

SECTION 78912
FIBERGLASS-REINFORCED PLASTIC TANKS
MANUFACTURED BY L.F. MANUFACTURING, INC.
Specification # LFTK001

PART 1—GENERAL

1.1 WORK INCLUDED

- A. This Section specifies the requirements to furnish fiberglass-reinforced plastic (FRP) tanks.

1.2 RELATED WORK

- A. This section shall be used in conjunction with the individual tank data sheets and related Contract Documents to establish the total requirements for FRP tanks:
- B. CAUTION: Use of this Section without including the above listed items will result in omission of basic requirements.
- C. In the event of conflict regarding FRP tank requirements between this section and any other section, the provisions of the tank data sheet shall govern.

1.3 FURNISHED INFORMATION

The following information shall be supplied with the request for quotation.

- A. Drawings, referenced standards, and this specification. Drawings should list vessel dimensions, tank connections, and accessories as a minimum.
- B. Chemical environment, concentrations, and specific gravity.
- C. Tank heating and insulating requirements when applicable.
- D. Design pressure and temperature.
- E. Operating pressure and temperature.
- F. UV inhibitors when required.
- G. Any special requirements that could affect tank construction.

1.4 DESIGN CRITERIA

- A. Tanks shall be designed, fabricated, and inspected in accordance with the latest issue of the following standards:
1. ASTM D-3299, Filament-Wound Glass-Reinforced Chemical-Resistant Tanks, latest edition.
 2. ASTM C-582, Contact-Molded Reinforced Thermosetting Plastic Laminates for Corrosion-Resistant Equipment.
 3. ANSI B 16.5, Flange Dimensions.
 4. ASTM D-2583, Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impression tester.
 5. ASTM D-2584, Test Method for Ignition Loss of Cured Reinforced Resins.

6. National Bureau of Standards (NBS) Voluntary Product Standard PS 15-69, Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment.
 7. ASTM D-2563, Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
 8. ASTM D-4097, Contact Molded Glass – Fiber Reinforced Thermosetting Resin Chemical-Resistant Tanks.
- B. FRP tanks shall be corrosion-resistant to the specified tank contents and shall be suitable for the intended service life.
- C. FRP tanks shall have roofs capable of withstanding an external uniformly distributed loading of 50 pounds per square foot. Flat-top tanks to have a maximum 25 pounds per square foot. Additional loads from mixers, pumps, or catwalks shall be supported externally from the tank.
- D. Dimensional Requirements-Cylindrical Vessels and Tanks: Diameters shall be measured internally. Tolerance on nominal diameter including out-of-roundness shall be plus or minus 1 percent. Measurements shall be taken with the tank in the vertical position. Taper shall not exceed 0.25 percent per side. The minimum knuckle radius on formed heads shall be 1-1/2 inches unless noted otherwise on the attached data sheets.
- E. The final locations of nozzles and accessories shall be subject to change until shop drawing approvals.
- F. All FRP tanks shall be designed for outdoor service with direct sunlight exposure.
- G. Tanks shall be designed to meet pressure, loading or seismic criteria using strengthening ribs, unless otherwise indicated on the data sheets. Where no strengthening ribs are specified, loads shall be distributed over a uniform side shell thickness.

1.5 QUALITY ASSURANCE

- A. Quality Control Program
1. The fabricator shall have a quality control program in place.
 2. All phases of the tank fabrication shall be certified as passing the fabricator's quality control program.
 3. A current production schedule shall be available for inspection that identifies the vessel fabrication or storage location, current status, and expected completion data for each vessel.
 4. All areas of the facility where vessels are being fabricated or stored under this specification shall be available for inspection during normal working hours.
 5. Prior to the start of initial manufacturing, the fabricator shall have approved shop drawings showing the fabrication procedure.
- B. Testing, Inspection:
1. Tanks shall be tested and inspected at the point of manufacture with the written documentation of the test result supplied to the Contractor. The Contractor shall

be notified a minimum of 2 weeks prior to all scheduled testing of tanks at the manufacturer's site. Tests shall include, but are not limited to the following:

- a. Visual internal and external examination of all tank surfaces and fittings, including nozzle interiors and FRP accessories per ASTM D-2563. The outer surface of the tank shall be smooth and have no glass fibers exposed.
 - b. Barcol hardness measurements per ASTM D-2583. Cure development test per ASTM D-3418. This test will be performed at the following locations as a minimum:
 - 1) Four equally spaced points on the tank top exterior surface and four equally spaced points on the tank top inner surface (unlined tanks).
 - 2) Four equally spaced points on the inner surface at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ on the tank straight wall height (total of 12 points).
 - 3) Two points at each nozzle and manway where it is joined on the inner surface (floor, wall or top) of the tank.
 - 4) Four equally spaced points on the tank bottom inner surface.
 - c. Resin cure development test (gel test) shall be performed on each tank exterior resin mix.
 - d. Acetone test at equally spaced external locations, as described in 1.4.A.1b above, to detect inadequate cure. Acetone tests will be conducted as follows:
 - 1) Saturate a clean, lint-free rag with commercial grade acetone.
 - 2) Wipe the rag to wet a 6-inch diameter circle.
 - 3) Allow wet circle to dry for 5 to 10 minutes.
 - 4) Touch the circle. If the surface is tacky, the cure is inadequate and additional curing (possibly at elevated temperature) or other approved remedial action is required.
 - 5) Acetone test shall be done with the tank well ventilated.
 - e. Compliance check of tank and accessory dimension per vendor drawings.
2. The Contractor may inspect tanks at any time during tank fabrication, testing, or preparation for shipping. Notify the Contractor at least 24 hours prior to loading tanks for shipping.
 3. Tanks shall not be shipped without approval from the Contractor. A clearance for shipment shall not relieve the fabricator's responsibility as to performance guarantees, quality of materials and workmanship, and dimensional conformity with the drawings.
- C. Laminate Quality: Laminate quality shall meet the requirements of the visual acceptance criteria in ASTM C-582, NBS PS15-69, and ASTM D-2583, including, but not limited to the following:
1. Appearance.
 2. Defects.
 3. Cut edges.
 4. Construction joints.
- D. Repair of Defects – Structural Defects: Defects extending into the structural layer shall not be ground out, but shall be surface ground and built up using hand lay up techniques per ASTM D-4097 to repair the corrosion barrier and external filament winding to restore structural integrity. The Contractor shall be notified of any structural defects found during fabricator's inspection as to type of defect, defect location and size, and a detailed description of the proposed repair procedure.

1.6 DELIVERY AND HANDLING

- A. Preparation for Shipment:
 - 1. In addition to any special requirements for shipping, handling, storage, and protection provided in this specification, the tanks shall be prepared and protected for shipment and shipped as specified in ASTM D-3299.
 - 2. Prior to inspection and loading, all dirt and extraneous materials shall be removed from the tank interior. All exterior surface markings, coatings, or contaminants shall be removed prior to shipment.
 - 3. Tanks designed for high-purity water service shall be internally pressure washed. Non high-purity tanks shall be rinsed with potable water.
- B. Packing and Loading
 - 1. All materials fabricated to this Specification shall be packaged, crated, or protected in such a manner as to prevent damage in handling and while in transit.
 - 2. No components or other pieces shall be shipped loose inside the tanks.
 - 3. Regardless of the mode of transportation, all components shipped shall be firmly fastened and padded to prevent shifting of the load or flexing of components while in transit.
 - 4. The fabricator shall deliver undamaged tanks meeting all specifications and standards to the job site.
 - 5. Pipe, tubing, fittings, gaskets and bolts to any other small miscellaneous parts and accessories shall be padded and packaged in a crate or box and shall be shipped separately. Ladders do not need to be crated.

1.7 SUBMITTALS

- A. Provide the following in addition to the standard requirements with bid:
 - 1. Detailed description of the laminate and the type of reinforcing to be used in construction for each layer, including:
 - a. Resin blend.
 - b. Catalyst/promoter/accelerator.
 - c. Structural reinforcement materials and sizes.
 - d. Interior surface veil thickness and composition.
 - e. Manufacturer's product data for tank interior corrosion liner construction and thickness including number of veil and mat layers to be used.
- B. Shop drawings shall be submitted within 2 weeks of subcontract for review, including:
 - 1. Tank warranty.
 - 2. Detailed shop drawings showing dimensions of equipment, all nozzles and manways, and construction materials.
 - 3. If required, calculations shall be submitted. The calculations shall show that the proposed tank design is structurally suitable to the service. Arrangements can be made for P.E. stamp by an engineer registered in the state of Texas.
 - 4. Anchor bolt size, type, number, and location.
- C. The fabricator shall provide updated shop drawings showing as-built fabrication information.

PART 2—PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
1. L.F. Manufacturing Inc.
P.O. Box 578/Highway 290 East @ CR236
Giddings, Texas 78942
Phone: (979) 542-8027 / 1-800-237-5791
Fax: (979) 542-0911

2.2 MATERIALS

- A. Resin:
1. The equipment shall be fabricated using the corrosion-resistant resin specified below. Unless otherwise specified, the resin shall be used throughout all laminates
 2. Catalyst/promoter/accelerators shall be commercial grade cobalt naphthenate with dimethyl aniline, benzoyl peroxide, and methyl ethyl ketone peroxide appropriate to the resin blend, enforcement and manufacturer's equipment. Positive measurement control of catalysts, promoters, and resins shall be maintained at all times.
 3. No fillers, additives, or pigments shall be employed in the resin, except as specified below. A thixotropic agent for viscosity control may be used as recommended by the resin manufacturer. No thixotropic agent is to be used in the corrosion liner or on surfaces to be in contact with the corrosive environment. Use of this additive is subject to the approval of the Contractor.
 4. Resin putty shall be made using the same resin as was used in the component laminates. Resin putty shall contain a minimum 15 percent by weight of milled glass fibers. The use of silica flour, grinding dust or other fillers is not allowed.
 5. Resin: acceptable commercial-grade vinyl-ester resins, including Co-Rezyn 8300, Derakane 411, and Hetron 922. The manufacturer shall confirm the recommended resin and corrosion barrier is appropriate for the specified contents. All corrosion barrier surfaces must be fabricated from the same resin blend.
- B. Reinforcement:
1. Type and sequence of reinforcement to be used shall be as designed in Section 2.3.
 2. All glass fiber reinforcing shall have epoxy compatible with silane-type surface finish and binder that is recommended by the glass manufacturer for the particular resin system to be used.
 3. Surfacing veils on interior surfaces shall be 10-mil Nexus® veil or Type C-glass veil as specified on the tank data sheets.
 4. Surfacing veil used on the tank exterior (if requested) surfaces shall be 10-mil Type C-glass veil.
 5. Mat shall be type E glass, 1 ½ ounces or ¾ ounce per square foot as specified in the laminate sequence charts with nominal fiber length of 1.25 plus or minus 0.75 inch.
 6. Continuous roving used in chopper gun for spray up shall be Type E glass.
 7. Woven roving shall be Type E glass, nominal 24 ounces per square yard, 4 by 5 weave with silane-type finish.
 8. Continuous roving used for filament winding shall be Type E glass with a silane-type finish with a nominal yield of 110 yards or more per pound.
- C. The final exterior coat shall be pigmented to form a uniform color coat. The pigment shall be dispersed in the resin used for the final coat. Tanks shall have a UV inhibitor added to the final exterior resin coat. Tank colors will be submitted with bid request.

2.3 FABRICATION

- A. All tanks shall be filament/chop-hoop shell construction wound in accordance with ASTM D-3299, Type I or Type II, as applicable, with continuously supported flat bottoms and straight sides.
- B. Corrosion barrier construction (number of veil and mat layers) and minimum thickness shall be as specified on the tank data sheets. The corrosion barrier strength shall not be included in tank structural calculations.
- C. Post-curing of the FRP laminate (if necessary) shall consist of a cure temperature of at least 180-degree F for a minimum of 4 hours. Where steam is used in the curing process, care shall be taken that no steam impinges on the interior surface or the inside of any nozzle. For this purpose, a steam spurge pipe projecting at least 12 inches beyond the interior surface of the nozzle and 12 inches from any wall is recommended. During steam post curing, the tank shall be maintained at atmospheric pressure.
- D. The mechanical properties of any contact-molded reinforced laminate shall meet or exceed all requirements of ASTM C582.
- E. Lifting Lugs: Closed-top tanks shall be provided with at least two lifting lugs equally spaced and located appropriately. Lifting lugs shall be designed to limit flexing when used to lift the tank vertically or horizontally. Lifting lugs shall be of manufacturer's design using galvanized steel. Eyebolts shall be commercially available steel eyebolts suitable for supporting the tank at any angle during unloading and installation. Follow fabricator's handling recommendations.
- F. Tank Tie-Down System: Tanks shall have either a fixed location tie-down lug system consisting of at least four equally spaced lugs or an adjustable location tie-down system consisting of a continuous exterior ledge at the side shell/bottom knuckle. Lugs shall be galvanized steel. Do not use the tie-down lugs as lifting lugs. Follow fabricator's handling recommendations.
- G. Nozzles and manways shall be fabricated per ASTM D3299 and in compliance with ANSI B. 16.5 for 150-pound drilling. All nozzles shall be single-piece construction, contact molded by hand lay-up. No slip-on flanges are permitted. Machine facing of the back of the flanges is not permitted. All nozzles and flanges shall have a minimum thickness as specified by ASTM D4097-881. Compression-molded and filament-wound flanges are not acceptable. Nozzle boltholes shall straddle tank vertical centerline or radial centerlines on tank tops. Tolerance in bolthole locations and bolt circle diameter shall be with ¼ inch. Boltholes shall be spot faced for SAE washers. Bolt/nuts for manways and blind flanges shall be a minimum of zinc plated steel unless otherwise specified on tank data sheets.
- H. All flanges 12" and under shall be reinforced with 3/8-inch minimum thickness flat plate gussets, except for drain nozzles, which require specially designed reinforcing. Nozzles shall include four plate gussets each. Gusset locations shall not interfere with flange bolting. Gussets shall continuously contact the nozzle exterior surface and the tank wall (or top). Gusset contact length at tank wall and nozzle shall be equal.

- I. Gaskets: The manway and blind flange nozzles shall be provided with the gaskets specified in the tank data sheets.
- J. All cured resin surfaces to be joined shall be roughened by sanding or grinding extending beyond the work area. Surfaces shall be clean and dry prior to lay-up prior or winding. The entire sanded surface shall be resin coated when the joint is made.
- K. The tanks shall be shipped as a single integral unit, except for ladders, catwalks, and other large appurtenances, which may be shipped separately.

2.4 ACCESSORIES

- A. Tank tops: If requested, the top surface of all tanks shall be provided with a full non slip surface created by a heavy sprinkling of sand into the final surface resin coating.
- B. Railings: Where railings are required, as indicated on tank data sheets, they shall comply with the following:
 - 1. 42-inch high minimum railing height.
 - 2. Fabricated in compliance with OSHA requirements.
 - 3. Hot dipped galvanized steel frame construction.
 - 4. Removable, attached to tank with zinc plated steel fasteners
- C. Ladders: Where ladders are specified on the tank data sheets, they shall be of hot dipped galvanized steel construction bolted to hot dipped galvanized steel tank brackets. Ladders will be attached to the tank brackets with zinc-plated bolts, nuts, and double washers.
- D. Ladder Fabrication Requirements:
 - 1. Shall meet all regulatory requirements.
 - 2. Bottom rung shall be no higher than 8 inches above the tank bottom.
 - 3. Rungs shall be evenly spaced not more than 12 inches on center.
 - 4. Top rungs shall be flush with landing surface.
 - 5. Clear Rung Width: 16 inches min.
 - 6. Rungs shall be 7 inches from centerline of rungs to surfaces behind the ladder.
 - 7. Standoff clips shall be evenly spaced but not more than 8 feet on center at each side rail.
 - 8. Top standoff clips shall be 6 inches below landing surface.
 - 9. Side rails shall extend 42 inches above landing surface.
 - 10. Safety cages shall be provided with all ladders over 20 feet in height.
- E. Walkways: Where tank-mounted walkways or catwalks are required on the attached tank data sheets, they shall comply with the following:
 - 1. 30-inch minimum inside width.
 - 2. 42-inch high minimum railing height.
 - 3. Fabricated in compliance with OSHA requirements.

4. Hot dipped galvanized steel frame.
 5. Grated hot dipped galvanized steel walkway.
- F. Nameplates: Attach a permanent weatherproof equipment identification label to each tank. The label shall state the following information:
1. Equipment identification number.
 2. Capacity in U.S. gallons
 3. Name of manufacturer.
 4. Manufacturer serial number.
 5. Year built.
 6. Purchase order number.
 7. Resin blend and catalyst/promoter system.
 8. Surface veil.
 9. Liner material.
 10. Design temperature and pressure.
 11. Tank dimensions.
 12. Tank weight (empty).
 13. Tank weight (full of water).

The label shall be clear coated to prevent chemical corrosion steel.

PART 3 – EXECUTION

- A. During installation of the tanks, care shall be taken to prevent contamination of the interior of the tank. Nozzles and manways shall be covered except when work is being done on the tank. At least one nozzle shall remain open to prevent pressure buildup in the tank.
- B. Entry into tanks shall be minimized. When working in the tanks, care shall be taken not to damage the interior surfaces. If ladders are placed in the tank, protection shall be provided between the tank surface and the ladder.
- C. Tanks are considered a confined space. A confined space entry permit shall be obtained, and all contractor confined space entry procedures shall be followed.
- D. After hydrostatic testing, tanks shall be thoroughly rinsed, drained, and dried. Tanks for high-purity services shall be dried within 24 hours of testing.
- E. The tank shall be inspected by the Contractor after completion of field assembly and testing and prior to field cleaning.