Specification for Fiberglass Reinforced Plastic Tanks

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Contents

Contents

Specification for Fiberglass Reinforced Plastic Tanks

1 Scope

1.1 General

This specification covers material, design, fabrication, and testing requirements for fiberglass-reinforced plastic (FRP) tanks. Only shop-fabricated, vertical, cylindrical tanks are covered. Tanks covered by this specification are intended for aboveground and atmospheric pressure service. Unsupported cone bottom tanks are outside the scope of this specification.

This specification is designed to provide the petroleum industry with various standard sizes of FRP tanks. Because of the versatility of FRP tanks, the user shall be responsible for determining the suitability of FRP tanks for the intended service.

NOTE The consequences of exposing FRP tanks to high temperatures created by exposure fires should be considered. This material loses strength as the temperature increases. FRP tanks should be suitably protected against fire exposure or so located that any spills resulting from the failure of these materials could not unduly expose persons, buildings, structures, or other equipment to the possible fire incident.

1.2 Compliance

1.2.1 The manufacturer is responsible for complying with all of the provisions of this specification. The purchaser is responsible defining their specific requirements in the Data Sheet. The purchaser may make any investigation necessary to be satisfied with compliance by the manufacturer and may reject any material that does not comply with this specification.

NOTE The purchaser is encouraged to arrange for inspection independent of the inspection furnished by the manufacturer, and the purchaser's inspector should follow closely all the details of shop fabrication and testing herein specified that affect the integrity and safety of the completed structure.

1.2.2 If specified by the purchaser on the Data Sheet, the tank shall be constructed in accordance with API Q1 and the API Monogram Program (see Annex A).

1.2.3 This specification applies to new tanks. The requirements may be applied to existing tanks at the discretion of the owner/operator.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Recommended Practice 545, *Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids*

API Standard 2000, *Venting Atmospheric and Low-pressure Storage Tanks*

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

AISC [1] *Steel Construction Manual*

[1] American Institute of Steel Construction, One East Wacker Drive Suite 700, Chicago, IL 60601-1802, www.aisc.org.

ASCE 7 [2], *Minimum Design Loads for Buildings and Other Structures*

ASME B1.1 [3], *Unified Inch Screw Threads, UN and UNR Thread Form*

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard*

ASTM A36/A36M [4], *Standard Specification for Carbon Structural Steel*

ASTM A153, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A307, *Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength*

ASTM A325, *Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength*

ASTM A325M, *Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric)*

ASTM B695, *Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel*

ASTM C581, *Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

ASTM A563, *Standard Specification for Carbon and Alloy Steel Nuts*

ASTM D790, *Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*

ASTM D2583, *Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor*

ASTM D2584, *Standard Test Method for Ignition Loss of Cured Reinforced Resins*

ASTM D2990, *Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics*

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

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

ASTM F436, *Standard Specification for Hardened Steel Washers*

ASTM F844, *Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use*

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2 American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191, www.asce.org.
3 ASME, Two Park Avenue, New York, NY 10016-5990, www.asme.org.
4 ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428, www.astm.org.

ICC, *International Building Code* [5]

SPI E-1067 [6], *Recommended Practice for Acoustic Emission Examination of Fiberglass Tanks/Vessels*

SSPC-SP1 [7], *Solvent Cleaning*

U.S Government, 29 *CFR* Section 1910, General Industry Regulations, OSHA [8]

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1
chop-hoop
A unique blend of chop-spray and filament winding. The FRP composite is constructed using the chop-spray and the filament winding processes simultaneously. This process gives the strength from the directional glass from the filament winding process plus the higher resin content from the chop-spray process, which provides improved corrosion protection to the reinforcement.

3.2
chop-spray
Continuous strand glass roving and catalyzed resin are fed through a chopper gun, which cuts the fiberglass into specific lengths that can be adjusted on site. The chopper gun deposits the resin-saturated “chop” on the mold. The laminate is then rolled to thoroughly saturate the glass strands and compact the chop. Additional layers of chop laminate are added as required for thickness.

3.3
design thickness
The thickness necessary to satisfy tension and compression strength requirements by this Specification or, in the absence of such expressions, by good and acceptable engineering practice for specified design conditions, without regard to construction limitations or corrosion allowances.

3.4
fiberglass-reinforced plastic (FRP)
A fiber-reinforced plastic composite which is a combination of a polymer matrix resin, referred to as plastic, (thermoset resin such as polyester, isopolyester, vinyl ester, epoxy, phenolic) and fiber reinforcement such as glass, carbon, aramid or other reinforcing material.

3.5
filament wound
Filament winding is an automated open molding process that uses a rotating mandrel as the mold. The male mold configuration produces a finished inner surface and a laminate surface on the outside diameter of the product. Filament winding results in a high degree of fiber loading, which provides high tensile strengths in the manufacture of hollow, generally cylindrical products such as chemical and fuel storage tanks, pipes, stacks, and pressure vessels.

3.6
inspector
The person(s) designated by the purchaser or manufacturer to perform inspections.

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5 International Code Council, 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001, www.iccsafe.org.
6 Society of the Plastics Industry, 1425 K Street NW., Suite 500, Washington, DC 20005, http://www.plasticsindustry.org.
7 The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222, www.sspc.org.
8 U.S. Department of Labor, Occupational Safety and Health Administration, 200 Constitution Avenue, NW, Washington, DC 20210, www.osha.gov.

3.7
mandatory
Required sections of the specification become mandatory if the specification has been adopted by a legal jurisdiction or if the purchaser and the manufacturer choose to make reference to this specification on the nameplate of in the manufacturer's certification.

3.8
manufacturer
The party having the primary responsibility to construct the tank.

3.9
purchaser
The owner, owner's engineer, or operator who specifies the tank Data Sheet for the purchase.

3.10
purchaser's option
A choice to be selected by the purchaser and indicated on the Data Sheet. When the purchaser specifies an option covered by an annex, it then becomes a requirement.

3.11
recommendation
Criteria that provides a good/acceptable design and may be used at the option of the purchaser and the manufacturer.

4 Material

4.1 General

The materials used in the manufacture of tanks furnished to this specification are composite materials consisting of a thermosetting polymer reinforced with glass fibers. Permitted polymer resins are polyester resins, epoxy resins, or vinyl ester resins. The purchaser shall define the specific material on the Data Sheet if there is any specific condition, such as extreme temperature, in the service that could affect the material selection.

4.2 Resin

4.2.1 The resin used shall be commercial grade thermosetting polymer and shall not contain fillers and pigments, except if specified by the purchaser on the Data Sheet.

Any thixotropic agent used for viscosity control shall not interfere with visual inspection. The thixotropic agent shall not exceed 5 % by weight. Resin paste/putty used to fill crevices before overlay shall not be subject to these limitations.

4.2.2 The effects of long exposure to ultraviolet radiation, such as surface chalking and discoloration, shall be mitigated by incorporating one or more of the following:

a) UV absorber into the resin—these are incorporated in the external coat at a level of 0.1 to 0.3 weight percent,

b) pigment outer resin layers/pigment to opacity,

c) external surface paint as specified in the Data Sheet (see Annex D for additional coating requirements),

d) UV-inhibited gelcoat compatible with underlying resin.

NOTE Additions of any of the above may interfere with visual inspection of laminate quality.

4.2.3 If specified on the Data Sheet, antimony compounds or other fire retardant agents shall be added to the laminate to provide improved fire resistance. The resulting laminate must meet the physical properties of this specification.

NOTE Metal powder, carbon, or other types of conductive compounds provide improved conductivity. Additions of such compounds interfere with visual inspection of laminate quality and physical properties of the laminate.

4.2.4 Resistance to attack by hydrocarbons shall be verified by testing in accordance with ASTM C581. Tensile and flexural strength shall be determined at the rated temperature by testing in accordance with ASTM D2990. This testing shall be conducted by the manufacturer or his agent, the records kept on file, and submitted to the purchaser upon request.

4.3 Reinforcing Material

Reinforcing materials shall be a commercial grade of E- or E-CR-type glass fiber having a coupling agent chemically compatible with the resin used. The reinforcing material used to fabricate the tank shall be that used to generate the corrosion resistance and physical property design data required by Section 4.

4.4 Surfacing Material

Reinforcing used on the inner surface shall comply with ASTM D3299.

4.5 Appurtenances

Woven roving used for reinforcement of knuckles, manways, and other appurtenances shall be tested in compliance with, and meet the requirements of, the most suitable industry standard.

4.6 Bolting Materials

See Annex C and the Data Sheet for requirements applicable to bolting materials.

5 Design

5.1 General

5.1.1 The purchaser shall determine and specify the design and operating pressures on the Data Sheet. The standard design is limited to:

— working pressure of 152.4 mm (6 in.) water column (0.217 psig or 1.496 kPa) with the static head of the stored fluid for the operating pressure, and

— vacuum condition of 50.8 mm (2 in.) water column (0.072 psig or 0.497 kPa).

5.1.2 Design requirements pertaining to filament winding, chop-spray, and combinations of these methods (commonly referred to as chop-hoop) are covered in this section. Tanks constructed using hand lay-up (contact molding) shall be designed to the same standard as chop-spray construction. Dimensions shall conform to Figure 2 and Table 1.

5.2 Shell Design—Chop-spray

5.2.1 The allowable shell design tensile stress (S_a) shall be 10 % of the ultimate stress (S_u). Ultimate stress shall be determined by tests in accordance with ASTM D638 for each composite combination used by the manufacturer. This test shall be conducted for all standard composite combinations offered by the manufacturer. Shell thickness for testing is defined as the structural layer plus the exterior layer. Test specimens shall be constructed with resins

Table 1—Tank Dimensions (See Figure 2)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Nominal Capacity bbl	**Approximate Working Capacity** bbl **(See Note)**	**Inside Diameter** ft, in. ±1/2 in. **A**	**Shell Height** ft, in. ±1/2 in. **B**	**Height of Overflow Line Connection** ft, in. ±1/8 in. **C**	**Height of Walkways Lugs** ft, in. ±1/8 in. **D**	**Size of Connections** in.	
						C-1, C-4	**C-3, C-2, C-5, C-6**
90	74	8, 0	10, 0	9, 6	7, 7	3	3
110	96	8, 0	12, 6	12, 0	10, 1	3	3
150	92	8, 0	16, 6	16, 0	14, 1	3	3
150	122	10, 0	10, 6	10, 0	8, 1	3	3
200	166	12, 0	10,0	9,6	7,7	3	4
210	185	10, 0	15, 0	14, 6	12, 7	3	4
210	176	12, 0	10, 6	10, 0	8, 1	3	4
250	217	12, 0	12, 6	12, 0	10, 1	4	4
300	267	12, 0	15, 0	14, 6	12, 7	4	4
400	368	12, 0	20, 0	19, 6	17, 7	4	4
500	459	14, 0	18, 6	18, 0	16, 1	4	4
500	445	15, 6	16, 0	15, 6	13, 7	4	4
500	466	12, 0	25, 0	24, 6	22, 7	4	4
750	705	15, 6	24, 0	23, 6	21, 7	4	4
1000	955	15, 6	30, 0	29, 6	27, 7	4	4
1000	935	21, 6	16, 0	15, 6	13, 7	4	4
1500	1438	21, 6	24, 0	23, 6	21, 7	4	4

NOTE The approximate working capacities shown in Column 2 apply to flat-bottom tanks.

containing all additives used in the finished product. These tests may be conducted on a one-time basis and the results kept on file if there have been no revisions to ASTM D638.

5.2.2 The minimum shell thickness shall be in accordance with the following design equation, but not less than 4.8 mm (0.1875 in.):

$$t = PD/2S_a \quad (1)$$

where

t is the minimum allowable shell thickness at the point where P is determined,

P is the pressure exerted by a combination of fluid head and gas blanket,

D is the inside diameter of the tank,

S_a is the allowable shell design tensile stress.

5.3 Shell Design—Filament Wound and Chop-hoop

Allowable design tensile stress (S_a) is that stress which produces 0.001 mm/mm (in./in.) tensile strain according to the formula:

$$S_a = 0.001E \quad (2)$$

where

E is the tensile modulus of elasticity for the particular filament wound laminate in the direction of loading.

Modulus of elasticity and ultimate stress shall be determined in accordance with ASTM D638. The specified test shall be conducted for each standard composite combination used by the manufacturer. Test specimens shall be constructed with resins containing all additives used in the finished product. If S_a calculated by Equation (2) is greater than 0.10 of the ultimate tensile stress, then S_a becomes $S_a = 0.10 \times S_u$. Minimum shell thickness shall be determined using Equation (1), but shall not be less than 4.8 mm (0.1875 in).

5.4 Shell Design—Laminate Construction

5.4.1 General

The laminate comprising the structural components (bottom, cylindrical shell, and roof) shall consist of an inner surface, interior layer, structured layer, and an exterior layer.

5.4.2 Inner Surface

The inner surface shall be between 0.254 mm to 0.508 mm (0.010 in. to 0.020 in.) of reinforced resin-rich material, reinforced with a chemical-resistant glass fiber surface veil or with an organic fiber surface veil, as specified in the Data Sheet. The manufacturer shall provide documentation that the material utilized for the inner surface layer is suitable for the fluid specified in the Data Sheet. This resin-rich surface shall contain less than 20 % by weight of reinforcing material.

5.4.3 Interior Layer

To eliminate weeping, the inner surface exposed to the corrosive environment shall be applied over a an interior layer composed of resin, reinforced only with non-continuous glass-fiber strands applied in a minimum of two piles of chopped-strand mat equivalent to a total of 0.92 kg/m^2 (3 oz/ft^2). As an alternative, a minimum of two passes of chopped roving with a minimum length of 12.7 mm (0.5 in.) to a maximum length of 50.8 mm (2 in.) shall be applied uniformly to an equivalent weight of 0.92 kg/m^2 (3 oz/ft^2). Each ply of mat or pass of chopped roving shall be rolled prior to the application of additional reinforcement. The combined thickness of the inner surface and interior layer shall not be less than 2.03 mm (0.080 in.). To prevent weeping, glass content of the inner surface and the interior layer combined shall be 27 ±5 % by weight when tested in accordance with ASTM D2584.

5.4.4 Structural Layer (Chop-hoop, Filament Wound)

Subsequent reinforcement shall be continuous strand roving. The thickness of the structural layer shall be sufficient to provide minimum strength requirements at various tank heights, as specified in Section 5.3. If additional reinforcement is required, woven fabric, unidirectional fabric, chopped-strand mat, or chopped strands interspersed in the winding may be used to provide additional strength. Glass content of this structural layer shall range from 45 % to 55 % for chop-hoop wound laminates and from 50 % to 80 % for filament wound laminates when tested in accordance with ASTM D2584.

5.4.5 Structural Layer (Chop-spray)

As an alternative to 5.4.4, subsequent reinforcement shall consist of 0.46 kg/m^2 (1.5 oz/ft^2) chopped strand mat or an equivalent weight of chopped roving and an additional number of alternating piles of 0.81 kg/m^2 (2.7 oz/ft^2) woven roving and 0.46 kg/m^2 (1.5 oz/ft^2) chopped-strand mat, or equivalent chopped roving, as required to achieve the thickness calculated per 4.2. Each successive ply or pass of reinforcement shall be rolled prior to the application of additional reinforcement. Glass content of this structural layer shall be a minimum of 35 % when tested in accordance with ASTM D2584. Alternating layers of directional reinforcement shall be lapped a minimum of 38.1 mm (1.5 in.) with laps staggered at least 57.15 mm (2.25 in.) from one layer to the next.

5.4.6 Exterior Layer

Tank shell, bottom, and roof shall have an exterior layer consisting of chopped strand, chopped-strand mat, or surfacing mat. No glass fibers shall be exposed. Resin used in the exterior layer shall be resistant to ultraviolet degradation. Ultraviolet resistance shall be accomplished as specified by 4.2.2.

5.5 Bottom Knuckle Radius Design

The bottom knuckle shall be reinforced with an overlay of glass fiber and resin extending from the flat bottom tangent line upward a minimum of 304.8 mm (12 in.), with an additional 101.6 mm (4 in.) of thickness transition. Reinforcement of the knuckle radius shall taper so that it is tangent with the flat bottom and shall not extend beyond the tangent line onto the tank bottom. The reinforced perimeter shall not prevent the bottom from uniformly contacting a flat support surface when liquid covers the bottom inside of the tank. The minimum thickness of this radius section shall be equal to the combined thicknesses of the bottom shell wall and the bottom. The minimum acceptable knuckle radius shall be 2 in. (50.8 mm), as shown in Figure 1.

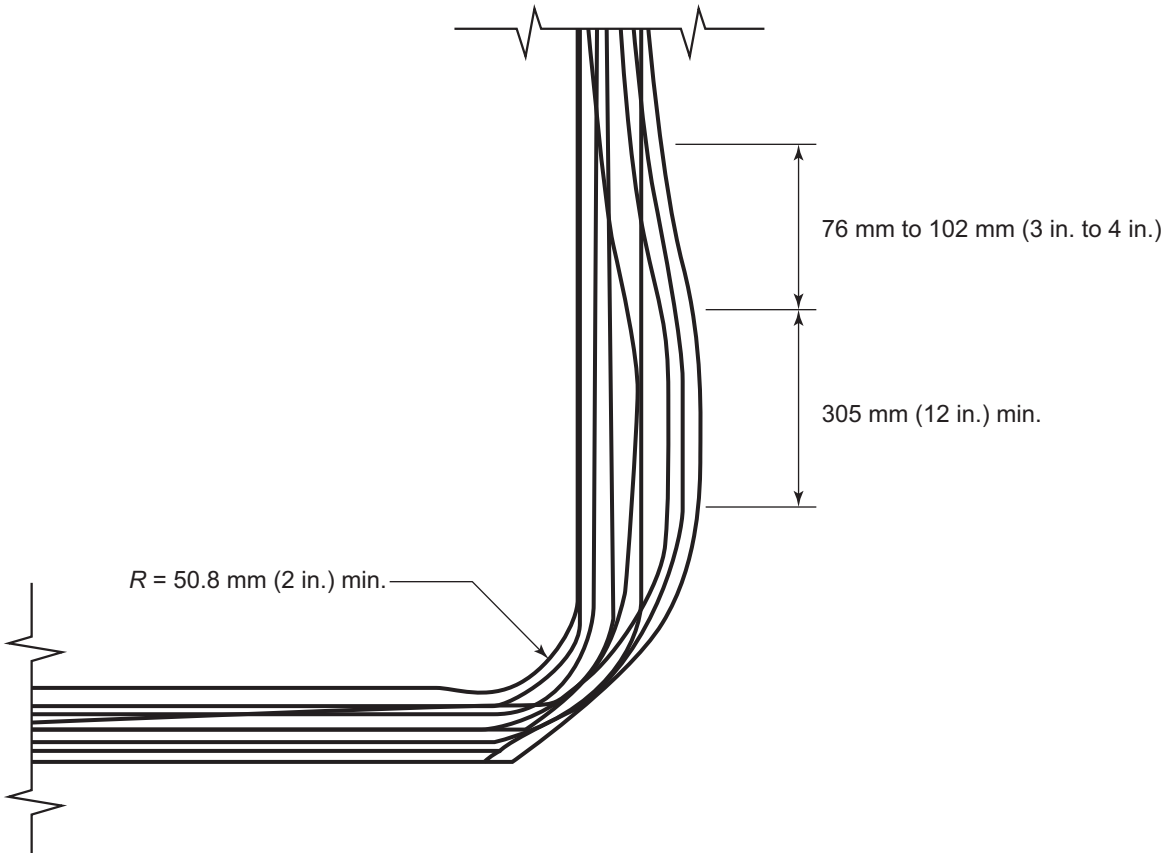


Figure 1—Bottom Knuckle of Flat-bottom Tank

5.6 Bottom-to-Shell Joint (Chop-spray) Design

If tank bottoms and shells are fabricated separately and joined by use of a laminate bond, the joint shall be of alternating layers of mat (or chopped strand) and 0.81 kg/m^2 (24 oz/yd^2) woven roving. The minimum thickness of this overlay shall be equal to the thickness of the tank shell at the joint. The reinforcement shall meet the requirements specified in Section 6.5 of ASTM D4097. The interior layer of the joint shall be reinforced with at least two layers of 0.46 kg/m^2 (1.5 oz/ft^2) material. The minimum width of this seal joint is 152.4 mm (6 in.). The inner surface of the joint shall be sealed according to Section 5.4.

5.7 Bottom Strength

Minimum acceptable bottom thickness shall be 6.35 mm (0.25 in.) for fully supported flat or cone bottoms for tanks 3.66 m (12 ft) in diameter, or less. For tanks greater than 3.66 m (12 ft) in diameter, the minimum acceptable bottom thickness shall be 9.52 mm (0.375 in.). Bottom laminate construction shall conform to Sections 5.4, 5.4.2, 5.4.3, and 5.4.5.

5.8 Geometry

5.8.1 The roof configuration shall be:

— ellipsoidal dome, or

— flanged or dished dome, or

— conical roof with 1:12 pitch or steeper.

5.8.2 Regardless of shape, the roof shall be able to support a concentrated 1.112 kN (250 lb) load on any single 101.6 mm × 101.6 mm (4 in. × 4 in.) area without damage, with a maximum deflection of $^1/_2$ % of the inside tank diameter. The use of stiffener ribs or sandwich construction stiffening systems is acceptable.

5.9 Roof Laminate Construction

5.9.1 Roof laminate construction shall conform to Sections 5.4, 5.4.2, 5.4.3, and 5.4.5. The minimum roof thickness shall be 4.8 mm (0.1875 in.).

5.9.2 If the tank has a gas blanket installed, the purchaser shall consider the option of laminating the interior of the top roof seam (see Data Sheet, Annex D).

5.10 Cleanout

Cleanout or manway flange cover dimensions and bolting shall conform to the dimensions shown in Table 2 or ASTM D3299, Table 5. Cleanout flanged nozzle construction shall conform to ASTM D3299, Table 4. The bottom of the cleanout shall not extend lower than 304.8 mm (12 in.) from the bottom of the tank. The requirements in Annex C apply to cleanout and manway bolting.

5.11 Nozzles

Unless specified otherwise by the purchaser, the tank shall be furnished with the nozzles shown in Figure 2. The size and location of the nozzles shall conform to Table 1 and Figure 2.

NOTE The configuration covered above is the default or standard design.

Table 2—Dimensions of Manways

Size [a]		Diameter of Flange and Cover		Thickness of Flange and Cover		Diameter of Bolt Circle		No. of Bolts	Bolt Hole Diameter	
mm	(in.)	mm	(in. ±3/32)	mm	(in. ±1/32)	mm	(in. ±3/32)		mm	(in. ±1/32)
Side-shell Manway—Up to 15 psig (104 kPa) Hydrostatic Head										
457	(18)	635	(25)	25	(1)	578	(22 3/4)	16	19	(3/4)
508	(20)	699	(27 1/2)	25	(1)	635	(25)	20	22	(7/16)
559	(22)	762	(30)	25	(1)	686	(27)	20	25	(1)
610	(24)	813	(32)	38	(1 1/2)	749	(29 1/2)	20	25	(1)
Roof Manway—Up to 0.5 psig (3.5 kPa) Static Head										
457	(18)	635	(25)	10	(3/8)	578	(22 3/4)	16	13	(1/2)
508	(20)	699	(27 1/2)	10	(3/8)	635	(25)	20	13	(1/2)
559	(22)	762	(30)	10	(3/8)	686	(27)	20	13	(1/2)
610	(24)	813	(32)	10	(3/8)	749	(29 1/2)	20	13	(1/2)

[a] Bolt size = bolt hole diameter minus 3 mm (1/8 in.).

The purchaser may modify the orientation, size, and quantity of nozzles. The nameplate marking shall denote the nozzle configuration. See Section 8.

Nozzles shall be female NPT. However, the purchaser may specify on the Data Sheet other types of nozzles such as flanged, grooved, or male NPT. Fittings C-1 and C-4 shall be of a full coupling design to allow for internal connection (drain and inlet downcomer). All nozzles shall be of the glassed-in type.

5.12 Cutout Reinforcements

Cutouts for nozzles and cleanouts that will bear hydrostatic pressure shall be reinforced on a circular area concentric with the cutout. The thickness of the reinforcement (T_r) in mm (in.) shall be determined as follows:

$$T_r = PDK/2S_a \tag{3}$$

where

K is 1.0 for nozzles NPS 6 and larger or $d/(d_r - d)$ for nozzles smaller than NPS 6;

d is the nozzle outside diameter;

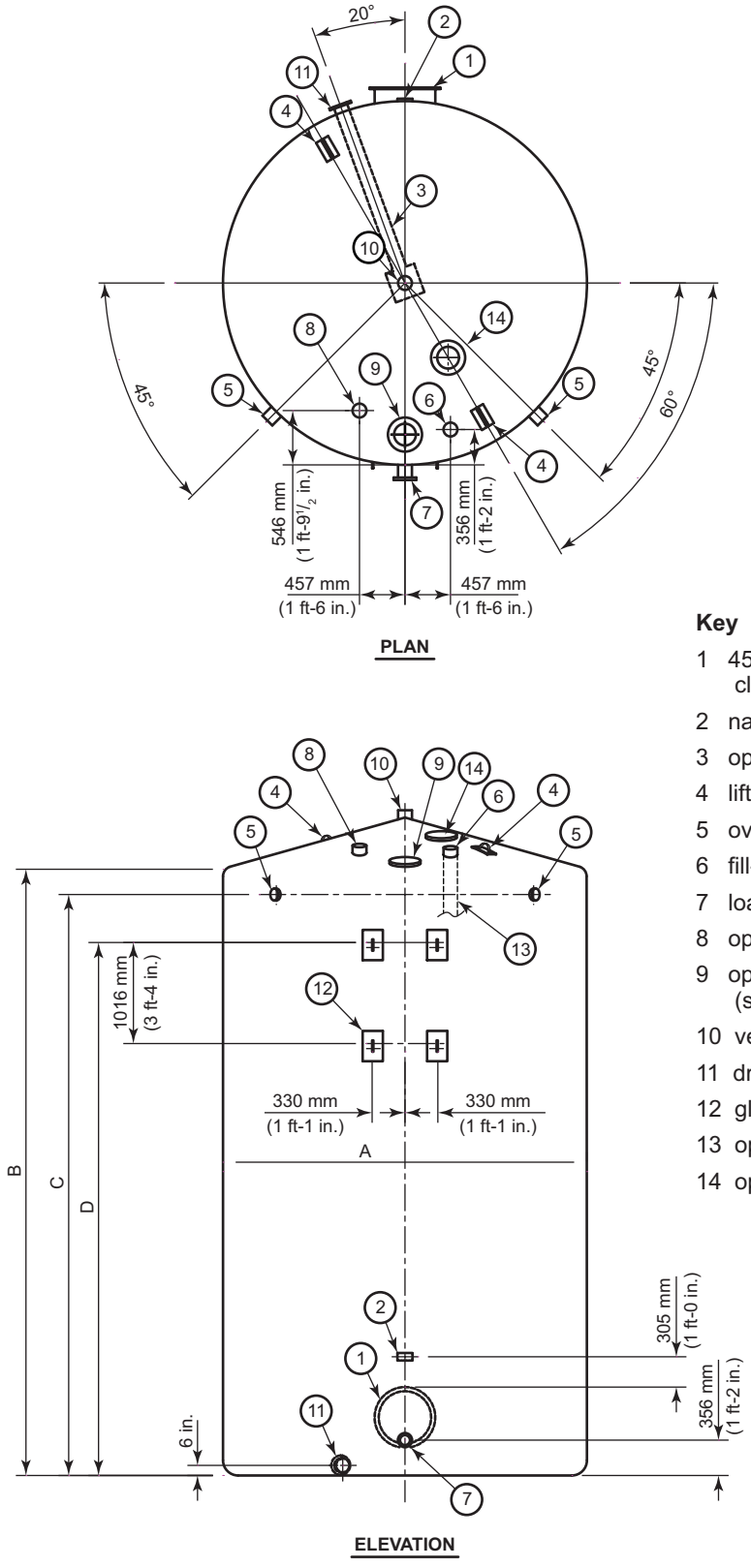
d_r is the reinforcement diameter, inches = $2 \times d$ for nozzles NPS 6 or larger or $d + 6$ for nozzles smaller than NPS 6;

P is the hydrostatic pressure at the point of nozzle installation;

D is the inside diameter of the tank;

S_a is the allowable tensile stress (see 5.2.1).

For T_r < 3.2 mm (1/8 in.), no additional reinforcement shall be required other than the overlay for glassed-in nozzles.



Key

1 457 mm to 610 mm (18 in. to 24 in.) circular cleanout (see Table 2)
2 name plate
3 optional anti-channel drain
4 lift lugs (location optional)
5 overflow-line connection (C-3)
6 fill-line connection (C-1)
7 loadout-line connection (C-5)
8 optional level gauge connection (C-6)
9 optional gauge/thief-hatch cutout connection (see Figure 3)
10 vent line connection (C-2)
11 drain line connection (C-4)
12 glassed-in walkway bracket lugs
13 optional downcomer pipe
14 optional emergency relief vent connection

NOTE See Table 1 for connection sizes

Figure 2—Closed Top FRP Tank Dimensions (See Table 1)

5.13 Appurtenances

5.13.1 Nozzles, cleanouts, and other appurtenances shall be installed in accordance with 5.10 to 5.12. Installation laminates shall meet minimum standards shown in Figure 5 and Figure 6 of ASTM D3299.

5.13.2 FRP flanged nozzle construction and design shall conform to ASTM D3299, Table 4. Flange drilling and bolting shall conform to ASME B16.5 for Class 150 flat faced flanges.

5.13.3 All fittings below the liquid level shall be reinforced internally with at least two layers of 0.46 kg/m^2 (1.5 oz/ft^2) mat. The inner surface shall be sealed according to 5.4.3.

5.13.4 For bolting requirements applicable to all appurtenances, see Annex C.

5.14 Walkway, Ladder, Lifting, Hold-down, and Tie-down Lugs

5.14.1 The manufacturer shall demonstrate by physical testing on a prototype that all lifting lugs, as a set, are capable of withstanding two times the empty weight of the tank. Lugs shall not be installed by the use of fasteners that penetrate the shell. Walkway and ladder loads are specified in Annex C.

5.14.2 If hold-downs (wind anchorage lugs) are specified by purchaser, the manufacturer shall use ASCE 7 or IBC to calculate wind loads. Hold-down lugs shall be placed on the tank so they do not protrude below the bottom surface of the tank.

5.14.3 If a safety tie down is specified in the Data Sheet for field personnel working on the tank roof, a tie down anchor lug shall be provided at an appropriate roof location. The anchor lug shall be designed per 29 *CFR* 1910 or equivalent national regulation. A tank lifting lug may be utilized as the tie down anchor if it is designed accordingly.

5.15 Downcomer Pipe

A conductive downcomer pipe, with a spray deflector shall be installed if specified in the Data Sheet.

NOTE The downcomer pipe system is used to reduce the internal static build up caused by liquid splashing from the filling drop.

5.16 Gauge/Thief Hatches

Gauge or thief or hatch pressure and vacuum ratings shall be in accordance with the design conditions (see 5.1). Figure 3 provides suggested bolt patterns for two typical flanges used on gauge/thief hatch openings. A grounding lug shall be installed on the hatch for grounding purposes. The lug size shall accommodate the attachment of an AWG No. 4 wire. A striker plate consisting of a minimum of 4.8 mm $\times$ 406.4 mm $\times$ 406.4 mm (0.1875 in. $\times$ 16 in. $\times$ 16 in.) steel plate shall be laminated to the tank bottom directly below the gauge/thief hatch.

NOTE Manual gauging that includes opening the gauge or thief hatch has some inherent personal safety risk due to the personnel exposure to possible gases in the tank. The purchaser can mitigate this risk by providing a remote tank level gauging system using radar gauge, float valve, level transmitter, etc.

5.17 Design Considerations for Potential Electrostatic Hazards

Electrostatic hazards which might arise when filling or emptying FRP tanks may be divided into two types:

1) those due to the accumulation of a charge on the outside of the tank,

2) those due to the build-up of an electric field inside the tank.

Each tank metal appurtenance shall be equipped with a flexible bonding conductor. To minimize the risk of the first type of hazard, the gauge/thief hatch shall be connected to electrical ground. Any metallic walkway, stairway, or ladder attached to an FRP tank shall be connected to electrical ground.

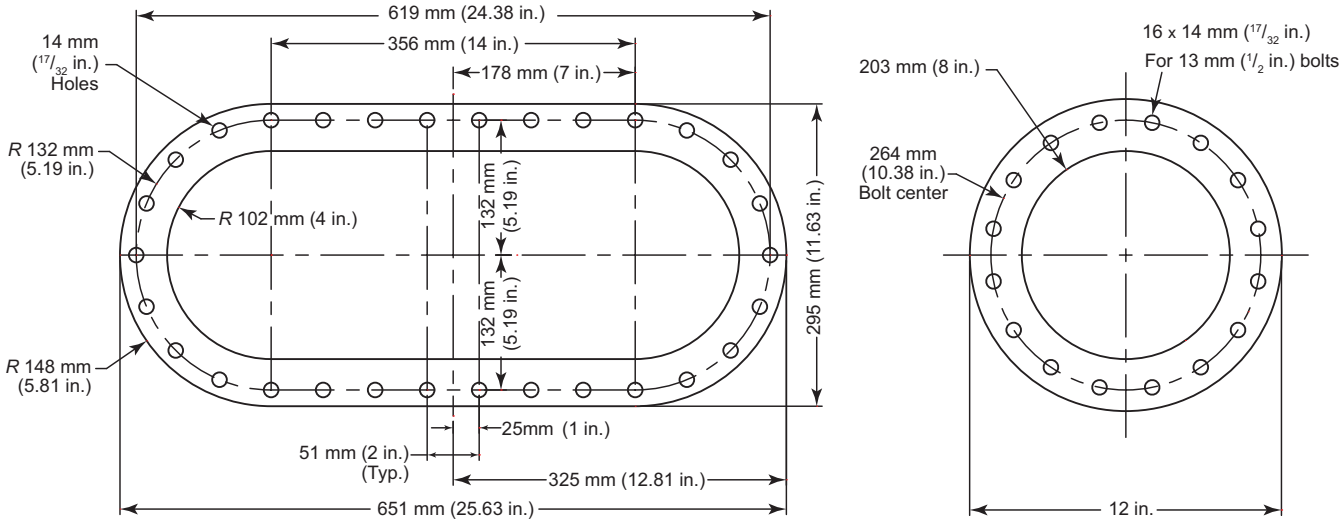


Figure 3—Typical Gauge/Thief Hatch Opening

To minimize the risk of the second type of hazard, several different options shall be considered by the purchaser. As in metal tanks, the primary method utilized to minimize charge accumulation inside of tanks is to limit flow rates until the filling pipe is covered. The use of conductive metallic downcomers shall also be considered. Conductive tank materials used in tank construction and properly grounded can also be utilized, as specified in the Data Sheet. All metal components in contact with the vapor space and the liquid containment portion of the tank shall be bonded. In addition, the bond cable shall be grounded so that all metal components are bonded and grounded. In severe cases the use of a suspended conductor within the tank can be used (see Figure 4).

5.18 Grounding

If specified in the Data Sheet the manufacturer shall provide a means to ground the interior fluid.

NOTE The following are some methods currently used:

a) conductive downcomers that are suspended from electrically bonded connections at the tank roof, and extending to the bottom of the tank floor;

b) conductive ground rods (vertical or horizontal);

c) carbon c-veil (embedded on the tank internal shell surface);

d) a suspended static conductor inside the tank.

API 2003 and API 545 provide more complete guidance to address static and lightning protection issues as they relate to tank installation and operation.

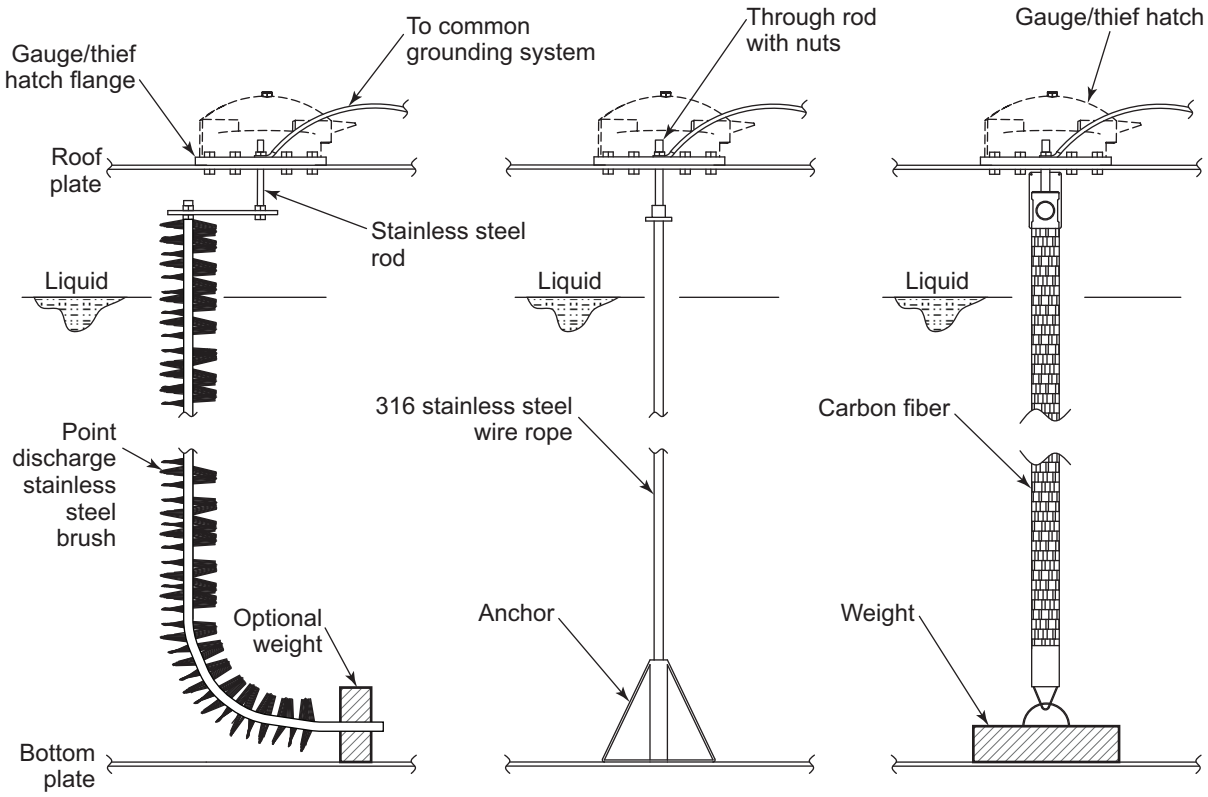


Figure 4—Example of Suspended Static Conductor Bond to Grounding System

6 Venting Requirements

6.1 Normal Venting

Closed top tanks shall be positively vented to atmosphere. Connection C-2 is provided for normal inbreathing and outbreathing due to temperature changes and to liquid movement into and out of the tank. The size of this connection shall be equal to, or greater than, the size of the largest outlet or inlet connection. These connections should be fitted with pressure-vacuum valves properly sized in accordance with API 2000. Gauge/thief hatches and pressure/vacuum valves shall be in accordance with the design conditions (see 5.1).

6.2 Emergency Venting

The purchaser shall consider providing emergency venting for upset conditions. This shall be addressed in the Data Sheet.

NOTE However, emergency venting capacity due to an external tank fire is not normally required for FRP tanks, as they will fail at temperatures in the neighborhood of 93.3 °C (200 °F). This temperature occurs before vaporizing sufficient amount of the liquid in the tank to create a venting problem.

7 Fabrication and Testing

7.1 Fabrication

7.1.1 General

Tanks shall be fabricated by the contact-molded or filament-wound process. Contact-molded tanks shall meet the requirements of ASTM D4097 and filament-wound tanks shall meet the requirements of ASTM D3299. Both of these methods may be used to construct the tank. Tanks fabricated using a combination of the two aforementioned methods shall meet the standard applicable to the method used for the respective part fabricated.

7.1.2 Joints

Joints between the hoop sections of tanks formed separately shall be formed by overlay to at least the minimum widths appearing in ASTM D4097, Table 2, with an overlay thickness equal to the required design shell thickness. The overlay shall be tapered back from this minimum thickness to become flush with the adjoining section over a minimum width of 76 mm (3 in.). The inner surface of the joint shall be sealed in accordance with 5.4.3.

7.1.3 Dimensional Tolerances

Tanks shall be fabricated to the dimensions in Table 1 and within the tolerances listed. The shell, bottom, and roof thicknesses shall not be less than those specified in Section 5. In addition, there shall be no abrupt visual transition or bulging on the shell outside surface.

7.1.4 Defects

The tank shall be free of visual defects such as foreign inclusions, dry spots, air bubbles, pinholes, and delaminations.

a) The internal surface of the tank shall be smooth, free of cracks and crazing and shall contain no more than 2 pits per 0.093 m^2 (1 ft^2) area. Acceptable pits are those less than 3.2 mm ($^1/_8$ in.) in diameter and less than 0.8 mm ($^1/_{32}$ in.) deep. Acceptable pits shall be covered with sufficient resin to ensure coverage of the inner surface reinforcement. Pits of larger dimensions are not acceptable and shall be repaired. Some waviness is permissible as long as the surface is smooth and free of pits.

b) The exterior surface of the tank shall be smooth and free of exposed fibers.

7.2 Hydrostatic Testing

7.2.1 The tank shall be hydrostatically tested in the manufacturer's shop.

NOTE If the purchaser elects to have a second hydrotest performed in the field after installation, this test is outside of the scope of this specification. See the Data Sheet for the specific requirements.

7.2.2 Testing shall be conducted with clean, fresh water to which a surfactant has been added.

7.2.3 The test shall be held for a minimum period of one hour, unless a longer period is specified by the purchaser. If there is a sign of cracks or excessive deformation, then the test period shall be at least four hours long.

7.2.4 The tank shall be tested by filling through use of a temporary standpipe 0.305 m (12 in.) above the top crown of the tank.

7.2.5 All connections shall be plugged or blinded during the test, using the type and size of fittings intended for use after installation, to conform thread or flange sealing integrity.

7.2.6 All leaks and defects found shall be repaired by the manufacturer and the tank retested for a minimum of 2 hours. If the tank shows a consistent defect(s), it shall be rejected.

7.3 Quality Control Tests

7.3.1 The tests described in this section shall be conducted by the manufacturer or his subcontractor on the completed tank to confirm that this specification is met. These tests include thickness, degree of cure, dimensional tolerances, and surface cure.

7.3.2 Tank shell thickness shall be measured and recorded at all cutouts to verify specified minimum thickness is met or exceeded. Readings shall be taken utilizing a micrometer, calipers, ultrasonic measurement or any other equally sensitive method capable of producing repeatable data. Measurements shall be taken at two locations approximately 180° apart and aligned in the circumferential direction at each cutout.

7.3.3 Degree of cure of the laminate shall be determined to meet the resin manufacturer's standards by measuring Barcol hardness in accordance with ASTM D2583.

7.3.4 Tank dimensions and standard nozzle locations shall be verified on the finished tank to meet the tolerances stipulated in Table 1 and locations specified in Figure 2.

7.3.5 An acetone test shall be used to detect surface inhibition on external surfaces and secondary bond surfaces exposed to air during cure (non-mold surfaces). The following procedure shall be used: wipe surface with clean acetone for 30 seconds, allow to dry (typically for 10 to 20 seconds), and check for tackiness. If the surface is tacky, it failed the test. Tackiness is an indication of incomplete cure. If tackiness is determined to be present, the Barcol hardness test shall be performed to verify incomplete cure. If an incomplete cure is evident, the tank shall be either repaired and then retested, or scrapped at the purchaser's option.

7.4 Optional Tests

Other tests shall be conducted if specified by the purchaser. These tests may include any or all of the following: tensile strength (ASTM D638), flexural strength (ASTM D790), glass content (ASTM D2584), temperature resistance of resin (ASTM D790), acoustic emission examination (SPI E-1067), and/or destructive tests. If the purchaser specifies destructive testing requirements, the destructive tests shall be conducted on nozzle and manway cutouts. The manufacturer is responsible for retaining cutouts of sufficient size for testing.

7.5 Painting

External surface paint (see 4.2.2), if used, may also be used to provide the finishing color. The exterior coating system shall consist of surface preparation, primer and finish coating. The surface preparation shall be per SSPC-SP1 solvent cleaning to remove dirt, grease, and oil by solvent washing or washing with a good detergent, followed by rinsing with potable water. Uniformly and lightly abrade the surface to remove the gloss and provide an etch or anchor profile without reducing the design thickness. This shall be done with abrasive blasting using a fine (40 to 100 mesh) abrasive or by sanding with 100 grit sandpaper or abrasive pads. Polyamide epoxy may be applied as a primer and aliphatic polyurethane for finishing. The application shall follow the coating manufacturer's product Data Sheet.

8 Marking

8.1 The tank shall be identified with a metal nameplate located as shown in Figure 2 and marked according to Figure 5. The nozzle configuration shall be denoted on the nameplate as either "Standard" or "Modified" and the reference to API 12P shall be shown on the nameplate. The API monogram shall also be shown on the nameplate if applicable to the tank manufacture. See 5.11 Annex A (Use of API Monogram by Licensees), and Annex D (FRP Tank Data Sheet).

8.2 If the purchaser specifies requirements that conflict with this specification, then the tank shall not be monogrammed and the nameplate shall not refer to API-12P.

NOTE If there is any exception made to a requirement in API-12P, the nameplate should be marked to refer to the purchaser's specification.

8.3 The nameplate shall be affixed with bolts and nuts or by other suitable means.

Manufactured in Accordance with API Specification 12P

Manufacturer _____

Serial Number _____

Date of Manufacture _____

Nominal Diameter _____

Nominal Height _____

Nominal Capacity _____

Type of Resin Used in Manufacture _____

Minimum and Maximum Operating Temperature _____ °C or °F

Design Pressure _____ MPa or oz.

Design Fluid Specific Gravity _____

Design Vacuum _____ mm or in. of WC

Nozzle Configuration (Standard or Modified) _____

Figure 5—Metal Nameplate Format

Annex A
(informative)

Use of API Monogram by Licensees

A.1 Scope

The API Monogram® is a registered certification mark owned by the American Petroleum Institute (API) and authorized for licensing by the API Board of Directors. Through the API Monogram Program, API licenses product manufacturers to apply the API Monogram to new products which comply with product specifications and have been manufactured under a quality management system that meets the requirements of API Q1. API maintains a complete, searchable list of all Monogram licensees on the API Composite List website (www.api.org/compositelist).

The application of the API Monogram and license number on products constitutes a representation and warranty by the licensee to API and to purchasers of the products that, as of the date indicated, the products were manufactured under a quality management system conforming to the requirements of API Q1 and that the product conforms in every detail with the applicable standard(s) or product specification(s). API Monogram program licenses are issued only after an on-site audit has verified that an organization has implemented and continually maintained a quality management system that meets the requirements of API Q1 and that the resulting products satisfy the requirements of the applicable API product specification(s) and/or standard(s). Although any manufacturer may claim that its products meet API product requirements without monogramming them, only manufacturers with a license from API can apply the API Monogram to their products.

Together with the requirements of the API Monogram license agreement, this annex establishes the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products that satisfy the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program requirements.

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8145 or by email at certification@api.org.

A.2 Normative References

API Specification Q1, *Specification for Quality Management System Requirements for Product Manufacturing for the Petroleum and Natural Gas Industry*

A.3 Terms and Definitions

For purposes of this annex, the following terms and definitions apply.

A.3.1
API monogrammable product
Product that has been newly manufactured by an API licensee utilizing a fully implemented API Q1 compliant quality management system and that meets all the API specified requirements of the applicable API product specification(s) and/or standard(s).

A.3.2
API specified requirements
Requirements, including performance and licensee-specified requirements, set forth in API Q1 and the applicable API product specification(s) and or standard(s).

NOTE Licensee-specified requirements include those activities necessary to satisfy API specified requirements.

A.3.3
API product specification
Prescribed set of rules, conditions, or requirements attributed to a specified product that address the definition of terms; classification of components; delineation of procedures; specified dimensions; manufacturing criteria; material requirements, performance testing, design of activities; and the measurement of quality and quantity with respect to materials; products, processes, services, and/or practices.

A.3.4
licensee
Organization that has successfully completed the application and audit process and has been issued a license by API.

A.3.5
design package
Records and documents required to provide evidence that the applicable product has been designed in accordance with API Q1 and the requirements of the applicable product specification(s) and/or standard(s).

A.4 Quality Management System Requirements

An organization applying the API Monogram to products shall develop, maintain, and operate at all times a quality management system conforming to API Q1.

A.5 Control of the Application and Removal of the API Monogram

Each licensee shall control the application and removal of the API Monogram in accordance with the following.

a) Products that do not conform to API specified requirements shall not bear the API Monogram.

b) Each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/ monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:

   1) define the authority responsible for application and removal of the API Monogram;

   2) define the method(s) used to apply the API Monogram;

   3) identify the location on the product where the API Monogram is to be applied;

   4) require the application of the licensee's license number and date of manufacture of the product in conjunction with the use of the API Monogram;

   5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and

   6) require application of the additional API product specification(s) and/or standard(s) marking requirements.

c) Only an API licensee may apply the API Monogram and its designated license number to API monogrammable products.

d) The API Monogram license, when issued, is site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location.

e) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Requirements for alternative API Monogram marking are detailed in the API Policy, *API Monogram Program Alternative Marking of Products License Agreement*, available on the API Monogram Program website at http://www.api.org/alternative-marking.

A.6 Design Package Requirements

Each licensee and/or applicant for licensing must maintain a current design package for all of the applicable products that fall under the scope of each Monogram license. The design package information must provide objective evidence that the product design meets the requirements of the applicable and most current API product specification(s). The design package(s) must be made available during API audits of the facility.

In specific instances, the exclusion of design activities is allowed under the Monogram Program, as detailed in *Advisory # 6*, available on API Monogram Program website at http://www.api.org/advisories.

A.7 Manufacturing Capability

The API Monogram Program is designed to identify facilities that have demonstrated the ability to manufacture equipment that conforms to API specifications and/or standards. API may refuse initial licensing or suspend current licensing based on a facility's level of manufacturing capability. If API determines that additional review is warranted, API may perform additional audits (at the organization's expense) of any subcontractors to ensure their compliance with the requirements of the applicable API product specification(s) and/or standard(s).

A.8 API Monogram Program: Nonconformance Reporting

API solicits information on products that are found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API specified requirements. Customers are requested to report to API all problems with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at http://compositelist.api.org/ncr.asp.

Annex B
(informative)

Recommended Installation and Handling

B.1 Installation

Vertical flat bottom tanks should be installed on a base providing continuous support for both the tank bottom and knuckle radius, and having sufficient bearing strength to support the weight of the tank full of liquid, and with negligible settlement. The following materials are recommended for use, when possible, for tank grades:

— compacted gravel with a top clean sand layer to provide a smooth uniform support;

— smooth surfaced concrete, or a concrete grout.

Per API 12R1, the tank support base should be elevated and the outer grade should be sloped down to allow drainage away from the tank bottom. Retaining rings are highly recommended for tank gravel pads to help prevent wind and water erosion around the tank base. The use of rock riprap, large diameter gravel, or other coarse material around the base of the tank after installation will mitigate tank grade erosion.

B.2 Handling

During installation of the tank, several methods of handling are recommended. Tanks may be handled with a crane utilizing the lifting lugs laminated to the tank.

Caution—Do not attempt to lift by attaching to a fitting.

When using cranes for handling, care should be taken to prevent damage to the knuckle radius or to connections by dragging the tank. A tank skid should only be used with a bottom plate to protect the knuckle radius, ensuring the base of the tank is setting solidly on the base of the tank skid and is securely fastened to the tank skid by chains or web belting. Care should also be taken when tail boarding with a tank skid that there is sufficient ground clearance for maneuvering the tank onto the grade and that the tank is not severely dropped when set into place. After the tank is installed on the grade, a final inspection is recommended to ensure that there are no fractures in the base, knuckle, sidewall, or connections, either in the interior or exterior of the tank. Because the majority of problems with fiberglass tanks tend to occur during handling and shipping, it is strongly recommended that the manufacturer’s special instructions be followed in all cases.

B.3 Fire Protection

FRP tanks should be remotely located from any obvious ignition source and/or so located that any spill resulting from the failure of these materials could not unduly expose persons, buildings, or structures.

Annex C
(normative)

Walkways, Stairways, and Ladders

C.1 General

Walkways and stairways furnished to this specification shall be constructed from prefabricated components designed to be field erected alongside of tanks or similar structures. Walkways and stairways shall be structurally designed per the AISC *Steel Construction Manual* to withstand code specified loadings as per ASCE 7 or IBC. All material shall be metal as per ASTM A36, or equivalent, unless specified otherwise by the purchaser. Material finishing shall be either galvanized or paint coated per the purchaser's specification.

C.2 Access

Walkways, platforms, and stairways or ladders provide access to devices on or near the roof that are within easy reach from the ladder or platform, and are not for employee egress onto the roof itself. If individuals are required to have access to the roof, guard railings shall be installed.

C.3 Walkways

Walkways shall consist of flooring (decking) sections, railing assemblies, and toeboards designed and assembled so that the completed structure will support a uniform load of 244 kg/m^2 (50 lb/ft^2), or a concentrated load of 4.45 kN (1000 lb) at any place on the span without deflecting more than $^1/_{240}$ of the unsupported span length. Walkway decking width shall be a minimum of 0.66 m (26 in.) wide. The maximum span between tank brackets or ground supports shall be 7.62 m (25 ft). Intermediate column supports shall be provided, as required, to limit the free span and deflection. The base for ground supports shall be of concrete or other suitable permanent foundation.

C.4 Walkway Decking and Stair Tread

Walkway decking and stair treads shall be made of grating, expanded metal or other material having a non-slip surface, as specified by the purchaser. Stair treads shall be equipped with nosings having a non-slip finish per 29 *CFR* 1910.

NOTE For corrosive service (i.e. exposure to salt water or H_2S), the purchaser should consider the corrosion effect for the lifetime of the structure when specifying the material and finishing requirements.

C.5 Railings

Railings shall consist of posts, horizontal braces, sway (truss) braces, gusset plates, toeboards, a midrail, and a top rail. Railings shall be assembled so that the top rail is 1.07 m (42 in.) above the treadway. The completed structure, when assembled, shall be capable of withstanding a concentrated force of 890 N (200 lb) applied in any direction, and at any point, on the top rail.

If walkway railing is structurally designed as a permanent part of the walkway truss, no part of the railing shall be removable during normal walkway service.

C.6 Toeboards

Toeboards shall be installed on all open sides (except at the entrance of stairways or ladders) to provide an installed height of 101.6 mm (4 in.) above the treadway.

C.7 Midrail

A midrail shall be installed approximately halfway between the treadway and top rail. Where the midrail projects into a walkway area, the ends shall be formed to a smooth contour.

C.8 Brackets

The tank shall be equipped with two bracket assemblies securely bolted to the lugs specified in Figure 2. The brackets shall be installed to provide a 0.66 m (26 in.) wide access to the tank at the point of attachment.

C.9 Stairways

Stairways, if required for access to walkway sections, shall be designed for field erection and shall be capable of supporting a minimum of 0.445 kN (100 lb) per linear foot of tread width, or a concentrated load of 4.45 kN (1000 lb) at any point on the stairway without deflecting more than $^{1}/_{240}$ of the unsupported stairway length. Stairway width shall be a minimum of 0.66 m (26 in.) Stairways shall be designed and installed to have an angle of 45 degrees with the horizontal, unless otherwise specified by the purchaser. When installed at 45 degrees, the stairway shall have a run and rise of 215.9 mm ($8^{1}/_{2}$ in.) with a nominal tread width of not less than 203.2 mm (8 in.). Other uniform rise and tread combinations which will produce a stairway within angles to the horizontal between 30 degrees and 50 degrees are acceptable if all other requirements of this specification are met. The rise height and tread width shall be uniform throughout any stairway, including any foundation used as one or more steps.

C.10 Railings

C.10.1 Railings shall be installed on both sides of stairways and shall be designed so that the completed assembly will withstand a minimum of 890 N (200 lb) force in any direction, applied at any point on the top rail. The top rail shall be installed so that it is not less than 762 mm (30 in.), nor more than 864 mm (34 in.), measured vertically from the upper surface of the nose of a tread. Protection against falling shall be provided between the stairway runners and the top rail.

C.10.2 The juncture of the top rail of the stair railing shall make a smooth transition to the top rail of the walkway railing through the use of a structural gusset member, if possible.

C.10.3 If a stairway railing is structurally designed as a permanent part of the walkway truss, no part of the railing shall be removable during normal walkway service.

C.11 Spiral Stairways

Spiral stairways, attached to brackets on the circumference of the tank, may be used in lieu of straight stairways, provided all of the above requirements are met, with the exception that railings are required only on the outside of the stairway. See the Data Sheet for the type of stairway required by the purchaser. The run of the stair tread will depend on the radius of the exterior arc, and the minimum effective tread shall be 17.8 cm (7 in.), measured 33 cm (13 in.) from the exterior arc.

NOTE Spiral stairways are not recommended for installation on tanks less than 4.72 m (15.5 ft) in diameter.

C.12 Ladders

If specified by the purchaser, fixed industrial ladders shall be used in lieu of stairways. The use of a platform is optional per the Data Sheet, but when used, the platform shall comply with OSHA 1910 (or equivalent).

Ladder spacing from the tank wall, caging, and rung configuration/dimensions shall comply with OSHA 1910 (or equivalent) requirements.

C.13 Bolting

C.13.1 General

This section covers bolting connections for the entire tank, including flange bolting and bolting for walkways, stairways, and ladders. Bolting dimensions, e.g. length and diameter, shall be determined in the design process.

C.13.2 Materials

Unless specified otherwise by the purchaser, all carbon steel bolts for walkways, stairways, ladders and flange bolting shall conform to ASTM A307, A193M/A193, ASTM A325, or ASTM A325M. Nuts shall comply with ASTM A563. Washers shall comply with ASTM F844 or F436. Heavy hex bolts, nuts, and washers shall be used. See the Data Sheet for any additional requirements.

C.13.3 Finish

C.13.3.1 Bolts, nuts, and washers shall be galvanized, or as otherwise specified by the purchaser.

C.13.3.2 If galvanized bolting materials are required, bolts and nuts shall be hot-dip galvanized in accordance with the requirements of ASTM A153, Class C. Nuts shall be tapped after galvanizing.

C.13.3.3 If specified in the Data Sheet to be mechanically galvanized, bolts and nuts shall be mechanically zinc coated, and the coating shall conform to the requirements for ASTM B695, Class 55, or to the coating thickness, adherence, and quality requirements for ASTM A153, Class C. Mechanically zinc-coated nuts for assembly with mechanically zinc-coated bolts shall be tapped oversize prior to coating and need not be re-tapped afterwards.

C.13.4 Threads

Threads of unplated product shall be coarse-thread series, as specified for screw threads (ASME B1.1 of latest issue) having a Class 2A tolerance for bolts and Class 2B tolerance for nuts. After galvanizing, the maximum limit of pitch and major diameter may exceed the Class 2A limit by 0.53 mm (0.021 in.).

C.13.5 Bolting Procedure

Bolt hole dimension and bolting installation tension requirements shall follow the AISC *Steel Construction Manual*.

C.13.6 Anchor Bolt

An anchor bolt system, if required, shall be designed according to the *International Building Code*.

Annex D
(normative)

FRP Tank Data Sheet
(With Tank Nozzle Location Guide) [9]

[9] Users of the forms in this Annex should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

Where applicable, authorities having jurisdiction should be consulted.

General Information

Company _____
Lease _____
Field _____ Approx. Location _____
Estimate No _____ Inquiry No _____
Requisition No _____
Contact _____ Phone No _____
Cost Estimate Only _____ [ ] For Purchase _____ [ ]
Inquiry Date _____ Required Date _____

Specifications

API 12P: [ ] Yes [ ] No, [If "No" is checked, then Purchaser Specification must also be checked "Yes"]
Apply API Monogram: [ ] Yes [ ] No, [If "Yes" is checked, then API-12P must also be checked "Yes"]
Purchaser Specification: [ ] No [ ] Yes _____

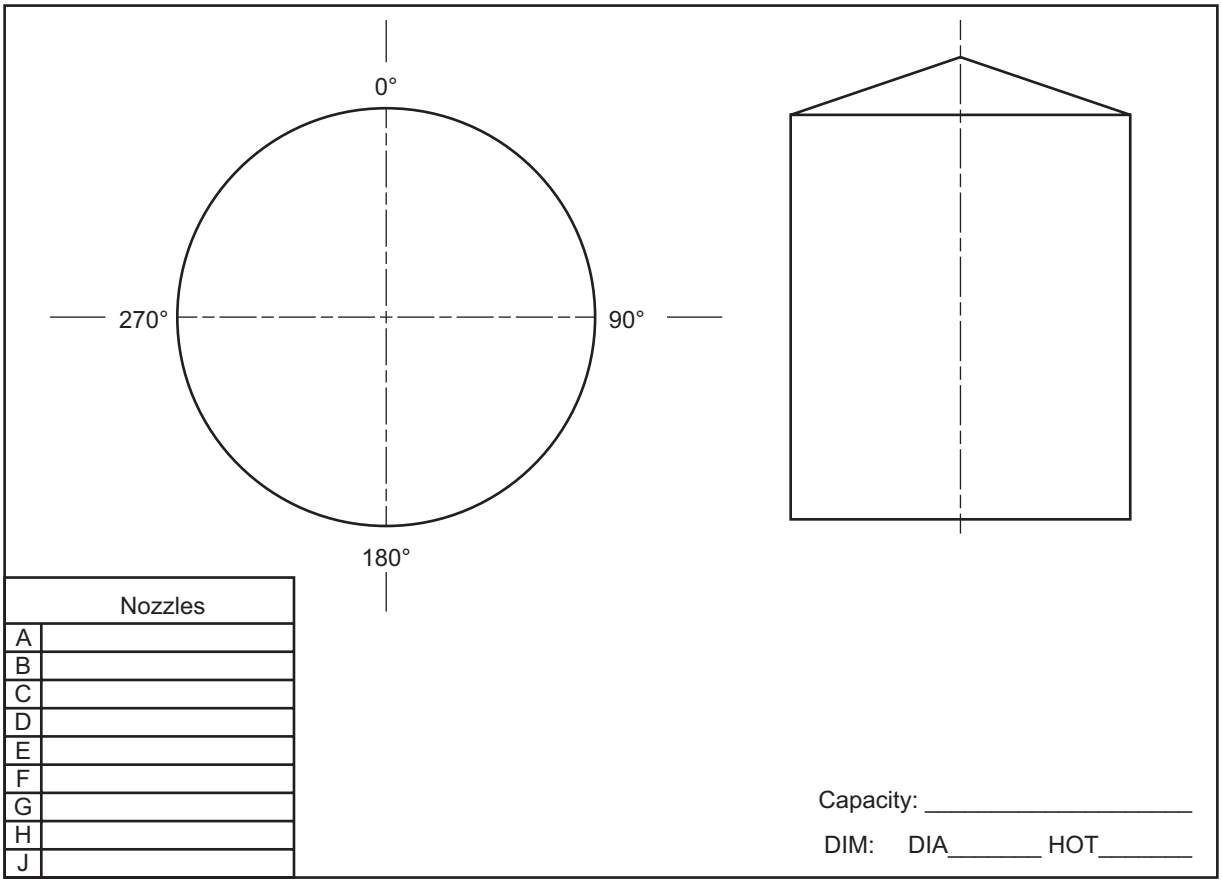
Number of Units Required _____
Capacity _____
Diameter _____ Height _____
Style of Top [ ] Cone [ ] Dome [ ] Flat [ ] Other
Style of Bottom [ ] Flat [ ] Cone [ ] Other
Type of Fluid _____
Specific Gravity _____ Design Vacuum _____
Maximum Operating Pressure _____
Design Pressure _____
Minimum and Maximum Operating Temperature _____
Testing Requirements: Standard [ ] Other _____

Wind Load [ ] No [ ] Yes, Wind Speed_____ mph or [ ] Per ASCE -7/IBC
Seismic Load [ ] No [ ] Yes _____ (Specify spectral acceleration, or per ASCE 7/IBC)
Snow Load [ ] No [ ] Yes _____ (Specify load in PSF, or per ASCE 7/IBC)

Resin Temperature Rating [ ] 150°F [ ] 170°F [ ] 190°F Plus [ ] Other _____
Liner [ ] _____ Mil. C-Veil [ ] _____ Mil. Nexus [ ] Other _____
UV Protection [ ] UV Inhibitor [ ] Pigmenting [ ] Gelcoating
[ ] Painting [ ] Other _____
Tank Color [ ] Natural [ ] Other _____
Fire Retardants [ ] No [ ] Yes
Grounding Ground Rod [ ] No [ ] Yes Type _____
Carbon C-Veil [ ] No [ ] Yes
Other _____
Downcomer Pipe [ ] No [ ] Yes Type _____
Nozzle Location [ ] Per Figure 2 of API 12P or [ ] "Modified" _____
Nozzle Ends [ ] Threaded [ ] Grooved [ ] Flanged [ ] Gusseted Flanges
Manway [ ] 18 in. (45.7 cm) [ ] 20 in. (50.8 cm) [ ] 22 in. (55.9 cm) [ ] 24 in. (61 cm) Quantity
Walkway Brackets [ ] Painted Steel [ ] Galvanized Steel
Lifting Lugs [ ] Painted Steel [ ] Galvanized Steel
[ ] Fiberglass [ ] Stainless Steel
Gauge/Thief Hatch Model
Pressure _____ Vacuum _____
Plastic Trim [ ] No [ ] Yes Type _____
Pipe Support Brackets [ ] No [ ] Yes Quantity _____
Insulation [ ] No [ ] Yes Type _____
Heat Tracing [ ] No [ ] Yes
Ladder [ ] No [ ] Yes [ ] Fiberglass [ ] Painted Steel [ ] Galvanized Steel _____
Caged Ladder (OSHA) [ ] No [ ] Yes [ ] Fiberglass [ ] Painted [ ] Galvanized Steel _____
Tie Down Lugs [ ] No [ ] Yes [ ] Painted Steel [ ] Galvanized [ ] Fiberglass [ ] Stainless Steel _____
Interior Top Seam Laminated [ ] No [ ] Yes *
Striker Plate [ ] No [ ] Yes Specific size _____
Stairway Required [ ] No [ ] Yes [ ] Spiral [ ] Straight [ ] Galvanized [ ] Painted
Length _____ Units _____ Width_____ Units_____
Walkway Required [ ] No [ ] Yes [ ] Galvanized [ ] Painted
Length _____ Units _____ Width_____ Units_____.

Enclosed
Walkway/Stairway/Ladder Drawing [ ] No [ ] Yes
Nozzle Orientation Drawing [ ] No [ ] Yes

*Suggested if tank is to have a gas blanket.



FRP Tank Nozzle Location Guide (Used with Data Sheet)

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