Fiberglass Fabricators, Incorporated

Standard Specification for Fiberglass Reinforced Wash Troughs and Launders

1 Scope

1.1 Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install fiberglass-reinforced plastic (FRP) troughs, and appurtenances complete and operational as shown and specified. All anchor bolts, fasteners and accessories shall be included. Standard design calculations for both round and flat bottom trough configurations shall incorporate load evaluations, displacement, and stress calculations. Calculations will comply with the American Water Works Association procedures set forth in specification ANSI/AWWA F101-91. Furthermore, this standard includes additional requirements for enhanced performance and lifetime over and above AWWA spec F101-91.

2 General

2.1 Troughs are fabricated using a general-purpose polyester resin with 24-oz. woven roving inter-layered with glass mat reinforcement. The interior of the trough shall be smooth, while the exterior of the trough is finished with one ply of surfacing mat to give a smooth and uniform appearance.

2.2 Drawings are to be taken as standard for troughs. Thicknesses of layers shall be as specified for each combination of diameter, depth, and span as determined by computerized calculations using classical lamination theory. Factors of safety shall be reported for all critical areas.

2.3 **Loadings:** The troughs shall be designed to supply, within stress and deflection limitations, the following loadings.

a. **Gravity Load -** Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and the spreader bars, together with the weight of water to fill the trough. Any additional loads, such as piping, and so forth, shall also be considered.

b. **Buoyant Load -** Upward vertical loads shall include the weight of the displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.

c. **Lateral Load -** Loads acting against the trough sidewalls by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or, when the trough is full and the tank is empty, shall be used when calculating deflection, fiber stress, etc.

2.4 **Thermal Stresses -** The troughs shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion and contraction between the trough and tank material or support members.

2.5 **Torsional Stability -** The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered:

a. Trough-to-Trough Stabilization
b. Torsional Stiffeners
c. Support Spacing and/or Shell Stiffening Methods
d. Internal Baffles and/or Flow traighteners

2.6 **Deflections Under Load -** Maximum vertical deflection under full buoyant or gravity load shall be less than *or* equal to L/1000, where L is defined as the unsupported trough length in inches. Under no circumstances shall the maximum vertical deflection, measured at the midpoint between trough supports, exceed 3/16 inch.

Maximum trough sidewall horizontal deflection under full lateral load shall be less than *or* equal to D/100, where D is defined as the trough depth, in inches. Under no circumstances shall the maximum sidewall deflection exceed 3/16 inch.

Trough bottom deflection under full buoyant or gravity load shall be less than or equal to W/l00, where W is defined as the trough width in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

2.7 **Fiber Stress Limitations -** Supplemental to the deflection criteria established in the previous section 2.6, the troughs shall be designed such that the maximum wall stress under the most severe loading condition is less than *or* equal to 1500 psi. This stress criterion is approximately equivalent to an 8:1 factor of safety as applied to the tensile and flexural properties of contact-molded troughs and launders.

2.8 **Thermal Expansion/Contraction -** The troughs shall be designed to accommodate thermally induced expansion and contraction of 1/8 inch per 20 foot length of trough over a temperature range of -10^0F to 100^0F, without exceeding the deflection or strain limitations set forth in Sections 2.6 and 2.7.

2.9 Governing Criteria

The following presents additional design requirements that should be incorporated over and above the AWWA standard to yield a trough design with enhanced performance and endurance characteristics.

2.9.1 **Buckling of Cross Braces -** In addition to AWWA F101-91, the design should include critical buckling load calculations for the trough cross braces or spreaders. This calculation is required to ensure that the cross braces do not approach the critical Euler column buckling load when the trough is empty and the tank is being filled, thereby placing the braces in compression.

2.9.2 **Blind End Stress -** The blind or closed end of the trough is anchored to the wall with 3/8 inch thick FRP spacer washers to allow for thermal expansion along the length of the trough. Using the thermal excursion as specified in AWWA F101-91, maximum thermal displacements will be calculated and applied to the mounting area on the blind end to determine plate bending stresses. The plate thickness will then be calculated so that stresses do not exceed the level set forth in the AWWA spec.

3 Materials

3.1 Resin Requirements

The resin shall be a commercial-grade polyester thermosetting resin which has been determined to be acceptable for the service conditions. The resin shall contain no fillers or additives except as follows:

a. A thixotropic agent may be added for viscosity control.
b. Pigments shall be light stable, not soluble in water, and compatible with the resin.
c. Typical color shall be blue-green.

3.2 Ultraviolet Resistance

Ultraviolet stabilizers are required in all laminates exposed to ultraviolet light whether it be in the form of pigmentation or ultraviolet absorbers.

3.3 Glass Reinforcement

The reinforcing materials used shall be 24/15 oz woven roving mat combination Type E glass with a chrome or silane finish, and a binder compatible with the resin. Surfacing veil shall be Type C veil with a binder containing silane and compatible with the lay-up resin.

3.4 Fasteners

All trough mounting brackets and hardware shall be type 316 stainless steel and shall be supplied by the trough manufacturer.

3.5 Metal Reinforcement

When metal reinforcements are used, they shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated with a minimum of 1/8 inch thick laminate.

3.6 Composite Reinforcement

When composite sandwich structures are used as reinforcements, liquid resistant materials such as end-grain balsa wood or structural PVC core may only be used as core materials.

3.7 Laminate Minimum Physical Properties

Minimum physical properties for the product shall conform to those presented in Table 1 below:

Table 1. Laminate Minimum Physical Properties

Property @ 70^0F	**Value**	**Test Method**
Tensile Strength Trough	26,500 psi	ASTM D 638
Tensile Strength Weir	12,500 psi	ASTM D 638
Tensile Modulus Trough	1,550,000 psi	ASTM D 638
Tensile Modulus Weir	900,000 psi	ASTM D 638
Compressive Strength Trough	26,500 psi	ASTM D 695
Compressive Strength Weir	26,000 psi	ASTM D 695
Compressive Modulus Trough	1,500,000 psi	ASTM D 695
Flexural Strength Trough	39,000 psi	ASTM D 790
Flexural Strength Weir	32,000 psi	ASTM D 790
Flexural Modulus Trough	1,550,000 psi	ASTM D 790
Shear Strength Trough	12,500 psi	ASTM D 732
Barcol Hardness Trough	50	ASTM D 2583
Glass Content Trough	45%	ASTM D 2584
Water Absorption	.09% Max	ASTM D 570
Coefficient of Linear Thermal Expansion (in/in/^{0}F) - Molded	15 x 10^{-6}	ASTM D 696

4 Submittals

4.1 Final approval for incorporation into the project will be made only after the review of shop drawings, specifications, and data as follows:

a. Shop drawings complete with all dimensions, details of connecting piping, and the size and location of any required openings.
b. Specifications for all components.
c. Details of the major fabricated components showing the arrangement of components and labeled with member sizes and materials of construction.

d. Structural calculations for all components.
e. Manufacturer's recommended procedures for jobsite storage of equipment, handling, and erection.

4.2 Design Calculations

Classical or advanced numerical techniques should be used to determine optimum design for the specified operating conditions. As a standard, strength of materials approaches coupled with computerized classical lamination theory should be used to determine displacements, stresses, and factors of safety. Factors of safety for each lamina used in high stress areas will include values using the Tsai-Hill or equivalent approach in order to determine the minimum factor of safety for each ply.

A written narrative that clearly states all of the basic design assumptions and parameters that were used in the computerized calculations shall accompany the calculations. Approval by the engineer shall not relieve the manufacturer of responsibility for providing material and designs conforming to the intent of this specification.

5 Quality Assurance

5.1 Qualifications

Contractor shall have a minimum of five (5) years of history of successful installations of similar design. Past job list with customer contact information will be supplied if required.

5.2 Manufacturer's Quality Control

All fabrication shall be carefully inspected at the factory by inspectors who shall use whatever means necessary to assure the proper fit of all field connections and compliance with all material and fabrication requirements of the specifications.

5.3 Warranty

Manufacturer shall warrant the Fiberglass Reinforced Wash Trough and Launders to be free of defects in materials and workmanship for a minimum of one (1) year after installation with a maximum of eighteen (18) months from date of shipment.

5.4 The contractor shall be responsible for verifying all field dimensions to develop and approve shop drawings.

6 Manufacture

6.1 Materials, equipment, and components in this section shall be the products of:

Fiberglass Fabricators, Incorporated
P.O. Box 17068
964 Douglas Pike
Smithfield, RI 02917

6.2 The inner surface of the trough shall he smooth and resin-rich, reinforced with a surfacing

veil as described in Section 3.3.

6.3 Each ply of reinforcement shall be thoroughly wetted with resin and rolled out to exclude all air pockets and bubbles prior to the application of the next ply.

6.4 The exterior or outer surface shall consist of a layer of paraffinated resin not less than 0.020 inch thick to prevent air inhibition. This layer is applied after the cure of the structural layer to embed all reinforcing fibers.

6.5 When it is necessary to cut the laminate, drill holes, and/or machine slots, all cut edges shall be sanded smooth and sealed with paraffinated resin solution to prevent water from penetrating or wicking into the laminate.

6.6 The top edges of the trough shall be level and parallel within a tolerance of +/- 1/8 inch as measured when the trough is not loaded. The length of a trough section shall have a tolerance of +/-1/8 inch per 10 foot length.

6.7 Laminate thickness shall be in accordance with the design requirements set forth in Section 2, but not less than 3/16 inch. The thickness tolerance shall be plus 1/16 inch, minus 0 inch.

6.8 Thickness at locations of supports such as saddles shall be a least 1-1/2 times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in Section 2.7.

6.9 End flanges and blind ends shall be a minimum of 1-1/2 times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in Section 2.7.

6.10 An integrally molded water stop shall be provided on the trough wherever the trough is grouted into and/or passes through a wall.

6.11 Cross braces or spreaders shall be bolted between the trough walls on approximate 3 foot centers to enhance the structural rigidity of the trough system.

7 Installation, Storage, Handling, and Maintenance

7.1 The manufacturer shall provide detailed written instructions for the installation, long term storage, handling, and maintenance for the products provided.