Specification for Bolted Tanks for Storage of Production Liquids

API SPECIFICATION 12B
FOURTEENTH EDITION, FEBRUARY 1, 1995

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

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FOREWORD

This specification is under the jurisdiction of the API committee on Standardization of Production Equipment.

This specification is based on the accumulated knowledge and experience of purchasers and manufacturers of bolted steel storage tanks of various sizes and capacities for internal pressures approaching atmospheric. The object of this publication is to provide a purchase specification to facilitate the manufacture and procurement of storage tanks for production service, such as storage of crude oil, condensate, hydrocarbon products and nonpotable water. If tanks are purchased in accordance with these specifications, the purchase is expected to specify certain basic requirements.

This standard shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

Specification for Bolted Tanks for Storage of Production Liquids

1 Scope

This specification covers material, design, fabrication, and testing requirements for vertical, cylindrical, aboveground, closed and open top, bolted steel storage tanks in various standard sizes and capacities for internal pressures approximately atmospheric, not to exceed those listed in Column 2, Table 3.1.

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.

2 Material

2.1 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 these listed may be used by agreement between the purchaser and the manufacturer. Where higher strength materials are used, the minimum thicknesses called for in this specification shall not be reduced.

2.2 PLATES

Plates shall conform to the latest edition of the following ASTM Standards*:

A 36P: *Structural Steel*

A 283: *Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality*, grade C only.

2.3 SHEETS

Sheets shall be commercial quality having a minimum tensile strength of 52,000 psi. Sheets may be ordered on a weight or thickness basis, at the option of the tank manufacturer.

2.4 STRUCTURAL SHAPES

Structural shapes shall be open-hearth, electric-furnace or basic oxygen process and shall conform to the latest edition of ASTM A 36.

2.5 PIPING

Pipe shall conform to Grade A or B of the latest edition of API Specification 5L; ASTM A 53 or ASTM A 106.

2.6 FLANGES

Flanges shall be steel, conforming to one of the following ASTM Specifications: A-216 for Cast Steel, or A-181 or A-105 for Forged Steel.

2.7 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 ANSI†B16.11: *Forged Steel Fittings, Socket-Welding and Threaded.*

2.8 FINISH

"Tanks shall be furnished with mill finish, painted, galvanized, or with factory applied coating for corrosion control, as specified on the purchase order." When galvanizing is specified on the purchase order, the galvanized coating on all tank plates, sheets, and structural shapes shall be applied after shop fabrication and shall conform to ASTM A 123, except that, at the option of the manufacturer, written assurance may be furnished to the purchaser as to compliance, in lieu of actual test reports.

2.9 BOLTING

Tank bolting ½ in. in diameter to and including 1½ in. in length shall conform to the requirements as given in Appendix A. All other bolting shall conform to the latest revision of ASTM A 307 Grade A and shall have dimensions conforming to ANSI regular square or regular hex.

3 Design

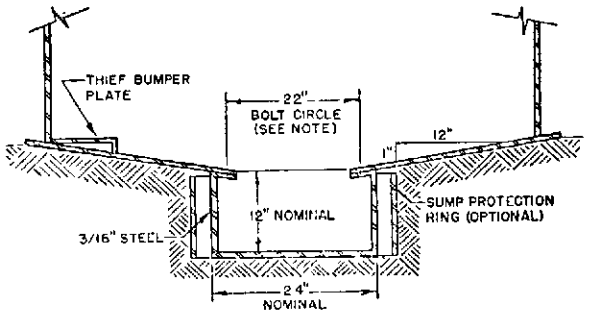
3.1 GENERAL

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/cu ft at 60 F) and at the internal pressure specified in column 2. Table 3.1. 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.

3.2 SIZE

Tanks shall conform to the sizes and dimensions shown in Table 3.1 as specified on the purchase order



NOTE: *30 holes $\frac{3}{4}$ in. diameter required for all sizes, except 21 ft 6½ in. diameter tanks which require 28 holes $\frac{3}{4}$ in. diameter.*

Figure 3.1—Cone Bottoms (See Par. 3.3b)

3.3 Tank bottoms shall conform to one of the following requirements as specified on the purchase order:

a. Flat Bottoms. Flat bottoms shall conform to the requirements of Table 3.2 and Fig. 3.2 and 3.3 for the particular size tank ordered. Bottom segments shall be supplied with a ¼ in. identification hole as shown in Fig. 3.2 and 3.3.

b. Cone Bottoms. Cone bottoms for tank sizes 29 ft 8⅝ in. in diameter and smaller shall conform to the requirements of Fig. 3.1. Cone bottom segments shall have the same dimensions as deck segments, Fig. 3.5, but without flange, for the particular size tank ordered, except the flanged deck dome shall not be furnished. When a cone bottom is furnished, the inside center support shall be either extended to the sump bottom or the sump opening shall be adequately bridged and the center support securely attached to such bridge.

c. By agreement between purchaser and manufacturer, a bottom design alternative to those specified in Par. 3.3a and 3.3b may be furnished, providing such alternative design possesses equivalent strength, tightness, and utility.

3.4 STAVES

Tank staves shall conform to the requirements of Table 3.2 and Fig. 3.4 for the particular size of tank ordered.

Note: When open-top tanks are supplied under this specification, a top reinforcing member shall be provided. The minimum section modulus of this member shall conform to the following formula:

$$S = 0.0001\ HD^2$$

wherein:

S = section modulus, in inches cubed.

Table 3.1—Sizes and General Dimensions

(1)	(2)	(3)	(4)		(5)		(6)
Nominal Capacity 42-gal bbl	Pressure Design oz. per sq. in. Press. Vac.	Number of Rings	Inside Diameter,[1] ft.	in.	Height of Shell[2] ft.	in.	Calculated Capacity,[3] 42-gal bbl
100	3 ½	1	9	2¾	8	0½	96
200	3 ½	2	9	2¾	16	1	192
300	3 ½	3	9	2¾	24	1½	287
250	3 ½	1	15	4⅝	8	0½	266
High 500	3 ½	2	15	4⅝	16	1	533
750	3 ½	3	15	4⅝	24	1½	799
Low 500	2 ½	1	21	6½	8	0½	522
High 1,000	2 ½	2	21	6½	16	1	1,044
1,500	2 ½	3	21	6½	24	1½	1,566
Low 1,000	2 ½	1	29	8⅝	8	0½	994
2,000	2 ½	2	29	8⅝	16	1	1,987
3,000	2 ½	3	29	8⅝	24	1½	2,981
5,000	1 ½	3	38	7⅝	24	1½	5,037
10,000	1 ½	3	54	11¾	24	2	10,218

[1]The inside diameter is an approximate dimension. The values shown are 2 in. less than the bottom bolt-circle diameters.
[2]Shell heights shown do not include thickness of gaskets.
[3]The calculated capacity is based on the inside diameter (Col. 4) and height of shell (Col. 5).

H = height of tank, in feet.
D = diameter of tank, in feet.

3.5 TANK DECK

Tank decks shall conform to the requirements of Table 3.2 and Fig. 3.5 for the particular size of tank ordered, except that if so agreed between the purchaser and the manufacturer, an alternative design of deck (including supporting members) of equivalent strength, tightness, and utility shall be furnished.

3.6 DECK SUPPORTS

All elements of deck supports not specifically dimensioned herein, shall be designed to support a live load of not less than 20 psf 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

20,000

Compression. psi, max. .....$1+L^2/20{,}000r^2$
L/r ratio, max. 200
Formed Sections:
Basic design stress, psi, max.....18,000

Column Footings:
Soil-bearing load, psf, max.....4,000
(Based on maximum water load plus super-imposed roof load.)

3.7 Tanks of 100-, 200-, 300-, 250-, high 500-, 750-, low 500-, high 1000-, and 1500-bbl capacity shall be furnished with structural-type center support, with the upper end fastened inside the dome with three bolts in each leg and the lower end fastened to a bottom attachment base designed to permit height adjustment.

3.8 Tanks of low 1000-, 2000-, and 3000-bbl capacity shall be furnished with a structural- or pole-type center support, including a rafter support ring. The distance from the tank center to the point of attachment of the rafter to the rafter support ring clip shall be $38^{1}/_{32}$ in.

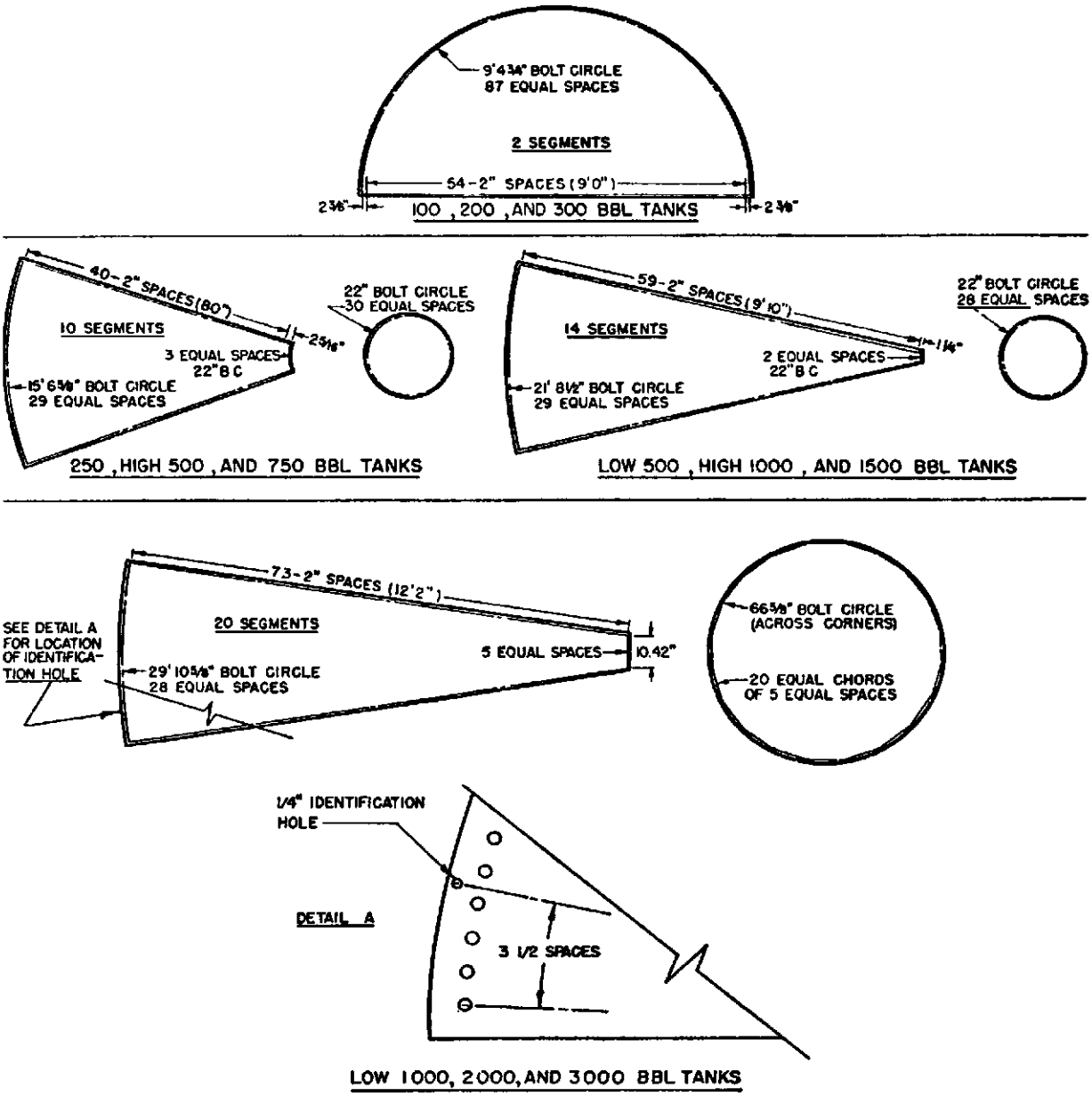
3.9 Tanks of 5000- and 10,000-bbl capacity shall be furnished with pole-type center support. The distance from the tank center to the point of attachment of the rafter to the rafter support ring clip shall be 28 in. for the 5,000 bbl tank and 60% in. for the 10,000-bbl tank.

3.10 Tanks of low 1000-, 2000-, 3000-, 5000-, and 10,000-bbl capacity shall be furnished with rafters attached to each radial deck joint. Rafters shall conform to the allowable design stresses as given in Par. 3.6. Each rafter shall be attached to the center support ring and by suitable brackets to the top

Table 3.2—Details of Bottoms, Shells, and Decks

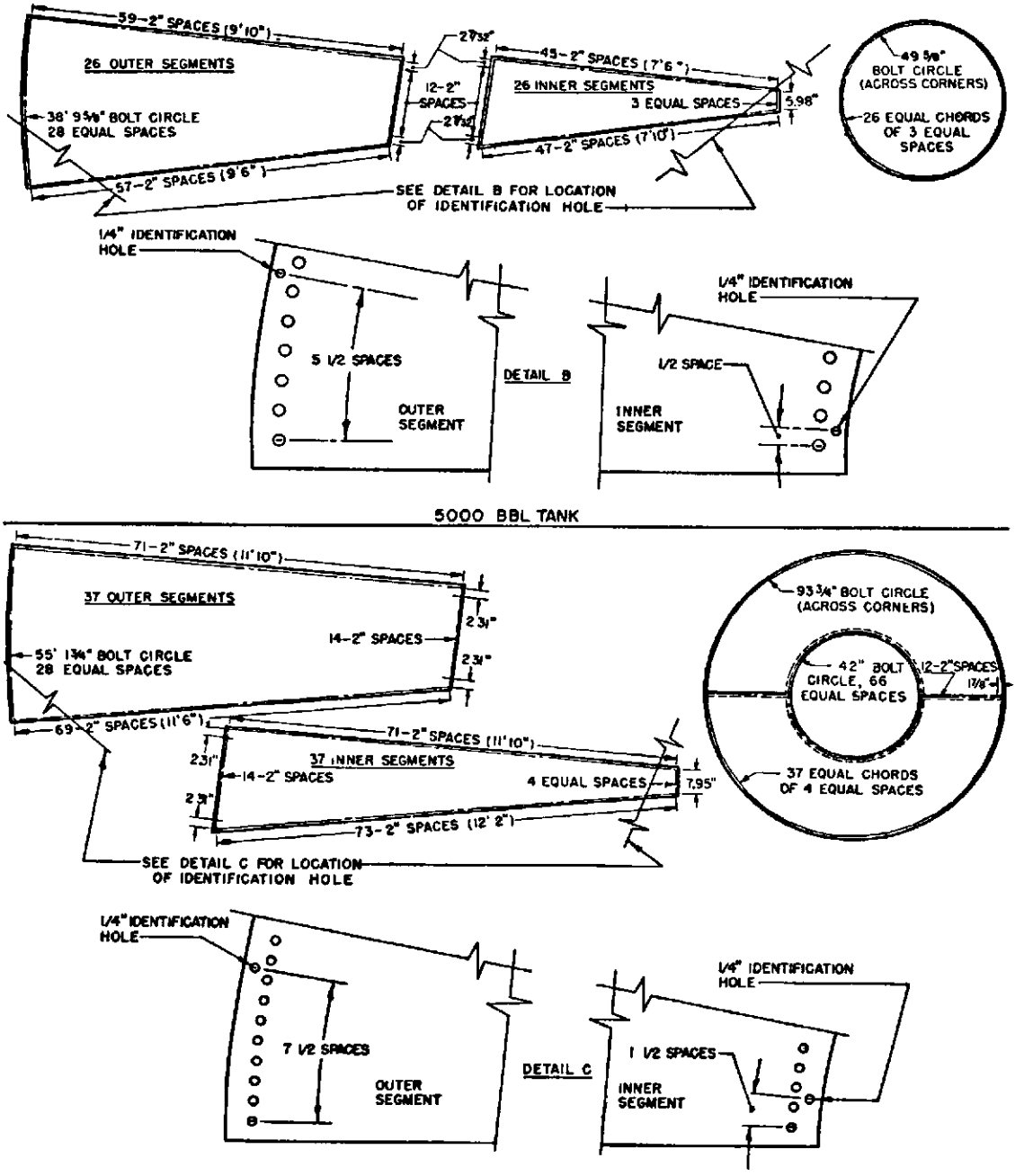
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Bottom		Shell							Deck	
Nominal Capacity 42-gal bbl	No. of Botton Segments (see Fig. 3.2 and 3 3)	Thickness of Bottom Elements,[1] in.	No. of Staves per Ring	Thickness of Staves,[1] in. 1st Ring[2]	2nd Ring	3rd Ring	No. of Rows of Bolts in Vertical Seams 1st Ring[2]	2nd Ring	3rd Ring	No. of Deck Segments (see Fig. 3.5	Thickness of Deck Elements,[1] in.
100	2	0.105	6	0.105	—	—	1	—	—	6	0.105
200	2	0.105	6	0.105	0.105	—	1	1	—	6	0.105
300	2	0.105	6	0.105	0.105	0.105	1	1	1	6	0.105
250	10	0.105	10	0.105	—	—	1	—	—	10	0.105
High 500	10	0.105	10	0.105	0.105	—	1	1	—	10	0.105
750	10	0.105	10	0.135	0.105	0.105	1	1	1	10	0.105
Low 500	14	0.105	14	0.105	—	—	1	—	—	14	0.105
High 1,000	14	0.105	14	0.105	0.105	—	1	1	—	14	0.105
1,500	14	0.105	[3]14	0.105	0.105	0.105	2	1	1	14	0.105
Low 1,000	20	0.105	20	0.105	—	—	2	—	—	20	0.105
2,000	20	0.105	20	0.105	0.105	—	2	2	—	20	0.105
3,000	20	0.105	20	0.135	0.105	0 105	2	2	2	20	0.105
5,000	26*	0.135	26	0.135	0.135	0 105	2	2	2	26*	0.105
10,000	37*	0.135	37	$^{3}/_{16}$	0.135	0.135	3	2	2	37*	0.105

Notes
[1]Thickness of bottoms, staves and decks are minimum, and may be increased to 0.135", $^{3}/_{16}$" or $^{1}/_{4}$" by agreement between the purchaser and the manufacturer.
[2a]Sheet (less than $^{3}/_{16}$ inch) shall be ordered to decimal thickness. Tolerance shall be per ASTM A-568. Corresponding AISC gage numbers and thicknesses are as follows:
12-gage: 0.1045 (0.105) inch
10-gage: 0.1345 (0.135) inch
[2b]Plate ($^{3}/_{16}$ inch and over) shall be ordered to nominal thickness. Tolerance shall be per ASTM A-6.
[3]The first ring is the bottom ring.
[4]The first ring of the 1500-bbl tank shall consist of 14 regular staves, and a fill-in stave having 15 bolt-hole spaces on the chimes.
*Two piece segments.



NOTE 1. ***Edge distance, all seams = ¾ in. min.***
NOTE 2. ***Bolt-hole diameter = 1¼ in.***
NOTE 3. ***Bolt diameter = ⅛ in.***
NOTE 4. ***All bolt-circle dimensions are diameter measurements.***

Figure 3.2—Bottom Elements (See Par. 3.3a)



NOTE 1. *Edge distance, all seams = ¾ in. min.*
NOTE 2. *Bolt-hole diameter = 1 1/16 in.*
NOTE 3. *Bolt diameter = ⅞ in.*
NOTE 4. *All bolt-circle dimensions are diameter measurements.*

Figure 3.3—Bottom Elements (See Par. 3.3a)

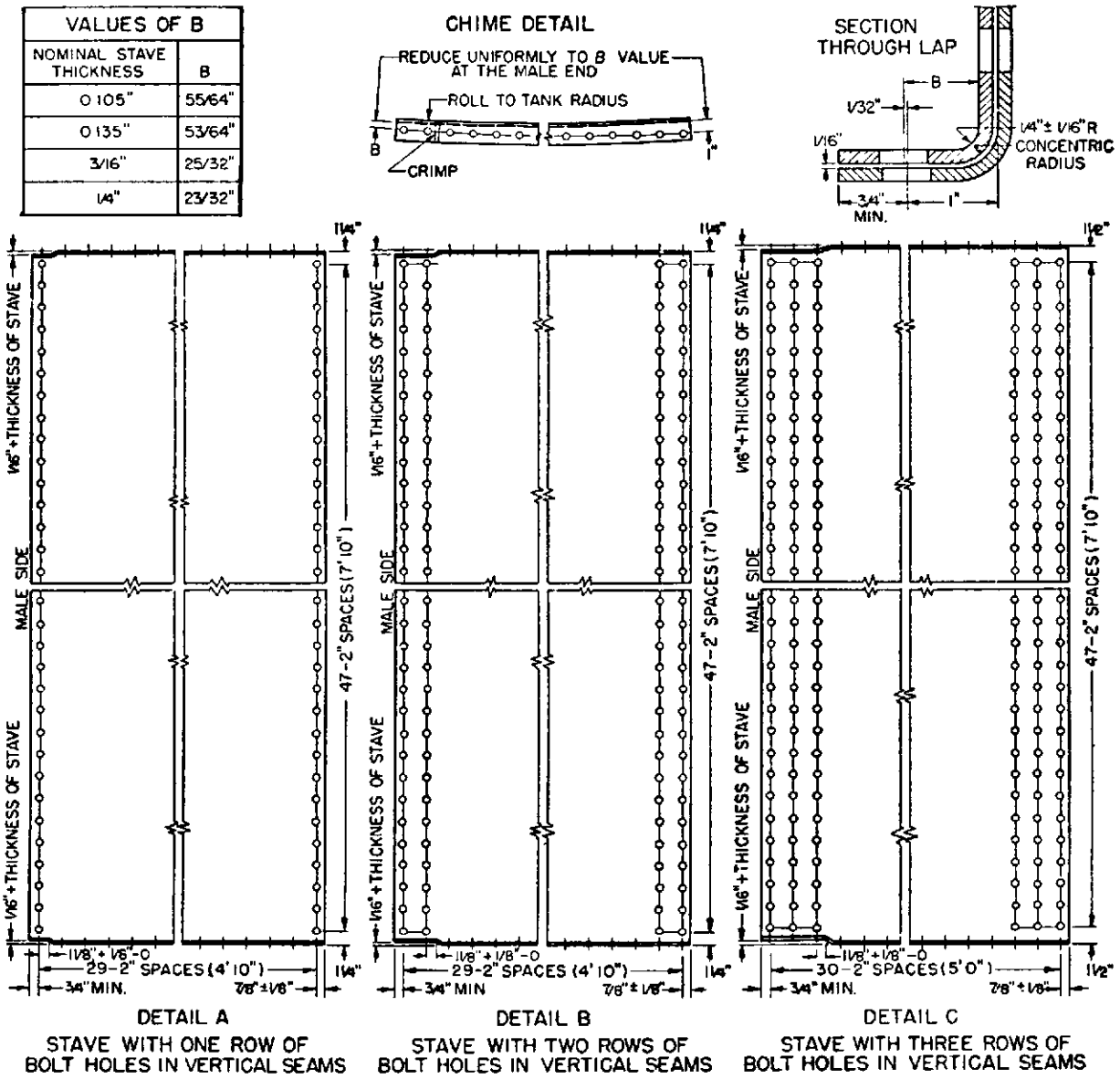


Figure 3.4—Stave Elements (See Par. 3.4)

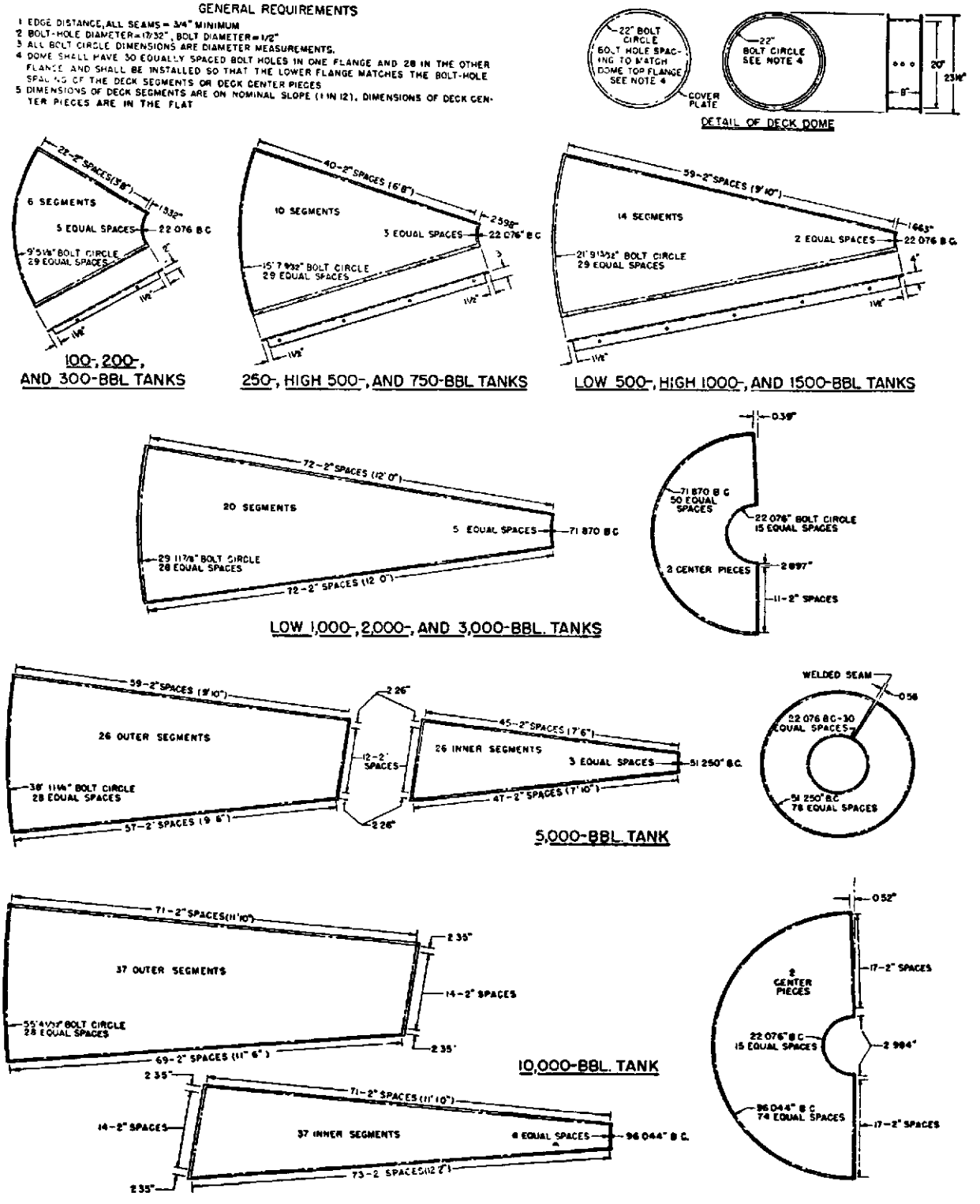
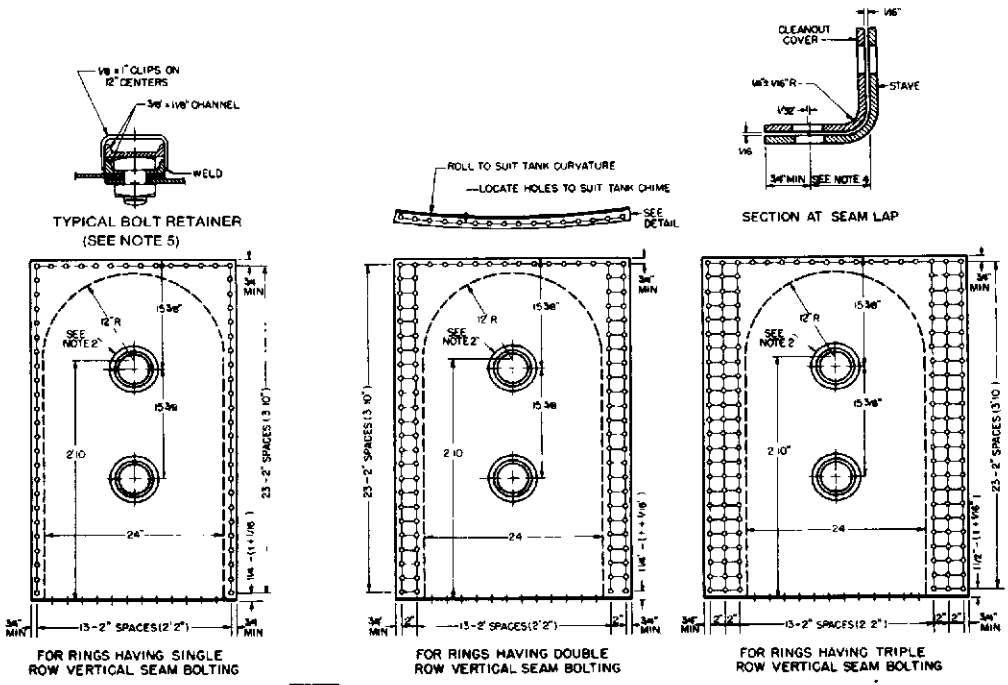


Figure 3.5—Deck Elements (See Par. 3.5)



NOTE 1. *The nominal thickness of the cleanout cover shall be not less than that of the stave to which attached.*

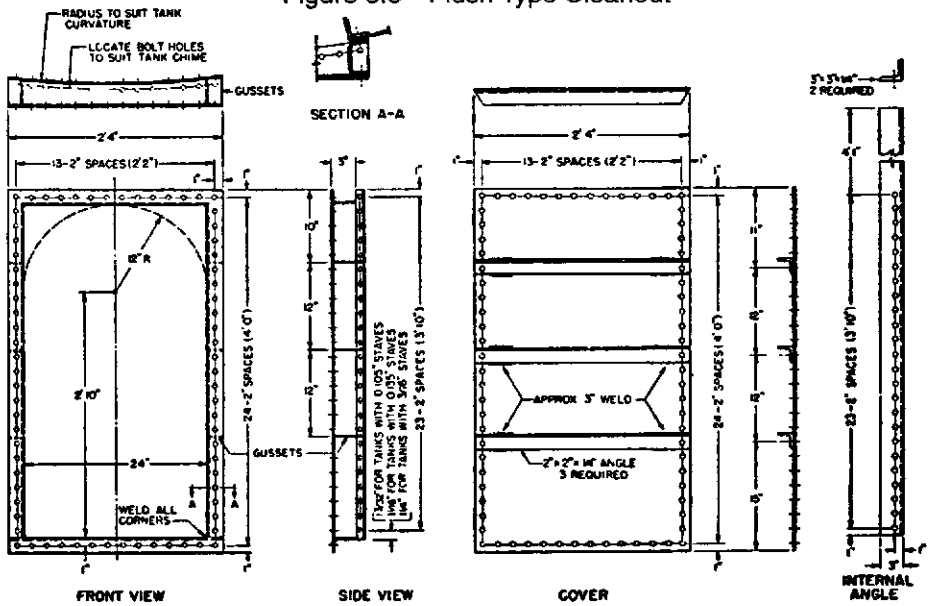
NOTE 2. *Cleanouts shall be furnished with bolt retainers, or handholes, or both, if so specified on the purchase order. If not otherwise specified, retainers only shall be supplied. Alternative types of retainers may be substituted if demonstrated adequate.*

NOTE 3. *See Par. 3.17 for alternative designs.*

NOTE 4. *See Fig. 3.4.*

NOTE 5. *Bolt retainers are not required when round-head bolts are used.*

Figure 3.6—Flush Type Cleanout



NOTE 1. *All sheet and strip shall be 0.135 in. nominal thickness.*

NOTE 2. *See Par. 3.18 for alternative height of cleanout.*

Figure 3.7—Extended-Neck Type Cleanout

chime area. The depth of rafters, measured from the underside of the deck at each end shall be 5 1/2 in. for low 1000-, 2000-, 3000-, and 5000-bbl tanks, and 6 3/4 in. for 10,000-bbl tanks. Rafters shall be punched or drilled to accommodate supporting clips for bolt retainers.

3.11 Except as provided in Par. 3.10 rafters shall be furnished in conformance to design details as agreed upon between the purchaser and manufacturer.

3.12 BOLTED JOINTS

Bolt holes shall be 17/32 inch diameter. The tolerance on bolt-hole spacing shall be ± 1/32 inch between any two holes, measured in the flat before forming.

When using square head or hex head bolts, bolt retainers in the form of channels or other shapes shall be provided outside of all bottom joints, and inside of all staves, cleanouts, and decks to prevent inaccessible bolt heads from turning.

3.13 JOINT GASKETS

Joint gaskets shall be dimensioned on the assumption that the final net thickness in place will be 1/16 in.

3.14 BOLTING

All tank bolts and nuts, except flange bolting, shall be 1/2 in. diameter and shall comply with Appendix A.

3.15 CLEANOUT

Cleanouts shall be furnished unless otherwise specified on the purchase order. The location of the cleanout shall be as specified on the purchase order.

3.16 TYPE OF CLEANOUT

Cleanouts shall be of the flush type, the extended-neck type of proven strength, or other type of proven strength, as specified on the purchase order.

3.17 FLUSH-TYPE CLEANOUTS

Flush-type cleanouts shall conform to the requirements of Fig. 3.6. except that alternative widths and heights of cleanout opening in the tank stave shall be supplied, if so agreed between the purchaser and the manufacturer.

3.18 EXTENDED-NECK OR OTHER TYPE CLEANOUTS

Cleanouts of the extended neck or alternative type shall conform to the following requirements:

a. The height of cleanout opening in the stave shall be 3 ft 10 in. except that, when so agreed upon between the purchaser and the manufacturer. the height of opening shall be 3 ft.
b. The bolting details for attachment of the cleanout neck to the stave shall conform to Fig. 3.7 regardless of type of cleanout.
c. The design shall provide a minimum factor of safety of 2 1/2 as installed and as determined by proof test. The manufacturer shall submit evidence acceptable to the purchaser of compliance with this requirement.

Note: The design of extended-neck cleanout shown in Fig. 3 7 has been determined by proof test to be adequate for tanks of high 1000-bbl and smaller capacity, in the sizes shown in Table 3.1. When used on such tanks the requirements of Par. 3.18c shall be considered to have been satisfied.

3.19 CLEANOUT COVER PLATE

Cover plates for all types of cleanouts shall be of one-piece or two-piece construction; if of the two-piece construction, the pieces shall be joined by a horizontal lap seam having one row of 1/2 in. bolts on 2-in. centers.

3.20 INLET AND OUTLET CONNECTIONS

Inlet and outlet connections shall conform to the sizes and locations specified on the purchase order.

3.21 PIPING FLANGES

Piping flanges shall conform to the requirements given herein, except that if so specified on the purchase order or if so agreed between the purchaser and the manufacturer, alternative types having equivalent strength, tightness, and utility shall be furnished.

3.22 BOLTED PIPING FLANGES

Except as otherwise provided in Par. 3.21, bolted piping flanges shall be attached by bolts or bolt-studs, and shall conform to the following requirements:

Table 3.3—Bolted Piping Flanges (See Fig. 3.8)

(1)	(2)	(3)	(4)	(5)	(6)
Size, in	2	3	4	6	8
Diameter of bolt circle, in.	4	5 3/8	6 3/8	9	11 1/4
Number of bolts	4	4	5	6	8
Diameter of bolts, in	1/2	5/8	5/8	5/8	5/8
Diameter of bolt holes, in.	5/8	3/4	3/4	3/4	3/4
Minimum thread length, Y, in.	7/8	1 3/16	1 5/16	1 9/16	1 3/4
Depth of counterbore	Optional with manufacturer				
Outside diameter of flange, *O*, in.	5 1/8	6 5/8	7 3/4	10 1/2	12 3/4

a. Flanges shall be furnished in the sizes given in Table 3.3 as specified on the purchase order, and shall conform to the provisions of Table 3.3 and Fig. 3.8.
b. The inner flange shall be provided with bolt-head or bolt-stud nut retainers.
c. The length of thread shall conform to the requirements of Table 3.3. In all other respects the threads shall conform to the requirements of API Specification 6A: Specification for Wellhead Equipment.

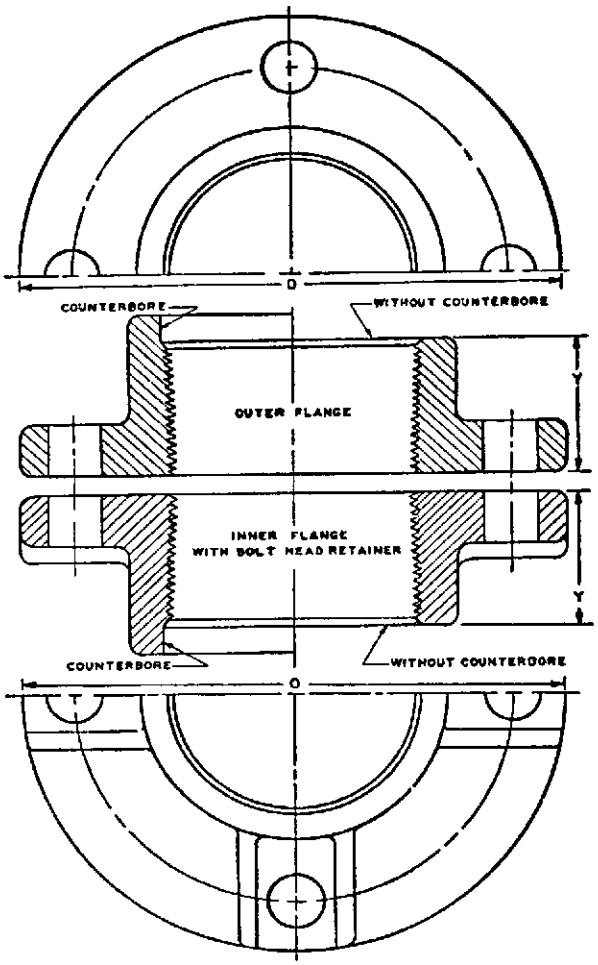


Figure 3.8—Bolted Piping Flanges
(See Table 3.3 for dimensions)

3.23 FLANGE ATTACHMENT

When bolted piping flanges conforming to Table 3.3 and Fig. 3.8 are furnished, the tank members shall be drilled for flange attachment in accordance with the following stipulations:

a. The bolt-circle diameter and the number of bolt holes shall be as shown in Table 3.3 and Fig. 3.8.
b. Bolt-hole size shall be optional with the manufacturer, but shall be sufficient to accommodate the size of bolts given in Table 3.3.
c. Flange bolt holes shall straddle the radial centerlines on decks and bottoms and vertical centerlines on staves, except that for the 4-in. 5-hole flange the odd hole shall be located on the centerline toward the center of the deck or the top of the stave.

3.24 DOWNCOMER PIPE

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

3.25 BOLTING PATTERNS FOR THIEF HATCHES AND RELIEF VALVE

When tank decks are cut and drilled for the direct attachment of bolted thief hatches, pressure-relief valves, or vacuum-relief valves, bolting patterns shall be as shown in Figures 3.9, 3.10, or 3.11 as specified on the purchase order.

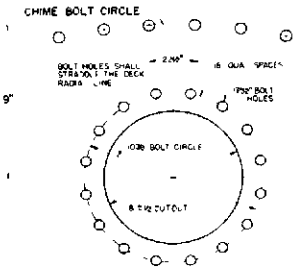


Figure 3.9—Bolting Pattern for 8-In. Circular Thief Hatches, Pressure-Relief, and Vacuum-Relief Valves

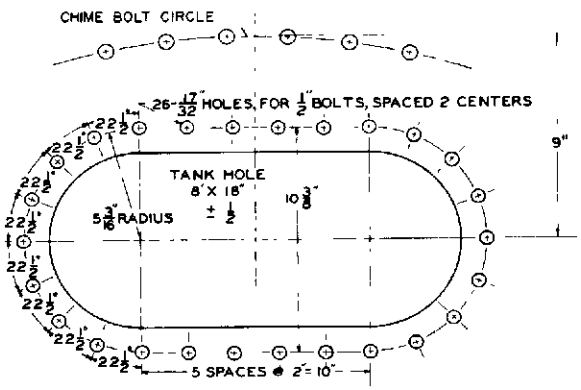


Figure 3.10—Bolting Pattern for 8-In. x 18-In. Oblong Thief Hatches, Pressure-Relief, and Vacuum-Relief Valves

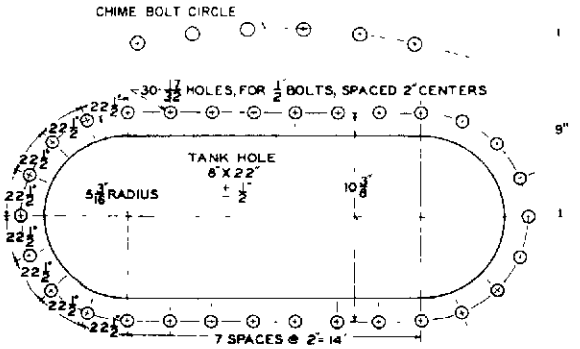


Figure 3.11—Bolting Pattern for 8-In. x 22-In. Oblong Thief Hatches, Pressure-Relief, and Vacuum-Relief Valves

4 Venting Requirements

4.1 NORMAL VENTING

The purchaser shall specify the number, size and location of connections to be installed in the deck of each tank to provide for normal inbreathing and outbreathing due to temperature changes and to liquid movement into and out of the tank. These connections should be fitted with pressure-vacuum valves properly sized in accordance with API Standard 2000. The pressure setting should be from 1/2 to 1 ounce per sq. in. less than the opening pressure of devices used for emergency venting. Appendix B is provided as a guide to aid in the selection of venting devices, where required.

4.2 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 Column 6 of Table C-1. Pressure relieving devices may take the form of larger or additional vent valves, larger or additional thief hatches or deck dome covers (See Fig. 3.5) installed with loose fitting long bolts and suitable gasket so that the dome cover will lift at the required pressure.

Note: *With drainage* as used in column 5, Table C-1 means that flammable or combustible liquids will not be retained near the tank by dykes or firewalls.

5 Erection

5.1 Tank staves shall be erected with the male side on the left when facing the outside surface of the stave. See Fig. 3.4.

Note: The dimensions as specified herein are based on the assumption that most of the slack, due to the difference in bolt and bolt-hole diameters, will be taken up in all stave joints by slippage when the tank is initially filled. The bottom and deck bolt-circle diameters provide for such slippage. At the time of erection, some pinning of the vertical stave joints will be required to bring the bolt holes into alignment.

5.2 CLEANING UP

Upon completion of erection, the erector shall remove or dispose of all rubbish and other unsightly material caused by his operations and shall leave the premises in as good condition as he found them.

6 MARKING*

6.1 Tanks manufactured in conformance with this specification shall be identified by a nameplate bearing, as a minimum, the information shown in Fig. 6.1.

6.2 Nameplates shall be made of a corrosion-resistant material and installed on the cleanout stave approximately 8 inches above the top of the cleanout cover or frame. Installation of the nameplate may be on a boss seal welded to the stave (prior to galvanizing if applicable) or by any other suitable means to identify the product for the expected service life of the tank.

*Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. The American Petroleum Institute continues to license use of the monogram on products covered by this specification but it is administered by the staff of the Institute separately from the specification. The policy describing licensing and use of the monogram is contained in Appendix E, herein. No other use of the monogram is permitted.

12B

MANUFACTURER _____

NOMINAL DIAMETER _____

NOMINAL HEIGHT* _____

NOMINAL CAPACITY* _____ BBL

DESIGN PRESSURE _____ OZ.

Figure 6.1—Suggested Name Plate Format
(*May be completed after field erection

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

7 Inspection and Rejection

7.1 INSPECTION NOTICE

Where the inspector representing the purchaser desires to inspect this material, reasonable notice shall be given of the time at which the run is to be rnade.

7.2 INSPECTION

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 the inspector, without charge, all reasonable facilities to satisfy him 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 operation of the works.

7.3 REJECTION

Material which shows injurious defects on mill 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 specification.

APPENDIX A—SPECIFICATION FOR TANK BOLTING

A.1 Scope

This Appendix covers tank bolting ½ inch in diameter to and including 1½ inch 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. per sq. in. based on the stress area (mean thread area) or approximately 91,000 lb. per sq. in. 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 Par. A.2., without stripping.

A.5 Head Test

During the tension test specified in Par. 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 5000 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

Threads of unplated product shall be coarse-thread series as specified for screw threads (ANSI 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 inches.

A.9

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 ANSI B18.2.1, Square and Hex Bolts and Screws.

A.10

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 ANSI B18.2.2, Square and Hex Nuts.

A.11 Galvanizing

Unless otherwise specified, galvanized bolts and nuts shall be hot-dip galvanized in accordance with the requirements of Specification A 153. The weight of coating shall be that specified for Class C materials in Specification A 153 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 Specification B 454 or to the coating thickness, adherence, and quality requirements for Class C of Specification A 153. 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 his own use.

ALTERNATE SPECIFICATION FOR TANK BOLTING USING ROUND-HEAD BOLTS

A.101 Scope

This appendix covers tank bolting using ½ inch diameter SAE Grade 5 round-head bolts. Bolts and nuts shall be mechanically galvanized, hot-dip galvanized, or electro-zinc plated.

A.102 Physical Properties

The breaking load of the bolts, tested in full size, shall not be less than 17,000 lbs.

Note: The breaking load of 17,000 lbs. is equivalent to a tensile strength of 120,000 lbs/sq. in. based on the stress area (mean thread area) or approximately 135,000 lbs/sq. in. based on the root thread area.

A.103 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.104 Stripping Test

The nuts for bolts shall be capable of developing the load specified on Par. A.102 without stripping.

A.105 Head Test

During the tension test specified in Par. A.103, failure shall occur in the threaded section and not at the junction of the head and shank.

A.106 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 5000 pieces or fraction thereof.

A.107 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.108

Threads of unplated product shall be coarse-thread series as specified for screw threads (ANSI 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 inches.

A.109

Round-head bolts shall have a fin neck or ribbed neck to prevent turning when tightened. The height of the head shall be .25 to .27 inches, with a diameter of 1.0 to 1.06 inches.

On ribbed neck bolts, the longitudinal ribs shall have a length of .186 in. to .206 in. with an outside diameter of .540 in. to .550 in. There shall be at least 16 ribs.

On fin neck bolts, there shall be four radial fins equally spaced under the bottom side of the head. The longitudinal length of the fins shall be .156 in. to .187 in., with an outside diameter of .675 in. to .695 inches.

For corrosion protection, the head of the bolt may be encapsulated with Polyvinylidene Fluoride (PVDF), ABS, or Polyester. A sealing ring shall be molded under the head of the bolt.

A.110

Nuts shall be regular square or regular hex. All nuts shall comply with the applicable section of the latest edition of ANSI B18.2.2, Square and Hex Nuts.

For corrosion protection, nuts in contact with the stored liquid may be protected with threaded PVDF nut caps, or the nuts may be encapsulated with Polyester.

A.111 Finish

Galvanized bolts and nuts shall be hot-dip galvanized in accordance with the requirements of ASTM A 153. The weight of coating shall be that specified for Class C materials in ASTM A 153 and the nuts shall be tapped after galvanizing. Mechanically galvanized bolts and nuts shall be mechanically zinc-coated, and the coating shall conform to the requirements for Class 50 of ASTM B 454 or to the coating thickness, adherence, and quality requirements for Class C of ASTM A 153. Mechanically zinc-coated nuts for assembly with mechanically zinc-coated bolts shall be tapped oversize prior to coating and need not be retapped afterwards.

Electro-zinc plated bolts and nuts shall have a minimum zinc coating of .0005 in. with a yellow dichromate dip. Electro-zinc plated nuts do not require oversize tapping prior to plating.

A.112 Marking

Bolt heads or shank ends shall be marked to identify the bolt manufacturer, including three radial marks indicating SAE Grade 5. Encapsulated bolts are to be marked prior to being encapsulated. Markings may be either raised or depressed.

APPENDIX B—RECOMMENDED PRACTICE FOR NORMAL VENTING

Table B-1—Venting Capacity Requirements (See Par. 4.1)

(1)	(2)		(3)		(4)	(5)	(6)	(7)
						Thermal Venting, SCFH		
							Pressure (Outbreathing)	
Nominal Tank Capacity, bbl	Tank Size Diameter ft.-in.	Tank Size Height ft.	Design Pressure oz. per sq. in. Press.	Design Pressure oz. per sq. in. Vac.	Surface Area, sq. ft.	Vacuum (Inbreathing) All Stocks	Flash Point 100 F or Above	Flash Point Below 100 F
100	9-2	8	3	1/2	233	100	60	100
200	9-2	16	3	1/2	468	200	120	200
300	9-2	24	3	1/2	703	300	180	300
250	15-6	8	3	1/2	388	250	150	250
H-500	15-6	16	3	1/2	780	500	300	500
750	15-6	24	3	1/2	1,170	750	450	750
L-500	21-6	8	2	1/2	543	500	300	500
H-1000	21-6	16	2	1/2	1,090	1,000	600	1,000
1500	21-6	24	2	1/2	1,620	1,500	450	1,500
L-1000	29-9	8	2	1/2	750	1,000	600	1,000
2000	29-9	16	2	1/2	1,500	2,000	1,200	2,000
3000	29-9	24	2	1/2	2,250	3,000	1,800	3,000
5000	38-8	24	1	1/2	2,840	5,000	3,000	5,000
10,000	55-0	24	1	1/2	4,170	10,000	6,000	10,000

Notes:

[1]Filling and Emptying Venting:

a. Outbreathing at Maximum Filling Rate. For flash points less than 100 F, provide 1200 standard cubic feet per hour (SCFH) for each 100 bbl per hour. For flash points of 100 F or more, provide 600 SCFH for each 100 bbl per hour.

b. Inbreathing at Maximum Emptying Rate. For all liquids, provide 600 SCFH for each 100 bbl per hour.

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

APPENDIX C—RECOMMENDED RELIEVING CAPACITIES

Table C-1—Emergency Venting Requirements (See Par. 4.2)

(1)	(2)	(3)		(4)	(5)		(6)
Nominal Capacity bbl	Diameter x Height ft-in.	Design Pressure, Ounces		Exposed Area sq. ft.	Emergency Venting Required SCFH		Max. Press. During Emergency Venting, Ounces
		Pressure	Vacuum		With Drainage*	Without Drainage	
100	9-2 3/4 × 8-0 1/2	3	1/2	233	114,750	229,500	4 1/2
200	9-2 3/4 × 16-1	3	1/2	468	170,250	340,500	4 1/2
300	9-2 3/4 × 24-1 1/2	3	1/2	703	214,000	428,000	4 1/2
250	15-4 5/8 × 8 -0 1/2	3	1/2	388	154,650	309,300	4 1/2
H-500	15-4 5/8 × 16-1	3	1/2	780	227,600	455,200	4 1/2
750	15-4 5/8 × 24 -1 1/2	3	1/2	1,170	271,800	543,600	4 1/2
L-500	21-6 1/2 × 8-0 1/2	2	1/2	543	184,600	369,200	3
1000	21-6 1/2 × 16-1	2	1/2	1,090	267,200	534,000	3
1500	21-6 1/2 × 24-1 1/2	2	1/2	1,630	308,380	617,760	3
L-1000	29-8 5/8 × 8-0 1/2	2	1/2	750	222,500	445,000	3
2000	29-8 5/8 × 16-1	2	1/2	1,500	300,250	600,500	3
3000	29-8 5/8 × 24-1 1/2	2	1/2	2,260	344,650	689,300	3
5000	38-7 5/8 × 24-1 1/2	1	1/2	2,840	371,000	742,000	1 1/2
10,000	54-11 3/4 × 24-1 1/2	1	1/2	4,170	371,000	742,000	1 1/2

Note: Normal vents (Par. 4.1 and Appendix B) may satisfy all or part of these requirements.
*In applying recommended emergency venting required *with drainage*, careful attention should be given to the provisions of Par. 2—2.3.2 and 2—2.5.7, NFPA No. 30, available from National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210.

Table C-2—Calculated Venting Capacity of Thief Hatches

(1)	(2)	(3)	(4)
	Venting Capacity, SCFH		
Tank Pressure, Ounces	8" Round A = 44 sq. in.	8" × 18" Obround A= 130 sq. in.	8" × 22" Obround A = 154 sq. in.
1.5	59,783	174,650	206,892
3.0	84,547	246,992	292,590
4.5	103,548	302,503	358,348
6.0	119,567	349,299	413,785
12.0	169,094	— Not Applicable —	

Note: Values in the above table are based on the following formula:

$$Q = 1667\, C_f A \sqrt{Pt - Pa}$$

Where:

Q = Venting capacity in standard cubic feet of free air per hour (SCFH).
C_f = 0.5 (the flow coefficient).
A = hatch alea, square inches.
P_t = absolute pressure inside the tank in inches of water.
P_a = absolute pressure outside the tank in inches of water.

APPENDIX D—WALKWAYS, STAIRWAYS AND LADDERS

General

D.1

Walkways and stairways furnished to this specification shall be constructed from prefabricated components designed to be field erected alongside of tanks of similar structures. All material shall comply with the applicable parts of Section 2.

D.2

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.

Walkways

D.3

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 per sq ft, or a concentrated load of 1,000 lb at any place on the span without deflecting more than $^1/_{360}$ of the unsupported span length. The maximum span between tank brackets or ground supports shall be 25 feet. 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 inches 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 buildup 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 inches 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 inches 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, supported from the top and bottom chimes of the top ring. The brackets shall be installed to provide a 26-inch wide access to the tank at the point of attachment.

Stairways

D.9 Stairways

When required for access to walkway sections, stairways shall be designed for field erection, and shall be capable of supporting a minimum of 100 lb per linear foot of tread width, or a concentrated load of 1,000 lb at any point on the stairway without deflecting more than $^1/_{360}$ of the unsupported stairway length. Stairway width shall be a minimum of 26 inches. 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 $8^1/_2$ inches with a nominal tread width of not less than 8 inches. 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 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 inches nor more than 34 inches 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, 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. The run of the stair tread will depend on the radius of the exterior arc, and the minimum effective tread shall be 7 inches, measured 13 inches from the exterior arc. Spiral stairways are not recommended for installation on tanks less than 15 feet, 6 inches in diameter.

Ladders

D.12

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 inches by 30 inches with standard railings except at the entrance from the ladder.

D.13

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

D.14

Rungs shall be a minimum of 3/4 inch diameter, spaced a maximum of 12 inches, center to center, with a minimum clear length of 16 inches, and designed to support a minimum load of 200 lb.

D.15

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

APPENDIX E—USE OF THE API MONOGRAM*

E.1 Marking

The following marking requirements apply to licensed manufacturers using the API monogram on products covered by this specification.

E.2

Tanks manufactured in conformance with this specification shall be identified by the nameplate bearing, as a minimum, the information shown in Fig. E.1.

E.3

Nameplates shall be made of a corrosive-resistant material and installed on the cleanout stave approximately 8 inches above the top of the cleanout cover or frame. Installation of the nameplate may be on a boss seal welded to the stave (prior to galvanizing if applicable) or by any other suitable means to identify the product for the expected service life of the tank.

E.4

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

E.5 API Monogram

Tanks conforming to this specification shall be marked with the API monogram by manufacturers authorized to use the monogram. The monogram shall not be applied to tanks which do not conform to this specification, nor by manufacturers who have not been authorized to use the monogram.

*API licensees only. *Contact API for information on licensing.*

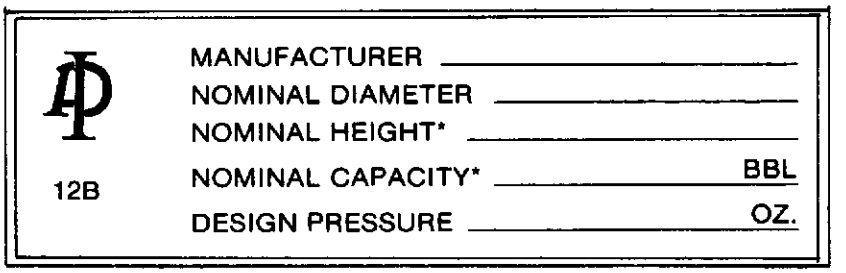


Figure E-1—Suggested Nameplate Format
(*May be completed after field erection)

APPENDIX F—SUGGESTIONS FOR ORDERING BOLTED TANKS

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

Specification ..... API Spec 12B
Number of tanks .....
Nominal capacity ..... Col. 1, Table 3.1
Size:
- Inside diameter ..... Col. 4. Table 3.1
- Height of shell ..... Col. 5. Table 3.1

Type of cleanout ..... Par. 3.16
Design of flush-type cleanout ..... Par. 3.17 and Note 2, Fig. 3.6
Design of extended neck cleanout ..... Par. 3.18
Cut-outs for thief hatch and relief valve ..... Par. 3.25
Delivery date and shipping instructions .....
Inspection by purchaser ..... Par. 7.1

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

Finish ..... Par. 2.8
Bolting ..... Par. 2.9
Bottom, stave, and deck thickness ..... Footnote 1, Table 3.2
Open-top tanks ..... Note, Par. 3.4
Two-piece cleanout cover plates ..... Par. 3.19
Cleanout location ..... Par. 3.15
Inlet and outlet connections ..... Par. 3.20
Piping flanges ..... Par. 3.21 and 3.22
Walkways, stairways and ladders ..... Appendix D
Venting connections ..... Par. 4. I
Downcomer pipe and design ..... Par. 3.24

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

Alternative designs of tank bottoms ..... Par. 3.3
Alternative designs of decks ..... Par. 3.5
Rafter design ..... Par. 3.11
Alternative widths and heights of cleanout ..... Par. 3.17
Alternative designs of piping flanges ..... Par. 3.21

APPENDIX G—CURRENT PUBLICATIONS OF THE AMERICAN PETROLEUM INSTITUTE PERTAINING TO STORAGE TANKS

API

Spec 12B: Specification for Bolted Tanks for Storage of Production Liquids.

Covers material, design, fabrication, and testing requirements for vertical, cylindrical, above-ground. closed and open top, bolted steel storage tanks in nominal capacities of 100 to 10,000 bbl (in standard sizes). Also includes appurtenance requirements.

Spec 12D: Specification for Field Welded Tanks for Storage of Production Liquids.

Covers material, design, fabrication, and testing requirements for vertical, cylindrical, above-ground, closed top, field welded steel storage tanks in nominal capacities of 500 to 10,000 bbl (in standard sizes).

Spec 12F: Specification for Shop Welded Tanks for Storage of Production Liquids.

Covers material, design, fabrication, and testing requirements for shop-fabricated vertical, cylindrical, aboveground closed top, shop-welded steel storage tanks in nominal capacities of 90 to 500 bbl (in standard sizes).

Std 620: Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks.

These rules cover the design and construction of large, welded, field-assembled storage tanks used for petroleum intermediates and finished products operated at a gas pressure of 15 psig and less, down to an internal gas pressure close to atmospheric pressure, which are not now provided for in API Std 650.

Std 650: Welded Steel Tanks for Oil Storage.

This standard covers material, design, fabrication, erection, and testing requirements for vertical, cylindrical, aboveground, closed- and open-top, welded steel storage tanks, in various sizes and capacities, for internal pressures approximating atmospheric pressures. also includes an alternate basis for shell design, as well as one for calculating tank shell thickness.

Std 2000: Venting Atmospheric and Low-Pressure Storage Tanks.

This standard applies to the normal and emergency venting requirements for aboveground liquid petroleum storage tanks and aboveground and belowground refrigerated storage tanks designed to operate from ½ oz. per sq. in. vacuum through 15 psig pressure. The requirements of the standard do not apply to floating- or lifter-roof tanks.

RP 2003: Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents.

Described in this publication are some of the conditions which have resulted in oil fires ignited by electrical sparks and arcs from so-called natural causes, as well as the methods which the petroleum industry currently is applying for the prevention of ignitions from these sources.

RP 2015: Cleaning Petroleum Storage Tanks.

A discussion of safe practices in tank cleaning—including use of suitable mechanical equipment and protective clothing, use of proper cleaning methods, elimination of potential ignition hazards, and provision for means of entrance and exit in an emergency. Combines and updates information contained in *Accident Prevention Manual No. 1: Cleaning Petroleum Storage Tanks—Section A, Crude Oil and Unfinished Products Tanks and Bull. 2016: Cleaning Tanks Used for Gasoline or Similar Low-Flash products.*

Std 2550: (ASTM D 1220-65)(75),† Measurement and Calibration of Upright Cylindrical Tanks, 1966 (ANSI Z11.197-1971) (Redesignated Chapter 2.2.2, API Manual of Petroleum Measurement Standards)

This standard describes the procedures for calibrating upright cylindrical tanks larger than a barrel or drum. It is presented in two parts: Part I outlines procedures for making necessary measurements to determine total and incremental tank volumes. Part II presents the recommended procedure for computing volumes. Sample calculations are included in an appendix.

Std 2555: (ASTM D 1406-65)(75),* Liquid Calibration of Tanks, 1966 (ANSI Z11.202-1971) (Redesignated Chapter 2.6, API Manual of Petroleum Measurement Standards)

This standard describes the standard procedure for calibrating tanks, or portions of tanks, larger than a barrel or drum by introducing or withdrawing measured quantities of liquid.

Guide for Inspection of Refinery Equipment, Chapter XIII, Atmospheric and Low-Pressure Storage Tanks.

This chapter covers the inspection of atmospheric storage tanks which have been designed to operate at pressures from atmospheric through 0.5 psig, and of low-pressure storage tanks which have been designed to operate at pressures above 0.5 psig through, but not over, 15 psig. Such details as reasons for inspection, frequency and time of inspection, methods of inspection and of repair, and records are some of the principal items included.

RP 12R1: Recommended Practice for Setting, Connecting, Maintenance and Operation of Lease Tanks.

A guide for new tank battery installations and a guide for revamping existing batteries if this is necessary for any reason.

†Joint standards for which ASTM has prime responsibility
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