

Specification for Field Welded Tanks for Storage of Production Liquids

API SPECIFICATION 12D
ELEVENTH EDITION, OCTOBER 2008

EFFECTIVE DATE: APRIL 1, 2009



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Upstream Segment

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Specification for Field Welded Tanks for Storage of Production Liquids

1 Scope

1.1 General

This specification covers material, design, fabrication, and testing requirements for vertical, cylindrical, aboveground, closed top, welded steel storage tanks in various standard sizes and capacities for internal pressures approximately atmospheric, not to exceed those listed in Table 1, Column 2.

This specification is designed to provide the oil production industry with tanks of adequate safety and reasonable economy for use in the storage of crude petroleum and other liquids commonly handled and stored by the production segment of the industry. This specification is for the convenience of purchasers and manufacturers in ordering and fabricating tanks.

1.2 Compliance

The manufacturer is responsible for complying with all of the provisions of this specification. The purchaser may make any investigation necessary to be satisfied of this compliance by the manufacturer and may reject any material that does not comply with this specification. It is urged that the purchasers avail themselves of this right and furnish their own inspection independently of any supervisor inspection furnished by the manufacturer, and that the purchaser's inspector follow closely all the details of shop fabrication and/or field construction and testing herein specified which affect the integrity and safety of the completed structure.

2 References

API Specification 5L, *Specification for Line Pipe*

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

ASME B1.1 ¹, *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*

ASME B16.11, *Forged Steel Fittings, Socket-Welding and Threaded*

ASME B18.2.1, *Square and Hex Bolts and Screws (Inch Series)*

ASME B18.2.2, *Square and Hex Nuts (Inch Series)*

ASME Boiler and Pressure Vessel Code: Section IX—*Welding and Brazing Qualifications*

ASTM A36 ², *Standard Specification for Carbon Structural Steel*

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

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

¹ ASME International, 3 Park Avenue, New York, New York 10016, www.asme.org.

² ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

ASTM A283, *Specification for Low and Intermediate Tensile Strength Carbon Steel Plates*

ASTM A285, *Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength*

ASTM A307, *Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength*

ASTM A1011, *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength*

ASTM B454, *Specification for Mechanically Deposited Coatings of Cadmium and Zinc on Ferrous Metals* (Withdrawn 1981)

AWS A5.1 ³, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*

NACE RP 0372 ⁴, *Method for Lining Lease Production Tanks with Coal Tar Epoxy*

NFPA No. 30 ⁵, *Flammable and Combustible Liquids Code*

3 Definitions

3.1

butt weld

A weld placed in a groove between abutting members. Grooves may be square, V (single or double), or U (single or double).

3.2

double-welded butt joint

A joint between two abutting parts lying in approximately the same plane and welded from both sides.

NOTE A joint with filler metal added from one side only is considered equivalent to a double-welded butt joint when means are provided for accomplishing complete penetration and reinforcement on both sides of joint.

3.3

double-welded lap joint

A joint between two overlapping members in which the overlapped edges of both members are welded with fillet welds.

3.4

fillet weld

A weld of approximately triangular cross-section joining two surfaces approximately at right angles to each other, as in a lap joint, tee joint, or corner joint.

3.5

full-fillet weld

A fillet weld whose size is equal to the thickness of the thinner member joined.

3.6

single-welded butt joint with backing

A joint between two abutting parts lying in approximately the same plane and welded from one side only, with a backing strip, bar, or other suitable material.

³ American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126, www.aws.org.

⁴ NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77218-8340, www.nace.org.

⁵ National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169-7471, www.nfpa.org.

3.7**single-welded lap joint**

A joint between two overlapping members, in which the overlapped edge of one member is welded with a fillet weld.

3.8**tack weld**

A weld made to hold parts of a weldment in proper alignment until the final welds are made.

4 Material**4.1 General**

Materials listed in this section have been selected to provide adequate strength and reasonable service life. Other materials having mechanical properties equal to or greater than those listed may be used by agreement between the purchaser and the manufacturer. Where higher strength materials are used, the minimum thickness called for in this specification shall not be reduced.

4.2 Plates

Plates shall conform to the latest edition of one of the following ASTM standards: ASTM A36, ASTM A283 (Grade C or D) and ASTM A285 (Grade C).

Shell plates for which minimum thicknesses have been fixed for practical reasons (greater than required by computation) and which will not under run the required computed thickness by more than 0.01 in., as well as all roof and bottom plates, may be purchased on a weight basis. The plate thicknesses or weights, as stipulated herein, are minimums: thicker or heavier material may be required on the order at the option of the purchaser.

4.3 Sheets

Sheets shall conform to the latest revision of ASTM A1011, Grade C or D, open-hearth process and basic oxygen process. Sheets may be ordered on a weight or thickness basis, at the option of the tank manufacturer.

4.4 Welding Electrodes

Manual arc-welding electrodes shall conform to the E60 and E70 Series of Classification (suitable for the electric current characteristics, the position of welding, and other conditions of intended use) in the latest edition of AWS A5.1.

4.5 Structural Shapes

Structural shapes shall be of open-hearth, electric-furnace, or basic oxygen process and shall conform to the latest edition of ASTM A36.

4.6 Piping

Pipe shall conform to Grade A or B of the latest edition of API 5L, ASTM A53, or ASTM A106.

4.7 Flanges

Hub slip-on welding and welding-neck flanges shall conform to the material requirements for forged carbon steel flanges as specified in ASME B16.5.

4.8 Couplings

Couplings for threaded connections may be supplied with or without recess, complying with the dimensional physical and chemical requirements of the latest edition of API 5L, Grade B. Alternatively, couplings may comply with the latest edition of ASME B16.11.

4.9 Bolting

Tank bolting $\frac{1}{2}$ in. in diameter to and including $1\frac{1}{2}$ in. in length shall conform to the requirements given in Annex A. All other bolting shall conform to the latest revision of ASTM A307, Grade A or B. Unless otherwise specified on the purchase order, black-finish bolts and nuts shall be furnished. When specified to be galvanized, bolts and nuts shall be zinc-coated in accordance with Annex A or the applicable ASTM specification. Alternative materials and/or finish conforming to recognized standards for bolting may be furnished by agreement between the purchaser and the manufacturer.

5 Design

5.1 General

Tanks covered by this specification have been designed using established engineering calculations to determine minimum metal thickness and bolting specifications for each size tank filled with water (62.37 lb/ft^3 at 60°F) and at the internal pressure specified in Table 1, Column 2. In order to assure structural stability and integrity, additional metal thickness has been added to that determined by calculation. The minimum metal thickness specified in this specification shall in no case be decreased.

5.2 Joint Design Definitions

Definitions in Section 3 shall apply to tank-joint designs.

5.3 Size of Weld

The size of a weld shall be based on the following dimensions:

- a) groove weld: the joint penetration (depth of chamfering plus the root penetration when specified);
- b) fillet weld: for equal leg fillet welds, the leg length of the largest isosceles right-triangle which can be inscribed within the fillet-weld cross-section; while for unequal leg fillet welds, the leg lengths of the largest right-triangle which can be inscribed within the fillet-weld cross-section.

5.4 Joint Restrictions

The following restrictions on type and size of joints or welds shall apply.

- a) Tack welds shall not be considered as having any strength value in the finished structure.
- b) The minimum size of fillet welds shall be as follows: plate $\frac{3}{16}$ in. in thickness, full-fillet welds; plates over $\frac{3}{16}$ in. thick, not less than one-third the thickness of the thinner plate at the joint, with a minimum of $\frac{3}{16}$ in. except as otherwise noted.
- c) Single-welded lap joints shall not be permissible on shell plates.

5.5 Size

Tanks under this specification shall be furnished in the sizes and dimensions as stipulated in Table 1 and Figure 1, as specified on the purchase order.

5.6 Bottom Type Design

The tank bottom shall be flat or of the Type A cone design, as specified on the purchase order. Type A cone bottoms shall conform to Figure 2.

Table 1—Tank Dimensions (See Figure 1)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Nominal Capacity bbl	Design Pressure oz/in. ² ^a	Approximate Working Capacity bbl (See Note)	Nominal Outside Diameter ft, in. A	Nominal Height ft, in. B	Height of Overflow-line Connection ^b ft, in. C	Height of Walkway Lugs ft, in. D	Location of Fill-line Connection ^b in. E	Size of Connections in.
	Pressure, Vacuum							
High-500	8, 1/2	479	15, 6	16, 0	15, 6	13, 7	14	4
750	8, 1/2	746	15, 6	24, 0	23, 6	21, 7	14	4
Low-500	6, 1/2	407	21, 6	8, 0	7, 6	5, 7	14	4
High-1,000	6, 1/2	923	21, 6	16, 0	15, 6	13, 7	14	4
1,500	6, 1/2	1,438	21, 6	24, 0	23, 6	21, 7	14	4
Low-1,000	4, 1/2	784	29, 9	8, 0	7, 6	5, 7	14	4
2,000	4, 1/2	1,774	29, 9	16, 0	15, 6	13, 7	14	4
3,000	4, 1/2	2,764	29, 9	24, 0	23, 6	21, 7	14	4
5,000	3, 1/2	4,916	38, 8	24, 0	23, 6	21, 7	14	4
10,000	3, 1/2	9,938	55, 0	24, 0	23, 6	21, 7	14	4
Tolerance	—	—	—	—	± 1/8 in.	± 1/8 in.	± 1/8 in.	—

NOTE The approximate working capacities shown in Column 3 apply to flat-bottom tanks. Type A (unskirted) cone-bottom tanks have 6 in. greater working height than the corresponding flat-bottom tanks. The approximate increase in capacity is 17 bbl for the 15-ft, 6-in. diameter tanks, 32 bbl for the 21-ft, 6-in. diameter tanks, 62 bbl for the 29-ft, 9-in. diameter tanks, 104 bbl for the 38-ft, 8 in. diameter tanks, and 208 bbl for the 55 ft diameter tanks.

^a See 5.17 for frangible deck limitations.

^b *Viscous oil option.* When so specified on the purchase order, tanks shall be furnished for viscous oil service. On such tanks, dimension C of the overflow-line connections shall be 6 in. less than shown in Column 6 above, and dimension E of the fill-line connection shall be 6 in., ± 1/8 in.

5.7 Bottom Thickness Design

The thickness of bottom plates shall be 1/4 in. (10.20 lb/ft²) nominal, except the sump of the Type A cone bottom which shall be 3/8 in. (15.30 lb/ft²) nominal.

5.8 Bottom Joints

Bottom joints shall be double-welded butt joints, single-welded butt joints with backing, or single-welded full-fillet lap joints with a 1 1/4 in. minimum lap when tack welded.

Butt welds shall have complete penetration.

5.9 Shell Attachments

The tank bottom shall be attached to the tank shell by full-fillet welds, both inside and outside.

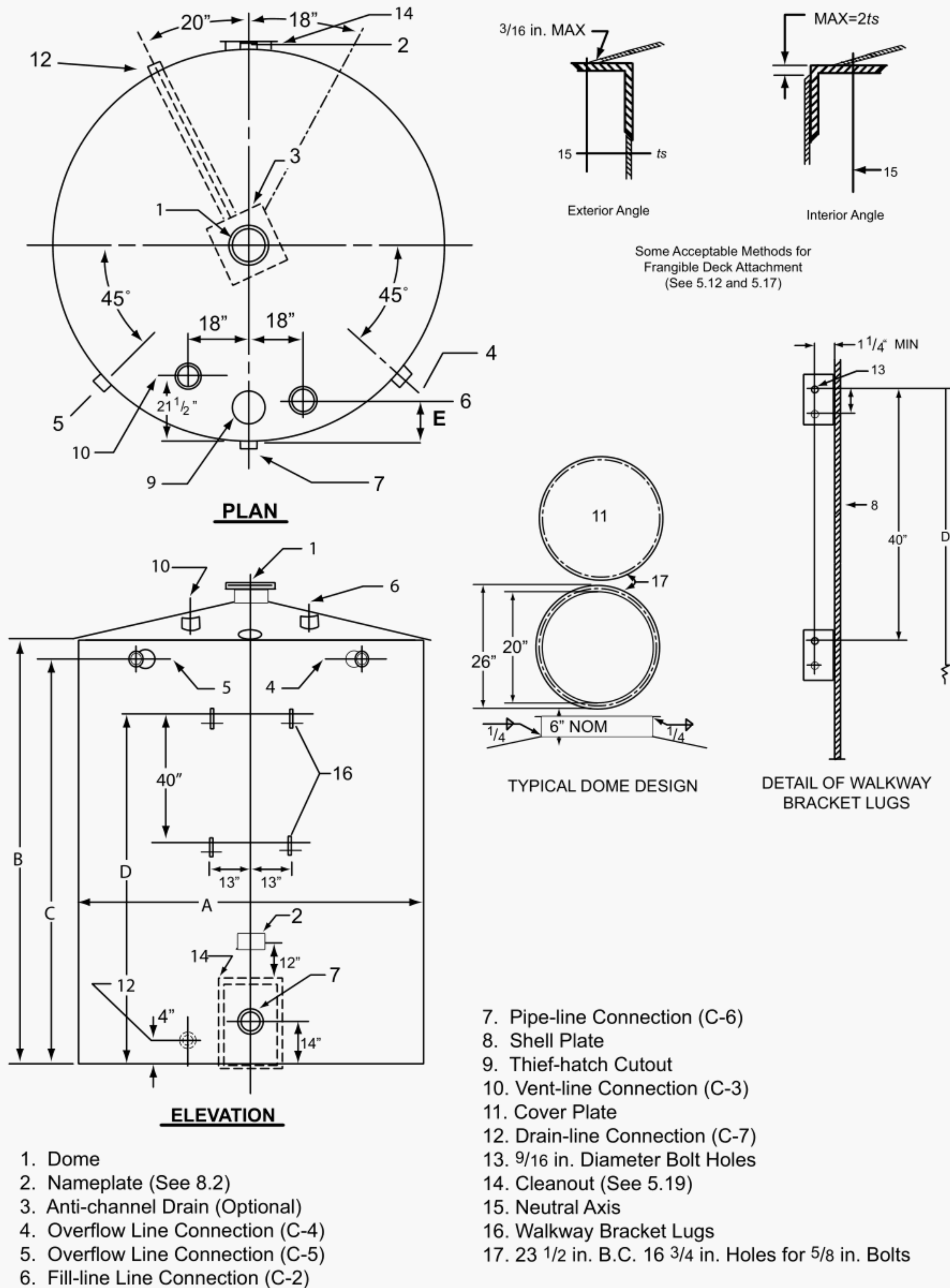


Figure 1—Tank Dimensions

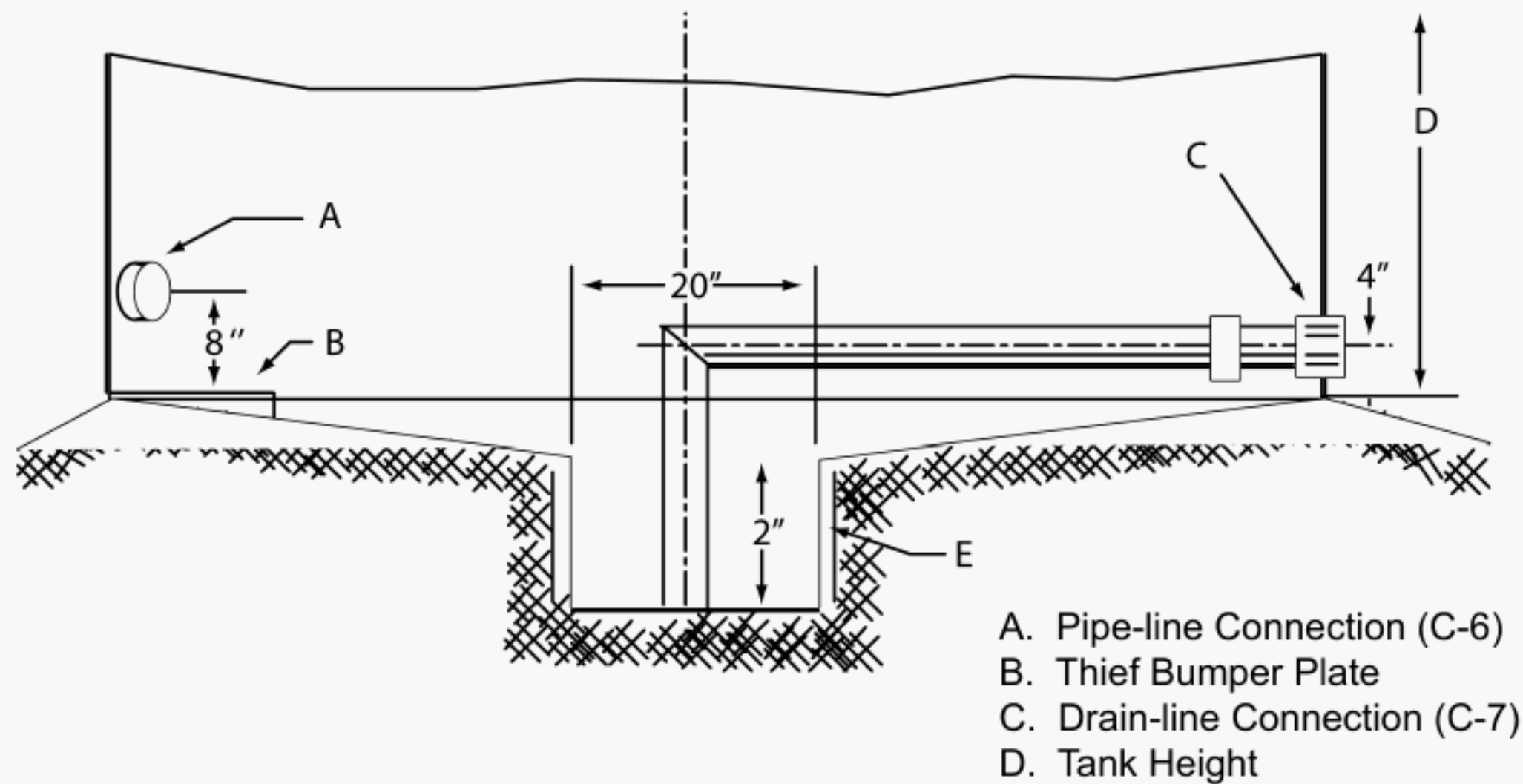


Figure 2—Type A (Unskirted) Cone Bottom

5.10 Shell Thickness Design

The thickness of shell plates shall be either $\frac{3}{16}$ in. (7.65 lb/ft²) nominal, or $\frac{1}{4}$ in. (10.20 lb/ft²) nominal, as specified on the purchase order. The thickness of the first 8 ft 0 in. of shell plates for 10,000 bbl tanks shall be not less than $\frac{1}{4}$ in. nominal (10.20 lb/ft²). The width of shell plates shall be determined by the manufacturer, but preferably should be not less than 60 in.

5.11 Shell Joints

Shell-plate joints shall be double-welded butt joints with complete penetration.

5.12 Compression Ring

The shell shall be fitted with a top angle having minimum dimensions of 2 $\frac{1}{2}$ in. \times 2 $\frac{1}{2}$ in. \times $\frac{1}{4}$ in. The angle may project either inside or outside, and may be attached either by full-fillet welds on both sides where the angle abuts the shell, or by a full penetration butt weld between the top shell plate and the top angle.

5.13 Deck Type Design

The deck shall be of the cone type, with a slope of 1 inch in 12 inches, and shall be furnished with a center dome and center deck support.

- a) For decks 15 ft, 6 in. in diameter, added structural supports in the form of rafters shall be provided if the thickness of the deck is less than $\frac{1}{4}$ in. nominal.
- b) For decks larger than 15 ft, 6 in. in diameter, added structural supports in the form of rafters shall be provided.

5.14 Deck Thickness Design

The thickness of deck plates shall be either $\frac{3}{16}$ in. (7.65 lb/ft²) nominal, or $\frac{1}{4}$ in. (10.20 lb/ft²) nominal, as specified on the purchase order, except the thickness of the dome components shall be at least 6 $\frac{1}{4}$ in.

5.15 Deck Joints

Deck joints shall be double-welded butt joints, single-welded butt joints with backing or single-welded, full-fillet lap joints with a 1 1/4 in. minimum lap as tack welded. Butt joints shall have complete penetration.

5.16 Shell Attachment

The tank deck shall be attached to the tank shell by full fillet welds, both inside and outside, except as provided in 5.17.

5.17 Shell Attachment for Frangible Decks

When so specified by the purchaser, the tank may be provided with a frangible deck, in which case the design pressure shall not exceed the weight of the deck, including rafters if external. The deck shall be attached to the compression ring by a single-fillet weld not to exceed 3/16 in. and applied to the top side only. Internal rafters, if used, shall not be welded to the deck.

5.18 Deck Support

Deck supports shall be designed to support a live load of 20 lb/ft², in addition to the dead load. Allowable design stresses shall be as follows:

Rolled Structural Shapes:

Tension, psi, max	20,000
Bending, psi, max	20,000
Compression, psi, max	$\frac{20,000}{1 + L^2/20,000r^2}$
L/r ratio, max	200

Formed Sections:

Basic design stress, psi, max	18,000
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Column footings:

Soil-bearing load, psf, max	4,000 (Based on maximum water load plus super-imposed roof load)
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NOTE Formed sections shall be fabricated from sheet or strip not less than 3/16 in. in thickness.

5.19 Cleanout

Tanks shall be furnished with an extended-neck cleanout having a minimum opening of 24-in. × 36-in. The thickness and shape of the neck shall be designed to completely reinforce the shell course, or additional external compensation shall be added. The bottom of the cleanout shall be flush with the bottom of the tank. Cover plates may be one-piece or two-piece, as specified on the purchase order. When specified on the purchase order, handles for lifting the cleanout cover plate(s) shall be furnished.

5.20 Connections

Tanks shall be provided with inlet and outlet connections as shown in Table 1 and Figure 1. Unless otherwise specified by the purchaser, connections shall be full couplings, and shall be attached to the tank member by full-fillet welds on both inside and outside surfaces, with equal projections inside and outside the tank, except that half-coupling may be used for connections C-4, C-5, and C-6, at the option of the manufacturer. Additional or fewer

connections of other sizes or locations may be provided, if so agreed upon between the purchaser and the manufacturer. When flanged or other types of connections are specified, the nozzle neck shall be a minimum of standard weight pipe and attached by full fillet welds both inside and outside. The bolting pattern for thief hatches shall conform to one of those shown in Figure 3. Thief hatches, when used, should be 8-in. × 22-in. obround for pressures up to and including 4 oz and 8-in. round for pressures greater than 4 oz. The purchaser shall provide full details of external piping loads or vibration excepted to be imposed on connections in the liquid section of the shell. The manufacturer shall provide additional reinforcement of these openings where required.

5.21 Dome

The dome shall be fabricated from $\frac{1}{4}$ in. material and shall be installed as shown in Figure 1. The cover shall be provided with an oil resistant gasket of $\frac{3}{16}$ in. minimum thickness.

5.22 Center Support

All tanks shall be provided with either a structural-type or a pole type center support, suitably attached to the rafter structure and to a bearing plate seal welded to the bottom. Where cone bottoms are furnished the center support shall not interfere with the function of the sump.

5.23 Anti-channel Drain Baffle

An anti-channel drain baffle conforming to the following requirements shall be furnished, if so specified on the purchase order.

- a) The periphery of the baffle, in plan view, shall be 64 in.
- b) The height of the baffle from the inside surface of the tank bottom to the top of the baffle shall be 5 $\frac{1}{4}$ in. minimum.
- c) The baffle shall be equipped with the spacers so that the bottom edge of the baffle is 1 in. above the tank bottom.
- d) A drain line shall be provided from the baffle to the tank shell. The line size shall be 4 in. nominal.
- e) The baffle shall be attached to the tank bottom by a J-bolt passing through an eye retainer welded to the tank bottom, and by the line connection to the tank shell. The baffle shall not be welded to the tank bottom.

5.24 Downcomer Pipe

A downcomer pipe shall be installed, if requested by the purchaser: design of downcomer to be agreed between purchaser and manufacturer.

6 Venting Requirements

6.1 Normal Venting

Connection C-3 (see Figure 1) is provided for normal inbreathing and outbreathing due to temperature changes and to liquid movement into and out of the tank. This connection should be fitted with pressure-vacuum valve properly sized in accordance with API 2000. The pressure setting should be from 2 oz/in.² to 4 oz/in.² less than the opening pressure of devices used for emergency venting. Annex B is provided as a guide to aid in the selection of venting devices, where required.

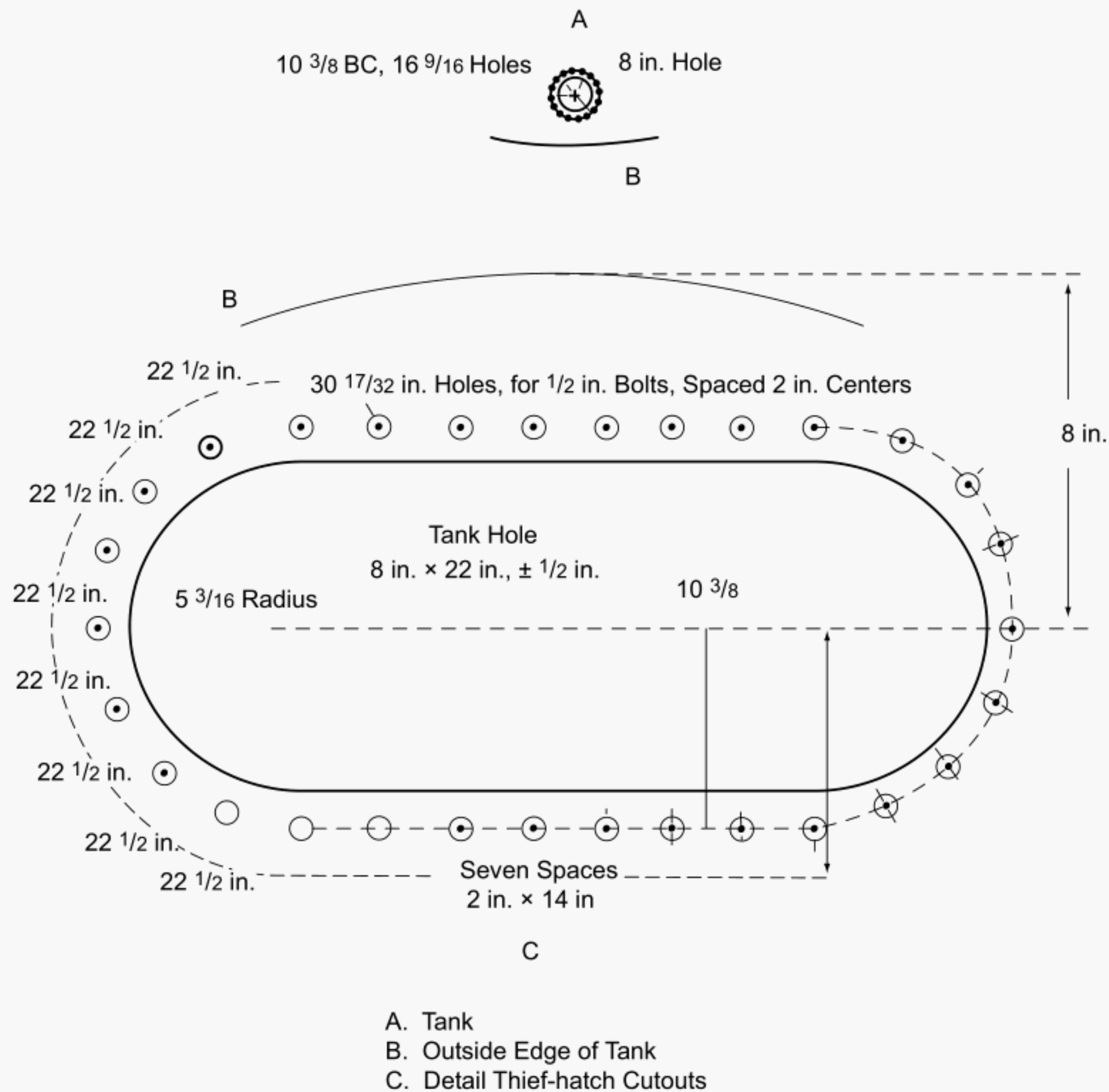


Figure 3—Thief-hatch Cutouts

6.2 Emergency Venting

When storage tanks containing flammable liquids are exposed to fire, the venting rate may be in excess of that resulting from a combination of normal thermal effects and oil movement. Unless tanks are installed in remote locations, the purchaser shall provide, or cause to be provided, pressure relieving devices which will provide capacity in addition to normal venting to meet the requirements tabulated in Table C.1. The opening pressure of such devices shall not exceed the design pressure of the tank on which they are installed. The maximum internal pressure under relieving conditions should not exceed that tabulated in Table C.1, Column 6. Pressure relieving devices may take the form of larger or additional vent valves, larger or additional thief hatches or deck dome covers (see 5.21 and Figure 1) installed with loose fitting long bolts and suitable gasket so that the dome cover will lift at the required pressure.

NOTE 1 Tanks having frangible decks complying with 5.17 need not be fitted with additional pressure relieving devices for emergency venting.

NOTE 2 When installing tanks having frangible decks, no piping should be connected to the deck which would restrict movement of the deck.

NOTE 3 With drainage as used in Table C.1, Column 5 means that flammable or combustible liquids will not be retained near the tank by dykes or firewalls.

7 Fabrication, Testing, and Painting

7.1 Fabrication

Fabrication shall be completed in the field in accordance with the applicable paragraphs of this specification, using the best modern practices. When agreed upon between the purchaser and the manufacturer, tanks may be completely fabricated in the manufacturer's shop prior to delivery to field location.

7.2 Welding

Welding procedures shall be established and welding operators qualified by the manufacturer. Qualification of welders in accordance with the applicable parts of the latest edition of Section IX of the ASME *Boiler and Pressure Vessel Code* is recommended.

7.3 Testing

Bottoms of field erected tanks shall be tested by applying vacuum to the joints, and using soap suds, linseed oil, or other suitable material for the detection of leaks. The completed tank shall be tested by filling with water for a period of not less than 12 hours, and testing the deck either by applying air pressure or by vacuum testing the joints. Test water shall be provided and removed by the purchaser, unless otherwise agreed upon. Alternatively, if so agreed upon between the purchaser and the manufacturer, the tank may be tested with air pressure at 1 1/2 times the design pressure of the tank (see 5.1 and 5.17).

Caution: When testing air, adequate valves, regulators, and pressure relief devices shall be used to prevent overpressure or permanent deformation.

Testing and the repair of any defects shall be completed before connecting any piping to the tank.

NOTE Vacuum testing may be conveniently performed by means of a testing box, 6 in. × 30 in., with a glass window in the top, the open bottom being sealed against the tank surface by a sponge rubber gasket. Suitable connections, valves, and gauges must be provided. About 30 in. of the seam under test should be brushed with a soap-suds solution or linseed oil. In freezing weather, a non-freezing solution may be necessary. Place the vacuum box over the coated section of seam, and apply a vacuum to the box. The gauge should register a partial vacuum of at least 2 lb/in.². Porosity in the seam is indicated by bubbles or foam produced by air sucked through the welded seam. A vacuum can be drawn on the box by any convenient method, such as connection to a gasoline or diesel motor intake manifold, or to an air ejector or special vacuum pump.

7.4 External Painting

After erection, tanks shall be cleaned of rust, grease, scale and weld spatter. Preparation for coating and the application of primer or finish coatings shall be by agreement between the purchaser and the manufacturer.

7.5 Internal Coating

Where internal coating is required, procedures and methods outlined in NACE RP 0372 are recommended, as a minimum requirement. Other coatings and methods may be used by agreement between purchaser and manufacturer.

7.6 Cleaning Up

Upon completion of erection, the manufacturer or erector shall remove or dispose of all rubbish and other unsightly material caused by erecting operations and shall leave the premise in as good condition, as found.

8 Marking

Tanks manufactured in conformance with this specification shall be identified by a nameplate bearing the information shown in Figure 4.

Manufactured in Accordance with API Specification 12D	
Manufacturer	_____
Serial Number	_____
Year Built	_____
Nominal Diameter	_____
Nominal Height	_____
Bottom Thickness	_____ Type _____
Shell Thickness	_____
Deck Thickness	_____
Design Pressure	_____ oz
Nominal Capacity	_____ bbl
Erected by	_____

Figure 4—Nameplate Format

The nameplate shall be stamped, etched or embossed on corrosion-resistant material and permanently attached to a bracket plate of ferrous material. Alternatively, nameplate information may be die stamped on a steel plate. The bracket, backing plate or nameplate shall be seal-welded to the tank shell in the location shown in Figure 1.

9 Inspection and Rejection

9.1 Inspection Notice

Where the inspector representing the purchaser desires to inspect tanks purchased or witness any specified tests, reasonable notice shall be given of the time at which such inspection should be made.

9.2 Inspection by Purchaser

The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which will concern the manufacture of the material ordered. The manufacturer shall afford, without charge, all reasonable facilities to satisfy the inspector that the material is being manufactured in accordance with this specification. All inspections should be made at the place of manufacture prior to shipment, unless otherwise specified on the purchase order; and shall be so conducted as not to interfere unnecessarily with the manufacturer's operations.

9.3 Rejection

Material which shows injurious defects on initial inspection or subsequent to acceptance at manufacturer's works, or which proves defective when properly applied in service, may be rejected, and the manufacturer so notified. If tests that require the destruction of material are made at other than the place of manufacture, the purchaser shall pay for material complying with all of the provisions of this specification, but shall not pay for any material which fails to meet the specifications.

9.4 Compliance

The manufacturer shall be responsible for complying with all provisions of this specification. The purchaser may make any investigation necessary to be assured of compliance by the manufacturer and may reject any material that does not comply with this specification.

Annex A (normative)

Specification for Tank Bolting

A.1 Scope

This annex covers tank bolting $\frac{1}{2}$ in. in diameter to and including $1\frac{1}{2}$ in. in length. Bolts and nuts shall be either black-finish or galvanized as specified on the purchase order.

A.2 Physical Properties

The breaking load of the bolts, tested in full size, shall not be less than 11,350 lb.

NOTE The breaking load of 11,350 lb is equivalent to a tensile strength of 80,000 lb/in.² based on the stress area (mean thread area) or approximately 91,000 lb/in.² based on the root thread area.

A.3 Tension Test

Tension tests of bolts shall be taken on the finished bolt with the load applied between the head and a nut or suitable fixture, either of which will have sufficient thread engagement to develop the full strength of the bolt. The nut or fixture shall be assembled on the bolt leaving at least three full bolt threads exposed within the grip. If failure occurs by threads stripping before reaching the minimum required tensile load, the individual test shall be discarded.

A.4 Stripping Test

The nuts for bolts shall be capable of developing the load specified in A.2 without stripping.

A.5 Head Test

During the tension test specified in A.3, failure shall occur in the threaded section and not at the junction of the head and shank.

A.6 Number of Tests

The requirements of these specifications are those met in continuous production for stock during which the manufacturer has made such sample inspections as to insure normally that the material is controlled within the specified limits. For this reason, additional tests by the manufacturer of the individual shipments of material are not contemplated. If specified on order, one tension test shall be made from each lot. A lot shall consist of 5,000 pieces or fraction thereof.

A.7 Retests

Should the sample from the lot fail to meet the requirements of a specified test, two additional samples shall be tested; in which case, both samples shall meet the test.

A.8 Thread Requirements

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. Bolts to be galvanized shall have Class 2A threads before hot dip or mechanical galvanizing. After galvanizing, the maximum limit of pitch and major diameter may exceed the Class 2A limit by 0.021 in.

A.9 Bolt Requirements

Bolts shall be regular square, unless otherwise agreed upon between the purchaser and the manufacturer, in which case they may be regular hex. All bolts shall comply with the applicable section of the latest edition of ASME B18.2.1, *Square and Hex Bolts and Screws (Inch Series)*.

A.10 Nut Requirements

Nuts shall be regular square, unless otherwise agreed upon between the purchaser and the manufacturer, in which case they may be regular hex. All nuts shall comply with the applicable section of the latest edition of ASME B18.2.2, *Square and Hex Nuts (Inch Series)*.

A.11 Galvanizing

Unless otherwise specified, galvanized bolts and nuts shall be hot-dip galvanized in accordance with the requirements of ASTM A153. The weight of coating shall be that specified for Class C materials in ASTM A153 and the nuts shall be tapped after galvanizing. When specified by the purchaser to be mechanically galvanized, bolts and nuts shall be mechanically zinc-coated, and the coating shall conform to the requirements for Class 50 of the ASTM B454 or to the coating thickness, adherence, and quality requirements for Class C of ASTM A153. Mechanically zinc-coated nuts for assembly with mechanically zinc-coated bolts shall be tapped oversize prior to coating and need not be retapped afterwards.

A.12 Marking

Bolt heads shall be marked (by raised or depressed mark at the option of the manufacturer) to identify the manufacturer. The manufacturer may use additional marking for internal use.

Annex B (informative)

Recommended Practice for Normal Venting

Table B-1—Venting Capacity Requirements (See 6.1)

(1)	(2)		(3)	(4)	(5)	(6)	(7)
Nominal Tank Capacity bbl	Tank Size		Design Pressure ^a oz/in. ²	Surface Area ft ²	Thermal Venting SCFH		
			Pressure, Vacuum		Vacuum (Inbreathing) All Stocks	Pressure (Outbreathing)	
	Diameter ft, in.	Height ft				Flash Point 100°F or Above	Flash Point Below 100°F
High-500	15, 6	16	8, 1/2	780	500	300	500
750	15, 6	24	8, 1/2	1,170	750	450	750
Low-500	21, 6	8	6, 1/2	540	500	300	500
High-1,000	21, 6	16	6, 1/2	1,080	1,000	600	1,000
1,500	21, 6	24	6, 1/2	1,620	1,500	450	1,500
Low-1,000	29, 9	8	4, 1/2	750	1,000	600	1,000
2,000	29, 9	16	4, 1/2	1,500	2,000	1,200	2,000
3,000	29, 9	24	4, 1/2	2,250	3,000	1,800	3,000
5,000	38, 8	24	3, 1/2	2,840	5,000	3,000	5,000
10,000	55, 0	24	3, 1/2	4,170	10,000	6,000	10,000

NOTE 1 Filling and emptying venting.

— *Outbreathing at maximum filling rate:* For flash points less than 100°F, provide 1,200 standard cubic feet per hour (SCFH) for each 100 bbl/hr. For flash points of 100°F or more, provide 600 SCFH for each 100 bbl/hr.

— *Inbreathing at maximum emptying rate:* For all liquids, provide 600 SCFH for each 100 bbl/hr.

NOTE 2 The values calculated for filling and emptying venting requirements shall be added to the appropriate thermal venting requirements.

^a See 5.17 for frangible deck limitations.

Annex C (informative)

Recommended Relieving Capacities

Table C.1—Emergency Venting Requirements (See 6.2)

(1)	(2)	(3)	(4)	(5)		(6)
Nominal Capacity bbl	Diameter × Height ft, in.	Design Pressure ^a oz/in. ²	Exposed Area ft ²	Emergency Venting Required SCFH		Max. Press. During Emergency Venting oz
		Pressure, Vacuum		With Drainage ^b	Without Drainage	
High-500	15, 6 × 16, 0	8, 1/2	780	227,600	455,200	12
750	15, 6 × 24, 0	8, 1/2	1,170	271,800	543,600	12
Low-500	21, 6 × 8, 0	6, 1/2	543	184,600	369,200	9
1,000	21, 6 × 16, 0	6, 1/2	1,090	267,200	534,400	9
1,500	21, 6 × 24, 0	6, 1/2	1,630	308,380	617,760	9
Low-1,000	29, 9 × 8, 0	4, 1/2	750	222,500	445,000	6
2,000	29, 9 × 16, 0	4, 1/2	1,500	300,250	600,500	6
3,000	29, 9 × 24, 0	4, 1/2	2,260	344,650	689,300	6
5,000	38, 8 × 24, 0	3, 1/2	2,840	371,000	742,000	4 1/2
1,000	55, 0 × 24, 0	3, 1/2	4,170	371,000	742,000	4 1/2
NOTE Normal vents (see 6.1 and Annex B) may satisfy all or part of these requirements.						
^a See 5.17 for frangible deck limitations						
^b In applying recommended emergency venting required <i>with drainage</i> careful attention should be given to the provisions of 2.3.2 and 2.5.7, NFPA No. 30.						

Table C.2—Calculated Venting Capacity of Thief Hatches

(1)	(2)	(3)	(4)
8 in. Round Hatch $A = 44 \text{ in.}^2$		8 in. × 22 in. Obround Hatch $A = 154 \text{ in.}^2$	
Tank Pressure, oz	Venting Capacity SCFH Q	Tank Pressure oz	Venting Capacity SCFH Q
1.5	59,783	1.5	206,892
3.0	84,547	3.0	292,590
4.5	103,548	4.5	358,348
6.0	119,567	6.0	413,785
12.0	169,094	Not Applicable	Not Applicable

NOTE Values in the above table are based on the following equation:

$$Q = 1667 C_f A \sqrt{P_t - P_a} \quad (\text{C.1})$$

where

Q is the venting capacity in standard cubic feet of free air per hour (SCFH);

C_f is 0.5 (the flow coefficient);

A hatch area, in.²;

P_t absolute pressure inside the tank in inches of water;

P_a absolute pressure outside the tank in inches of water.

Annex D **(normative)**

Walkways, Stairways and Ladders

D.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. All material shall comply with the applicable parts of Section 4.

D.2 Access

It should be noted that walkways, platforms and stairways or ladders are intended to provide access to devices on or near the deck within easy reach from the ladder or platform, and not for employee egress onto the deck itself. Where individuals are required to have access to the deck, suitable guard railings should be installed to prevent their falling.

D.3 Walkways

Walkway shall consist of tread (decking) sections, railing assemblies, and toeboards designed and assembled so that the completed structure will support a uniform load of 50 lb/ft², or a concentrated load of 1,000 lb at any place on the span without deflecting more than $\frac{1}{360}$ of the unsupported span length. The maximum span between tank brackets or ground supports shall be 25 ft. Where intermediate supports are required, the vertical members shall terminate at the top rail. The base for ground supports shall be of concrete or other suitable permanent foundation.

D.4 Treadway

Treadway shall be a minimum of 26 in. wide. Tread shall be uniformly perforated from the bottom with shaped punches to form a non-skid surface. Optionally, at the request of the purchaser, the deck of treadway sections may be fabricated from structural expanded metal or grating to avoid the build-up of snow or ice.

D.5 Railings

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

D.6 Toeboards

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

D.7 Midrail

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

D.8 Brackets

Each tank shall be equipped with two bracket assemblies, securely bolted to the lugs specified in Figure 1. The brackets shall be installed to provide a 26-in. wide access to the tank at the point of attachment.

D.9 Stairways

Stairways, when required for access to walkway sections, shall be designed for field erection, and shall be capable of supporting a minimum of 100 lb per linear ft of tread width, or a concentrated load of 1,000 lb at any point on the stairway without deflecting more than $\frac{1}{360}$ of the unsupported stairway length. Stairway width shall be a minimum of 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 8 $\frac{1}{2}$ in. with a nominal tread width of not less than 8 in. Other uniform rise and tread combinations which will produce a stairway within angles to the horizontal between 30 and 50 degrees shall be acceptable, so long as 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.

D.10 Railings

Railings shall be installed on both sides of stairways, and shall be designed so that the completed assembly will withstand a minimum of 200 lb force in any direction applied at any point on the top rail. Top rails shall be installed so that the top rail is not less than 30 in. nor more than 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.

The juncture of the top rail of the stair railing shall make a smooth transition with the top rail of the walkway railing, preferably through the use of a structural gusset member.

D.11 Spiral Stairways

Spiral stairways, attached to brackets or welded securely to the shell 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. The run of the stair tread will depend on the radius of the exterior arc, and the minimum effective tread shall be 7 in., measured 13 in. from the exterior arc. Spiral stairways are not recommended for installation on tanks less than 15 ft, 6 in. in diameter.

D.12 Ladders

Fixed industrial ladders may be used in lieu of stairways. The use of a platform is optional with the purchaser, but when used, the platform shall have minimum dimensions of 26 in. \times 30 in. with standard railings except at the entrance from the ladder.

Ladders, when used, shall be substantially anchored with the center of the rung at least 7 in. from the surface of the tank or other obstruction.

Rungs shall be a minimum of $\frac{3}{4}$ in. diameter spaced a maximum of 12 in. C-C (center to center), with a minimum clear length of 16 in., and designed to support a minimum load of 200 lb.

Open ladders may be used to climb a maximum of 20 ft, and caged ladders or acceptable safety slide devices should be used when the climbing height is between 20 ft and 30 ft.

Annex E

(informative)

Suggestions for Ordering Field Welded Tanks

In placing orders for tanks to be manufactured in accordance with the stipulations of API 12D, purchasers should specify the following on their purchase order:

Specification	API 12D
Number of Tanks	
Nominal Capacity	Table 1, Column 1
Size	5.5
Outside diameter	Table 1, Column 4
Height of shell	Table 1, Column 5
Type of bottom	5.6
Shell plate thickness	5.10
Deck plate thickness	5.14
Delivery date and shipping instructions	
Inspection by purchaser	9.2

The purchaser should also state on the purchase order his/her requirements concerning the following stipulations, which are optional with the purchaser:

Bolting	4.9
Viscous oil option	Table 1, Footnote b
Cleanout cover-plate design	5.19
Anti-channel drain baffle	5.23
Downcomer pipe and design	5.24
Walkways, stairways and ladders	Annex D

Attention is called to the following stipulations, which are subject to agreement between the purchaser and the manufacturer:

Additional connections	5.20
Finish coats of paint	7.4
Alternative bolting requirements and/or finish	4.9
Materials	4
Internal coating	7.5

Annex F (informative)

Use of the API Monogram by Licensees

F.1 Scope

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements. The use of the Monogram on products constitutes a representation and warranty by the Licensee to purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification.

When used in conjunction with the requirements of the API License Agreement, API Q1, in its entirety, defines the requirements for those organizations who wish to voluntarily obtain an API License to provide API monogrammed products in accordance with an API product specification.

API Monogram Program Licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Q1 in total, and the requirements of an API product specification. Customers/users are requested to report to API all problems with API monogrammed products. The effectiveness of the API Monogram Program can be strengthened by customers/users reporting problems encountered with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at <https://ncr.api.org>. API solicits information on new product that is 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.

This annex sets forth the API Monogram Program requirements necessary for a supplier to consistently produce products in accordance with API specified requirements. For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, D.C. 20005 or call 202-962-4791 or by email at certification@api.org.

F.2 References

In addition to the referenced standards listed in Section 2 of this document, this annex references the following standard:

API Specification Q1

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

F.3 API Monogram Program: Licensee Responsibilities

F.3.1 For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

- a) the quality management system requirements of API Q1;
- b) the API Monogram Program requirements of API Q1, Annex A;

- c) the requirements contained in the API product specification(s) for which the organization desires to be licensed; and
- d) the requirements contained in the API Monogram Program License Agreement.

F.3.2 When an API-Licensed organization is providing an API monogrammed product, conformance with API specified requirements, described in API Q1, including Annex A, is required.

F.3.3 Each Licensee shall control the application of the API Monogram in accordance with the following.

- a) Each Licensee shall develop and maintain an API Monogram Marking Procedure that documents the marking/monogramming requirements specified by the API product specification to be used for application of the API Monogram by the Licensee. The marking procedure shall define the location(s) where the Licensee shall apply the API Monogram and require that the Licensee's License number and date of manufacture be marked on monogrammed products in conjunction with the API Monogram. At a minimum, the date of manufacture shall be two digits representing the month and two digits representing the year (e.g. 05-07 for May 2007) unless otherwise stipulated in the applicable API product specification. Where there are no API product specification marking requirements, the Licensee shall define the location(s) where this information is applied.
- b) 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 nonconforming with API specified requirements. Products that do not conform to API specified requirements shall not bear the API Monogram.
- c) Only an API Licensee may apply the API Monogram and its License to API monogramable products. For certain manufacturing processes or types of products, alternative Monogram marking procedures may be acceptable. The current API requirements for Monogram marking are detailed in the API Policy Document, *Monogram Marking Requirements*, available on the API Monogram Program website at <http://www.api.org/certifications/monogram/>.
- d) The API Monogram shall be applied at the licensed facility.
- e) The authority responsible for applying and removing the API Monogram shall be defined in the Licensee's API *Monogram Marking Procedure*.

F.3.4 Records required by API product specifications shall be retained for a minimum of five years or for the period of time specified within the product specification if greater than five years. Records specified to demonstrate achievement of the effective operation of the quality system shall be maintained for a minimum of five years.

F.3.5 Any proposed change to the Licensee's quality program to a degree requiring changes to the quality manual shall be submitted to API for acceptance prior to incorporation into the Licensee's quality program.

F.3.6 Licensee shall not use the API Monogram on letterheads or in any advertising (including company-sponsored web sites) without an express statement of fact describing the scope of Licensee's authorization (License number). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

F.4 Marking Requirements for Products

These marking requirements apply only to those API Licensees wishing to mark their products with the API Monogram.

F.4.1 Manufacturers shall mark equipment on the nameplate with the information identified in Section 8 of this specification, as a minimum, including "API Spec 12D."

F.4.2 As a minimum, equipment should be marked with English (Imperial) units.

F.4.3 Nameplates shall be made of a corrosion-resistant material and shall be located as indicated in the marking section of this specification. If the location is not identified, then F.3.3 a) of this annex shall apply.

F.4.4 Nameplates may be attached at the point of manufacture or, at the option of the manufacturer, at the time of field erection.

F.4.5 The API Monogram shall be marked on the nameplate, in addition to the marking requirements of this specification. The API Monogram License number shall not be used unless it is marked in conjunction with the API Monogram.

F.5 API Monogram Program: API Responsibilities

F.5.1 The API shall maintain records of reported problems encountered with API monogrammed products. Documented cases of nonconformity with API specified requirements may be reason for an audit of the Licensee involved, (also known as audit for "cause").

F.5.2 Documented cases of specification deficiencies shall be reported, without reference to Licensees, customers or users, to API Subcommittee 18 (Quality) and to the applicable API Standards Subcommittee for corrective actions.



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