



SPECIFICATIONS

FIBERGLASS REINFORCED PLASTIC ABOVEGROUND STORAGE TANKS

HEE ENVIRONMENTAL ENGINEERING, LLC

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PART 1 GENERAL

1.1 DEFINITIONS:

A.	FRP	Fiber reinforced plastic
B.	PE	Polyethylene
C.	PPL	Polypropylene
D.	PVC	Polyvinyl chloride
E.	CPVC	Chlorinated polyvinyl chloride
F.	NEMA	National Electrical Manufacturer's Association
G.	NFPA-70	The National Electrical Code
H.	UL	Underwriter's Laboratory
I.	ASTM	American Society for Testing and Materials
J.	NBS	National Bureau of Standards

1.02 SCOPE:

- A. The work specified herein shall include design, furnishing, and installation necessary to provide the Owner with an operational Chemical Storage Tank(s), with all necessary accessories. The system's components and manner of construction shall be suitable for the intended service.
- B. There shall be () Chemical Storage tank system required, as delineated below:

Number Vessels	Vessel Diameter	Vessel Height	Gallons Required	Chemical Solution

1.03 REFERENCE STANDARDS:

- A. PS 15-69: National Bureau of Standards Voluntary Product Standard "Custom contact molded Reinforced Polyester Chemical Resistant Process Equipment".
- B. ASTM D-883: "Definition of Terms Relating to Plastics".
- C. ASTM D-2583: "Test for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor".
- D. ASTM D-2563: "Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts".
- E. ASTM D-4097-82 & D-3299: "Standard Specifications for Contact Molded and Filament Wound Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks".

1.04 MANUFACTURER'S QUALIFICATIONS

- A. Manufacturer: The Chemical Tank shall be from a Manufacturer who has been regularly engaged in the design and manufacture of FRP equipment and who has a minimum of ten (10) years experience in design, fabrication, and testing of FRP materials and scope specified herein, and shall show evidence of at least ten (10) installations in satisfactory operation. The Chemical Tank Supplier shall demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by the manufacturer specifically named herein. Any manufacturer whose main business is not the manufacturing of FRP equipment shall not be accepted.

The Manufacturer shall maintain a regular production facility. This facility shall be open for inspection by a representative of the Owner or Engineer at any time during the construction and testing of this equipment.

The Manufacturer shall be one recognized and established in the design, production and manufacturing of FRP tank systems.

B. Acceptable Manufacturer:

**HEE Environmental Engineering
2143 Convention Center Way, Suite 180 Ontario, CA 91764 (909) 230-6120**

C. Design Basis: Equipment indicated on the drawings is based on Harrington HEE Environmental Engineering fiberglass reinforced plastic (FRP) chemical storage tank. The Contractor shall be responsible for determining any changes to mechanical, civil and electrical design necessitated by the use of an alternate system. Any design changes shall be the Contractor's responsibility and all design and construction costs associated with any design changes necessitated shall be borne by the Contractor. All design changes shall be subject to review and approval by the Engineer.

D. Substitutions: Any substitutions or deviations in equipment or arrangement from that shown on the drawings or specified Manufacturer herein shall be the responsibility of the Manufacturer or Contractor. Any deviations must be accompanied by detailed structural, mechanical, and electrical drawings and data for review by the Engineer. All costs associated with review of substitutions or deviations and costs associated with project drawing changes as a result of approval of such shall be borne by the Manufacturer or Contractor. There shall be no additional costs to the Owner due to substitutions or deviations.

1.05 DESIGN CRITERIA:

Fiberglass reinforced plastic design shall follow the procedures and methods, utilize the equations and formulas, and incorporate the factors of safety and allowable design stresses and strains as set forth in ASTM D-4097, ASTM D-3299 and the provided structural engineer calculations for the tank design. Where design conflicts arise between the various standards, the most stringent design shall be used.

- a. Seismic Zone_____
- b. Wind Load_____
- c. Chemical_____
- d. Specific Gravity_____
- e. Temperature_____

PART 2 PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

The tanks shall be manufactured with a Nexus veil liner followed by a chopped strand material completed with filament wound fiberglass structural fiberglass over wrap. The resin used shall be a premium grade AOC F010 vinyl ester resin material through out the laminate. Construction of the filament wound fiberglass tanks shall be in accordance with ASTM D-3299. Construction of the contact molded tank dome ends shall be in accordance with ASTM D-4097 and the NBS PS 15-69 specifications.

- A. Resin: The tanks shall be fabricated using a corrosion resistant vinyl ester resin. Unless otherwise specified, the same resin shall be used throughout all laminates.
 - 1. For Non-fire Retardant Applications: Premium grade vinyl ester resin as manufactured by AOC F010 and recommended by the resin manufacturer for the specific operating environment.
 - 2. For Fire Retardant Applications: Premium grade vinyl ester resin as manufactured by AOC K022 and recommended by the resin manufacturer for the specific operating environment. Add antimony trioxide or pentoxide for Class 1 fire rating to the structural laminate only.
- B. Catalysts and promoters shall be of the type and amount recommended by the resin manufacturer for use with their resin in the required service. Positive measurement control of catalysts, promoters, and resins shall be maintained at all times.

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- C. No fillers, additives, or pigments shall be employed in the resin. A thixotropic agent for viscosity control may be used in the proportion and type 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.
- D. Resin putty shall be made using the same resin as was used in the original fabrication of the parts to be joined. Resin putty shall contain a minimum 15 percent (15%) by weight of milled glass fibers. A fumed-silica additive such as Aerosil 200 or Cab-O-Sil TS 720 shall be added to increase the viscosity of the putty. The use of silica flour, grinding dust, or other fillers is not allowed.

2.02 REINFORCEMENT:

- A. Glass fiber reinforcement used shall be a commercial grade corrosion-resistant borosilicate glass, as manufactured by Owens-Corning, PPG, Certainteed, or equal, unless otherwise noted.
- B. All glass fiber reinforcing shall have an epoxy compatible silane type surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used. This surface finish should allow the maximum possible chemical bonding between the resin and glass.
- C. Synthetic surface veil shall be 10 mil thick polyester surfacing veil, such as Nexus.
- D. Mat shall be Type E (electrical grade) glass with nominal fiber length of 1.25" + 0.75".
- E. Continuous glass roving used in chopper guns shall be Type E chopper roving.
- F. Woven roving shall be 24 oz./yd.² Type E glass with a 5 x 4 plain weave.
- G. Continuous roving used in filament wound construction shall be Type E glass winder roving with a yield of 200 yards or more per pound.
- H. Unidirectional reinforcement shall be weft unidirectional fabric, Type E glass, 15.7 oz./yd.² as manufactured by Excel, Kytex, Brunswick or equal.

2.03 METAL HARDWARE:

- A. Exterior metal hardware such as anchor lugs, lifting lugs, bolts and attachment clips shall be fabricated from type 316 stainless steel.
- B. Exterior fasteners shall be made from type 316 stainless steel.

2.04 GASKETS:

- A. All gaskets shall be made from EPDM. Gaskets for use with FRP flanges shall be flat, full faced, and drilled to match the drilling of the mating flanges.

2.05 CORROSION BARRIER:

- A. The inner surface of the corrosion barrier shall be resin-rich and reinforced with two ply layer of Nexus-veil.
- B. The interior layer of the corrosion barrier shall consist of a minimum of 1-1/2 oz/ft² chopped strand material. Each ply shall be rolled separately to remove entrapped air.
- C. All plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
- D. All edges of surfacing veils in wet lay-up shall be lapped a minimum of one inch.

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2.06 FILAMENT WOUND STRUCTURAL LAMINATES (ROUND CONSTRUCTION):

- A. The corrosion liner laminate shall be followed by structural laminates of varying construction types.
- B. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained. This laminate shall contain 45 to 65 percent glass by weight.
- C. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely cover the surface with two bi-directional layers. Each layer shall be a maximum of one roving in thickness. Singular cycles shall not exceed a thickness of 0.05 inches.
- D. Spacing of filaments within the winding band shall be sufficiently close that bridging is avoided and glass content is maintained within the specified limits. Spacing of the filaments shall be uniform across the winding band without bunching or gapping.
- E. The helix angle of winding shall be as shown in the structural calculations, and as measured from the centerline of revolution of the equipment shell.
- F. Tolerance on helix angle is 2 degrees.
- G. If chopped glass or layers of mat are needed to insure proper bonding between the corrosion liner and required strength requirements, they may be added at the Manufacturer's option.
- H. If for any reason, winding is interrupted to the point where the outer surface is gelled or exotherm temperatures are excessive, production shall stop and the laminate shall be allowed to cure. Any prominent ridges left on the cured surface shall be ground to smooth the projections and prevent bridging. Following the grinding, a bedding layer of 3/4 oz. per sq. ft. mat or chopped glass shall be applied and thoroughly rolled to remove air. Winding with continuous strand may be resumed before this layer gels. The additional mat layer is extra material and will result in a wall thickness greater than that calculated.

2.07 HAND-LAY-UP STRUCTURAL LAMINATES (TANK ENDS):

- A. The corrosion liner laminate shall be followed by structural laminates of varying construction types.
- B. Hand-lay-up structural laminates shall be Type II laminates consisting of alternating plies of mat and woven roving as described in ASTM D4097.
- C. All woven roving plies shall have a ply of mat on each side. Two adjacent plies of woven roving are not permitted.
- D. All edges of woven roving material in wet lay-up shall be lapped a minimum of two inches. Lapped edges of adjacent layers shall be staggered to obtain the maximum possible strength.
- E. Laminates containing primarily 1-1/2 oz. per sq. ft. mat layers in conjunction with woven roving shall contain not less than 35 percent or more than 45 percent glass by weight.

2.08 FLANGE CONNECTIONS:

- A. The standard nozzle projection shall be 4" from the face of the flange to the closest point on the tank wall. Flange face and bolting correspond to ASA Standard B16.5 for 150 lb. steel flanges. Flange thickness corresponds with 25 psi rated fiberglass pipe and flanges. Flanged nozzles shall be designed for use only with soft, full-face gaskets. Gaskets shall be 1/8" thick and between 40 and 60 durometer EPDM. All flanged liquid connections shall be gusseted to the tank wall with 1/4 inch thick flat plate gussets. Standard flanged fittings shall be used on all installations. The data following applies also to other nozzles that are given separate designations because of their specialized style or function.

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- B. Flanged nozzles shall be used for piping-up to the reinforced plastic tanks. They shall be made of the same resin and construction as the tank, and be properly bonded into the tank wall and offer the same degree of corrosion resistance. Through-bolting shall be used in lieu of metallic thread inserts or studs.
- C. Flanged nozzles shall be hand laid-up as separate components with the flange face and the pipe neck formed on the mold as an integral piece. Installation shall be performed after the tank has been fabricated. Because this is a post-fabrication installation, exacting laminate amounts and sequences must be established to ensure proper rebuilding of strength in the area of the nozzle cutout. The installation laminate must maintain continuity of the inner "corrosion barrier" of the scrubber wall right out to the flange face.
- D. Flanged nozzles are classified as either Type 1 or Type 2 depending upon the method of installation:
 - 1. Type 1 nozzles shall be used for top installations particularly where a directed flow stream into the tank is required.
 - 2. Type 2 nozzles shall be used in all other installations that do not meet the Type 1 criteria, i.e. side or bottom installations. The cut edge of the pipe neck shall be more positively covered with the inside lay-up. Where flow rates are critical, or where accessories, such as thermal wells, are to be inserted, a larger pipe size should be used.

2.09 ACCESSORIES:

- A. External Ladders, Safety Cages and Handrails
- B. Site Gauge
- C. Level Indication or Control

2.10 SUBMITTALS:

- A. Drawings: Showing overall dimensions, arrangement of connections, size and location.
- B. Material of construction: Resin, resin cure, glass type and hardware, documentation of chemical resistance of materials.
- C. Documentation of laminate properties, layer sequence used to fabricate the vessel.
- D. Design calculations: Confirming the design criteria and stamped by a registered professional engineer.

PART 3 EXECUTION

3.01 INSPECTION AND TESTING:

- A. The Contractor shall be responsible for the successful installation, start-up and testing of the Chemical Storage Tank System. The Contractor shall provide all necessary equipment, manpower, chemicals, tools, instrumentation, and laboratory testing services required during this phase of the work.
- B. Upon completion of the installation, the tanks shall be checked for misalignment, clearances, supports, and adherence to safety standards.

3.02 ASSEMBLY:

- A. All cutouts from the equipment shall be marked, indicating their original location, and retained. All cutouts shall become the property of the owner
- B. Install flanged nozzles with bolt holes straddling principle centerlines of the vessel. For tank tops, nozzle bolt holes straddle radial centerlines.
- C. When requested, Fabricator shall supply to the CONTRACTOR, at the earliest possible time, a template which locates anchor bolt holes within plus or minus 1/8 inch for each vessel.
- D. Where specified, a non skid surface shall be provided on the exterior surface of the cover. Silica grit may be applied in conjunction with the final resin coat. Other methods may be submitted.

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- E. Furnish and overlay on the outside of the equipment a plastic nameplate showing the following information:
 - 1. Name of manufacturer
 - 2. Date of manufacture
 - 3. Equipment name/number
 - 4. Resin number and manufacturer
 - 5. Design pressure and temperature
 - 6. Vessel diameter, height, and weight
 - 7. Gallons
- F. Butt joints or shell joints shall be in the number and location(s) as indicated on the fabrication drawings. Additional joints are not allowed. Slip joints, "mod joints," or other methods not conforming to the fabrication drawings are not allowed. If joint locations are not indicated on the fabrication drawings, fabricator shall submit number and location.
- G. Allowable tolerances shall be as listed in ASTM D 3299 or ASTM D 4097, except as modified herein or on the fabricator drawings.
- H. When joining components, gaps at mating edges shall be limited to ¼-inch maximum, and misalignment or inside surfaces shall not exceed 1/3-inch of the lesser wall thickness.
- I. The flat bottoms after assembly shall be flat within plus or minus ½ inch. In addition, localized indentations or protrusions shall not exceed plus or minus ¼ inch within 2 feet.

3.03 TANK INSTALLATION:

- A. For flat bottom vessels without legs, the foundation must provide full non elastic support to the flat bottom, preferably through the use of grout, which will allow continuous support even though surfaces may not be flat.
- B. All anchor lugs or leg pads shall be set on a 1-inch thick layer of non-shrink grout. Do not use hard shim to fill void between the lugs and foundation.
- C. Unless otherwise agreed, independently support all piping so as not to apply loads to the vessel nozzles. Isolate potential load due to thermal expansion of piping from the vessel. During installation, do not force piping into alignment, which can create excessive stresses in the tank.
- D. Do not mate raised face flanges of ring gaskets to full faced fiberglass reinforced plastic nozzles.
- E. Vertically support ladders at the tank foundation or platform. Ladder lugs attached to the vessels shall provide lateral support only.
- F. Where tank foundations are cut out to accommodate full bottom drains, fill the cutout area after tank installation with grout or other material that will provide localized support.

3.04 OPERATION AND MAINTENANCE MANUALS:

- A. Six manuals shall be submitted prior to final acceptance of the equipment.

3.05 MANUFACTURER'S SERVICES:

- A. The system manufacturer's representative shall be present at the job site for the following time period, travel time excluded: Eight hours for inspection and certification of the installation.

3.06 WARRANTY:

The Manufacturer shall guarantee that the Chemical Storage Tank will perform as described in these Specifications. The Manufacturer shall warrant the Chemical Storage Tank to be free from defects in materials or workmanship for a period of twelve (12) months after start-up or eighteen (18) months after delivery, whichever comes first.

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3.07 QUALITY ASSURANCE:

The engineer may provide and direct inspectors to inspect the equipment at the place of manufacture or upon arrival at the job site. The manufacturer shall furnish all reasonable assistance, if required by the engineer or inspector, for the proper inspection of the work. Inspection shall not relieve the manufacturer from any obligation to perform the work strictly in accordance with this specification. Work not so performed shall be replaced by the manufacturer at his expense.

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