

## FRP Fuel Tanks Standard Specification

### 1. Scope

- The conditions of service of the FRP tanks to be provided under this specification shall be as specified herein.
- The Contractor shall furnish, test, and place in satisfactory operation the fiberglass reinforced plastic (FRP) tanks of the dimensions and number called for herein and as shown on the Contract Drawings.
- The FRP tanks shall be furnished complete with liquid level gages, all accessories, special tools, spare parts, base attachments, mountings, anchor bolts and other appurtenances as specified or as may be required for a satisfactory installation.
- The tanks will be used for the storage of Fuel that will be pumped into the tanks from tanker trucks and pumped out of the tanks by metering pumps or fuel transfer pumps.

### 2. Design Criteria

- The design of FRP products including connections shall be in accordance with governing building codes and standards as applicable.
- Regardless of the theoretical design requirements, the minimum structural laminate thickness of the tanks shall not be less than 3/8-inch, without exception. The corrosion barrier layer shall not be included in the structural layer thickness.
- FRP tanks shall be designed to adequately support all static and dynamic loads imposed on the tank surfaces.
- The following design requirements shall pertain to all of the tanks provided under this Detailed Specification:
  1. The tanks shall be FRP, closed-top, vertical, and cylindrical, with flat bottoms and domed tops.
  2. Tanks shall be designed and constructed in accordance with ASME RTP-1 Type II laminate structure and as hereinafter specified- Tanks do not require ASME RTP-1 Stamp.
  3. Tank bottoms shall have a minimum thickness as required by ASME RTP-1, Section 3A-260, or as specified in Section 105A above, whichever is greater.
  4. The tanks shall be installed inside the Chlorination Room- The design loading need not consider snow loads for tank and tank top design.
  5. Tanks shall have an ASTM E84 Flame Spread Rating of less than 25 achieved by fabricating the outermost three (3) mat layers and outer surface veil layer from the halogenated resin with additional Antimony Pentoxide and cure system specified- The entire corrosion barrier and structural laminate shall be fabricated using the corrosion resistant resin and cure system specified.
  6. Resins used in the corrosion barrier and resin-rich inner liner shall not have any fire retardant agents or antimony compounds.

7. No thixotropic agent shall be added to resins used for the corrosion barrier or resin-rich inner liner.
8. Laminate construction shall consist of the following:
  - a. The corrosion barrier shall consist of two resin rich veil layers (saturated with catalyzed resin) followed by three layers of chopped strand mat (saturated with catalyzed resin).
  - b. The total thickness of the resin rich veil layer shall be 20 to 30 mil (0.02 to 0.03-inch) These first layers consisting of veil and resin shall contain 90 percent resin and 10 percent veil material by weight.
  - c. Each layer of chopped strand mat (saturated with catalyzed resin) shall have a thickness of 43 mils- The chopped strand mat layers in the finished corrosion barrier laminate shall be 70-80 percent resin and 20-30 percent glass by weight.
  - d. The inner corrosion barrier plus the three mat layers shall total 0.149-inches minimum thickness and constitute the inner lining. The entire lining shall reach complete cure before the structural layers are applied- The corrosion barrier thickness shall not be included in the structural laminate thickness calculations.
9. The structural layer shall consist of a Type II laminate saturated with catalyzed resin. The structural layer shall be placed over the corrosion barrier within twelve hours after the corrosion barrier has cured, otherwise the surface of the corrosion barrier must be completely ground to assure adequate bonding with the structural layer being applied. The structural layer shall have an average glass content of at least 35 percent by weight per ASTM D2584.
10. The outer fire retardant exterior layer shall consist of three mat layers and an outer surface C-Veil layer saturated with catalyzed halogenated resin with added Antimony Pent oxide- The outer fire retardant layer shall have an average glass content of at 25-30 percent by weight per ASTM D2584. The fire retardant exterior layer thickness shall not be included in the structural laminate thickness calculations.
11. The post-cure process shall be a heat post cure utilizing a forced hot air heating system or an oven curing system.
12. If a forced hot air heating system is used for the heat post-cure, as per the resin manufacturer's recommendations, the manufacturer shall utilize a forced hot air heating system that induces the heat on the interior and forces the heat through the wall to the exterior. An optimum cure is achieved when the temperature normalizes on the tank exterior.
13. Post-curing may also be conducted in a hot air convection curing oven such that both the interior and exterior laminate surfaces are exposed to the same hot air temperatures.
14. Post-curing ovens/structures shall be equipped with time/temperature recording devices such that the temperatures are logged. A continuous

recorder chart or curing air temperatures shall be made available for review by the Engineer prior to shipment of the tanks.

15. Manufacturer shall post-cure the equipment at a minimum of 180 degrees.

- Post-cure temperature shall not exceed the Heat Distortion Temperature of the resin.
- The post-cure hold period shall be a minimum of 4 hours- The duration of the hold period shall be engineered based upon laminate volume. Laminate volume calculations shall be made available for review by the Engineer along with the post curing temperature charts specified above.
- The post-cure temperature shall be ramped up to and down from the hold period temperature to avoid thermal shock to the laminates being cured. The post-cure period, including ramping and holding time shall be a minimum of 6 hours and shall be engineered based upon laminate volume plus laminated thermal properties- The calculations shall be made available for review by the Engineer along with the previously specified calculations.
- Any cracking that results from the post-cure process shall meet the minimum visual defect levels as specified for the inner surface plus interior and exterior layers of the laminates.
- The equipment must be properly supported to minimize dimensional changes, such as warping and shrinking that may result from the process. Dimensional changes are limited to the dimensional tolerances specified.
- All FRP covers and blinds shall be removed from the tanks during post cure; however, all FRP accessories such as the man way covers and blinds shall be post-cured.
- All shop repairs or rework shall be performed prior to post-cure.
- The tanks shall be designed for a maximum fill rate of 200 gallons per minute.
- Unless otherwise specified herein, the tanks shall be designed for a contained liquid temperature of 40 to 90 degrees Fahrenheit.
- The tanks shall be designed such that they can be transported intact to their installation locations through the building/structure openings and access ways shown on the Drawings- No cutting of the tanks will be allowed.

### 3. Materials

- Materials used in the manufacture of the FRP tanks shall be raw materials in conformance with the specification.
- All materials shall be of the kind and quality specified.
- All FRP Fuel Tanks shall be manufactured utilizing Polyester or Vinyl ester resin with flame retardant and ultraviolet (UV) inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. The flame retardant FRP shapes shall achieve a flame spread rating in accordance with ASTM test method E-84. (Polyester resin is available without flame retardant and UV inhibitor additives.)

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- FRP Tanks exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a one mil minimum UV coating shall be applied.
- All exposed surfaces shall be smooth and true to form.

#### 4. Electrical properties & Flammability

<b>ELECTRICAL</b>	ASTM TEST METHOD	UNITS/ VALUE	Amount
Arc Resistance, LW <sup>○</sup>	D495	seconds	120
Dielectric Strength, LW <sup>○</sup>	D149	KV/in	35
		KV/mm	1.38
Dielectric Strength, PF <sup>⊖</sup>	D149	volts/mil	200
<b>FLAMMABILITY</b> ⊗	ASTM TEST METHOD	UNITS/ VALUE	Amount
Tunnel Test	E-84		25 Max
NBS Smoke Chamber	E-662		650-700 (typical)
Flammability	D635		Self Extinguishing
UL Thermal Index	Generic	°Cs	130
British Fire Test	BS 476-7		Class 1

Table 1: Electrical properties & Flammability

All values are minimum ultimate properties from coupon tests except as noted.

∞ This value is determined from full section simple beam bending of Edgeng structural shapes.

∞ The Shear Modulus value has been determined from tests with full sections of Edgeng structural shapes.  
(See the Edgeng *Design Manual* for further information.)

⊖ Plate compressive stress/modulus measured edgewise and flexural stress/modulus measured flatwise.

⊕ Measured as a percentage maximum by weight.

○ Typical values because these are shape and composite dependent tests.

⊖ This is a typical value which varies with composite thickness.

LW = Lengthwise

PF = Perpendicular to laminate face

CW = Crosswise

N.T. = Not Tested

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## 5. Submittals

A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Contractor's Working Drawings, Design and Shop Drawings and Submittal Procedures for Working Drawings and Correspondence. Working drawings and shop drawings shall include, but not be limited to:

- Shop drawings and catalog data.
- Data sheets identifying all materials used and methods of fabrication.
- Complete assembly, layout required clearances and installation drawings with clearly marked dimensions.
- Weights of all component parts, assembled weight of units and approximate total shipping weight.
- List of manufacturer's recommended special tools and spare parts to be supplied.
- Maintenance manuals.
- Tank label information.
- Certification from the manufacturer that the FRP tanks are capable of meeting the specified performance requirements with the contained liquids specified in this Detailed Specification.
- Structural design computations for FRP tanks.
- Dimensions of tanks, fittings, attachments and anchor bolt locations.
- Wall thickness (shell, top and bottom).
- Location of fittings, attachments, and joints.
- Width and thickness of joint overlays.
- Complete description of chemical resistance for all materials that will come in contact with the materials stored, including a statement from the manufacturer that the various materials, including resins and veils, used are suitable for the intended service.
- Evidence of manufacturer experience and of the successful operation in other facilities of equipment similar to that proposed for this project, as specified herein and in the General Conditions.
- Laminate specifications including resin and reinforcing materials used, intended application (including maximum rated chemical concentrations and temperature), layer construction and thickness, glass data and specifications, resin properties, resin curing processes, post cure processes, and any and all catalysts used.
- Description of fabrication process and detailed fabrication drawings, including field joint assembly requirements.

B. After Fabrication, Contractor shall submit the following for approval prior to shipment:

- Certified copies of all factory test results, including, but not limited to, laminate glass content test results including glass content and tensile/flexural test results.
- Material certifications shall be provided for the FRP components in accordance with the General Conditions at the time of inspection.
- The material certifications shall include as a minimum: laminate reinforcements; resin and cure system used for the structural layer; resin and cure system used for the corrosion resistant barrier; fire retardant, additives and gasket materials. As part of the initial submittal, Certified Material

Test Reports (CMTRs) shall be provided for the proposed laminate sequence. Test reports shall include test results for flexural strength, flexural modulus, tensile strength, tensile modulus, and glass content of the structural and corrosion layers. Additionally, the resin manufacturer's certification shall be provided for the resins used. This certification shall state that the resins used in the fabrication of the laminates have been evaluated in accordance with ASTM C581 for chemical resistance for a service comparable to the intended service and that the resin is recommended by the resin manufacturer for the intended service.

- Prior to the beginning of the shop performance tests, provide manufacturer's Certification of Compliance with the approved laminate schedule
- Acetone sensitivity test results for each section in accordance with **ASTMC582**.
- Barcol hardness test results for each section in accordance with **ASTMD2583**.
- Provide cutouts and retain cutout samples of the laminate for assessment of laminate properties and laminate construction **by** the City- **If** the sizes of the cutouts are insufficient, an extension to the shell of suitable size shall be added for testing purposes.
- Provide glass content test results of the laminate cutouts in accordance with this Detailed Specification and **ASTM D2584** of both the corrosion layer and the structural layer.
- Provide Tensile Test results of the structural layer of laminate cutouts per**ASTM D-638**
- Provide Flexural Test results of the structural layer of laminate cutouts per**ASTM D-790**.
- Certification of compliance of visual acceptance criteria in accordance with this Detailed Specification.
- Resin and reinforcing material used.

#### C. Samples

- Representative laminate samples of both the cylindrical shells and the tops shall be furnished. These samples shall be from plant production and shall be representative of actual construction, workmanship, appearance and surface hardness of tanks to be furnished- Any tank which does not meet the standard of the representative samples will be rejected **by** the Engineer.

D. Reports of certified shop tests shall be submitted as specified herein. No equipment shall be shipped from its place of manufacture before the certified shop tests reports have been approved **by** the Engineer.

- Prior notification of shop tests shall be submitted for all equipment, shall be as specified in Article 12 of the General Conditions, and shall include, but not limited to, a description of the proposed testing facilities and procedures.

## Quality Assurance

### A. Qualifications:

- Five years successful experience in fabricating FRP Fuel Tank Systems would be the minimum requirement for the manufacturer.
- FRP Fuel Tank System manufacturer shall retain a registered professional engineer legally qualified to practice in same state as the Site.
- Responsibilities include:
  - FRP Fuel Tank System performance and design criteria stated in the Contract Documents shall be reviewed.
  - Written requests should be prepared for clarifications or interpretations of performance or design criteria for submittal to engineer or contractor.
  - Preparation of design calculations verifying compliance of FRP Fuel Tank System with requirements of the Contract Documents should be supervised.
  - Signing and sealing all calculations.
  - Design of FRP Fuel Tank System was performed in accordance with performance and design criteria stated in the Contract Documents should be certified
- Installer Qualifications
  - Retain a single installer trained and with record of successful experience in installing FRP Fuel Tank Systems.
  - Installer shall have record of successfully installing FRP Fuel Tank Systems in accordance with recommendations and requirements of manufacturer, or shall provide evidence of being acceptable to the manufacturer.
  - Installer shall employ only tradesmen with specific skill and successful experience in the type of Work required.
  - When requested by the engineer, submit name and qualifications of installer with the following information for at least three successful, completed projects:
    - Names and telephone numbers of owner and architect or engineer responsible for each project.
    - Approximate contract cost of the FRP Fuel Tank Systems for which installer was responsible.

## B. System Manufacture

### 1. EDGENG

2. If Contractor wished to furnish an alternate system manufacturer, Contractor shall first make written application to Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified and be suited to the same use as that specified. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which will be considered by Engineer in evaluating the proposed substitute.

## C. Source Quality Control:

- FRP Fuel Tank System manufacturer shall prepare all Shop Drawings and other submittals (except for delegated design submittals, when professional engineer is retained by other than FRP Fuel Tank System manufacturer) for all components furnished under this Section.

- Components shall be specifically constructed for specified service conditions and shall be integrated into overall assembly by FRP Fuel Tank Systems.

### 6. Warranty

Minimum of one year for the materials and for the workmanship of the fabricated product, after the installation with a maximum of eighteen months would be the general warranty for these FRP Fuel Tanks.

### 7. Material Handling

- At the time of delivery, all materials shall be inspected for shipping damage.

The freight company and the Manufacturer shall be notified immediately of any damage or quantity shortages.

- The Contractor shall protect FRP materials from cuts, scratches, gouges, abrasions, and impacts. When lifting FRP materials, spreader bars shall be used (not wire slings unless materials are fully protected). FRP components shall not be dragged across one another unless separated by a non-scratching spacer.



## REFERENCES

- A. **ASTM C581** - Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service
- B. **ASTM C582** - Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment
- C. **ASTM D570** - Test Method for Water Absorption of Plastics
- D. **ASTMD638** - Test Method for Tensile Properties of Plastics
- E. **ASTM D790** - Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- F. **ASTM D883** - Terminology Relating to Plastics
- G. **ASTM D2563** - Classifying Visual Defects in Glass-Reinforced Plastic Laminated Parts
- H. **ASTM D2583** - Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impresser
- I. **ASTM D2584** - Test Method for Ignition Loss of Cured Reinforced Resin
- J. **ASTM D3299**- Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks
- K. **ASTM D3567**- Determining Dimensions of "Fiberglass" (Glass-Fiber- Reinforced- Thermosetting Resin) Pipe and Fittings
- L. **ASTM D4097** - Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks
- M. **ASTM E84** - Test Method for Surface Burning Characteristics of Building Materials
- N. **NFPA 704** - Hazard Identification System
- O. **ASME RTP-1**- Reinforced Thermoset Plastic Corrosion Resistant Equipment
- P. **NYCRR** - Standards for New or Modified Hazardous Substance Storage Facilities
- Q. **ANSI Z1291-2000**- Hazardous Industrial Chemicals - Precautionary Labeling