by the manufacturers. Where specified hereinabove, start-up, testing, and adjustment shall be provided by a representative of the equipment supplier.
  - B. Refer to Section 23 05 93 for additional start-up, testing, and adjustment requirements.
- 3.6 IDENTIFICATION:
- A. Refer to Section 23 03 00, for applicable painting, nameplates, and labeling requirements.

**END OF SECTION 23 82 20**

### UTILITY EXHAUST FANS

Furnish and install Greenheck Model SWB or approved equal ACME or Cook exhaust fans as scheduled. Fan shall be a belt drive, single width, single inlet utility vent set with an aluminum backward inclined non-overloading centrifugal fan wheel. Fan shaft shall have pillow block bearings. All fan bearings shall be factory lubricated and equipped with standard hydraulic grease fittings. Extended lube lines shall be furnished where bearings are not accessible and shall terminate on the outside of drive end of each unit including extension to allow greasing without removal of drive guard.

V-belt fan drives with variable pitch motor sheave shall be selected for 150% of motor horsepower and anti-static belts shall be furnished. Drive guards shall have accessible opening to read rpm.

Fan housing and drive guard shall be minimum 16 gauge arc-welded steel. Housing shall have a 1" FPT coupling welded to bottom of housing with automatic trap drain provided and installed by Mechanical Contractor to automatically drain the fan housing. Fan motors shall be ball bearing 1750 rpm open dripproof (ODP) type for indoor use and shall have electrical characteristics as scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 15100).]** Motor base shall be equipped with adjustable base of rails.

All parts of the fan that come into contact with the air-stream shall be coated with a high temperature acid resistant epoxy coating.

Fan accessories shall include belt guard, heat slinger wheel, high temperature drive belts, high temperature wheel bearings and bearing grease, access door, gravity backdraft damper, discharge guard and factory installed disconnect switch.

### SMOKE REMOVAL FANS

Furnish and install Flakt Products, Inc. Model AV or approved equal belt driven fixed pitch axial flow type smoke removal fans of the size and capacity scheduled.

Fans shall be Arrangement 9 V-belt drive with fan rotor mounted on separate shaft and bearings in an enclosed tube with fixed pitch belt drive with a 1.5 safety factor.

Fan casings shall be welded of hot-rolled steel plate .135" in small sizes up to 28" with continuously welded flanges. The next fan sizes up to 50" shall be 3/16" thick with flanges rolled at inlet and outlet. Sizes of 50" or greater diameter shall be of 1/4" plate steel with rolled flanges at inlet and outlet. Concentricity of fan casings shall be insured through the use of welding jigs and fixtures. A fabricated adjustable steel motor support of plate steel shall be supported by adjustable rods welded to a base on the outside of the fan casing.

Fan casings shall be fitted with mounting legs or hanging clips as shown on the drawings. Fan mounting legs shall be fabricated from minimum 3/16" steel plate suitably braced to insure stability and rigidity. Clips for horizontal suspension shall be of minimum 3/8" steel plate mounted at fan center line. Clips for vertical suspension shall be mounted at center of moment of inertia of fan assembly.

Fan rotor shall be of fabricated steel. Fan blades shall be designed for maximum efficiency and be air-foil shaped, varying in twist and width from base to tip. Blade tip clearance shall be within tolerance to meet certified performance of fan.

The fan rotor assembly shall be statically and dynamically balanced. Belt drive rotors shall be installed on their fan shafts for balancing to tolerances as listed below in mils double amplitude:

FAN RPM RANGE	MILS PK-PK
2400 - 3600	0.4
1800 - 2400	0.6
1200 - 1800	0.8
900 - 1200	1.2
LESS THAN 900	1.6

The fan rotor shall be secured on the fan shaft by a key and keyway, and by locking hardware threaded on the end of the shaft.

Fan motors shall be foot-mounted NEMA standard **[open dripproof (ODP)] [totally enclosed fan cooled (TEFC)]** continuous duty, ball bearing, with Class "B" insulation. Motor leads shall terminate in the

conduit box mounted on the exterior of the motor. External grease fittings with extended grease leads shall be supplied for lubrication of the fan shaft bearings.

After fabrication, fans shall be prime coated and finish painted. Zinc chromate epoxy primer shall be applied after surfaces are cleaned and degreased. Finish coat shall be air dry acrylic enamel.

All fan bearings shall have a B-10 life as defined by AFBMA of at least 25,000 hours.

Fans shall be furnished with high temperature belts, high temperature grease, heat slinger, shall be all steel construction per City of Houston High Rise Code requirements and shall be suitable for continuous operation with 500\_o\_F exhaust air.

#### SMOKE REMOVAL FANS

Furnish and install Industrial Air, Inc. Series 047 or approved equal smoke removal fans of the size and capacity scheduled.

Fan shall be of a bifurcated vane axial design with an insulated motor well and heat slinger induced air cooling and shall be suitable for use with exhaust air temperatures up to 500\_o\_F. Cooling air intakes shall have louvered covers.

Fan shall be direct drive type with high temperature aluminum alloy blades. Blades shall be manually adjustable from the front of the wheel.

Fan shall be designed for duct inlet and outlet.

Fan motor shall be factory installed and aligned and to entire rotating assembly shall be statically and dynamically, balanced.

#### SMOKE REMOVAL FANS

Fan shall be an up-blast propeller type constructed to meet The City of Houston High Rise Code for smoke exhaust and shall be of the size and capacity as indicated on the drawings.

Construction features shall include:

- Painted Steel curb
- Heavy duty painted steel curb cover
- Painted steel weather cover over motor
- Butterfly dampers with rubber weather seal
- Sheaves and belts out of the air stream
- Welded drum assembly welded to curb cap

Fan shall be a Cincinnati model RA or approved equal.

#### HOOD EXHAUST FANS

Furnish and install Dual Industries Model [????] or approved equal utility fans of the size and capacities scheduled.

Fan shall be belt driven, single width, single inlet, centrifugal blower with vertical discharge. The blower housing shall be PVC with PVC inlet and outlet angle flanges and PVC drain. Frame shall be phenolic coated steel. Fan wheel shall be PVC coated steel. Motor shall be totally enclosed, fan cooled, ball bearing type.

Other features to include: heavy angle iron bracing. over capacity shaft and oil-type, pillow block ball bearings, formed PVC venturi inlet, 155\_o\_F operating temperature, OSHA belt and shaft guards and ventilated weatherproof PVC motor and drive housing.

The fan and wheel inlet cone shall be non-sparking aluminum and of the high performance, centrifugal blower type. Wheel shall be statically and dynamically balanced.

Motor and drives shall be isolated from the exhaust airstream. Motors shall be of the heavy duty type with permanently lubricated, sealed ball bearings. Air for cooling the motor shall be taken into the motor chamber by means of an air tube from a location free of discharge contaminants.

The entire drive assembly and wheel, as a unit, shall be removable through the support structure without dismantling fan housing. The wheel shaft shall be mounted in heavy duty ball bearings. Drives shall be sized for 165% of driven horsepower. Pulleys shall be adjustable cast iron type keyed to the fan and motor shafts. The entire drive assembly shall be mounted on rubber vibration isolators.

Motors shall be 1750 RPM open dripproof (ODP) type for indoor use and totally enclosed fan cooled (TEFC) type for exterior use and shall be of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 15100).]**

Fan accessories shall include: 1/2" mesh aluminum birdscreen, gravity backdraft damper, disconnect switch and weather hood (where applicable).

#### FUME HOOD EXHAUST FAN

Furnish and install Greenheck Model SWB or approved equal ACME or Cook exhaust fans as scheduled. Fan shall be a belt drive, single width, single inlet utility vent set with an aluminum backward inclined non-overloading centrifugal fan wheel. Fan shaft shall have pillow block bearings. All fan bearings shall be factory lubricated and equipped with standard hydraulic grease fittings. Extended lube lines shall be furnished where bearings are not accessible and shall terminate on the outside of drive end of each unit including extension to allow greasing without removal of drive guard.

V-belt fan drives with variable pitch motor sheave shall be selected for 150% of motor horsepower and anti-static belts shall be furnished. Drive guards shall have accessible opening to read RPM.

Fan housing and drive guard shall be minimum 16 gauge arc-welded steel. Housing shall have a 1" FPT coupling welded to bottom of housing with automatic trap drain provided and installed by Mechanical Contractor to automatically drain the fan housing. Fan motors shall be ball bearing 1750 RPM open dripproof (ODP) type for indoor use and totally enclosed fan cooled (TEFC) for exterior use and shall have electrical characteristics as scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]** Motor base shall be equipped with adjustable base of rails.

All parts of the fan that come into contact with the air-stream shall be coated with a high temperature acid resistant epoxy coating.

Fan accessories shall include belt guard, weatherhood, access door, gravity backdraft damper and discharge guard.

#### FILTERED DOWNBLAST ROOF MOUNTED FAN

Furnish and install a Greenheck Model RSF or approved equal roof mounted supply air fans with capacities as scheduled.

Fans shall be a belt drive, double width, double inlet, forward curved centrifugal blower type with the blower assembly mounted on suitable vibration isolators. Drive shall be designed for a minimum of 165% of driven horsepower and shall be furnished with cast iron, adjustable type drive sheaves.

Motors shall be 1750 RPM open drip proof type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]** The motor and blower shall have permanently lubricated, sealed ball bearings.

The fan housing shall be heavy gauge galvanized steel **[and the unit shall be designed to elevate the air intake a minimum of 3 feet above the roof.]** The unit wind band shall be adequate to prevent moisture from entering the building. The fan cover shall be insulated and shall be securely held in place.

Reusable 1" permanent aluminum filters shall be provided. Fan accessories shall include a duct adapter, an extended insulated base roof curb **[to provide the minimum 3' intake height]**, a disconnect switch and a **[gravity] [pneumatic] backdraft damper. [Refer to Section 23 06 00 for damper operators and controls.]**

The fan unit shall bear the AMCA certified ratings seal for air performance with filters in place.

#### UNFILTERED DOWNBLAST ROOF MOUNTED FAN

Furnish and install a Greenheck FFS Series or approved equal power roof ventilator with capacities as scheduled.

Ventilator housing shall be heavy duty aluminum with rolled interlocking seams for reinforcement. The hood top shall be hinged for easy access to the fan.

Drives shall be adjustable and shall be sized for 165% of driven horsepower and shall be mounted on vibration isolators. The fan shall be axial propeller type with sealed ball bearing and cast iron drive sheaves. Motors shall be 1750 open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type. (Refer to Section 23 04 00).]** The motor and blower shall have permanently lubricated, sealed ball bearings.

Accessories shall include an expanded aluminum birdscreen, duct adapter, an insulated aluminum roof curb and a disconnect switch.

The fan unit shall bear AMCA seals for sound and air with the birdscreen in place.

#### ROOF MOUNTED PROPELLER SUPPLY FANS

Furnish and install Greenheck Model PBS, PDS or approved equal ACME, Cook or Carnes roof mounted propeller fans with capacities as scheduled.

Fans shall be axial type, belt or direct driven as scheduled. Blades shall be die formed and welded to a steel hub. A polished steel fan shaft shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. The drive frame assembly shall be formed steel. The fan panel shall have prepunched mounting holes, formed flanges with welded corners, and a deep formed venturi. A special arrangement for supply air shall be used with the fan panel reversed so that air flows through the panel in the proper direction in respect to the inlet venturi. Fans shall bear AMCA ratings seals for air and sound performance.

Round low profile discharge hood shall be fastened to roof curbs with heavy duty full length piano hinge. Fan motor brackets shall mount down inside roof curb to keep overall unit height as low as possible.

Motor shall be 1750 RPM open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]**

Accessories shall include 1/2" mesh birdscreen, prefabricated insulated aluminum roof curb, damper tray, disconnect switch, gravity backdraft damper. Refer to Section 15900 for controls.

#### SIDEWALL PROPELLER SUPPLY FANS

Furnish and install Greenheck Model SDE, SBPS or approved equal ACME, Cook or Carnes sidewall propeller fans with capacities as scheduled.

Fans shall be axial type, belt or direct driven as scheduled. Blades shall be die formed and welded to a steel hub. A polished steel fan shaft shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. The drive frame assembly shall be formed steel. The fan panel shall have prepunched mounting holes, formed flanges with welded corners, and a deep formed venturi. A special arrangement for supply air shall be used with the fan panel reversed so that air flows through the panel in the proper direction in respect to the inlet venturi. Fans shall bear AMCA ratings seals for air and sound performance.

Accessories shall include mounting collar, disconnect switch, pneumatic backdraft damper with end switch and motor side fan guard. Refer to Section 23 06 00 for damper operators and controls.

#### SIDEWALL MOUNTED PROPELLER SUPPLY FANS

Furnish and install Greenheck Model SPN or approved equal ACME, Cook or Carnes sidewall mounted propeller fans with capacities as scheduled.

Fans shall be axial type, belt or direct driven as scheduled. Blades shall be die formed and welded to a steel hub. A polished steel fan shaft shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. The drive frame assembly shall be formed steel. The fan panel shall have prepunched mounting holes, formed flanges with welded corners, and a deep formed venturi. A special arrangement for supply air shall be used with the fan panel reversed so that air flows through the panel in the proper direction in respect to the inlet venturi. Fans shall bear AMCA ratings seals for air and sound performance.

Motors shall be 1750 RPM open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]**

Accessories shall include mounting collar, disconnect switch, pneumatic control damper with end switch and motor side fan guard. Refer to Section 15900 for damper operators and controls.

#### IN-LINE SUPPLY FANS

Furnish and install Greenheck Model [????] or approved equal ACME, Cook or Carnes in-line supply fans with capacities as scheduled.

Fans shall be belt or direct driven in-line type with square heavy gauge galvanized steel housing which shall have a thermally fused epoxy finish. One of the sides shall be hinged and shall support the entire drive assembly and wheel allowing the assembly to swing out for cleaning, inspection, or service without dismantling the unit in any way. On belt drive models the motor shall be mounted on the hinged side exterior isolated from the airstream.

The belt and pillow block ball bearings shall be protected from the airstream by an enclosure. The shaft shall be keyed to both the wheel and pulley. On direct drive models the motor shall be isolated from the airstream by a motor enclosure and shall draw cooling air from outside the fan housing.

The fan inlet shall be spun venturi throat overlapped by a backward curved centrifugal wheel with spun cone for maximum performance.

The interior of all in-line fan housing shall have 1" thick, 3 P.C.F. density internal sound absorbing fiberglass insulation to reduce operating noise levels.

Motors shall be 1750 RPM open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]**

Fan accessories shall be as follows: Duct mounted automatic acting gravity type backdraft dampers of same size as fan housing, hanging support isolators with door side perpendicular to mounting surface and belt guard for belt driven fans.

#### UTILITY SUPPLY FANS

Furnish and install Greenheck Model AFSW or approved equal Peerless or Trane utility supply fans with capacities as scheduled.

Fans shall be of the centrifugal type with airfoil wheels.

The housing shall be constructed of continuously welded heavy-gauge steel to assure no air leakage. The housing and bearing support shall be constructed of structural steel members to prevent vibration and rigidly support the shaft and bearings.

All structural parts shall be phosphatized, primed and coated with a baked enamel finish.

Non-overloading single and double width wheels shall be constructed of heavy gauge, airfoil blades securely welded to the wheel cone and a heavy gauge backplate. The wheel cone and unit inlet cone shall be carefully matched and have precise running tolerances to provide for maximum efficiency. Each fan wheel shall be statically and dynamically balanced before being assembled into the fan.

Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class. Close tolerances shall be maintained where the shaft makes contact with the bearing. Bearings shall be heavy duty grease lubricated, self aligning ball bearing or roller pillow block type. Bearings shall be selected for a minimum of 400,000 hours life at maximum operating speed for each pressure class.

Inlet flanges welded to the inlet collar and outlet flanges welded to the fan outlet shall be provided flanged duct connections.

A 1" threaded drain connection with a plug shall be provided to drain moisture from the bottom of the fan housing.

A totally enclosed belt guard with provisions for measuring fan RPM without removing the guard shall be provided.

A motorized parallel blade backdraft damper with galvanized steel frame, aluminum blades, felt edge seals and steel end seals shall be provided mounted to each fan. Refer to Section 15900 for pneumatic operators and controls.

Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices and fans shall be licensed to bear the AMCA Certified Ratings Seal.

After assembly each fan shall be given a final balance test at the specified operating RPM to insure smooth vibration free operation.

Outside air fans shall be externally insulated in the field.

Motors for interior mounted fans shall be open dripproof (ODP) type and motors for exterior mounted fans shall be totally enclosed fan cooled (TEFC). Motors shall be 1750 RPM type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]**

Accessories shall include **[vented weather hood with]** expanded metal inlet guard, factory mounted disconnect switch, felt tipped automatic aluminum backdraft dampers, vibration isolators and drain connections.

#### STAIRWELL PRESSURIZATION FANS

Furnish and install Flakt Products, Inc. Series [????] or approved equal in-flight adjustable vaneaxial stairwell pressurization fans as scheduled.

**[Fans shall be Arrangement 4, Type 2 with the fan rotor mounted directly on the drive motor shaft and the motor enclosed entirely within the fan casing. Fans shall be designed for horizontal or vertical mounting as scheduled and shall be of a weatherproof design when indicated or required.]**

**[Fans shall be Arrangement 4, Type 3 having the fan rotor mounted directly on the drive motor shaft, with the drive motor supported on a structural steel base upstream of the fan rotor and external to the fan casing. The inlet bell and fan casing shall also be supported from the structural steel base. A protective wire cage shall be supplied at the fan inlet covering drive motor and inlet bell.]**

Fans shall consist of a fan casing followed by a separate removable guide vane section. Fan casings shall be welded of hot-rolled steel plate 3/16" thick in sizes through 50" diameter with 3/16" thick flanges continuously welded at inlet and outlet. Sizes greater than 50" diameter shall be of 1/4" thick steel with 1/4" thick flanges. Concentricity of fan casings shall be insured through the use of welding jigs and fixtures. A fabricated steel motor support shall be welded into the inlet end of the fan casing.

Guide vane sections shall be welded of 12 gauge steel and shall be fitted with a removable panel for access to fan rotor and control section. The guide vane section shall be arranged for attachment of a flexible connection at the discharge.

Fan casings shall be fitted with mounting legs or hanging clips as shown on the drawings. Fan mounting legs shall be fabricated from steel plate suitably braced to insure stability and rigidity. Clips for vertical support shall be mounted at center of moment of inertia of fan assembly.

Fan blades and hub shall be aluminum castings. Hub shall be heat treated alloy 356-T6 and blades shall be alloy 356. Fan blades shall be designed for maximum efficiency and be air-foil shaped, varying in twist and width from base to tip. Blade tip clearances shall be within tolerance to meet certified performance of fan.

The center of the hub shall be equipped with a blade operating mechanism. An **[electronic] [pneumatic]** operator shall be furnished with linkage to operate the fan blades. The fan blade angle shall be variable from zero to maximum angle. Mechanical adjustable stops shall be furnished for maximum angle. The **[electronic] [pneumatic]** operator shall be factory installed, complete with **[wiring] [piping]** and linkage to a positioning device mounted external to the vane section. **[Power shall be supplied to the electronic activator at the required voltage by the Division 16 Contractor.] [Control air shall be supplied to the pneumatic operator by the Temperature Controls Subcontractor at the required pressure.] [Air pressure to the pneumatic operator shall be 65 PSIG. The positioning device shall operate with a 3-15 PSIG control signal from a sensing device and controller furnished and mounted by the control manufacturer as specified elsewhere. The positioning device shall be reverse acting wherein the 3 PSIG control signal requests maximum blade angle and the 15 PSIG control signal requests minimum blade angle.]**

Operation of the control system shall be such that the fan blades on the lower fans go to the maximum angle upon loss of control **[power] [air]** and the upper fans go to the zero angle upon loss of control **[power] [air]**. The fan rotor assembly shall be statically and dynamically balanced. Direct drive rotors shall be balanced on their motor shafts to tolerances as listed below in mils double amplitude:

FAN RPM	MILS PK-PK
1760	0.8
1180	1.2
880	1.6

**[Fan Motors shall be totally enclosed air over (TEAO), continuous duty, ball bearing, with class "B" insulation. Motor leads shall be extended through an air tight conduit to a suitably sized conduit box on the side of the fan casing. Provide with external grease fittings and extended grease leads.]**

**[Fan motors shall be foot-mounted NEMA standard open drip proof (ODP) continuous duty, ball bearing, with Class "B" insulation. Motor leads shall be extended through an air tight conduit to a suitably sized conduit box mounted on the exterior of the fan casing. External grease fittings with extended grease leads shall be supplied for lubrication of the motor bearings.]**

After fabrication, fans shall be prime coated and finish painted. Zinc chromate epoxy primer shall be applied after surfaces are cleaned and de-greased. Finish coat shall be air dry acrylic enamel.

Fan performance data shall be the result of test data obtained in an AMCA approved laboratory using applicable portions of AMCA Standard 210 for flow and Standard 300 for sound power levels.

**ELEVATOR HOISTWAY PRESSURIZATION FANS**

Furnish and install Flakt Products, Inc. Series [????] or approved equal manual (fan stopped) adjustable vane axial elevator hoistway pressurization fans as scheduled.

Fans shall be Arrangement 4, Type 2 having the fan rotor mounted directly on the motor shaft with the assembly enclosed entirely within the fan casing.

Fan casings shall be welded of hot-rolled steel plate 3/16" thick with 3/16" thick flanges continuously welded at inlet and outlet. Concentricity of fan casings shall be insured through the use of welding jigs and fixtures. A fabricated steel motor support of not less than 1/4" plate steel shall be welded into the inlet end of the fan casing.

Fan casings shall be fitted with mounting legs or hanging clips as shown on the drawings. Fan mounting legs shall be fabricated from minimum 3/16" steel plate suitably braced to insure stability and rigidity. Clips for horizontal suspension shall be of minimum 3/8" steel plate mounted at fan center line clips for vertical suspension shall be mounted at center of moment of inertia of fan assembly.

Fan casing shall be fitted with an access panel for external adjustment of blade pitch angle. Access panel shall provide unimpeded accessibility for adjusting blade angle.

Fan blades and hubs shall be aluminum castings, alloy 356. Fan blades shall be designed for maximum efficiency and be air-foil shaped, varying in twist and width from base to tip. Blade tip clearance shall be within tolerance to meet certified performance of fan. Fan hub shall be a one piece aluminum casting and shall have a vernier scale to indicate blade position for each blade.

Fan blade pitch angle shall be individually manually externally adjustable through an access panel of the fan casing. External adjustment of blade angle shall be accomplished without disturbing the installation of removing fan from ductwork.

The fan rotor assembly shall be statically and dynamically balanced. Direct drive rotors shall be installed on their motor shafts to tolerances as listed below in mils double amplitude:

__FAN RPM__	__MILS PK-PK
3550	0.4
1760	0.8
1180	1.2
880	1.6

The fan rotor shall be secured on the motor shaft by a key and keyway, and by a locking bolt threaded into the motor shaft.

Fan motors shall be foot-mounted NEMA standard open drop proof (ODP) continuous duty, ball bearing, with Class "B" insulation. Motor leads shall be extended through an air tight conduit to a suitable sized conduit box mounted on the exterior of the fan casing. External grease fittings with extended grease leads shall be supplied for lubrication of the motor bearings.

After fabrication, fans shall be prime coated and finish painted. Zinc chromate epoxy primer shall be applied after surfaces are cleaned and de-greased. Finish coat shall be air dry acrylic enamel.

Fan performance data shall be the result of test data obtained in an AMCA approved laboratory using applicable portions of AMCA standard 210 for flow and Standard 300 for sound power levels.

**Return Air Fans**

Furnish and install Trane or an approved equal centrifugal return air fans with capacities as scheduled.

Fans shall include housing, wheel, fan shaft, bearings and side support structure as a factory assembled unit. All sheet metal parts shall be cleaned, conditioned and painted with enamel primer finish prior to final assembly. A final coat of gray enamel is applied to all exterior surfaces after assembly.

Fans shall have curved scroll housings with lockseam or spot welded construction with discharge configuration as shown on the Drawings. All housings are reinforced with rigid bracing to increase structural integrity.

Bearing support brackets are positioned to directly oppose belt tension forces.

Inlet collars on all single width fans extend beyond the fan housing to provide an uninterrupted duct connection. Slip joint discharge duct connections shall be provided.

Precisely positioned cutoffs and aerodynamically spun inlet cones shall provide smooth air flow through the fan and minimum turbulence.

Fan wheels shall non-power-overloading with forward curved, backwardly inclined air foil blades or backwardly inclined, plate type blades.



Blades on all sizes shall be securely welded to the spun rim and to the hub plate. Hubs shall be close grained cast iron. All wheels shall be carefully trued after assembly and dynamically balanced. Wheels shall be keyed to the shaft.

Fan shafts shall be solid AISI C-1040 or 1045 hot rolled steel accurately turned and polished. Close tolerances shall be maintained where the shaft makes contact with the bearings.

Bearings shall be grease lubricated, precision anti-friction extra heavy duty, split pillow block type with tapered, double spherical rollers selected for a minimum average life (AFBMA L-50) in excess of 400,000 hours operation at maximum cataloged operating conditions. Extended grease lines shall be provided as required.

Motors shall be 1750 RPM open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]**

Fans shall be tested and rated in accordance with AMCA Standard 210 and the Certified Ratings Program and shall be licensed to bear the AMCA Certified Ratings Seal.

#### BUILT-UP AIR HANDLING UNIT SUPPLY FAN

Furnish and install Peerless Electric or approved equal supply fans of the size and capacity scheduled. Fans shall be of the belt driven, single width, backward incline, non-overloading air foil blade, centrifugal type.

Fans shall be Arrangement 3 V-belt drive. Backward inclined airfoil blades shall be continuously seam welded to backplate and wheel cove. Fan shaft shall have pillow block bearings.

Fan shall be tested in accordance with the latest AMCA fan test procedures and shall bear an AMCA seal.

Fan casings shall be fitted with heavy angle or channel frame suitable for mounting on concrete pad. Fan mounting shall be fabricated from minimum 3/16" steel plate suitably braced to insure stability and rigidity.

Provide belt guard.

The fan assembly shall be certified to be statically and dynamically balanced at the factory.

Fan motors shall be foot-mounted NEMA standard open dripproof (ODP) continuous duty, ball bearing, with Class "B" insulation. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]** Motor leads shall terminate in the conduit box mounted on the exterior of the motor.

External grease fittings with extended grease leads shall be supplied for lubrication of the fan shaft bearings.

After fabrication, fans shall be prime coated and finish painted. Zinc chromate epoxy primer shall be applied after surfaces are cleaned and degreased. Finish coat shall be air dry acrylic enamel.

#### ROOF MOUNTED PROPELLER EXHAUST FANS

Furnish and install Greenheck Model PBE and PDE or approved equal ACME, Cook or Carnes roof mounted propeller exhaust fans with capacities as scheduled.

Fans shall be axial type, belt or direct driven as scheduled. Blades shall be die formed and welded to a steel hub. A polished steel fan shaft shall be mounted in permanently lubricated, sealed ball bearing pillow blocks.

The drive frame assembly shall be formed steel. The fan panel shall have prepunched mounting holes, formed flanges with welded corners, and a deep formed venturi. Fans shall bear AMCA ratings seals for air and sound performance.

Round low profile discharge hood shall be fastened to curb with heavy duty full length piano hinge. Fan motor brackets shall mounted down inside roof curb to keep overall unit height as low as possible.

Motors shall be 1750 RPM open dripproof (ODP) type of the horsepower and voltage scheduled. **[Motors 5 hp and larger shall be of the high efficiency, energy efficient type (Refer to Section 23 04 00).]**

Accessories shall include 1/2" mesh birdscreen, prefabricated, insulated, aluminum roof curb, damper tray, disconnect switch, gravity backdraft damper.

#### CENTRIFUGAL FANS:

A. General: Provide centrifugal fans of the single-width, single-inlet type with either forward or backward curved fan blades and adjustable belt drives.

B. Motors: Provide standard dripproof motors. Provide cast iron housings for motors larger than 10 hp, riveted or spot-weld wheels with steel rims and hub plates.

C. Fan: Blades shall be die cut and die-formed and hubs shall be machined close-grained cast iron.

Steel housings shall have lock-seam construction with discharge reinforcement and shall be adjustable with continuous inlet collars. Provide weatherproof enclosure for motors and drive, if units are exposed to weather.

D. Manufacturer: The equipment scheduled on the Drawings shall establish design requirements. Equipment that meets or exceeds these standards, manufactured by Buffalo Forge, Carrier, Sturtevant, American Blower, Chicago, Trane, Barry, York, or Clarage will be acceptable.

AXIAL FANS:

A. General: Provide vane-axial and tube-axial fans constructed of heavy gauge welded steel, hot-dipped galvanized after fabrication. Direct drive fans shall have motor support systems acceptable to the Engineer. Lubricated fittings shall be extended to the outside of the fan casing.

B. Fan: Fan blades shall be individually adjustable or controllable pitch. Each fan and fan wheel shall be statically and dynamically balanced and shall be so certified. Fans handling untreated air shall be capable of operating satisfactorily at 0 and 100°F across the fan.

C. Motors: Provide motors having totally-enclosed air over (TEAO) type, a service factor of 1.0, with Class F epoxy-enameled copper windings.

D. Accessories: Provide welded steel inlet and outlet cones, hot-dipped galvanized, and painted after fabrication, for each fan. Where fans are indicated to be controlled pitch, provide pneumatic actuators designed to operate with standard building control air.

E. Manufacturer: The equipment scheduled on the Drawings shall establish the design requirements. Equipment which meets or exceeds these requirements and as manufactured by Buffalo, Sturtevant, Trane, Joy, Woods, or Flakt shall be acceptable.

CEILING EXHAUST FANS:

A. General: Provide direct driven ceiling exhaust fans as scheduled on the Drawings. Fan shall be acoustically insulated and have a maximum sound level rating of 3.6 sones.

B. Motor: Motor shall be suitably grounded and mounted on rubber-in-shear vibration isolators and speeds shall not exceed 1050 rpm.

C. Accessories:

1. Provide totally noise-free, integral backdraft damper, with no metal-to-metal contact.
2. Inlet grille shall be white molded plastic with eggcrate shape and provide 85% free open area.
3. Provide terminal box on the housing with cord, plug, and receptacle inside the housing.