

SECTION 15860 - FRP DUCTWORK

City of San Diego, CWP Guidelines

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NTS: This Section covers round and rectangular ductwork systems to convey odorous air to odor removal systems.

The Specifier shall consider the possibility of differential settlement where duct passes through a wall to an outside odor removal system on a separate foundation and where buried duct enters a structure. Consider also the adverse effects of vibration of rotating equipment.

Condensation will accumulate at low points in the duct system, and provisions for drainage must be considered.

For runs of buried ductwork, consider ribbed or corrugated HDPE pipe or FRP mortar pipe.

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PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

- A. The WORK of this Section includes FRP ductwork systems including duct, bends, fittings, dampers, adapters transitions, closure pieces, supports, expansion joints, and appurtenances.
- [B. The WORK also includes structural of design of certain duct parameters.]

1.2 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - [1. Section 13251 - Activated Carbon Odor Control Systems]
 - [2. Section 13252 - Mist Type Chemical Odor Control Systems]
 - [3. Section 13253 - Packed Tower Type Chemical Odor Control Systems]
 - 4. Section 15000 - Piping Components
 - 5. Section 15020 - Pipe Supports
 - 6. Section 11000 - Equipment General Provisions
 - 7. Section 06610 - Glass Fiber and Resin Fabrications, General

1.3 SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:
 - 1. AMCA 500 Test Methods for Louvers, Dampers, and Shutters
 - 2. ASTM D 2240 Test Method for Rubber Property - Durometer Hardness

3. ASTM D 2310 Classification for Machine-Made Reinforced Thermosetting Resin Pipe
4. ASTM D 2992 Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
5. ASTM D 2996 Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
6. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
7. SMACNA Thermosetting FRP Duct and Construction Manual

1.4 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Duct
 - a. Name of manufacturer
 - b. Type of resin and identification of composite layers
 - c. Pressure, vacuum, and temperature rating of duct
 - d. Dimensions of sub-assemblies to be shipped
 - e. Certification of compliance with reference standards
 - [f. Stamped structural design calculations]
2. Dampers
 - a. Name of manufacturer
 - b. Type, model, materials of construction
 - c. Pressure rating
 - d. Overall dimensions, weight including operator
 - e. AMCA 500 leakage test results
3. Expansion Joints
 - a. Name of manufacturer
 - b. Type, model, materials of construction

- c. Force required for expansion and contraction
4. Supports
- a. Location plan with support type, details, and materials
 - b. Stamped structural design calculations for custom designed supports

1.5 FACTORY TESTING

- A. Duct shall be inspected at the factory for compliance with the defect criteria listed below.
- B. A randomly selected damper from each size classification shall be tested in accordance with AMCA 500 at an AMCA-approved testing laboratory.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. **Service Conditions:** Internally, duct systems will be exposed to air saturated with water vapor containing foul odors, primarily hydrogen sulfide. [Externally, duct systems will be exposed to odorous air inside the building and outside marine environmental conditions of sunlight, varying temperatures and humidities, and salt particulates.]

B. Design Requirements

1. Duct, adapters, transitions, expansion joints

- a. Internal positive pressure, in.wc - [25]
- b. Internal vacuum in.wc - [10]
- c. Temperature, deg. F. - [40 to 120]

2. Dampers

- a. Differential pressure, in.wc - [10]
- b. Temperature, deg. F. - [40 to 120]

3. Dimensions: The dimensions shown are net inside, the clear space inside the duct.

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NTS: Add criteria for other wall thicknesses if necessary.

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4. Physical Properties: Laminates shall have the following minimum properties:

Property	Standard	3/16 inch thick	1/4 inch thick	
Ultimate Tensile Strength, psi	ASTM D 638	9,000	12,000	
Flexural Strength, psi	ASTM D 790	16,000	19,000	
Flexural Modulus of Elasticity, psi (tangent)	ASTM D 790	700,000	800,000	

5. Reinforcement: Bends, fittings and special sections shall be reinforced or shall have shell thickness increased at those locations where the combined stresses due to internal pressure and bending will exceed the maximum stress recommended by the manufacturer. The duct manufacturer shall determine and provide reinforcements or additional shell thicknesses as required to keep the combined stresses within the recommended maximum.
6. Structural Criteria
 - a. Round duct shall have a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum service. Rectangular sections shall require special design consideration that shall be submitted to the CONSTRUCTION MANAGER for review and approval. Rectangular duct design shall be based on a maximum of 1 percent side wall deflection. Minimum wall thickness for round and rectangular duct shall be 3/16-inch.
 - b. After installation, horizontal rectangular duct shall not sag more than 2 percent of the shortest side dimension, measured from the theoretical centerline of the duct to the actual centerline at the midpoint between supports. Maximum sag of horizontal round duct shall not exceed 2 percent of diameter.
 - c. Sections of ductwork weighing more than 150 pounds shall have lifting lugs or eyes to facilitate handling and installation.
7. Chemical Resistance: The FRP duct shall provide chemical resistance to acids, caustic, water, hydrogen sulfide and other sulfide and disulfide compounds, mercaptans, and other materials commonly encountered in odorous air streams from wastewater treatment plants.
8. Flame Spread: FRP ducting and fabrications shall not exceed a flame spread index of 25 and smoke development rating of 50 when tested in accordance with ASTM E 84.
9. FRP Defects: FRP ductwork shall satisfy the following criteria:

Defect	Inside Surface	Outside Surface
Blister	None	Max dimension: 1/4-in dia x 1/8-in high; Max density: 1 per sq ft; Min separation: 2 in apart
Chips	None	Max dimension of break: 1/4-in and thickness no greater than 10 percent of wall thickness; Max density: 1 per sq ft
Crazing	None	Max length: 1/2 in; Max density: 5 per sq ft Min separation: 2 in
Cracks	None	None
Exposed Glass	None	None
Scratches	None	Max length: 1 in; Max depth: 0.010 in
Burned Areas	None	None
Surface Porosity	None	None
Foreign Matter	None	None
Sharp Discontinuity	None	None
Pits	Max: 1/8 in, dia by 1/32 in deep; Max: 10 per sq ft	Max 1/8 in dia by 1/16 deep; Max: 10 per sq ft
Dry Spot	None	1 sq in per sq ft
Entrapped Air	None at the surface 1/16 in and 10 per sq in max within laminate	1/8 in and 4 per sq in or 1/16 in and 10 per sq in

C. Ductwork and fittings shall have the manufacturer's name printed on the exterior surface.

2.2 DUCTWORK SYSTEMS

- A. **Round Duct:** Filament wound, complying with NBS PS-15 (69).
- B. **Rectangular Duct:** Contact molded, complying with NBS PS-15 (69), with structural layer thickness determined by structural calculation. Duct may be reinforced with FRP angles or tees.
- C. **Fittings and Flanges:** Manufacturer's standard, shop-fabricated, compatible with duct, chemically resistant same as duct, complying with NBS PS-15 (69). Flanges shall be at least 3/4-inch thick.
- D. **Manufacturers:** Duct, flanges, and fittings shall be as manufactured by Heil Products, Inc., Paramount Fabricators, Delta Fiberglass, J.B. Rogers, or equal.
- E. **Flange Gaskets:** Full face, Hypalon, 3/16-inch min. thickness, hardness of Durometer 50 to 70 when tested according to ASTM D 2240.
- F. **Bolts, Studs, Washers, Nuts:** Comply with Section 05500.
- G. FRP Construction
 - 1. Resin: Resin shall be premium corrosion-resistant, fire resistant vinyl resin as recommended by the manufacturer for the intended service. Resin shall be Hetron by Ashland Chemical, Derakane by Dow Chemical, or Rigidon by Heil Products.
 - 2. Fiber Glass Reinforcement: Chopped strand fiber glass mat shall be used as reinforcement material. Alternatives such as synthetic fiber cloth, woven roving, fiber glass cloth, chopped strand fiber glass spray-up, or filament may be accepted, subject to review by the CONSTRUCTION MANAGER.
 - 3. Laminates
 - a. Inner Surface: The inner surface exposed to the exhaust air environment shall be a resin-rich liner between 0.01-inch and 0.02-inch thick obtained by using one layer of Nexus veil saturated with resin.
 - b. Interior Layer: The interior layer shall consist of chopped strand glass mat or chopped glass roving saturated with resin to achieve a minimum thickness of 0.10 inch (100 mils).
 - c. Structural Layer: The structural layer shall be fabricated using either hand layup construction per NBS PS-15 or filament wound, depending on the duct shape in cross-section.
 - d. Outside Coat: The outside coat shall be resin rich with no exposed raw fibers. For interior duct, the final coat shall be an acceptable factory applied intumescent coating to achieve the designated results for low smoke development. For exterior duct, the final coat shall be an acceptable resin coat with ultraviolet (UV) inhibitor or a suitable paint resistant to UV attack on the surface. The color shall be selected by the CONSTRUCTION MANAGER.
- H. **Expansion Joints:** Expansion joints shall be of a material resistant to UV light and shall be fabric-reinforced Hypalon.

1. Expansion joints shall be slip-on or flanged type. The slip-on type shall be sized to fit tightly on the outside diameter of the duct and shall be secured in place by stainless steel worm screw type adjustable clamps to provide a gas-tight connection. Flange type expansion joints shall have split stainless steel retaining rings and shall have ANSI/ASME B16.1, Class 25 diameter and drilling.
2. Expansion joints shall be capable of compressing and elongating 1-inch under a maximum force of 100 pounds or less. The joints shall also allow lateral deflections of up to 1 inch. Expansion joint material shall be stiff enough to prevent sagging or contraction due to internal vacuum.

2.3 DAMPERS

A. Components

Frame	Fiberglass reinforced plastic with vinyl ester resin (and UV inhibitors where dampers are located outside).
Blade	Fiberglass reinforced plastic; stiffeners as required. If the largest dimension is 36 inches and less, thickness shall be at least 0.25 inches. If larger than 36 inches, 0.50 inches thick.
Axle	Continuous fiberglass reinforced plastic rod; 6-inch extension beyond frame; stiffeners as required.
Bearings	Molded PTFE.
Blade Stops	Fiberglass reinforced plastic bar.
Blade Seals	Neoprene.
Shaft Seal	Neoprene.
Flanges	Flanges shall comply with PS-15 Table 5 at a design pressure of 25 psi and shall have ANSI B16.1 Class 25 diameter and drilling.

- B. **Construction:** Dampers shall be of the single-blade type complete with channel-type frame, close-fitting blade, full-length axle, and bearings. The damper shall be constructed of fiberglass reinforced plastic using a vinyl ester resin similar to the duct and shall have the same dimensions as the inside of the connecting ductwork. Axles shall be not less than 1-inch in diameter and shall be continuous through the damper.

1. Dampers shall have a minimum pressure rating of 10-inch water column. Dampers used for isolation service shall be furnished with a blade seal and shaft seal. Dampers used for balancing shall be furnished with a full circumference molded in blade stop. Isolation dampers shall have a maximum leakage rate of 3 cubic feet per minute per square foot of damper area, at a differential pressure of 10 inches wc. AMCA leakage tests shall be furnished as part of the submittal. Dampers shall be AMCA rated and licensed to bear the AMCA seal.
2. Round dampers shall be **Swartwout Model 912** or equal.

3. Rectangular dampers shall be the single blade type with dimensions indicated in the damper schedule.
 4. Rectangular dampers shall be **Swartwout Model 1108AF** or equal.
- C. **Hand Actuators:** Dampers shall be provided with hand operators.
1. Hand actuators for dampers 24-inch diameter and larger shall be worm geared driven, totally enclosed, weather-proof, and permanently lubricated in a die-cast aluminum housing. Housing shall be epoxy coated in the factory with a minimum dry film thickness of 8 mils. Worms shall be heat-treated carbon steel and worm wheels shall be ductile iron. Shafting shall be stainless steel. Shaft and worm wheel seals shall be Buna-N rubber. Actuator shall be bolted to the duct with stainless steel bolts. Hand wheel sizes shall be computed assuming a maximum rim effort of 40 lbs. The allowable number of turns of the hand wheel in order to rotate the blade 90 degrees shall be a minimum of 4 and maximum of 12. Actuators shall be provided with indicating arrows to clearly identify directions of rotation for opening and closing of the dampers. Arrows shall be clearly legible and of substantial durability.
 2. Worm gear driven hand actuators shall be **Swartwout Dyna-Torque Model DT2**, or equal.
 3. Hand actuators for dampers less than 24-inch diameter shall be heavy duty, lever type actuators. Each heavy duty hand actuator shall be constructed of Type 316 stainless steel and shall have a locking quadrant suitable for positioning the blade at any intermediate position.
 4. All dampers with shaft centerlines more than 5 feet 6 inches above the floor shall be provided with chain wheels and operating chains. Each chainwheel shall be equipped with a chain guide that will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable actuator extensions shall be provided, if necessary, to prevent interference of chain and adjacent piping or equipment below. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend within 4 feet of the floor below damper.
 5. Galvanized tie-back hooks shall be provided on adjacent pipe supports to hold operating chains out of walkways or maintenance access areas when the damper is not being operated.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. **Field Measurements:** Duct lengths shall be determined from measurements taken at the Site. Dimensions shown on drawings are approximate, not for fabrication.
- B. **Delivery, Storage, and Handling:** Duct, fittings, and dampers shall be protected from damage and shall be properly supported to avoid damage due to flex strains during shipping and installation. Debris or other extraneous material shall not be allowed to enter the duct. Duct, fittings, and dampers shall not be thrown or dropped.
- C. **Installation:** Ducts shall be installed as indicated. All necessary provisions shall be taken into consideration during fabrication and installation of ductwork to provide for expansion and

contractions. Ductwork shall be free from vibration when in operation. All necessary vibration isolation devices shall be provided.

1. Antiseize compound shall be applied to bolt threads.
 2. Smooth bends or internal turning vanes shall be installed at elbows, tees, and other points where air flow changes direction.
 3. The ductwork shall be supported per manufacturer's recommendation and as required herein.
 4. The inside of duct, specials, and fittings shall be smooth, clean, and free from blisters, sand, and dirt when installed.
 5. Ductwork shall be airtight.
- D. **Joints:** Joints shall be carefully and neatly made in accordance with the requirements herein and as recommended by the manufacturer.
- E. **Flanges:** Flange bolts shall be tightened sufficiently to slightly compress the gasket and make a good seal, but not so tightly as to distort the flanges. A flat washer shall be installed under each nut and bolt head.
- F. Dampers shall be positioned to fit in the connecting ductwork at the locations indicated on the drawings. Unless necessary for proper operation of the damper, axles shall be installed in the horizontal position.
- G. Supports and Hangers
1. Supports for the FRP duct shall comply with SMACNA Standards and appropriate code requirements for aluminum duct installation. Supports and hangers shall transmit all loads into the building structural frame through a system of intermediate beams and struts as necessary to comply with these specifications. The CONTRACTOR shall submit his proposed support details plan to the CONSTRUCTION MANAGER for approval.
 2. Supports or hangers employing clip angles or similar devices for attachment to the duct are prohibited and all supports shall be designed to resist UBC Zone 4 seismic forces. Supports shall be as indicated in Section 15020 - Pipe Supports.
- H. **Alignment and Elevation:** Ductwork shall be provided to the lines and elevations indicated and shall slope to facilitate water drainage where indicated. Laser beam equipment or surveying instruments shall be used to maintain alignment and elevation. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the duct, precautions shall be taken to prevent or minimize further thermal deflections.

3.2 DUCT CLEANING

- A. Duct shall be blown clean of dust and debris using compressed air. The system fans shall not be used to provide air for duct cleaning. The duct being cleaned shall be purged continuously for not less than 48 hours at a flow rate not less than the design flow rate for that duct section.

** END OF SECTION **