

SECTION 23 31 16.16

PLASTIC DUCTS AND ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Air Movement and Control Association (AMCA): 500-D, Laboratory Methods of Testing Dampers for Rating.
  2. American National Standards Institute (ANSI).
  3. American Society for Testing and Materials (ASTM):
    - a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
    - b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
    - c. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

1.2 SUBMITTALS

- A. Shop Drawings:
1. Duct:
    - a. Pressure, vacuum, and temperature rating of duct.
    - b. Dimensions of subassemblies to be shipped.
    - c. Manufacturer's data and descriptive literature for duct accessories.
    - d. Drawings showing layout, support, and joint details.
    - e. Stamped and signed structural engineering design calculations.
    - f. Information, details, and requirements for installation and support of duct and torque values for flange bolting.
    - g. Name of manufacturer.
  2. Supports:
    - a. Location plan.
    - b. Type and details.
    - c. Materials of construction.
    - d. Stamped and signed structural engineering design calculations for special supports.
  3. Expansion Joints/Flexible Connectors:
    - a. Type and model.
    - b. Materials of construction.
    - c. Force required for expansion/contraction.
    - d. Name of manufacturer.
  4. Butterfly Dampers and Blast Gates:
    - a. Pressure, vacuum, and temperature rating.

- b. Materials of construction.
  - c. Total weight.
  - d. Drawings showing overall dimensions and connection size.
  - e. Type and model.
  - f. Name of manufacturer.
5. Vibration Isolation Devices:
- a. Type and Model.
  - b. Material.
  - c. Name of Manufacturer.
6. Extraction hoods
- a. Type and Model
  - b. Material
  - c. Name of manufacturer
  - d. Dimensions
- B. Information Submittals:
- 1. Manufacturer's installation instructions.

### 1.3 QUALITY ASSURANCE

- A. Suppliers of duct and fitting components shall provide on request the following information:
- 1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
  - 2. Laboratory performance data for fittings, including zero-length dynamic losses.
- B. Changes or alterations to layout or configuration of duct system shall be:
- 1. Specifically approved in writing by Contract Administrator.
  - 2. Proposed layout shall provide original design results, without increasing system total pressure.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
- 1. Do not ship ducting by nesting small diameter components inside larger diameter components.
  - 2. Protect flanged sections by bolting to wooden blinds 50 mm greater than outside diameter of flange.
  - 3. For nonflanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.
  - 4. Crate materials whenever practical prior to shipment.
  - 5. Firmly fasten and pad components shipped to prevent shifting or flexing of components while in transit.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Fasteners:
  - 1. Bolts: ASTM A193/A193M, Type 316 stainless steel, ASA coarse thread series, Grade B 8M hex head.
  - 2. Nuts: ASTM A194/A194M, Type 316 stainless steel, Grade 8M.
  - 3. Washers: ANSI B18.22.1, flat, Type 316 stainless steel.
- B. Supports:
  - 1. Wall mounted pipe supports shall have an adequate load-bearing surface free of rough or sharp edges and shall not cause damage to the duct during use. Supports and hardware shall be of a corrosive resistant material suitable for use in the system environment. Ductwork is to be supported independently of hoods, scrubbers, fans, tanks or other equipment wherever possible. Where flexible connections are provided as expansion joints, a suitable hanger or support shall be provided at each end of the flexible connection. Consideration shall be given to the possibility of solids accumulation; adequate system support shall be provided where required. Drains shall be installed where accumulation of moisture is expected at low points in the system as indicated on the drawings.

### 2.2 DUCTWORK

- A. Design Requirements:
  - 1. Ducting shall be schedule 80, virgin, rigid polyvinyl chloride (PVC) compound, with a Cell Classification of 12454 as defined in ASTM D1784.
  - 2. Duct manufacturer's design for round section, including duct wall thickness and stiffeners.
- B. Service Conditions:
  - 1. System Maximum Pressure: 1.5 kPa.
  - 2. System Maximum Vacuum: 1 kPa.
  - 3. Atmosphere Ducted: See drawings. Ducting will be used to vent chemical drums containing either sodium hydroxide or sodium bisulfite, ferric chloride and sulfuric acid, or hydrogen peroxide, or air drawn from above an ozone generator.
  - 4. Location: Inside and Outside (-40 to +40 degrees centigrade)

### 2.3 FABRICATION

- A. Keep use of flanges to a minimum; spigot joints are preferred method of joining sections of duct, unless otherwise indicated on drawings.
- B. Flange dimensions (except thickness) and drilling patterns for flanges that connect to equipment, valves, or dampers are to correspond to ANSI B16.5, Class 150 or ANSI B16.1, Class 125.
- C. Furnish gussets on flanged nozzles from ducts.

- D. Back Face of Flanges: Spot-faced, flat and parallel to flange face, and of sufficient diameter to accept ANSI metal washer under bolt head or nut.
- E. Duct and Fittings:
1. Fittings: Plain end or flanged, manufacturer's standard sizes. Comply with NBS PS-15 with a chemical resistance equal to or greater than the duct.
  2. Gaskets: EPDM, 5 mm thick, full-face, Type A Durometer of 50-60.
- F. Supports:
1. Supports for PVC ductwork shall be provided per Section 40 05 15 Piping Support Systems.
  2. Maximum Duct Deflection: 12 mm.
  3. Support Spacing:
    - a. 500 mm Diameter and Smaller: 2 m, maximum.
- G. Marking:
1. Product marking shall include the manufacturer's name (or the manufacturer's trademark when privately labeled); the nominal duct size; material designation; and the date of manufacture.
- H. Dampers:
1. Single-blade type, complete with channel-type frame, close-fitting axle, and bearings.
  2. Same inside diameter as connecting ductwork.
  3. Axles shall be continuous through damper.
  4. When used for isolation service, shall be furnished with blade seal and shaft seal.
  5. When used for balancing only, shall be furnished with full circumference molded in blade stop.
  6. Design Requirements:
    - a. Each damper shall be designed for the following conditions:
      - 1) Air Temperature Range: 0 to 40 degrees C.
      - 2) Differential Pressure: 1-kPa.
  7. Materials:
    - a. Material used for construction of dampers shall be virgin, rigid polyvinyl chloride (PVC) compound, with a Cell Classification of 12454 as defined in ASTM D1784 Construction:
    - b. Frames: PVC.
    - c. Blades: PVC. Blade thickness and stiffeners as required to meet design conditions.
    - d. Axles: Continuous PVC rod. Bearings: Molded PTFE.
    - e. Blade Stops: PVC.
    - f. Flanges or spigot joints: As specified to match ductwork flanges.
- I. Backdraft Dampers:
1. Backdraft dampers shall be of the single or multi blade round type.
  2. Backdraft dampers shall have the same inside dimensions as the connecting ductwork.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Verify dimensions and conditions in field.
- B. Layout routing in straight lines parallel to building lines.
- C. Coordinate support locations with layout and joints.

#### 3.2 INSTALLATION

- A. Ductwork:
  - 1. Cut, fit, and install in accordance with duct manufacturer's recommendations. The SMACNA manual may be used for guidance, but duct manufacturer's recommendations shall take precedence.
  - 2. Ductwork shall be free of vibration when in operation. Vibration isolation devices shall be provided and installed by Contractor as required.
  - 3. Install plumb and straight and in proper alignment.
  - 4. Provide for expansion and contraction of ductwork and fittings.
  - 5. Anti-seize thread compound shall be applied to all nuts and bolts.
  - 6. Flange bolts shall be tightened to torque values specified by manufacturer. Install flat washer under each nut and bolt head.
- B. Field Joints:
  - 1. Thermal welding shall be performed by personnel adequately trained in the art of PVC welding utilizing the hot gas fusion welding method using virgin PVC filler welding rod as manufactured for this purpose.
  - 2. When solvent cemented connections are utilized, the use of an extra heavy bodied PVC solvent cement and appropriate primer is recommended due to tolerance extremes that can be encountered when working with duct and fabricated duct fittings. Proper solvent cement joining procedures shall be followed.
- C. Dampers: Unless otherwise necessary for proper operation of damper, axles shall be installed in horizontal position.
- D. Extraction hoods: Install extraction hoods in accordance with the drawings.

#### 3.3 CLEANING

- A. Dampers shall be smooth, clean, and free of dirt when installed.

END OF SECTION

SECTION 23 34 00  
FANS

PART 1 GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration – Balance Quality Requirement of Rigid Rotors – Part 1, Determination of Permissible Residual Unbalance.
  2. Air Movement and Control Association International (AMCA):
    - a. 99, Standards Handbook.
    - b. 201, Fans and Systems.
    - c. 203, Field Performance Measurement of Fan Systems.
    - d. 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
    - e. 300, Reverberant Room Method for Sound Testing of Fans.
    - f. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
  3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
  4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): HVAC Applications Manual.
    - a. 52.2 Method of Testing General Ventilation Air – Cleaning Devices for Removal Efficiency by Particle Size.
    - b. HVAC Applications Manual.
  5. ASTM International (ASTM):
    - a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
    - b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
  6. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.
  7. National Fire Protection Association (NFPA): 45, Fire Protection for Laboratories Using Chemicals.
  8. Occupational Safety and Health Act (OSHA).
  9. Underwriters Laboratories Inc. (UL/ULC): 507, Electric Fans.

1.2 DEFINITIONS

- A. The following is a list of abbreviations which may be used in this Section:
1. AC: Alternating Current.
  2. CISD: Chemical Industry, Severe-Duty.
  3. dB: Decibel.
  4. DWDI: Double Width, Double Inlet.
  5. FRP: Fiberglass Reinforced Plastic.
  6. kW: Kilowatt.

- 7. ODP: Open Drip Proof.
- 8. SWSI: Single Width, Single Inlet.
- 9. TEFC: Totally Enclosed, Fan Cooled.
- 10. UV: Ultra Violet
- 11. XP: Explosion Proof.

### 1.3 SUBMITTALS

#### A. Action Submittals:

- 1. Provide for all products specified, as follows:
  - a. Identification as referenced in Contract Documents.
  - b. Manufacturer's name and model number.
  - c. Descriptive specifications, literature and drawings.
  - d. Dimensions and weights.
  - e. Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.
  - f. Fan Curves:
    - 1) Performance Curves Indicating:
      - a) Relationship of flow rate to static pressure for various fan speeds.
      - b) Brake horsepower curves.
      - c) Acceptable selection range (surge curves, maximum revolutions per minute, etc).
      - d) Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.
    - 2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.
  - g. Capacities and ratings.
  - h. Construction materials.
  - i. Fan type, size, class, drive arrangement, discharge, rotation and bearings.
  - j. Wheel type, diameter, revolutions per minute, and tip speed.
  - k. Motor data.
  - l. Power and control wiring diagrams, including terminals and numbers.
  - m. Vibration isolation.
  - n. Factory finish system.
  - o. Color selection charts where applicable.
- 2.
  - a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
  - b. Where submitted equipment results in change to ductwork and equipment configuration shown on drawings, submit detailed

information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

- B. Informational Submittals:
  - 1. Recommended procedures for protection and handling of products prior to installation.
  - 2. Manufacturer’s installation instructions.
  - 3. Test reports.
  - 4. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.4 QUALITY ASSURANCE

- A. Performance Ratings: Tested in accordance with AMCA 210.
- B. Sound Ratings: Tested in accordance with AMCA 300.
- C. Fabrication: In accordance with AMCA 99.

1.5 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts, and special tools:

Item	Quantity
Vee Belts	One complete set per unit
Special tools required to maintain or dismantle	One complete set for each different size unit

- B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.1 EQUIPMENT SCHEDULES

- A. Some specific equipment requirements are listed in Equipment Schedules. Refer to Drawings and the attached equipment schedules for details.

2.2 NAMEPLATES

- A. All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

2.3 OPERATING LIMITS

- A. Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408-69.

2.4 FAN DRIVES (Not applicable for direct drive external rotor motorized impeller type).

- A. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
- B. Sheaves shall be capable of providing 150 percent of motor horsepower.
- C. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
- D. Furnish motors for V-belt drives with adjustable rails or bases.
- E. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
- F. Motors 15 kW or Smaller:
  - 1. Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
  - 2. Final operating point shall be at approximate sheave midpoint.
- G. Motors Larger than 15 kW: Fixed-pitch sheaves.
- H. Drive Adjustment:
  - 1. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
  - 2. Provide trial and final sheaves, as well as drive belts, as required.
- I. Belt and Shaft Guards:
  - 1. Easily removable and to enclose entire drive assembly, meeting federal, OSHA, and Province of Manitoba requirements.
  - 2. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
  - 3. Bright yellow finish.
- J. Provide speed test openings at shaft locations.

2.5 FINISHES

- A. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
  - 1. Parts cleaned and chemically pretreated with a phosphatizing process.
  - 2. Alkyd enamel primer.
  - 3. Air-dry enamel topcoat.
- B. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

- C. Stainless Steel Parts: Finished smooth and left unpainted.
- D. Polyvinyl Chloride Parts: Finished smooth and left unpainted.

## 2.6 INLINE FAN, TUBULAR CENTRIFUGAL

- A. General:
  - 1. Factory-assembled tubular centrifugal fan, belt drive or direct drive external rotor motorized impeller type; including housing, fan wheel, drive assembly, motor and accessories.
- B. Housings:
  - 1. Type 316 Stainless Steel or Polyvinyl Chloride (CPVC)
  - 2. Construction:
    - a. Heavy gauge rolled metal casing, with continuous seam welding or heavy duty PVC casing.
    - b. Lifting lugs welded to housing (for fan and motor combined weight greater than or equal to 45 kg).
    - c. Mounting brackets, welded to housing, as required for indicated fan arrangement.
  - 3. Bearing Lubrication Lines:
    - a. Extended to outside of fan housing.
    - b. Type 316 stainless steel construction.
    - c. Terminate with zerk fittings.
  - 4. Inlets: Die-formed bell mouth, matched to fan wheel inlet shroud.
  - 5. Motor Base Plate: Minimum of 4.7 mm metal plate, welded to fan housing, to provide belt tensioning and adjustment (Not applicable for direct drive external rotor motorized impeller type).
  - 6. Duct Flanges: Angle ring flanges, same diameter as housing, at fan inlet and outlet, heavy construction, factory drilled. PVC fans may be provided with spigot type joint for direct connection to four inch CPVC schedule 40 pipe.
- C. Wheel:
  - 1. Material: Type 316 stainless steel or CPVC construction.
  - 2. Centrifugal, one-piece, nonoverloading, backwardly inclined blades or direct drive external rotor motorized impeller assembly type.
  - 3. Blades continuously welded to inlet shroud and backplate.
  - 4. Attached to fan shaft with split taper lock bushing.
- D. Shaft, Bearings, Drive:
  - 1. Shafts:
    - a. Turned, ground and polished type 316 or 304 stainless steel.
    - b. Keyed for sheave installation.
  - 2. Bearings:
    - a. Grease lubricated, precision antifriction ball, self-aligning type.
    - b. Selected for average life (ABMA 9 L<sub>50</sub>) of not less than 200,000 hours operation at maximum cataloged operating speed.
  - 3. Drives:

- a. In accordance with Article, Drives.
  - b. Factory set to the specified fan revolutions per minute.
  - c. Type: Belt or direct.
  - d. Arrangement (for belt drive fans): Arrangement 9
- E. Accessories: Provide as follows:
1. Disconnect: Factory installed, nonfused, NEMA 4X.
  2. Motor and Drive Cover:
    - a. Factory fabricated, OSHA type.
    - b. Sheet metal construction, same material as fan housing.
    - c. Vented, openings sufficient size for proper motor cooling.
  3. Belt Guard: Sheet metal construction, OSHA type.
  4. Housing Access Doors: Bolted and gasketed.
- F. Manufacturers and Products:
1. FanTech
  2. Other as approved by Contract Administrator

## 2.7 CORROSION PROTECTION COATING

- A. General:
1. Factory-applied corrosion protection coating for application to fan components and accessories, where required by this Section.
  2. Quality Control:
    - a. Verify dry film thickness before final baking.
    - b. Finished coating system shall be free from voids, checks, cracks and blisters.
  3. Surface Cleaning: Clean parts to be coated as follows:
    - a. Immerse parts in heated cleaning solution to remove lubricants, machining oils, and residual factory contamination.
    - b. Follow with immersion in potable water bath to neutralize and remove cleaning solution.
    - c. Chemical Pretreatment: Immerse parts in heated chemical solution, iron phosphate for steel, clear/yellow chromate for aluminum.
- B. Baked Enamel:
1. Material: Alkyd modified urea-melamine single component baking enamel.
  2. Surface Preparation: Clean surface to SSPC-SP 3.
  3. Application: Standard air-pressurized spray equipment.
  4. Curing: Oven baked at a metal temperature not to exceed 149 degrees C.
  5. Finished Thickness: 25 microns to 50 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Impact Resistance: 0.115 kg meter, ASTM D2794 test method.
    - b. Pencil Hardness: 2H, ASTM D3363 test method.
    - c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
    - d. Service Temperature: Maximum 110 degree C, continuous.

- C. Baked Polyester:
1. Material: Polyester.
  2. Surface Preparation: Sandblast surface to SSPC-SP 5.
  3. Application: Electrostatic spray.
  4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
  5. Finished Thickness: 38 microns to 62 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
    - b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
    - c. Impact Resistance: 1.15 kg meter, ASTM D2794 test method.
    - d. Pencil Hardness: 2H, ASTM D3363 test method.
    - e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
    - f. Service Temperature: Maximum 110 degrees C, continuous.
- D. Air-Dry Epoxy:
1. Material: Two-part catalyzed epoxy.
  2. Surface Preparation: Clean surface to SSPC-SP 3.
  3. Application: Standard air-pressurized spray equipment.
  4. Curing: Air dry.
  5. Finished Thickness: 100 microns to 150 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Salt Spray Test: Minimum 1,500-hour duration, ASTM B117 test method.
    - b. Pencil Hardness: H-2H, ASTM D3363 test method.
    - c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
    - d. Service Temperature: Maximum 65 degrees C, continuous.
- E. Baked Epoxy:
1. Material: Epoxy.
  2. Surface Preparation: Sandblast surface to SSPC-SP 10.
  3. Application: Electrostatic spray.
  4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
  5. Finished Thickness: 62 microns to 88 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
    - b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
    - c. Impact Resistance: 1.15 kg meter, ASTM D2794 test method.
    - d. Pencil Hardness: 2H, ASTM D3363 test method.
    - e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
    - f. Service Temperature: Maximum 110 degrees C, continuous.

- F. Air Dry Phenolic:
1. Material:
    - a. Phenolic resin, Heresite VR-500 Series.
    - b. For outdoor applications, apply an UV resistant topcoat, Heresite UC-5500.
  2. Surface Preparation: Sandblast surface to SSPC-SP 6.
  3. Application: Standard air-pressurized spray equipment.
  4. Curing: Air dry.
  5. Finished Thickness: 100 microns to 150 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Salt Spray Test: Minimum 500-hour duration, ASTM B117 test method.
    - b. Humidity Resistance: Minimum 500-hour duration, ASTM D2247 test method.
    - c. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
    - d. Service Temperature: Maximum 82 degrees C, continuous.
- G. Baked Phenolic:
1. Material: Phenolic resin, Heresite P-403.
  2. Surface Preparation: Sandblast surface to SSPC-SP 5.
  3. Application: Standard air-pressurized spray equipment.
  4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
  5. Finished Thickness: 125 microns to 175 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
    - b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.
    - c. Impact Resistance: 1.15 kg meter, ASTM D2794 test method.
    - d. Pencil Hardness: 2H, ASTM D3363 test method.
    - e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
    - f. Service Temperature: Maximum 121 degrees C, continuous.
- H. Baked Epoxy Phenolic:
1. Material:
    - a. Baking cross-linked epoxy-phenolic.
    - b. For outdoor applications, apply an UV resistant topcoat.
  2. Surface Preparation: Sandblast surface to SSPC-SP 5.
  3. Application: Electrostatic or conventional compressed air spray equipment.
  4. Curing: Oven baked at a metal temperature not to exceed 204 degrees C.
  5. Finished Thickness: 150 microns to 200 microns dry film thickness.
  6. Performance: Coating shall meet or exceed following criteria:
    - a. Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.
    - b. Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.

- c. Impact Resistance: 1.84 kg meter, ASTM D2794 test method.
  - d. Pencil Hardness: 3H, ASTM D3363 test method.
  - e. UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.
7. Service Temperature: Maximum 177 degrees C, continuous.

## 2.8 MOTORS

- A. General:
1. Provide integral self-resetting overload protection on single-phase motors.
  2. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
  3. Motors shall not operate into service factor in any case.
- B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:
1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
  2. Winding Thermal Protection: None.
  3. Space Heater: No.
  4. Number of Speeds: Single.
  5. Shaft Type: Solid, carbon steel.
  6. Mounting: As required for fan arrangement.
  7. Service Factor: 1.15.

## 2.9 ACCESSORIES

- A. Equipment Identification Plates: Furnish 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.
- B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

## 2.10 SOURCE QUALITY CONTROL

- A. General:
1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
  2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
  3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.
- B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
  2. Center punch fan shaft to accommodate tachometer readings.
- C. Balancing:
1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
  2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.
- D. Vibration Test:
1. Each fan furnished with a 3.7 kW or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
  2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
    - a. Belt Drive (except Vane Axial): 0.38 cm per second peak velocity.
    - b. Belt Drive Vane Axial: 0.2 cm per second peak velocity.
    - c. Direct Drive: 0.2 cm per second peak velocity.
  3. Written records of run test and vibration test shall be made available upon request.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install fans level and plumb.
- B. Scroll Drains: Pipe drain connection through running trap to floor drain.
- C. Labeling:
  1. Label fans in accordance with Article, Accessories.
  2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.
- D. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.
- E. Connections
  1. Refer to Section 23 31 16, Plastic Ductwork and Accessories
  2. Install ductwork adjacent to fans to allow proper service and maintenance.

### 3.2 FIELD QUALITY CONTROL

- A. Functional Tests:
  1. Verify blocking and bracing used during shipping are removed.

2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor (if applicable); verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
  - a. Energize motor and adjust fan to indicated revolutions per minute.
  - b. Measure and record motor voltage and amperage.
2. Operational Test:
  - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
  - c. Test and adjust control safeties.
  - d. Replace damaged and malfunctioning controls and equipment.

3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Balancing:
  1. Replace fan and motor sheaves or adjust dampers as required to achieve +/- 5% of the design airflow.
  2. Work to be completed in accordance with AABC or NEBB standards and work is to be completed by a firm AABC or NEBB certified.
  3. Submit TAB report to the Contract Administrator for review.

3.4 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.5 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification.
1. 23 34 00.01, Fan Schedule

END OF SECTION

FAN SCHEDULE

FANS														
SYMBOL	SERVICE	TYPE	FAN DATA						ELECTRICAL DATA			MANUFACTURER AND MODEL NO.	APPLICABLE REMARKS	
			AIRFLOW			DRIVE TYPE	WHEEL TYPE	MIN DIA INCH	MAXIMUM BHP	MOTOR				
			MAXIMUM L/s	@ SP kPa	MINIMUM L/s					HP	VOLT			PH
EF-X607	Ventilation of chemical drums containing Sodium Hydroxide	Inline duct fan	50	0.06	30	DIRECT	AF	4	1	1	120	1	Fantech FR100	
EF-X606	Venting of chemical drums containing Sulfuric Acid, Sodium Bisulfite and Ferric Chloride	Inline duct fan	50	0.12	35	DIRECT	AF	4	1	1	120	1	Fantech FR100	
EF-X608	Venting of a chemical drum containing hydrogen peroxide	Inline duct fan	40	0.05	20	DIRECT	AF	4	1	1	120	1	Fantech FR100	
EF-X609	Venting of air above an ozone generator	Inline duct fan	95	0.09	65	DIRECT	AF	6	1	1	120	1	Fantech FR150	
ABBREVIATIONS:														
FC:	FORWARD CURVED													
BI:	BACKWARD INCLINED													
AF:	AIR FOIL													