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Specification for Field-welded Tanks for Storage of Production Liquids

API SPECIFICATION 12D

THIRTEENTH EDITION XXX 2XX

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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Introduction

This specification is under the purview of the API Subcommittee on Aboveground Storage Tanks.

This specification is based on the accumulated knowledge and experience of purchasers and manufacturers of field- welded steel storage tanks of various sizes and capacities for internal pressures approaching atmospheric. This publication provides 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 non-potable water. If tanks are purchased in accordance with this specification, the purchaser is expected to specify certain basic requirements.

This specification shall become effective on the date printed on the cover.

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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 of approximately atmospheric, not to exceed those listed in Table 5.1a or Table 5.1b, Column 2.

This specification provides 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 provisions of this specification. The purchaser may make any investigation necessary to be satisfied that the manufacturer is in compliance and may reject any material that does not comply with this specification. It is urged that the purchaser exercise this right by providing an inspection independent of any supervisory inspection furnished by the manufacturer, and that the purchaser's inspector closely monitor all of the details of shop fabrication and/or field construction and testing herein specified that may affect the integrity and safety of the completed structure. The purchaser's inspection and approval does not relieve the manufacturer of their responsibility to comply with all provisions of this specification.

2 Normative References

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

API Standard 12R1, *Installation, Operation, Maintenance, Inspection, and Repair of Tanks in Production Service*

API Specification 5L, *Specification for Line Pipe*

API Standard 650, *Welded Tanks for Oil Storage*

API Recommended Practice 652, *Lining of Aboveground Petroleum Storage Tank Bottoms*

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

ASME Boiler and Pressure Vessel Code, Section IX ¹, *Welding, Brazing, and Fusing Qualifications*

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

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

ASTM A36/A36M ², *Standard Specification for Carbon Structural Steel*

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A106/A106M, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A123/A123M, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*

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

ASTM A333/A333M, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness*

ASTM A516/A516M, *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service*

ASTM A529/A529M, *Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality*

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

ASTM A1011/A1011M, *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*

AWS A5.1³, *Specification for Mild Steel Arc-Welding Electrode*

AWS A5.18/A5.18M:2005, *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*

AWS D1.1, *Structural Welding Code—Steel*

AWS D1.6, *Structural Welding Code—Stainless Steel*

NACE SP0178-2007⁴, *Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service*

¹ ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.

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

³ American Welding Society, 8669 NW 36th Street, #130, Miami, Florida 33166-6672, www.aws.org

⁴ AMPP, 1440 South Creek Drive, Houston, Texas 77084-4906, www.ampp.org.

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3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply to joints.

3.1 Double-welded butt joint

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

3.2 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.

3.3 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 Single-welded lap joint.

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

3.5 Butt weld

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

3.6 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.

3.7 Full-fillet weld

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

3.8 Groove weld

Weld beads that are deposited in a groove between two members to be joined.

3.9 Tack weld

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

3.10 Remote location

The location for a tank which is sufficiently distant from any occupied buildings and public areas so that hazards associated with exposure to an external tank fire (e.g. thermal radiation, projectiles, pool fire due to inventory release, etc.) cannot reach them. Public areas include those facilities not owned/operated as part of the tank operations, but rather in use by the general public, such as roads, dedicated, or otherwise permanently appropriated to the public for public use, occupied buildings, or other public infrastructure.

3.11 Bottom shell course

The shell course welded directly to the tank bottom.

3.12 Design pressure

The maximum pressure for normal and emergency venting cases. .

3.13 Maximum internal pressure (vacuum)

The maximum internal vacuum permitted in the tank, under the effects of loading and load combinations stated in section 5.

3.14 Operating pressure

The pressure at which the tank operates at without the over pressure protection devices opening.

3.15 Self-anchored tank

Tanks that use their self-weight and the stored product to resist overturning forces.

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4 Materials

4.1 General

4.1.1 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.

4.1.2 The use of rimmed or capped steels is not permitted.

4.2 Plates

4.2.1 Plates shall conform to one of the following specifications:

- a) ASTM A36/A36M,
- b) ASTM A516/A516M, Grade 70, or
- c) ASTM A573/A573M, Grade 70.

4.2.2 Where requested by the Purchaser for cold temperatures down to $-40\text{ }^{\circ}\text{C}$ ($-40\text{ }^{\circ}\text{F}$), and when applying a reduction to the design pressure of the tank, materials conforming to the following specifications may be used.

- a) ASTM A573/A573M, Grade 58. [Tanks are limited to 6 kPa (14 oz/in.2) design pressure and 9 kPa (21 oz/in.2) maximum pressure].
- b) ASTM A516/A516-60/A516M Grade 55 and CSA 38WT. [Tanks are limited to 5.6 kPa (13 oz/in.2) design pressure and 8.6 kPa (20 oz/in.2) maximum pressure].
- c) CSA G40.21 44WT.

4.3 Sheets

Sheets shall conform to ASTM A1011/A1011M, SS Grade 36, Type 1 or Type 2. Commercial steel (CS) and drawing steels (DS) are not permitted.

4.4 Welding Electrodes

4.4.1 Tanks and their structural attachments shall be welded by the shielded metal-arc, gas metal-arc, gas tungsten-arc, flux-cored arc, or submerged-arc process using suitable equipment. All tank welding shall be performed by manual, semiautomatic arc, machine, or automatic welding in accordance with the welding procedure specifications as described in Section IX of the ASME Code. Welding shall be performed in a manner that ensures complete fusion with the base metal.

4.4.2 Welding procedures for ladder and platform assemblies, handrails, stairways, and other miscellaneous assemblies, but not their attachments to the tank, shall comply with AWS D1.1, AWS D1.6, or Section IX of the ASME Code, including the use of standard WPSs.

4.5 Structural Shapes

Structural shapes shall conform to ASTM A36/A36M

4.6 Pipping

Pipe shall conform to Grade A or B of API Specification 5L, ASTM A53/A53M, ASTM A106/A106M, or ASTM A333/A333M Grade 6.

4.7 Flanges

4.7.1 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. Flanges shall conform to ASTM A105/A105M, ASTM A350/A350M Grade LF2, or ASTM A181/A181M.

4.7.2 Where gauge hatch connections are specified as API dimensions, gauge hatches may be fabricated from materials listed in section 4 and conform to the dimensions in Figure 5.1.

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 Specification 5L, Grade B. Alternatively, couplings may comply with the latest edition of ASME B16.11 for Steel Pipe Couplings.

4.9 Bolting

4.9.1 Bolting shall conform to ASTM A307, Grade A or B, or ASTM F3125/F3125M Grade A325

4.9.2 Nuts, when used with bolting, shall conform to ASTM A563.

4.9.3 Unless otherwise specified on the purchase order, black finish bolts and nuts shall be furnished.

4.9.4 When specified to be galvanized, bolts and nuts shall be zinc coated in accordance with ASTM F2329/F2329M.

4.9.5 Alternative materials and/or finish, conforming to recognized standards for bolting, may be furnished by agreement between the purchaser and the manufacturer.

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5 Design

5.1 General

Tanks covered by this specification have been designed using established engineering calculations to determine minimum metal thickness and bolting requirements for each size tank filled with water, Specific gravity = 1.2, at 15°C (60°F) and at the internal pressures specified in Table 5.1a, Table 5.1b, Column 2. In order to ensure structural stability and integrity, additional metal thickness has been added to that determined by calculation. The minimum metal thickness, specified in Table 5.1a, Table 5.1b shall not be decreased.

NOTE For pressures beyond those stated in Table 5.1a, Table 5.1b or for other conditions not covered by this specification, API 650, Annex F should be used for the design.

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5.2 Tank Size

Tanks under this specification shall be furnished in the sizes and dimensions as stipulated in Table 5.1 and Figure 5.1, and as specified on the purchase order.

Table 5.1a—Tank Dimensions (see Figure 5.1) (SI)

(1) Nominal Capacity (m ³)	(2) Design Pressure (Kpa) ^a		(3) Approximate Working Capacity (m ³) (See NOTE)	(4) Nominal Outside Diameter (m) A	(5) Nominal Height (m) B	(6) Height of Overflow-line Connection ^b (m) C	(7) Height of Walkway Lugs (m) D	(8) Location of Fill-line Connection ^b (mm) E	(9) Size of Connections (mm)
	a Pressure	b Vacuum							
High-79	3.5	0.2	74.8	4.5	4.8	4.7	4.1	360	360
118.5	3.5	0.2	112.9	4.5	7.3	7.1	6.6	360	360
Low-79	2.5	0.2	76.3	6.5	2.4	2.3	1.7	360	360
High-158	2.5	0.2	156	6.5	4.8	4.7	4.1	360	360
237	2.8	0.2	235.6	6.5	7.3	7.1	6.6	360	360
Low-158	1.75	0.2	146.3	9	2.4	2.3	1.7	360	360
316	1.75	0.2	299	9	4.8	4.7	4.1	360	360
474	1.75	0.2	451.7	9	7.3	7.1	6.6	360	360
790	1.25	0.2	763.3	11.7	7.3	7.1	6.6	360	360
1580	1.25	0.2	1,555.20	16.7	7.3	7.1	6.6	360	360
Tolerance	—			—	—	± 3 mm	± 3 mm	± 3 mm	—

NOTE The approximate working capacities shown in Column 3 apply to flat-bottom tanks. Cone-bottom tanks have 150 mm. greater working height than the corresponding flat-bottom tanks. The approximate increase in capacity is 2.7 m³ for the 4.5 m diameter tanks, 5.1 m³ for the 6.5 m diameter tanks, 9.9 m³ for the 9 m. diameter tanks, 16.5 m³ for the 11.7 m diameter tanks, and 33.1 m³ for the 16.7 m diameter tanks.

a See 5.7.5 for frangible roof 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 150 mm. less than shown in Column 6 above, and dimension E of the fill-line connection shall be 150 mm., ± 3 mm.

Table 5.1b—Tank Dimensions (see Figure 5.1)(USC)

(1) Nominal Capacity (bbl)	(2) Design Pressure (oz/in ²) ^a		(3) Approximate Working Capacity (bbl) (See NOTE)	(4) Nominal Outside Diameter (ft, in) A	(5) Nominal Height (ft, in) B	(6) Height of Overflow-line Connection ^b (ft, in) C	(7) Height of Walkway Lugs (ft, in) D	(8) Location of Fill-line Connection ^b (in) E	(9) Size of Connections NPS
	a Pressure	b 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-1000	6	1/2	923	21, 6	16, 0	15, 6	13, 7	14	4
1500	6	1/2	1438	21, 6	24, 0	23, 6	21, 7	14	4
Low-1000	4	1/2	784	29, 9	8, 0	7, 6	5, 7	14	4
2000	4	1/2	1774	29, 9	16, 0	15, 6	13, 7	14	4
3000	4	1/2	2764	29, 9	24, 0	23, 6	21, 7	14	4
5000	3	1/2	4916	38, 8	24, 0	23, 6	21, 7	14	4
10,000	3	1/2	9938	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. 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 5.7.5 for frangible roof 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.

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5.3 Weld Size

Weld size shall be based on the following dimensions.

5.3.1 Groove Welds

Groove weld size shall be based on joint penetration (depth of chamfering plus the root penetration when specified).

5.3.2 Fillet Welds

5.3.2.1 For equal leg fillet welds, weld size shall be based on: the leg length of the largest isosceles right triangle that can be inscribed within the fillet-weld cross section.

5.3.2.2 For unequal leg fillet welds, weld size shall be based on: the leg lengths of the largest right triangle that can be inscribed within the fillet-weld cross section.

5.4 Joints

5.4.1 General

See Section 3 for the definitions of terms related to joints as used in this specification.

5.4.2 Joint Restrictions

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

5.4.2.1 Tack welds shall not be considered as having any strength value in the finished structure.

5.4.2.2 The minimum size of fillet welds shall be as follows:

- a) Plate 5 mm (3/16 in.), in thickness: full-fillet welds;
- b) Plates over 5 mm (3/16 in.) thick, not less than one-third the thickness of the thinner plate at the joint, with a minimum of 5 mm (3/16 in.), except otherwise noted.

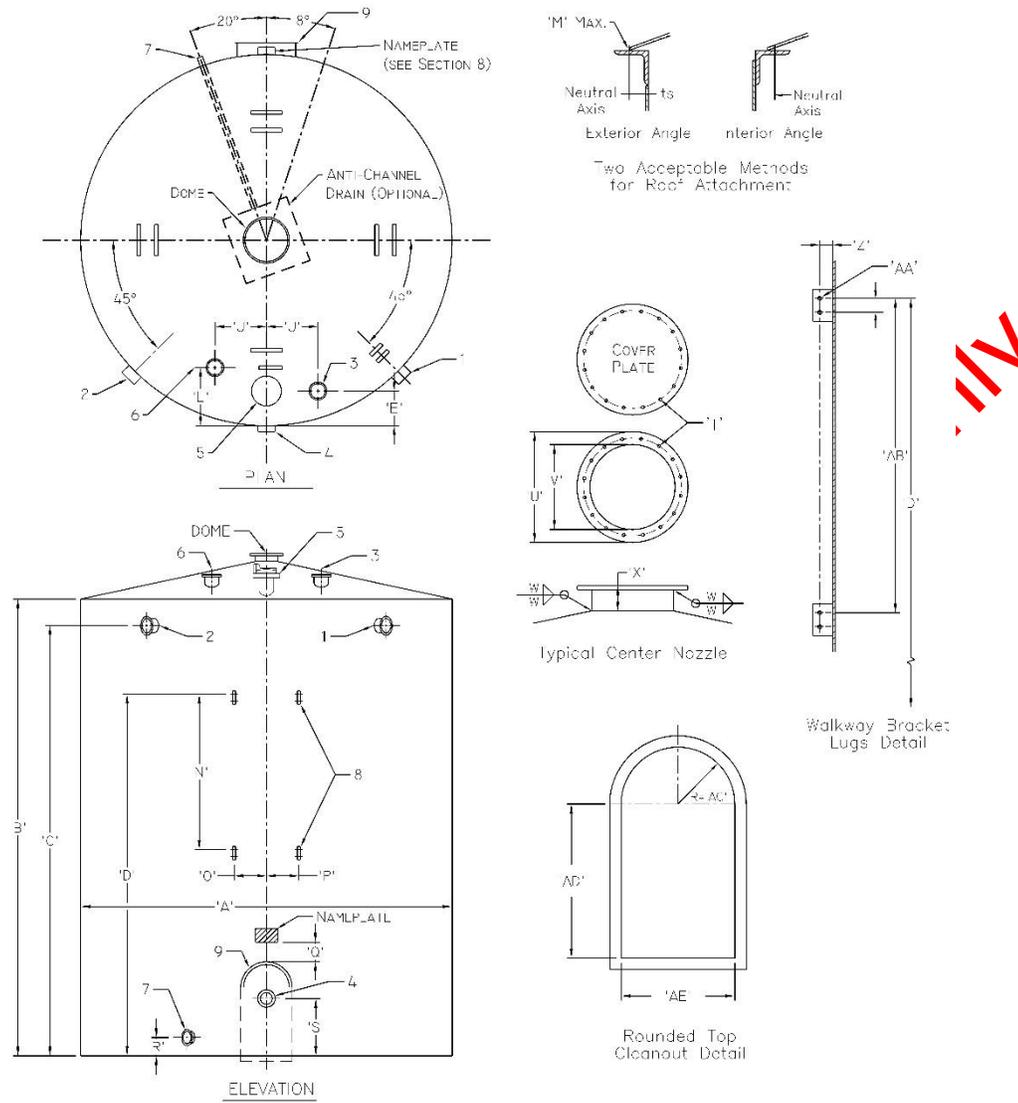
5.4.2.3 Single-welded lap joints shall not be used on shell plates.

5.4.2.4 Welds of couplings, cleanouts, other connections or appurtenances, and bottom plate joining butt joints shall not be placed in, or align within, 25 mm (1 in.) of shell or bottom weld seams. Reinforcing plates (if used) shall not overlap plate seams. If there is no other feasible option and the purchaser accepts the design, circular shell openings and reinforcing plates (if used) may be located in a horizontal or vertical groove-welded shell joint, provided that the minimum spacing dimensions of API 650 are met.

5.5 Bottom Design

5.5.1 Type

Tank bottoms shall be flat or of the cone design, as specified on the purchase order. In addition, if cone bottoms are used, they shall conform to Figure 5.2



- 1. Overflow Line Connection (C-4)
- 2. Overflow Line Connection (C-5)
- 3. Fill-line Connection (C-2)
- 4. Pipe-line Connection (C-6)
- 5. Gauge Hatch
- 6. Vent-line Connection (C-3)
- 7. Drain line Connection (C-3)
- 8. Walkway Bracket Lugs
- 9. Extended Neck Rounded Top Cleanout

Figure 5.1

SCA

Key to figure 5.1 – Dimensions

Assigned Variable	US units	SI units
A	Table 5.1b (ft, in)	Table 5.1a (m)
B	Table 5.1b (ft, in)	Table 5.1a (m)
C	Table 5.1b (ft, in)	Table 5.1a (m)
D	Table 5.1b (ft, in)	Table 5.1a (m)
E	Table 5.1b (ft, in)	Table 5.1a (mm)
I	18 in	450 mm
J	18 in	450 mm
L	21.5 in	545 mm
M	0.1875 in	5 mm
N	40 in	1 m
O	13 in	330 mm
P	13 in	330 mm
Q	12 in	300 mm
R	4 in	100 mm
S	14 in	355.5 mm
T	23 1/2 in B.C and (16) 3/4 in Holes for 5/8 in Bolts in	23 13 mm B.C and (16) 19 mm in Holes for 17 mm Bolts
U	26 in	660 mm
V	20 in	500 mm
W	0.25 in	6 mm
X	6 in	150 mm
Y	0.25 in	6 mm
Z	1.75 in	45 mm
AA	0.5625 in	14 mm
AB	40 in	1 m
AC	1 ft	300 mm
AD	2 ft	600 mm
AE	3 ft	1 m

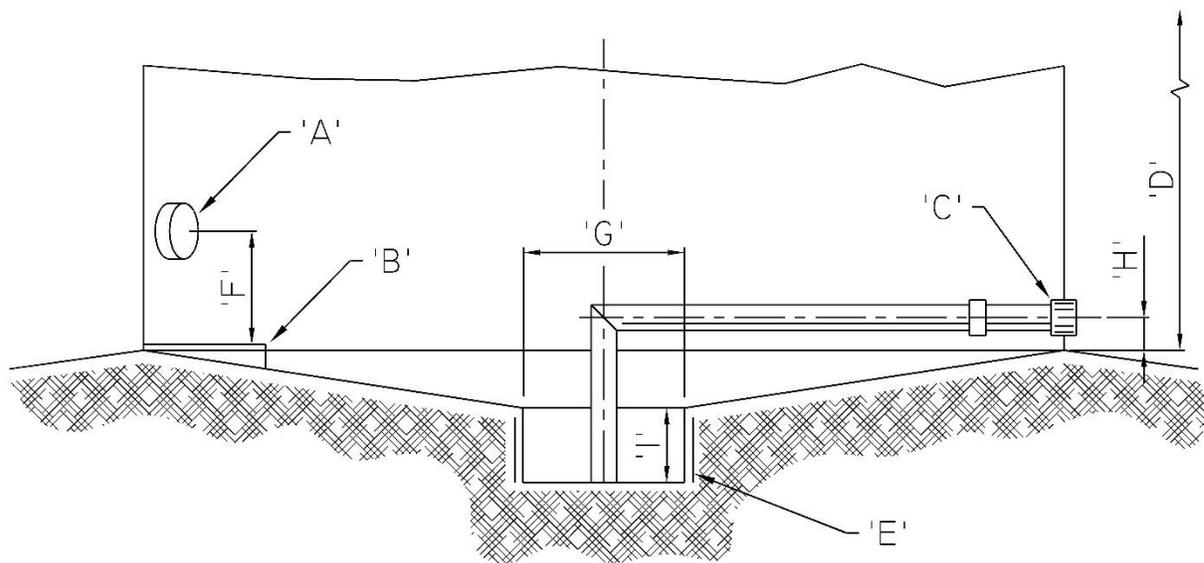


Figure 5.2—Cone Bottom

Key to figure 5.2 – Dimensions

Assigned Variable	US units	SI units
A	Pipe-line Connection	-
B	Gauge / Thief Bumper Plate	-
C	Drain-line Connection	-
D	Tank Height	-
E	Sump Protection Ring	-
F	8 in	200 mm
G	20 in	500 mm
H	4 in	100 mm
I	2 in	50 mm

5.5.2 Thickness

The thickness of bottom plates shall be 6 mm (1/4 in.) nominal, except that the sump of the cone shall be 10 mm (3/8 in.) nominal

5.5.3 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 25 mm (1 in.) minimum lap when tack welded. In addition, butt joints, if used, shall have complete weld penetration.

5.5.4 Shell Attachment

Tank bottoms shall be attached to tank shells by using full-fillet welds, both inside and outside.

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5.6 Shell Design

5.6.1 Shell Plates

5.6.1.1 Thickness

The thickness of shell plates shall be either 6 mm (1/4 in.) or 5 mm (3/16 in.), as specified on the purchase order.

5.6.1.1.1 The thickness of the first 2.4 m (8 ft.) vertical height of shell plates for 1,590 m³ (10,000 bbl) tanks shall not be less than 6 mm (1/4 in.)

5.6.1.1.2 The width of the shell plates shall be determined by the manufacturer, but preferably should not be less than 1.5 m (60 in.).

5.6.2 Shell Joints

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

5.6.3 Compression Ring

The shell shall be fitted with a top angle having minimum dimensions of 65 mm x 65 mm x 6 mm (2 1/2 x 2 1/2 x 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.

5.7 Roof Design

5.7.1 Type

The roof shall be of the cone type with a slope of 1:16, and shall be furnished with a center roof nozzle and a center roof support.

- a) For roofs 4.5 m (15 ft. 6 in.), in diameter, added structural supports in the form of rafters shall be provided if the thickness of the roof is less than 6 mm (1/4 in.) nominal. Roofs having a 6 mm (1/4 in.) thickness do not require additional structural supports unless needed for site load conditions.
- b) For roofs larger than 4.5 m (15 ft. 6 in.) in diameter, added structural supports in the form of rafters shall be provided.

5.7.2 Thickness

The thickness of roof plates shall be either 5 mm (3/16 in.) nominal, or 6 mm (1/4 in.) nominal, as specified on the purchase order.

5.7.3 Roof Joints

Roof joints shall be double-welded butt joints, single-welded butt joints with backing, or single-welded full-fillet lap joints with a 25 mm (1 in.) minimum lap when tack welded. In addition, butt joints, if used, shall have complete weld penetration.

5.7.4 Shell Attachment

The tank roof shall be attached to the tank shell by full fillet welds, both inside and outside, except as provided in 5.7.5.

5.7.5 Shell Attachment for Frangible Roofs

When specified by the purchaser, the tank may be provided with a frangible roof. In that case, the design pressure shall not exceed the weight of the roof, including rafters, if external. The roof shall be attached to the compression ring by a single-fillet weld not to exceed 5 mm (3/16 in.) and applied to the top side only. Internal rafters, if used, shall not be welded to the roof plates. The applicable requirements of API 650 shall apply for frangible roof design.

5.7.6 Roof Support

In addition to the dead load, roof supports shall be designed to support a live load of 1.0 kPa (20 lb/ft²). Allowable design stresses shall be as follows.

Table 5.7—Allowable Roof Support Stresses

Support Type	Allowable Design Stresses
Rolled Structural Shapes	
Tension, max	140 MPa (20,000 psi)
Bending, max	140 MPa (20,000 psi)
Compression, max	140 MPa (20,000 psi)
	$1 + L^2/20,000 \cdot r^2$
L/r ratio, max ^a	200
Formed Sections	
Basic design stress, max	124 MPa (18,000 psi)
Column Footings	
Soil-bearing load, max ^b	191 kPa (4,000 psi)
Note: a L is the unbraced length, in inches (mm), R is the governing radius of gyration, in inches (mm) b Based on max. water load plus super-imposed roof	

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5.8 Cleanout

Tanks shall be furnished with an extended-neck cleanout having a minimum opening of 600 mm (24 in.) by 900 mm (36 in.) high. The top of the cleanout shall be rounded with a minimum 300 mm (12 in.) radius. The thickness and shape of the neck shall be designed to completely reinforce the shell course, or additional external reinforcement 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 pieces, as specified on the purchase order. Handles for lifting the cleanout cover plate(s) shall be furnished.

5.9 Connections

5.9.1 Tanks shall be provided with inlet and outlet connections, as shown in Table 5.1 and Figure 5.1. Unless otherwise specified by the purchaser, connections shall be full couplings and shall be attached to the tank shell by full-fillet welds on both inside and outside surfaces, with equal projections inside and outside the tank, except that half-couplings may be used for the C-4 and C-5 overflow line connections and the C-6 pipe-line connection (see Figure 5.1) at the option of the manufacturer. Additional or fewer connections of other sizes or locations may be provided, if agreed upon between the purchaser and the manufacturer.

5.9.2 When flanges or other types of connections are specified, the nozzle neck shall be a minimum standard weight pipe and attached by full-fillet welds both inside and outside. The bolting pattern for gauge/thief hatches shall conform to one of those shown in Figure 5.3. Gauge/thief hatches, when used, should be 200 mm (8 in.) by 560 mm (22 in.) obround for pressures up to and including 1.75 kPa (4 oz/in.2) and 200 mm (8 in.) round for pressures greater than 1.75 kPa (4 oz/in.2).

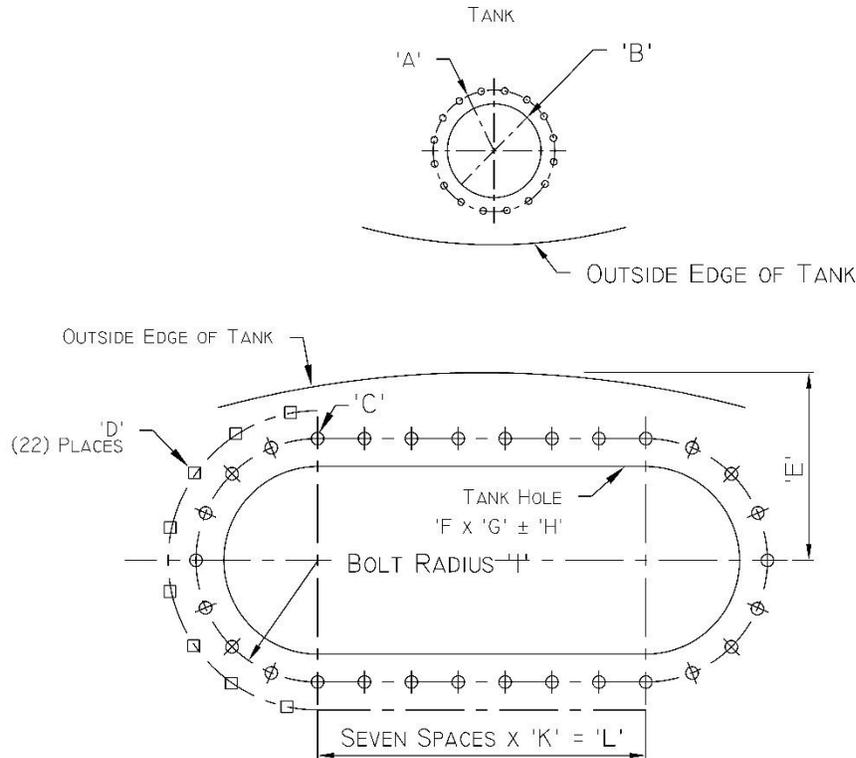


Figure 5.3—Gauge/Thief Hatch Cutout Details

Key to figure 5.3—Dimensions

Assigned Variable	US units	SI units
A	10 3/8-in BC, (16) 9/16 Holes	264mm BC, (16) 14 mm Holes
B	8 in	200 mm
C	(30) 17/32-in Holes, for 1/2-in bolts, spaced 2-in center	(30) 13.75 mm Holes, for 13 mm bolts, spaced 50 mm center
D	0.5 in	13 mm
E	8 in	200 mm
F	8 in	200 mm
G	22 in	560 mm
H	0.5 in	13 mm
I	0.1875 in	5 mm
J	0.375 in	10 mm
K	2 in	50 mm
L	14 in	355.5 mm

5.9.3 The purchaser shall provide full details of external piping loads or vibration expected to be imposed on the connections in the liquid section of the shell. The manufacturer shall provide additional reinforcement of those openings, when required.

5.10 Center Roof Nozzle

The center roof nozzle shall be fabricated from 6 mm (1/4 in.) material and shall be installed as shown in Figure 5.1. The cover shall be provided with a gasket of 5 mm (3/16 in.) minimum thickness and compatible with the stored product.

5.11 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. When cone bottoms are furnished, the center support shall not interfere with the function of the sump.

5.12 Anti-channel Drain Baffle

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

- a) The periphery of the baffle, in plan view, shall be 1625 mm (64 in.).
- b) The height of the baffle from the inside surface of the tank bottom to the top of the baffle shall be 133 mm (5 1/4 in.) minimum.

- c) The baffle shall be equipped with spacers so that the bottom edge of the baffle is 25mm (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 NPS 4.
- 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.

5.13 Downcomer Pipe

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

5.14 Walkways, Stairways, and Ladders

Walkways, stairways, and ladders, if provided, shall conform to 12R1.

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6 Venting Requirements

6.1 Normal Venting

A C-3 vent line connection (see Figure 5.1) is provided for normal inbreathing and outbreathing due to temperature changes and to liquid movement in and out of the tank. This connection should be fitted with a pressure-vacuum valve properly sized in accordance with API 2000. The pressure setting should be from 0.8 kPa (2 oz/in.2) to 1.7 kPa (4 oz/in.2) less than the opening pressure of devices used for emergency venting.

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 that will provide capacity in addition to normal venting to meet the requirements of API 2000. The opening pressure of such devices shall not exceed the design pressure of the tank on which the devices are installed. The maximum internal pressure under relieving conditions shall not exceed that tabulated in column 2a of Table 5.1a or Table 5.1b. Pressure-relieving devices may take the form of larger or additional vent valves or additional gauge / thief hatches.

7 Construction, Testing, and Painting

7.1 Construction

Tank construction shall be completed in the field in accordance with the applicable sections of this specification, using acceptable industry practices. When agreed upon between the purchaser and the manufacturer, tanks may be completely fabricated in the manufacturer's shop prior to delivery to the 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 & Pressure Vessel Code is recommended.

7.3 Testing

7.3.1 Bottoms of field erected tanks shall be tested by applying a 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 it with water for a period of not less than 12 hours and testing the roof either by applying air pressure or by vacuum testing the joints. Test water shall be provided and disposed of 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 5.7.5).

CAUTION When testing with air, adequate valves, regulators, and pressure relief devices shall be used to prevent overpressure or permanent deformation. There is an increased risk related to pneumatic testing if failure occurs. There is more potential energy stored in the compressed air and broken pieces can be launched a large distance.

7.3.2 Testing and the repair of any defects shall be completed before completion of hydrotest.

NOTE See API Standard 650 for additional information and requirements for vacuum testing of welded joints.

7.4 Visual Examination

7.4.1 All welds shall be examined by the visual method. The final weld shall be cleaned of slag and other deposits prior to examination. Visual examination acceptance and repair criteria are specified below.

7.4.2 The Manufacturer shall determine and certify that each visual examiner meets the following requirements.

- a) Shall have the ability (with correction, if necessary) to read Jaeger Number 2 letters or smaller at a minimum distance of 300 mm (12 in.) (or equivalent test) in at least one eye with or without correction. AWI, WI, or SWI shall take a color perception test and shall take a contrast differentiation shades of gray test.). Examiners shall be checked annually to ensure that they meet this requirement; and
- b) Is competent in the technique of the visual examination, including performing the examination and interpreting and evaluating the results; however, where the examination method consists of more than one operation, the examiner performing only a portion of the test need only be qualified for the portion that the examiner performs.

7.4.3 A weld shall be acceptable by visual examination if the inspection shows the following.

- a) There are no crater cracks, other surface cracks or arc strikes in or adjacent to the welded joints.
- b) Maximum permissible undercut is 0.4 mm (1/64 in.) in depth for vertical butt joints, vertically oriented permanent attachments, attachment welds for nozzles, manholes, flush-type openings, and the inside shell-to-bottom welds. For horizontal butt joints, horizontally oriented permanent attachments, and bottom joints, the maximum permissible undercut is 0.8 mm (1/32 in.) in depth. Welds have to be reinspected after grinding. Note that grinding could reveal near surface defects that were not previously visible as well as removing too much material.
- c) The frequency of surface porosity in the weld does not exceed one cluster (one or more pores) in any 100 mm (4 in.) of length, and the diameter of each cluster does not exceed 2.5 mm (3/32 in.).
- d) The reinforcement of the welds on all butt joints on each side of the plate shall not exceed 2.5 mm (3/32 in.) for vertical welds and 3 mm (1/8 in) for horizontal welds. The reinforcement need not be removed except to the extent that it exceeds the maximum acceptable reinforcement.

7.4.4 A weld that fails to meet the criteria given in 7.4.3 shall be reworked before final hydrostatic testing as follows.

- a) Any defects shall be removed by mechanical means or thermal gouging processes. Arc strikes discovered in or adjacent to welded joints shall be repaired by grinding and rewelding as required. Arc strikes repaired by welding shall be ground flush with the plate.
- b) Rewelding is required if the resulting thickness is less than the minimum required for design or hydrostatic test conditions. All defects in areas thicker than the minimum shall be feathered to at least a 4:1 taper.
- c) The repair weld shall be visually examined for defects.

7.5 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.

7.6 Internal Coating

Where internal coating is required, the procedures and methods outlined in API RP 652 and NACE SP0178 are recommended as a minimum requirement. Coating application, including surface preparation, shall be performed in accordance with the coating manufacturer's specifications. Other coatings and methods may be used by agreement between the purchaser and manufacturer.

7.7 Clean Up

Upon completion of erection, the manufacturer or erector shall remove or dispose of all rubbish and other unsightly material resulting from the work and shall leave the premises in as good a condition or better than what it was at the start of the work.

8 Marking

8.1 Tanks manufactured in accordance with this specification shall be identified by a nameplate bearing the information shown in Figure 8.1.

8.2 The nameplate shall be stamped, etched, or embossed on corrosion-resistant material and permanently attached to a bracket or backing plate of ferrous material. Alternatively, nameplate information may be die-stamped on a steel plate. In addition, the bracket, backing plate, or nameplate shall be seal welded to the tank shell in the location shown in Figure 5.1.

Manufactured in Accordance with API Specification 12D	
Manufacturer:	_____
Serial Number:	_____
Year Built:	_____
Nominal Diameter:	_____
Nominal Height:	_____
Bottom Thickness:	_____ Type: _____
Shell Thickness:	_____
Deck Thickness:	_____
Nominal Capacity	_____

Figure 8.1—Nameplate Format

API Staff NOTE: Prior to publishing Figure 8.1 will be modified to match the addition of Sect. 8.2, and a line will be added at the top to include the specific edition and date of Spec. 12D the tank bearing the nameplate is built to.

9 Inspection and Rejection

9.1 Inspection Notice

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

9.2 Inspection

9.2.1 The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, and to all parts of the manufacturer's works that 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. The manufacturer in agreement with the Purchaser shall produce an Inspection Test Plan (ITP) that clearly identifies witness and hold points both during shop fabrication and field construction.

9.2.2 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 so as not to interfere unnecessarily with the manufacturer's operations.

9.3 Rejection

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

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Annex A

(informative)

Use of API Monogram by Licensees

A.1. Scope

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

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

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

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

A.2. Normative References

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

A.3. Terms and Definitions

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

A.3.1 API Monogrammable Product

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

A.3.2 API Specified Requirements

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

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

A.3.3 API Product Specification

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

A.3.4 Licensee

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

A.3.5 Design Package

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

A.4. Quality Management System Requirements

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

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

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

- a) Products that do not conform to API specified requirements shall not bear the API Monogram.
- b) Each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:
 - 1) define the authority responsible for application and removal of the API Monogram;
 - 2) define the method(s) used to apply the Monogram;
 - 3) identify the location on the product where the API Monogram is to be applied;
 - 4) require the application of the licensee's license number and date of manufacture of the product in conjunction with the use of the API Monogram;

- 5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and
 - 6) require application of the additional API product specification(s) and/or standard(s) marking requirements.
- c) Only an API licensee may apply the API Monogram and its designated license number to API monogramable products.
 - d) The API Monogram license, when issued, is site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location.
 - e) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

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

A.6. Design Package Requirements

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

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

A.7. Manufacturing Capability

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

A.8. API Monogram Program: Nonconformance Reporting

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

Annex B (informative)

Suggestions for Ordering Field-welded Tanks

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

Specification	API Specification 12D
Number of tanks	_____
Nominal Capacity	Table 5.1, Column 1
Size	5.2
Outside diameter	Table 5.1, Column 4
Height of shell	Table 5.1, Column 5
Type of bottom	5.5.1
Shell plate thickness	5.6.1.1
Roof plate thickness	5.7.2
Delivery date and shipping instructions	_____
Inspection by purchaser	9.2
The purchaser should also state on the purchase order requirements concerning the following stipulations, which are optional with the purchaser.	
Bolting	4.9
Viscous oil options	Table 5.1, Footnote b
Cleanout cover-plate design	5.8
Anti-channel drain baffle	5.12
Downcomer pipe and design	5.13
Walkways, stairways, and ladders	12R1
Attention is also called to the following stipulations, which are subject to agreement between the purchaser and manufacturer.	
Materials	4.1

Alternative bolting materials and/or finish	4.9.5
Additional connections	5.9.1
Finish coats of paint	7.4
Internal coating	7.5

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Annex C (informative) Background on Past Editions

The table below provides a list of past editions and supplements.

Table D.1 Editions of API RP 12D

API Specification 12D	
Edition	Date
1 st Edition	1941
2 nd Edition	May 1942
2 nd Edition, Supplement 1	March 1943
2 nd Edition	May 1942
3 rd Edition	September 1944
3 rd Edition, Supplement 1	August 1946
3 rd Edition, Supplement 2	August 1947
4 th Edition	1954
5 th Edition	1955
6 th Edition	1956
7 th Edition	August 1957
8 th Edition,	January 1977
9 th Edition	January 1982
9 th Edition, Supplement 1	March 1983
9 th Edition, Supplement 2	May 1, 1985
10 th Edition	May 2000
11 th Edition	October 2008
12 th Edition	June 2017
13 th Edition	XXX 20XX



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