STANDARD SPECIFICATIONS

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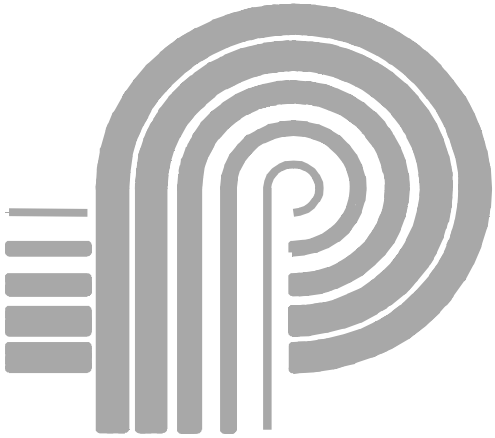

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Filament Wound and Contact Molded
Reinforced Thermoset Plastic Vessels

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1.0 General

1.1 Scope

1.1.1 This Specification, together with the purchaser's design sketches, covers the requirements for design, submittals, materials, fabrication, inspection, testing and shipping of reinforced thermoset plastic vessels.

1.1.2 All vessels shall be made by a combination of contact molding for the inner corrosion barrier followed by a filament wound, or contact molded structural layer using a room temperature cure. All tanks shells shall be made on a mandrel.

1.1.3 All conflicts between the requirements of this specification, design sketches, specified codes, local or federal regulations and/or insurance requirements shall be called to the purchaser's and the engineer's attention without delay. Where requirements on design sketches conflict with this specification, the drawings will take precedence.

1.1.4 Vessels shall be fabricated by Plas-Tanks Industries, Inc., Hamilton, Ohio. Telephone: (513) 942-3800.

1.2 Applicable Codes

1.2.1 Unless otherwise indicated in this specification, the design and fabrication of the vessel shall conform to the latest addition of the following codes and specifications:

A. For Basic Design and Fabrication

* ASTM D3299 - Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Vessels.

* ASTM D4097 - Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Vessels

* NBS Voluntary Product Standard PS 15-69 - Custom Contact Molded Reinforced Polyester Chemical Resistant Process Equipment.

B. Laminate Quality

* ASTM D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.

C. Determination of Laminate Properties

* ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.

* ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.

* ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

2.0 Proposals

2.1 Base bid/Alternates/Exceptions

2.1.1 Vessels shown on the drawings shall be fabricated to include all fittings, flanges, nozzles, reinforcements, ladders, and/or any other items, which form an integral part of the vessel. Contracts will not be awarded to a fabricator who does not offer a vessel complete with all accessories.

2.1.2 Quotation shall be made in accordance with the requirements of this specification and the purchaser's design sketches. All exceptions should be noted, and such quotations will be considered as "alternates".

2.2 Proposal shall indicate the basis of charges for items not shown on the material requisition sheets. Items to be included with proposal:

* Production schedule required to complete the project relative to the schedule provided;

* Estimated delivery time for equipment after receipt of drawings, assuming all materials are on hand;

* Length of validity of proposal;

* Terms of payment;

* Freight charges broken out as a separate line item;
* Cost of all inspection, hydro-test, loading and packaging shall be included in the quoted price, but broken out as separate line items.

2.3 No part of the vessel fabrication is to be subcontracted to others without prior written approval form the engineers or purchaser.

2.4 Henceforth, the company that is awarded a contract shall be called the fabricator.

2.5 The fabricator shall certify in writing that all integral parts and the vessel are suitable for the intended service under the specified design conditions.

3.0 Submittals

3.1 Fabricator shall submit drawings from AutoCAD™ electronically or three plotted "C" or "D" size drawing for approval by the engineer. When fully approved, certified for fabrication drawings will be required. Fabricator shall also submit one copy of all calculations for engineer's review and/or record.

3.1.1 Fabricator's certified drawings should include the following items:

* Plant name and location,
* Equipment name and item number,
* Empty weight,
* Capacity,
* Thickness (shell, heads, etc.),
* Allowable operating conditions,
* Material specifications,
* Contents.

3.1.2 Fabricator shall include detail drawings of tank shell attachment to top and bottom heads.

3.1.3 Fabricator shall give complete details of knuckle radius and lay-up sequences; minimum knuckle radius is 1-1/2".

3.1.4 Fabricator shall certify whether the method of fabrication is contact molded or filament wound.

3.1.5 Fabricator shall specify on the drawings what resins and cure systems are to be used.

3.2 Fabricator shall provide a tolerance drawing including flatness of bottom for vertical, flat bottom vessels, as well as dimensional tolerances such as those shown in ASTM specifications. Fabricator shall recommend in writing an installation procedure for such vessels.

3.2.1 Tolerance on nominal (internal) diameter including out-of-roundness, shall be ± 1%.

3.2.2 Tolerance on overall height of length shall not exceed ±1/2”.

4.0 Materials of Construction

4.1 Glass Reinforcement Materials

4.1.1 Chemical surfacing shall normally be type "C" glass veil 10 to 20 mils thick, with a silane finish and a styrene soluble binder compatible with the resin used. Synthetic, carbon fiber, or other veil shall be used when required by the service conditions, or when recommended by the resin manufacturer.

4.1.2 Woven roving shall be type "E" glass of 24-oz./sq. yd

4.1.3 Undirectional, biaxial, triaxial or other directional reinforcements shall be identified as to purpose, quantity, mechanical properties and placement within the laminate.

4.1.4 Chopped strand mat shall be type "E" glass, 3/4 oz/sq. ft or 1-1/2 oz./sq. ft. with a silane-type finish and a styrene soluble binder compatible with the resin used.

4.1.5 Continuous filament shall be type "E" glass with a minimum yield of 450 yds/lb. with polyester compatible finish or aramid or carbon fibers with a minimum yield of 1200 yds./lb.

4.2 Resins and Resin Additives

4.2.1 The type of resin used shall be suitable for the service conditions specified on the individual vessel requisition form. Resin suitability shall be verified by the resin manufacturer and acknowledged by the fabricator.

4.2.2 Curing systems, catalysts, and promoters shall be as specified or recommended by the resin manufacturer. This information shall be included in the drawing notes for the engineer’s review and record.

4.2.3 Cumene hydroperoxide, benzyl peroxide, or methyl ethyl ketone peroxide are acceptable curing systems and are to selected by the fabricator for workability and degree of cure.

4.2.4 Dyes, pigments, fire retardant agents, or any other additives that interfere with the visual inspection of the vessel shall not be used unless specified on the engineer’s drawings.

4.2.5 Thixotropic Agents may be added to the resin system to control viscosity, if recommended by the resin manufacturer. A maximum of 5% by weight of a thixotropic agent may be added. Thixotropic agent shall be Cab-O-Sil or approved equal. Thixotropes will not be used in laminates that will come in contact with any bleaching agent.

4.2.6 Ultra-Violet Light Inhibitors shall be used in the exterior layer of all vessels. Two to four percent by weight shall be added to the exterior resin to protect fiberglass reinforced plastic laminates from ultra-violet light degradation.

4.2.7 Recommended ultra-violet light inhibitor is UV-9 made by various manufactures.

4.2.8 A Fire Retardant Agent shall be added to resin only when called for by the engineer's drawing and then only to the structural portion of the laminate. Up to 5% by weight of antimony trioxide, or pentoxide, shall be added to the resin to give the reinforced plastic laminate a flame spread rating 25 or less, as determined by Underwriters Laboratories Tunnel Test ASTM E-84.

4.2.9 Paraffin Wax shall be added to resin when called for, and where air inhibition of cure could be a problem. Paraffin wax shall not be more than 8% by weight of a 5% dispersion in styrene. Wax shall be a commercial grade of paraffin having a melting point of 52°-55° C.

5.0 Laminate Construction

5.1 Filament-Wound Laminate Construction when Standard Corrosion Barrier Specified.

5.1.1 Inner Surface shall be 0.010" to 0.020" thick reinforced with type "C" glass, or synthetic surfacing veil, depending on the tank service conditions and the recommendations of the resin manufacturer. The amount of reinforcement required to prevent cracking in the resin-rich surface shall be between 10% to 20% as determined by the fabricator.

5.1.2 Interior Layer shall be fabricated from a minimum of two layers of type "E" glass chopped strand mat 1-1/2 oz. to 2 oz./sq. ft. per layer or four layers of ¾ oz./sq. ft. mat

5.1.3 Structural Layer shall be made in accordance with ASTM D3299, Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Vessels. Before applying filament structural layer to corrosion barrier, apply resin and chopped strand glass

to the exterior of the corrosion barrier to insure filament adhesion, and intersperse between subsequent cycles.

Structural laminate shall consist of continuous filament applied in a controlled uniform pattern at a specified helix angle. Winding pattern shall produce a dense laminate with minimum air entrapment and no bridging of filament during tank winding. Equal and constant pressure shall be applied to each glass filament during tank winding. Glass content of structural portion shall be 60% - 65% by weight.

5.1.4 Final Resin Gel Coat shall be applied to the exterior surface of structural filament winding. Gel coat shall contain 8% by weight of a 5% dispersion of paraffin wax in styrene to prevent air inhibition of the resin cure. This wax shall be a commercial grade having a melting point of 52° - 55° C.

5.1.5 Protective chemical barriers, such as "C" glass, or Nexus Synthetic veil shall not be applied to exterior surface of structural filament winding unless specified by the engineer.

5.1.6 Deviations from this specification complete with detailed design data and calculations must be submitted to the engineer for approval prior to fabrication.

5.2 Contact Molded Laminate Construction When Standard Corrosion Barrier is specified

5.2.1 Inner surface shall be 0.010" - 0.020" thick, reinforced with type "C" glass or synthetic surfacing veil, depending on the tank service conditions and the recommendations of the resin manufacturer. The amount of reinforcement required to prevent cracking in the resin-rich surface shall be between 10% and 20% as determined by the fabricator.

5.2.2 Interior Layer shall be fabricated from a minimum of three layers of type "E" glass chopped strand mat of 1-1/2 oz. to 2 oz. per square foot per layer

5.2.3 Structural Layer shall be alternate layers of woven roving or stitched roving such as biaxial or triaxial glass fabrics and type "E" glass chopped strand mat of 1-1/2 oz.- 2 oz/sq. ft., subject to cure specifications of paragraph 4.2.3 "Fabmat" or mat/stitched fabric is not allowed because of the potential for poor wetout and dry spots.

5.2.4 When step curing, each step cure shall have a maximum thickness of 0.25" in the structural and exterior layers. Each step cure in the laminate shall stop and start with a layer of glass mat.

5.2.5 Final Resin gel coat shall be applied to the exterior surface. Gel coat shall contain 8% by weight of a 5% dispersion of paraffin wax in styrene to prevent air inhibition of the resin cure. This shall be a commercial grade having a melting point of 52° - 55° C.

5.2.5 Deviations from this specification complete with detailed design data and calculations must be submitted to the engineer for approval prior to fabrication.

5.3 Additional Corrosion Barrier (sacrificial layer)

5.3.1 When vessels are used for chlorine dioxide, hot wet chlorine or abrasive corrosive services deemed by the purchaser to warrant additional protection, the engineer, or purchaser, shall specify an additional interior layer above and beyond those specified above in 5.1.1 and 5.2.1. No part of this additional layer shall be used in calculation laminate properties for design thickness as specified below.

6.0 Designs

6.1 The fabricator shall perform all calculations necessary to ensure the integrity of the vessel, and proper functioning of the associated components at the stated design temperature, concentrations, and pressure. These calculations shall be in sufficient order and detail to facilitate review by the engineer. No fabrication will start on vessels without the engineer's approval of all calculations.

6.2 Design calculations shall be based on the laminate physical properties listed as follows (latest edition):

* ASTM-D-638 Standard Test Method for Tensile Properties of Plastics;
* ASTM-D-695 Standard Test Method for Compressive Properties of Rigid Plastics;
* ASTM-D-790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;
* Or test data furnished by the fabricator

6.3 Vessels shall be designed using a safety factor of 10:1 for pressure conditions, 5:1 for vacuum and periodic loads and 2:1 for tie down, lifting devices or one-time test loads.

6.4 Design calculations shall take into account the following:

* External pressure loading,
* Internal pressure loading,

* Wind loads per Uniform Building Code, latest edition,

* Seismic loads per Uniform Building Code, latest edition,

* Snow loads,

* Personnel loading on vessel tops,

* Local stresses at tie downs and at the horn of saddle supports on horizontal vessels,

* Live loads, such as those induced by agitation.

7.0 Fabrication

7.1 Vessel shell shall be fabricated in accordance with ASTM D3299 or ASTM D4097.

7.2 Vessels shall be fabricated with bottom and side shell integrally molded with no joint within 4 ft. of the vessel bottom.

7.3 Bottom head corner or knuckle radius shall have a minimum radius of 1-1/2". The bottom radius area shall be reinforced to meet increased stress. Reinforcement thickness shall be the combined thickness of the vessel wall and bottom, and shall extend at least 4" up the side wall of vessels 2' ∅ to 4' ∅ and 12" up the side wall for vessels 4'- 6" ∅ or greater.

7.4 The vessel top head, regardless of shape, shall be designed to support a 250 lb. load on a 4” x 4” area. The maximum deflection shall be 0.5% of the shell diameter.

7.5 Nozzles

7.5.1 Flanges shall be full and flat-faced fiberglass. The flange face shall be perpendicular to the axis of the nozzle within 1/2° and shall be flat to .06” for nozzles up to 6", .09” for nozzles 8" - 16", .12” for nozzles 18" and over and .25” for manways.

7.5.2 Flange face and bolting shall correspond to ANSI Standard B 16.5 for 150#, steel flanges. All flange thickness shall be specified by fabricator for approval by the engineer.

7.5.3 All bolt holes shall straddle vessel natural centerlines. All flanges shall be fabricated using the same chemical resistant resins throughout as used to fabricate shell and heads.

7.5.4 Fittings, nozzles, or internal equipment shall not be fabricated using filament wound construction.

7.5.5 All nozzles up to 6" shall be conically or plate gussetted. Nozzles over 6" shall be gussetted when specified by the engineer.

7.5.6 All gussets shall be attached to the flange of flanged fittings, not merely to the neck.

7.5.7 Nozzle cutouts shall be saved and given to the engineer upon inspection of the vessel for verification of thickness. Failure to comply with this will be sufficient cause for rejection of the equipment. After inspection by the engineer, cutouts will be labeled and saved for one (1) year from date of manufacture.

7.6 As required by ASTM standards, areas surrounding manways and fittings shall be reinforced.

7.7 Welds

7.7.1 Fabricator's shop drawings shall locate all longitudinal and circumferential welds.

7.7.2 Shell welds shall be reinforced with an overlay of fiberglass with the same resin as the shell. Weld shall extend on both sides of the joint. The exterior weld shall start with two layers of mat and the remaining build-up shall consist of alternate layers of 1-1/2 oz. mat and 24 oz. woven roving. Thickness shall be equal to the contact molded structural thickness required for that portion of the vessel wall where the weld is being made.

7.7.3 Minimum ply width shall be 3". Each successive layer shall extend 1/2" on each side of the preceding layer. The internal overlay shall be equal to the corrosion barrier.

7.7.4 All cut edges shall be resin coated. Edges exposed to the chemical environment shall be treated with resin surfacing veil and laminates equal to the corrosion barrier.

7.8 Hold Down Lugs / Lifting Channels

7.8.1 Vessels shall have suitable lifting channels and tie down lugs for handling and anchoring the vessel in place. Tie down lugs and channels shall be fabricated from fiberglass reinforced plastic, zinc or galvanized plated carbon steel, or stainless steel. Upon request, results of pullout test shall be sent with calculations to the engineer for verification of lug capacity prior to commencement of fabrication.

8.0 Inspection and Test

8.1 Fabricator shall have a written quality control program demonstrating the capability to design and supply equipment conforming to customer specifications with periodic internal auditing and semi-annual external audits, such as ISO 9001 or equal.

8.2 Quality Program shall include:

* A written quality policy that defines and documents the objectives for and commitment to its program;

* The assignment of responsibility and authority to all personnel who manage, perform, and verify work effecting quality;

* Appointment of a management representative to ensure the policy is implemented and maintained;

* A written quality manual outlining the major areas affecting product quality, identifying the controls in place to monitor each.

* Operating procedures which detail the specific steps necessary to comply with customer requirements;

* Recording and analysis of quality records with resulting corrective action at appropriate inspection/review points in the contract negotiations, design, fabrication, shipping, installation or servicing of equipment supplied.

8.3 Only subcontractors/material suppliers demonstrating adherence to the fabricator's quality control program and listed on the "Approved Subcontractors" list shall be utilized in fulfilling any customer order.

8.4 Inspections and test shall include the following:

* Incoming materials;

* In-process thickness, dimensional and degree-of-cure data;

* Final inspection;

* Post loading and off-loading inspections.

8.5 Material property test shall not be required unless specified; when specified, separate line items shall show costs.

8.6 All equipment shall be visually inspected to ASTM 2563, Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts and shall meet 90% of resin manufacturer's minimum barcol hardness level in accordance with ASTM 2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor and should be hydrotested for leaks for a minimum of 2 hours. Inspection records and certification thereof shall accompany shipping papers to the customer's off-loading point.

9.0 Shipping

9.1 Fabricator shall specify method of transportation.

9.2 Fabricator shall support vessel using proper shipping techniques.

9.3 Protection shall be provided by openings being sealed and flanged protected by covers of an approved, inexpensive material.

9.4 It shall be the responsibility of the fabricator to protect vessel from damage during shipment.

9.5 Chains shall not be used as a means of holding vessel in position during transportation.

9.6 Where necessary, fabricator shall use vibration-dampening materials.

9.7 Open ends of vessel shall be braced to prevent damage in transit.

10.0 Field Erected Vessels

10.1 When required or due to shipping constraints, the vessel shall be fabricated and erected in the field.

10.2 The corrosions barrier described in sections 5.1.1 and 5.1.2 shall be fabricated in strips and trimmed to a width equal to the height of the field mold. The sections shall be rolled for shipment with inside corrosion barrier surface facing in.

10.3 The bottom head shall be flat or sloped (internally or externally) and molded directly on the concrete foundation on which the finished tank will rest. A minimum 12" side shell shall be molded integrally with the bottom with a reinforced knuckle with a minimum of 2" radius. The reinforcement shall be accomplished with a combination of chopped fibers and bi-directional and/or unidirectional rovings. Bottom shall be a minimum of 3/8" thick.

10.4 The exterior structural layer shall consist of continuous strand filament winding, applied at the job site in the following manner:

A sectioned mold shall be placed inside the completed bottom.

The top head, if required, shall be placed on top of the mold.

The shop fabricated interior corrosion barrier laminate, molded side in, shall be stretched around the mold, vertically seamed and allowed to cure. The mold is then expanded.

The exterior, filament wound layer is applied overlapping the previous course and/or top head 6”-12”. The glass content of filament winding shall be 60%-65% by weight.

The mold is collapsed, the shell is raised and the next course interior corrosion barrier is stretched around the, seamed and the exterior layer is applied in the same manner. This process is repeated until the desired height is achieved.

The final course is tied into the bottom and previous section. The mold is disassembled and removed through a tank access opening.

When applicable to satisfy longitudinal strength requirements, chopped glass is applied prior to the first cycle of winding and is interspersed between subsequent cycles.

No vertical seams shall be allowed in the exterior structural layer of the vessel.

No non-fiberglass reinforced plastic materials shall be used as structural support of the vessel shell, such as metal cable or banding.

10.5 Shipment of materials and subassemblies to the job site shall be included in the sellers bid, as shall the cost of all cranes, riggers, jacks or other devices necessary to properly erect the vessel.

The owner shall be responsible for site clearing and preparation to include pouring of concrete foundations acceptable to the seller. A level area that is twelve feet greater in diameter than the vessel being erected shall be provided. There shall also be access for a crane to the erection site.