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API Std 12A
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API
SPECIFICATION
for
OIL STORAGE TANKS
WITH RIVETED SHELLS

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API SPECIFICATION FOR TANKS WITH RIVETED SHELLS FOR OIL STORAGE

Foreword to September, 1951 Reprint of the Seventh Edition

a. At the November, 1941 meeting the tank committee agreed that all committee activity involving modifications and revisions of Std 12A be suspended. Accordingly, a number of proposed changes in Std 12A, which were approved by the committee at the 1941 meeting (and subsequently) were not balloted. These changes are detailed below. It is recommended that agreement be reached between the purchaser and the manufacturer regarding the application of these proposed changes.

I. Location of Name Plate

(Adopted November, 1941)

Existing Par. 38, Std 12A revised to require the attachment of the name plate to the shell plate adjacent to the manhole by continuous welding or brazing, or by permanent attachment to an auxiliary plate, the latter to be affixed to the shell plate by a continuous weld.

II. Inspection and Repairs

(Adopted November, 1941)

Existing Par. 88 and 89, Std 12A revised to require that weld quality and repair of defective welds conform to the applicable provisions of Std 12C.

III. Welded Appurtenances

(Adopted November, 1941)

Std 12A revised to permit the use of welded appurtenances conforming to Std 12C as an alternative to existing appurtenance requirements.

IV. Purchaser's Requirements on Appurtenances

(Adopted November, 1941)

Std 12A revised by the deletion of Table 17 which covers the purchaser's appurtenance requirements and Fig. 7 which covers location of appurtenances.

V. Plate Thickness

(Adopted November, 1941)

Par. 3, Std 12A revised to require that plates be specified on a thickness basis, where the thickness is such that the anticipated under-run on plates ordered on a weight basis will be sufficient to increase the joint stresses beyond the allowable maximum. (See Par. 2.2, Std 12C, 10th Edition.)

VI. Appendix B: Order Form

(Adopted November, 1941)

Appendix B: Order Form, Std 12A revised by changing the method of indicating the height of tank from "number of rings" to "feet."

VII. Appendix D: Recommended Practice

(Adopted November, 1941)

Par. f, Appendix D: Recommended Practice, Std 12A revised by changing the word "shall" to "should."

VIII. Rivets $\frac{3}{4}$ in. in Diameter and Smaller

(Adopted June, 1949)

Par. 67, Std 12A revised to permit rivets $\frac{3}{4}$ in. in diameter and smaller to be driven cold or hot, except that bottom rivets shall be driven hot, unless special conditions make cold driving necessary, and that rivets larger than $\frac{3}{4}$ in. in diameter shall be driven hot.

IX. Attachment of Outside Butt Plate to Adjoining Plate

(Adopted June, 1949)

Std 12A revised to permit the welding of outside butt plate directly to the adjoining shell plate as an alternative to scarfing.

X. Wind Girders for Open-Top Tanks

(Adopted June, 1949)

Std 12A supplemented by the addition of requirements on wind girders for open-top tanks as set forth in Std 12C.

b. Certain ASTM specifications are referenced in Std 12A. Changes in such specifications, which have been adopted by the tank committee for API Std 12C and which are applicable also to Std 12A, are detailed below. It is suggested that agreement be reached between the purchaser and the manufacturer regarding the application of any of these changes.

I. ASTM A 283, grade D

This specification covers carbon steel plates of a quality equivalent to ASTM A 7.

II. ASTM A 10

This specification has been withdrawn by ASTM and replaced by ASTM A 283, grade C.

III. ASTM A 27, grade A 3

Grade A 3 applied to steel castings in the full annealed condition with a minimum yield point of 30,000 psi. and a minimum tensile strength of 60,000 psi. This specification grade was dropped in the 1944 revision of A 27. The corresponding current grade designation is "60—30, full annealed."

Foreword to the Seventh Edition

(a) This Specification was prepared by the API Committee on the Standardization of Steel Tanks for Oil Storage, and is recommended for the use of the oil industry in all districts of the United States.

(b) This Specification is designed to provide the industry with tanks of adequate safety and reasonable economy in a sufficient range of sizes to cover usual operating requirements, so designed that the entire range of sizes can be built with a minimum number of plate sizes, and with details conforming with modern manufacturing practice.

(c) The detail drawings (bound separately) listed in Appendix E, which form a part of this specification, provide working designs in accordance with the Specifications for tanks having diameters of 36, 48, 60, 78, 102, 120 and 144 ft. built with 72-in. courses. Detail construction drawings for tanks of 12, 18, 24, 30, and 36 ft. diameter.

and for 9th and 10th courses, are not available. See Par. 14 and 42. Detail drawings also provide designs for manholes, oil connections, drain connections, roof openings, and stairways. The use of appurtenances shown on these drawings, or designs of equivalent strength and tightness, will be required on tanks to which the API monogram is attached.

(d) Tables 1 and 2 herein show the sizes and capacities of tanks that may be obtained under this specification.

(e) Other standards, under the jurisdiction of the Committee on Standardization of Tanks for Oil Storage, include the following:

12B: Specification for Bolted Tanks

Covers dimensional details for bolted tanks and their appurtenances, including stipulations on walkways and stairways.

12C: Specification for Welded Oil Storage Tanks

Covers materials, design, fabrication, and erection of welded oil storage tanks, including requirements for welding procedure and operator qualification. Includes also recommended practices for use of aluminum alloys and low-alloy, high-strength steels.

12D: Specification for Welded Production Tanks (Tentative)

Includes requirements on materials, plate thicknesses, and design factors for welded production tanks and, by reference, covers design, fabrication, and erection details, and other data.

12E: Specification for Wooden Tanks (Tentative)

Covers major dimensions, quality of material, and sizes for wooden tanks, including stipulations on bolted piping flanges, and on bolting patterns for thief hatches and relief valves.

(†) This specification provides major design details for 8-ring tanks with 100-in. plates, sizes 36 to 168 ft. diameter; for 9th and 10th courses of tanks with 72-in. plates, sizes 36 to 144 ft. diameter; and for all courses (1st to 10th inclusive) 72-in. plates, 168-ft. diameter tanks. These design details are based upon drilled holes and hot driven rivets, except where alternate lap joints are shown for hot and cold driven rivets. Slight improvements in design methods account for the differences in edge distance, back pitch, and rivet pitch between this group of tanks and those for which design details had been published previously. No changes have been made in the existing standard designs.

TABLE 1
TANK SIZES—72" COURSES
APPROXIMATE CAPACITIES IN 42-GAL. BARRELS,
TANK LEVEL FULL

Diameter (Ft.)	Nominal Height (Ft.) (1)								
	11.8	17.6	23.4	29.2	34.9	40.7	46.4	52.1	57.8
	Number of Courses								
	2	3	4	5	6	7	8	9	10
12(*)	240	360	480	590	720				
18(*)	540	810	1070	1340	1600				
24(*)	960	1440	1910	2380	2850				
30(*)	1500	2240	2980	3710	4450				
36(*)	2140	3190	4240	5290	6330	7380	8410	9440	10500
48(*)	3800	5670	7540	9410	11300	13100	15000	16800	18600
60(*)	6040	9000	12000	14900	17900	20800	23700	26700	29600
72(*)	10000	15000	19900	24900	29700	34600	39500	44300	49200
102(*)	17200	25600	34100	42500	50800	59200	67500	75800	84100
120(*)	23800	35500	47100	58800	70300	82000	93500	105000	116000
144(*)	34200	51100	67900	84700	101000	118000	135000	151000	168000
168(*)	46000	69000	91000	114000	136000	159000	181000	203000	225000

(1) Heights shown are approximate and are based on 72" sheets; see detail drawings for exact heights.

(2) Sizes having diameters 12" to 80", inclusive, adopted December, 1928; detail drawings not available; see Par. 42.

(3) Detail drawings available for sizes 86" to 144", inclusive, up to and including 8 courses; see Appendix "E".

(4) 9th and 10th courses, and 168-ft. diameter tank, adopted June, 1937; detail drawings not available. Use of these sizes of tanks is classed as a "Permissible Alternate", subject to agreement between supplier and purchaser. See Par. 14, 16, and 42, and Appendix "C". Joint details shall be in accord with Tables 6-A, 6-B, and 7 herein. See footnote to Par. (c) of Foreword.

TABLE 2
TANK SIZES—100" COURSES (1)
APPROXIMATE CAPACITIES IN 42-GAL. BARRELS,
TANK LEVEL FULL

Diameter (Ft.)	Nominal Height (Ft.)					
	16.3	24.4	32.5	40.6	48.6	56.6
	Number of Courses					
	2	3	4	5	6	7
36	2950	4420	5890	7360	8810	10800
48	5250	7860	10500	13100	15700	18200
60	8340	12500	16600	20800	24900	29000
72	13300	19900	26500	33100	39600	46100
102	23700	35500	47300	59100	70700	82400
120	32800	49200	65500	81800	97900	114000
144	47800	70800	94300	118000	141000	164000
168	64400	96800	128000	160000	192000	223000

(1) Detail drawings are not available for tanks with 100" courses. Use of these sizes of tanks is classed as a "Permissible Alternate", subject to agreement between supplier and purchaser. See Par. 14, 16, and 42, and Appendix "C". Joint details shall be in accord with Tables 8 and 9 herein. See footnote to Par. (c) of Foreword.

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PART I. DESIGN SPECIFICATION

SECTION 1. MATERIAL

Plates:

1. Plates shall conform to ASTM** A 7 or A 10. Open hearth steel only shall be used.
2. Copper-bearing steel may be used for roof plates if so specified by the purchaser.
3. Plate specification by weight is recommended, and plates purchased on weight specifications shall individually comply with the normal tolerances as they appear in this specification. The plate thicknesses, or weights, as stipulated herein are minimum; heavier material may be required on the order at option of the purchaser. Where plates are referred to by thickness in the specification, or on the drawings, the thickness shall be considered as nominal only.

Structural Steel:

4. Structural steel shall conform to ASTM** A 7.

**ASTM Specifications referred to herein may be secured from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. (See Special Note.)

Castings:

5. Steel castings shall conform at least to ASTM A 27, Grade A 3.

Rivets:

6. Rivets for hot driving shall conform to either ASTM A 141**, or ASTM A 31**, or ASME Boiler Code***.
7. Rivets for cold driving shall conform to ASTM A 31, soft annealed.
8. If copper-bearing steel is specified for the roof plates, the rivets shall contain the same percentage of copper.

SPECIAL NOTE: Attention is called to the fact that the minimum ultimate tensile strength requirements for steels meeting ASTM Specification A 7 was raised from 55,000 lb. per sq. in. in the 1933 issue to 60,000 lb. per sq. in. in the 1934 and subsequent issues. However, the consensus of the members of the API Tank Committee is that no attempt should be made to take advantage of the increased strength of these steels until further experience is had with them. Accordingly, the allowable stresses given in Paragraph 13 are unchanged from previous editions of this Standard.

***ASME Boiler Code referred to herein may be secured from the American Society of Mechanical Engineers, 29 West 39th St., New York City.

The principal provisions of these specifications are included in Appendix A, Tables 10 and 11.

SECTION 2. SHELL DESIGN

Loads and Working Stresses:

(See Appendix "A" for sample computations.)

9. Stresses are to be computed on the assumption that the tank is filled level full of water at 60 degrees Fahr.* and the tension in each ring is to be computed 12 inches above the bottom gauge line of the ring in question.

10. In computing net section of plate, rivet holes when punched $\frac{1}{8}$ inch over nominal diameter for hot driven rivets, are to be assumed $\frac{1}{4}$ inch larger than nominal diameter of the rivet; when punched $\frac{1}{4}$ inch over nominal diameter for cold driven rivets, holes are to be assumed $\frac{1}{2}$ inch larger than nominal diameter of rivet. When drilled, or when sub-punched and reamed, holes are to be assumed $\frac{1}{8}$ inch larger in diameter than nominal diameter of rivet.

*Water at 60° Fahr. weighs 62.37 lb. per cubic foot: see Merriman's Civil Engineers Pocket Book, (John Wiley & Sons, New York).

The net section of rivet to be used for computing shear values shall be, in the case of hot driven rivets, nominal diameter plus $\frac{1}{8}$ inch; in case of cold driven, nominal diameter plus $\frac{1}{4}$ inch.

11. All openings over 4 inches in diameter in the shell of the tank shall be reinforced. This reinforcement may be the flange of the fitting used, or an additional ring of metal, or both flange and ring.

12. The amount of reinforcement shall be computed as described in Appendix A of this specification.

13. The following maximum allowable working stresses shall be used in design:

Maximum tensile stress in net section of plate:
21,000 lb. per sq. in.

Maximum shear in net section of rivet:
16,000 lb. per sq. in.



Documents

Document Sharing Hub

Maximum bearing stress on plates or rivets:

35,000 lb. per sq. in. when rivets are in double shear.

32,000 lb. per sq. in. when rivets are in single shear.

Sizes of Plate and Tank:

14. Tank shall be designed so that the diameter is a multiple of six feet, using shell plates having a minimum net length (total length minus lap) of 6 pi feet (6 times 3.1416). The number of plates in each course shall not exceed the diameter of the tank divided by 6, and may be reduced from this number by agreement between purchaser and supplier. The minimum overall width of shell plates shall be 72 inches. Plates 100 inches wide, for tanks 36 feet and over in diameter, may be used by agreement between purchaser and manufacturer. Existing API standard drawings, which provide for eight courses using plate width of 72 inches, call for plate lengths of 6 pi feet. If longer plates are specified without change of width, vertical joint details shall be the same as for the standard plate length. Where 100-inch plates are used, or 72-inch plates are used for 9th and 10th courses or for 168-ft. diameter tanks, joint details shall conform to details given in Tables 6-A, 6-B, 7, 8, and 9.

When longer sheets are specified, or when 100-inch sheets are specified, or when 72-inch sheets are specified for 168-ft. diameter tanks or for 9th and 10th courses, it shall be considered as a "permissible alternate" to API Standard Riveted Tanks, subject to agreement between manufacturer and purchaser, and provision to use the API monogram on such tanks will be permitted, but such tanks may not be marked with the monogram until the manufacturer has furnished complete details of design, nor until such details have been approved by the purchaser; Appendices B and C are revised accordingly as given hereinafter.

15. The minimum thickness of shell plates shall be $\frac{1}{4}$ inch in tanks over 48 feet in diameter; and shall be $\frac{1}{8}$ inch in tanks 48 feet or less in diameter.

Note Paragraph 3.**Arrangement of Members:**

16. Tanks shall be designed with vertical rings so that all plates will be truly rectangular. Rings shall be arranged with relation to each other to permit the use of the same roof structure and riveted bottom details (except bottom angle) for all heights of tanks of one diameter.

NOTE: Available drawings for tanks 36' to 144' diameter inclusive are for plate widths of 72 inches, and employ the following arrangement of courses:

In tanks 6 rings high or less each ring is inside the one beneath it; in 7-ring tanks the second ring is outside the first and each ring above the second is inside the one beneath it; and in 8-ring tanks the second ring is inside the first, the third ring outside the second, and each ring above the third inside the one beneath it.

For tanks having 9 or 10 courses 72 inches wide, the first course shall be arranged as follows (See Note 4 to Table 1):

For 9 rings, the first ring shall be inside the second, and the second and higher rings shall be identical with a complete 8-ring tank.

For 10 rings, the first ring shall be outside the second, and the second and higher rings shall be identical with a complete 9-ring tank.

For tanks using 100-inch plates, arrangement of courses shall be as given above for 6, 7, and 8 course tanks.

17. The top angle shall ordinarily be placed on the inside of the shell; but may be placed on the outside if specifically so ordered by the purchaser.*

18. The bottom angle shall be inside the shell, unless ordered by the purchaser to be placed outside*.

Riveting:

19. The following combinations of rivet sizes and plate thicknesses are suggested:

$\frac{1}{8}$ " Plate		$\frac{1}{8}$ " Rivets
$\frac{1}{4}$ " Plate		$\frac{5}{16}$ " Rivets
$\frac{1}{4}$ " Plate		$\frac{3}{4}$ " Rivets
$\frac{3}{8}$ " Plate		$\frac{3}{4}$ " Rivets
$\frac{1}{2}$ " Plate		$\frac{3}{4}$ " Rivets
$\frac{1}{2}$ " to and incl. $\frac{5}{8}$ " Plate		$\frac{3}{4}$ " Rivets
Over $\frac{5}{8}$ " and incl. $\frac{3}{4}$ " Plate		1" Rivets
Over $\frac{3}{4}$ " and incl. $\frac{1}{2}$ " Plate		1 $\frac{1}{2}$ " Rivets
Over $\frac{1}{2}$ " Plate		1 $\frac{1}{4}$ " Rivets

20. In roundabout seams the same size of rivet shall be used as used in the vertical joint of the ring above.

21. Unless otherwise limited by considerations of stress, the minimum distance between centers of rivet holes shall be 3 times the nominal diameter of the rivet, and the maximum distance shall be 7 times the thickness of the plate, plus the nominal diameter of the rivet.

22. Where the net gage width of a course is not equal to a whole number of major pitches for the

*The drawings for sizes 36' to 144' inclusive, show bottom and roof plate layouts for riveted construction, with bottom and top angle inside. If riveted roof or bottom with angle outside is specified, then a different layout of sketch plates must be provided, showing the required extra lengths, and altered layout of circumference rivet circle. If welded roof or bottom is specified, layout will be similar to design shown for riveted, but laps at joints will be less, and sketch plates will ordinarily be cut to fit in the field. Longer sheets will be required for some of the sketch plates.

joint selected, the minor pitches at the plate edges shall be adjusted as shown in Fig. 1 herein. (This applies to 100-inch plates, and to 72-inch plates when used for 9th and 10th courses or for 168-ft. diameter tanks).

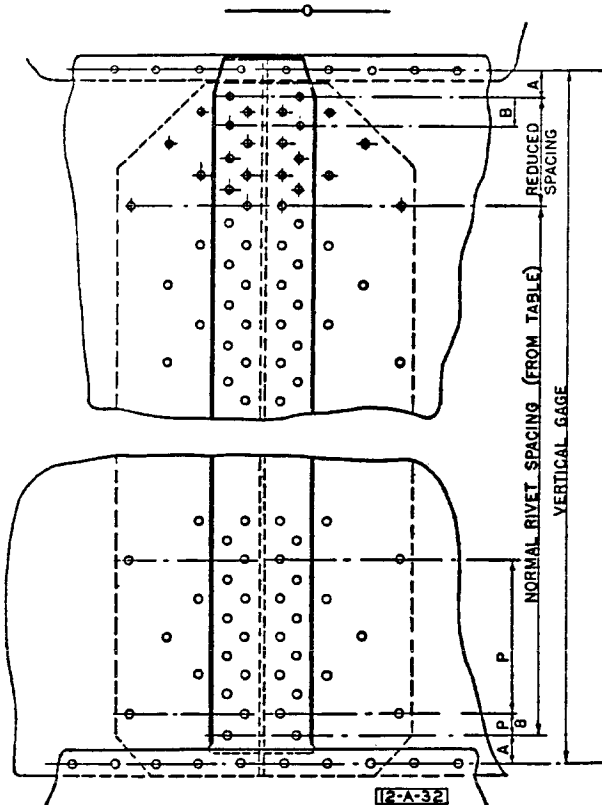


FIG. 1

EXAMPLE OF END ADJUSTMENT PITCHES

NOTES:

Dimension A may vary from two rivet edge distances (plus clearance if applicable) to maximum caulking pitch.

Dimension B may vary from three rivet diameters to the maximum caulking pitch. The number of minor pitches at reduced spacing is variable, but cannot exceed the number in one major pitch. Reduced spacing may be applied at the top of the course only.

Dimensions A and B should be selected to give reduced spacing which is as close as possible to the normal spacing for the course.

23. For tanks 144 feet in diameter or less, using eight 72-inch courses, or less, the distance from center lines of rivets to the edges of plates

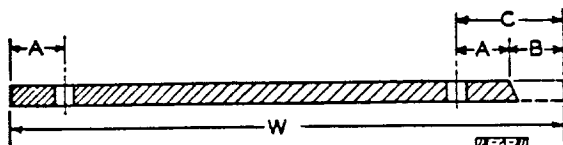


FIG. 2

and the allowance for bevel shearing or planing shall be as shown in Table 3. The distance between gauge lines of roundabout joints shall be exactly as found by deducting from "W", dimension "C" for edges to be caulked and dimension "A" for edges not to be caulked.

TABLE 3—EDGE DISTANCES

See Fig. 2

(See Par. 47 and 48)

(All Dimensions in inches)

Plate Thickness	Rivet Diameter	(See Sketch Above)		
		A	B	C
3/16	7/16	3/4	1/4	1
1/4	7/16	3/4	3/8	1-1/8
1/4	5/8	15/16	3/8	1-5/16
5/16	5/8	15/16	7/16	1-3/8
11/32	5/8	15/16	1/2	1-7/16
11/32	3/4	1-1/8	1/2	1-5/8
3/8	5/8	15/16	9/16	1-1/2
3/8	3/4	1-1/8	9/16	1-11/16
13/32	5/8	15/16	9/16	1-1/2
13/32	3/4	1-1/8	9/16	1-11/16
7/16	5/8	15/16	5/8	1-9/16
7/16	3/4	1-1/8	5/8	1-3/4
15/32	3/4	1-1/8	5/8	1-3/4
15/32	7/8	1-5/16	5/8	1-15/16
1/2	3/4	1-1/8	3/4	1-7/8
1/2	7/8	1-5/16	3/4	2-1/16
9/16	3/4	1-1/8	3/4	1-7/8
9/16	7/8	1-5/16	3/4	2-1/16
5/8	7/8	1-5/16	13/16	2-1/8
11/16	7/8	1-5/16	13/16	2-1/8
11/16	1	1-1/2	13/16	2-5/16
3/4	7/8	1-5/16	7/8	2-3/16
25/32	1	1-1/2	7/8	2-5/8
25/32	1-1/8	1-11/16	7/8	2-9/16
7/8	1-1/8	1-11/16	7/8	2-9/16
15/16	1-1/4	1-7/8	1	2-7/8
1	1-1/4	1-7/8	1	2-7/8
1-1/16	1-1/4	1-7/8	1	2-7/8

24. For tanks using 100-inch plates, or using 72-inch plates for 9th and 10th courses, or for 168-foot diameter tanks, the allowances for edge preparation are not specified but shall be held to a practical minimum.

25. For tanks 144 feet in diameter or less, using eight 72-inch courses, or less, the distance between the center lines of any two adjacent rows of rivets or the "back pitch," measured at right angles to the direction of the joint, shall be determined in accordance with Paragraphs A-4, A-5, and A-6, Appendix A. (These requirements correspond to Par. P-182, ASME Boiler Construction Code, edition of 1940.)

26. For tanks using 100-inch plates, or using 72-inch plates for 9th and 10th courses, or for 168-foot diameter tanks, the distance between the center line of any two adjacent rows of rivets, or the "back pitch," measured at right angles to the direction of the joint, shall be determined in accordance with Par. A-7 and A-8, Appendix "A".

SECTION 3. ROOF DESIGN

27. Conical steel roof and supporting structure shall be designed to carry a live load of 25 lbs. per sq. ft. in addition to the dead load, and the supporting structure shall be designed in accordance with the unit stresses given in Par. 31.

28. Structural channels shall be used for roof columns, except that steel pipe or other structural shapes of equivalent column strength may be used by agreement between manufacturer and purchaser.† The slope of the roof shall be $\frac{3}{4}$ inch in 12 inches, or other value as ordered by the purchaser, except that the slope of the self-supporting roof of the 12-foot tank shall be 2 inches in 12 inches‡.

29. Roof plates shall be $\frac{3}{8}$ inch thick**, not less than 72 inches wide, and shall have the same approximate length as $\frac{3}{8}$ -inch shell plates. Plates 100 inches wide may be used by agreement between purchaser and manufacturer. They may be either riveted or welded; if riveted, rivets shall be $\frac{3}{8}$ inch @ $1\frac{1}{2}$ inches pitch.

See "Permissible Variation" (C-4) in Appendix C.

30. Rafters shall be placed so that spacing in the outer row shall not be greater than 2 pi feet (2×3.1416); spacing on inner rows shall not be greater than $5\frac{1}{2}$ feet. In earthquake territory, $\frac{3}{4}$ -inch diameter tie rods shall be placed between rafters in the outer ring of rafters as indicated in Fig. 3. These tie rods may be omitted if I or H sections are used in rafters§.

31. Allowable Stresses: All parts of the structure shall be so proportioned that the sum of the maximum static stresses in pounds per square inch shall not exceed the following:*

Tension

Rolled Steel, on net section 18,000
On the area of the nominal diameter of rivets 13,500

Compression

Rolled Steel, on short lengths or where lateral deflection is prevented 18,000
On gross section of columns $1 + \frac{L^2}{18,000 r^2}$

**Note Paragraph 2.

†The detail drawings show channel columns; if pipe or other structural shapes are used, revised details of roof columns shall be provided by the manufacturer.

‡The drawings for sizes 86' to 144', inclusive, show roof plate layouts and roof support details for plates 72" wide, with a slope of $\frac{3}{4}$ inch in 12 inches. If a different slope or plate width is to be used, revised details of roof plates and supports shall be provided by the manufacturer.

§Drawings now call for channel section for rafters. I and H sections may be used as an alternate in earthquake territory by agreement between the purchaser and manufacturer.

*These requirements are based on the 1934 issue of the American Institute of Steel Construction "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", with certain changes made in recognition of the difference in load conditions between buildings and tank structures.

With a maximum of 15,000
in which "L" is the unbraced length of the column, and "r" is the corresponding least radius of gyration of the section, both in inches.

For main compression members, the ratio L/r shall not exceed 180

For bracing and other secondary members, the ratio L/r shall not exceed 200

Bending

On extreme fibers of rolled sections, and built-up sections, net section, if lateral deflection is prevented 18,000

When the unsupported length "L" exceeds $15 \times "b"$, the width of the compression flange, the stress in pounds per square inch in the latter shall not exceed 20,000

$$1 + \frac{L^2}{2,000 b^2}$$

The laterally unsupported length of beams and girders shall not exceed $40 \times "b"$ the width of the compression flange.

The above restrictions limiting beams to lengths with an L/b ratio not greater than 40, and to stress not greater than permitted by the formula for L/b ratios greater than 15, do not apply to rafters, which are in contact with the steel roof plating, it being assumed that under full load conditions, friction between the roof sheets and the rafters will provide adequate lateral support to the compression flange of the rafters.

On extreme fibers of pins, when the forces are assumed as acting at the center of gravity of the pieces 27,000

Shearing

On Pins 13,500

On Power-driven Rivets 13,500

On turned bolts in reamed holes with a clearance of not more than $1/50$ th of an inch 13,500

On Hand-driven Rivets 10,000

On Unfinished Bolts 10,000

On the gross area of the webs of beams and girders, where "h", (the clear distance between web flanges in inches) is not more than $60 \times "t"$ (the thickness of the web in inches), or when the web is adequately stiffened 12,000

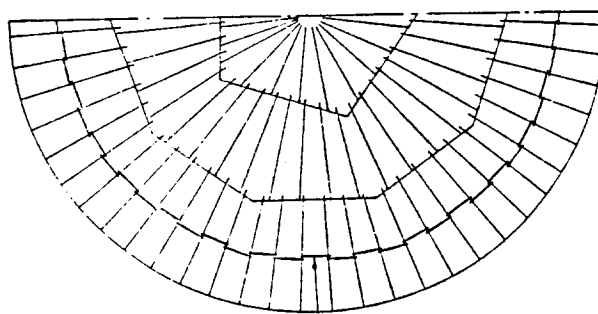
On the gross area of the webs of beams and girders, if the web is not stiffened where "h" is more than $60 \times "t"$ the greatest average shear per sq. inch, shall not exceed 18,000

$$1 + \frac{h^2}{7,200 t^2}$$

in which V is the total shear, and A is gross area of web in sq. inches.

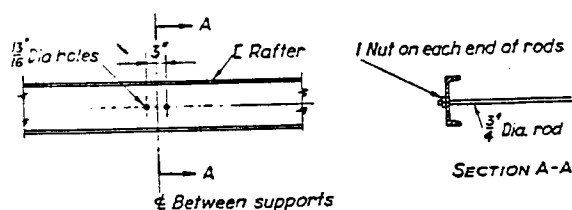
Bearing

	Double Shear	Single Shear
Pins	30,000	24,000
Power-driven Rivets	30,000	24,000
Turned bolts in reamed holes.....	30,000	24,000
Hand-driven Rivets	20,000	16,000
Unfinished bolts	20,000	16,000



$\frac{3}{4}$ " ϕ Tie rods between rafters
at outer ring only

TYPICAL HALF ROOF PLAN



RAFTER SHOWING TIE RODS

FIG. 3

TIE RODS FOR RAFTERS

SECTION 4. BOTTOM DESIGN

Plate Sizes:

32. The minimum width of bottom plates shall be 72 inches; plates of 100-inch width may be used by agreement between purchaser and manufacturer. Bottom plate joints may be either riveted or welded.

33. All rectangular bottom plates shall be $\frac{1}{4}$ -inch thick and shall have the same approximate lengths as $\frac{1}{4}$ -inch shell plates. Bottom sketch plates in tanks 48 feet in diameter and less shall be $\frac{1}{4}$ -inch thick, and in tanks over 48 feet in diameter shall be $\frac{3}{8}$ -inch thick.

Rivets:

34. For tanks with riveted bottoms the rivets shall be $\frac{5}{8}$ inch in diameter. The pitch of rivets shall conform to the requirements in Paragraph 21.

Welded Construction:

35. Tanks with welded bottoms may be supplied only upon agreement between the purchaser and the manufacturer. When so supplied the API monogram may be affixed to such tank indicating that otherwise the tank is manufactured in accordance with this specification, provided that the manufacturer shall stamp the letter "X" as a prefix to his certificate-of-authority number on the API name plate. Such welded bottoms, including the joint between shell and bottom, shall be in accordance with API Std. 12-C: "Specification on All-welded Oil Storage Tanks."

§See Par. C-5 of Appendix "C".

SECTION 5. MARKING

36. Tanks with riveted shells manufactured in accordance with this specification shall be identified by authorized manufacturers† by a special nameplate, detailed in Fig. 4, bearing the API monogram. Size of monogram on name plate shall be ½ inch high, substantially as shown. Authority to use the monogram will be granted to any manufacturer, in accordance with the rules and regulations laid down in Appendix "G".

37. The API monogram shall not be used on tanks which do not meet this specification.

38. Name plates for riveted tanks shall be fastened by tack welding or brazing to the tank shell plate or manhole reinforcing plate immediately above the manhole.

39. Where a manufacturer's shop practice is such that minor variations from the standard designs will enable him to fabricate tanks more economically, it shall not be considered a violation of the authority to use the API monogram, provided that such variations in no way conflict with essential requirements of this specification, and provided further that such variations are approved by the API Committee on the Standardization of Steel Tanks for Oil Storage. After approval of such variations they shall be published and included in Appendix C of these specifications as "permissible variations". When any permissible variation is used, the manufacturer shall notify the purchaser in advance and shall stamp the letter "X" as a prefix to his certificate-of-authority number on the name plate.

40. Each licensee shall report yearly to the Institute, on forms provided, regarding his use of the monogram. Failure to so report is cause for cancella-

tion of authority to use it. When a licensee makes material in accordance with this specification and fails to use the monogram thereon as stipulated herein, his certificate shall be cancelled. It will be necessary to make another application in order to be reinstated.*

41. The use of the letters "API" or reference to API specifications by any licensee, to describe material which does not completely comply with this specification, is prohibited and shall be sufficient cause for cancellation of authority to use the API monogram hereunder.

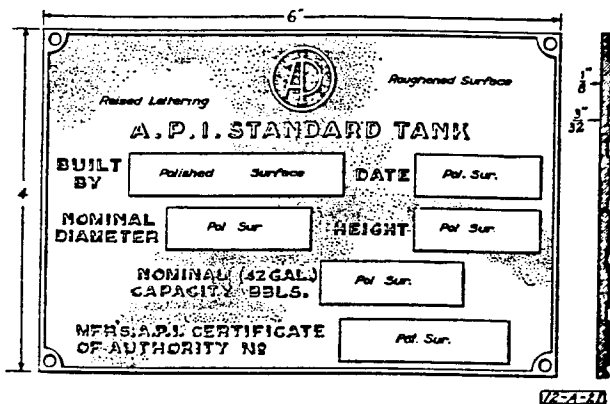


FIG. 4
API NAME PLATE

Name plates may be purchased anywhere at the manufacturer's option. If desired, the builder's name may be cast directly into plate instead of stamping it on polished surface after "built by" as shown in Figure 4.

*Adopted May, 1940, by the Institute's Central Committee on Standardization of Oil Field Equipment.

†See Appendix "F" for list of licensees.

PART II. FABRICATION SPECIFICATION

Workmanship:

42. All work of fabricating API Standard Tanks shall be done in accordance with the plans accompanying this specification, except as provided in Appendix C: "Permissible Variations", or in the case of tanks for which drawings have not been published, shall be the equivalent, and similar in details of fabrication, to those shown in the drawings for the standard tank nearest to the size being planned. The workmanship and finish shall be first class in every respect, subject to the closest inspection by manufacturer's inspector, whether or not purchaser waives any part of the inspection.

43. Straightening of material shall be done before being laid out or worked on in any way and by methods which will not injure it. Heating or hammering will not be permitted, except when heated to a forging temperature.

44. Laying out shall be done by experienced workmen only. Rivet holes shall be accurately spaced so that they come opposite each other in adjoining parts. If upon assembling, holes do not match within ⅛ inch, the plate or plates containing such unfair holes may be rejected at the option of the purchaser.

Rivet Holes:

45. All plates (except bottom or roof plates when a welded bottom or roof is ordered) shall be punched before being bevel-sheared, planed or rolled. All punched and reamed holes shall be clean-cut without torn or ragged edges. The diameter of the punch shall be the same as the nominal diameter of the hole. The diameter of the die shall not be less than ⅛ inch nor more than ⅛ inch larger than the diameter of the punch.

46. Where rivets are to be driven hot, finished diameter of the holes shall be $\frac{1}{8}$ inch larger than nominal diameter of rivet; where rivets are to be driven cold, finished diameter of holes shall be $\frac{1}{2}$ inch larger than nominal diameter of rivet. In plates $\frac{3}{8}$ inch thick and under, holes may be either punched to finished diameter, sub-punched and reamed to finished diameter, or drilled. In plates over $\frac{3}{8}$ -inch thick, rivet holes shall either be drilled full size, or sub-punched at least $\frac{1}{8}$ -inch less than finished diameter and reamed.

Finishing of Plate Edges:

47. Edges of plates shall be trued for caulking either by shearing, machining, or cut with a machine-operated gas torch. Plates $\frac{1}{2}$ inch and less in thickness shall be beveled. Plates over $\frac{1}{2}$ inch in thickness may be either beveled or squared. When beveled, the angle of bevel shall be not less than 65 degrees nor more than 75 degrees.

48. Shearing, machining, or flame cutting shall be done neatly and accurately. The distance from center lines of rivets to the edges of plates and the allowance for trueing shall be as provided in Par. 23 and 24. A tolerance of plus or minus $\frac{1}{8}$ inch will be permitted in edge distance after trueing.

49. Plates to be scarfed may be heated to a cherry red color.

Rolling:

50. After plates are punched and sheared they shall when necessary be shaped to the proper curve by cold rolling. Plates $\frac{1}{8}$ inch thick and less than $\frac{3}{8}$ inch thick shall be rolled to the specified radius for tanks 30 feet or less in diameter; plates $\frac{3}{8}$ inch thick and less than $\frac{1}{2}$ inch thick shall be rolled to the specified radius for tanks 60 feet and less in diameter; plates $\frac{1}{2}$ inch and less than $\frac{3}{4}$ inch thick shall be rolled for tanks 120 feet and less in diameter and plates $\frac{3}{4}$ inch and heavier shall be rolled for all sizes of tanks.

Marking:

51. All plates and roof members shall be marked as shown on the drawings.

Shipping:

52. Plates and tank material shall be loaded on cars in such a manner as to insure delivery without damage.

53. Bolts, nuts, rivets, railing connections, nipples and small details shall be boxed, crated, or put in kegs or bags for shipment.

Inspection:

54. An inspector representing the purchaser shall at all times have free entry to all parts of the manufacturer's works while work under the contract is being performed. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification, and shall furnish free of cost any samples or specimens of materials for the purpose of testing. Inspection shall be made at the place of manufacture prior to shipment unless otherwise specified. The manufacturer shall give the purchaser ample notice as to when he will start fabrication so that the inspector may be on hand when required.

55. Shop inspection shall not release the manufacturer from replacing any defective material which may be discovered in the field.

56. Any material or workmanship which in any way fails to meet the requirements of this specification will be rejected by the inspector and must not be used under the contract. Material which shows injurious defects subsequent to its acceptance at the manufacturing works will be rejected and the manufacturer will be notified to this effect, and required to furnish new material.

Adjustments:

57. The responsibility for policing compliance under this specification rests primarily with the purchaser. He is expected to make any investigation necessary to satisfy himself of compliance and in the event of apparent non-compliance, to confer with the manufacturer to determine the facts and fix the responsibility.

58. If agreement cannot be reached on the merits of any complaint, either party should refer the matter formally to the Institute by forwarding a complete record of the case to the Secretary of the Central Committee on Standardization who shall refer it to the Engineer's Subcommittee of the Standardization Committee responsible for the specification under which the material is supplied. It shall be the duty of the Engineers' Subcommittee to investigate the merits of the complaints on the evidence submitted. The evidence should be complete, including engineering or test reports, and correspondence bearing on the complaint in question. The ruling of the Engineers' Subcommittee shall be forwarded by the Secretary to the parties involved.

59. In case of dissatisfaction with the ruling of the Engineers' Subcommittee, either party may appeal to the Central Committee on Standardization which shall act as a final board of review and its decision in the matter shall be considered final insofar as compliance with this specification is concerned.

PART III.

ERECTION SPECIFICATION

General:

60. The manufacturer shall furnish all labor, tools, false work, scaffolding, and other equipment necessary for the erection of tanks complete and ready for use.

Assembling:

61. Plates shall be carefully and accurately "laid up", and shall then be firmly drawn together with common machine bolts or wedge bolts before riveting is commenced, placing bolts in at least one out of every five holes.

62. No paint or foreign material shall be used between surfaces in contact, except asbestos caulking strip at end of each bottom seam on riveted bottom, as shown on detailed drawings.

63. To insure full rivet sections, equal to computed area, all holes in vertical shell seams shall be reamed after bolting up, using a reamer $\frac{1}{8}$ inch greater in diameter than nominal diameter of rivet for hot driven rivets and $\frac{1}{16}$ inch greater than nominal diameter for cold driven rivets. Holes properly punched and matched will not require the removal of any metal by the reamer, but the tool must be inserted in each hole as a gauge. Where tolerances of $\frac{1}{16}$ inch for unmatched rivet holes required by Paragraph 44 are exceeded, the plate or plates containing the unmatched holes may be rejected at the option of the purchaser.

64. Burrs and fins on punched holes shall, if necessary, be removed in the field by a tool, countersinking not more than $\frac{1}{8}$ inch.

65. All field joints in shell, bottom and roof of tank shall be riveted unless welding is specified for bottom or roof plates or for top and bottom angles. All field joints in the roof supporting structure shall be bolted except that the column bases shall be riveted to the columns.

66. The size and pitch of the rivets shall be as specified on the drawings, and/or shown in Tables 4, 5, 6-A, 6-B, 7, 8, and 9. They shall be driven by pneumatic or hydraulic tools wherever possible.

67. Rivets $\frac{5}{16}$ inch in diameter and under may be driven cold or hot, except that bottom rivets must be driven hot, unless special conditions make cold driving necessary. All rivets over $\frac{5}{16}$ inch diameter shall be driven hot.

68. Hot rivets shall be driven with either steeple head or button head snaps having dimensions as shown in Fig. 5.

69. Shell rivets, when driven cold may be driven with either steeple or Liverpool snaps, and the dimensions of the latter shall be as shown in Figure 5. Bottom rivets, if driven cold, may be driven with Liverpool or double-radius snaps, as shown in Fig. 5.

70. Tolerances in snap dimensions shown in figures shall be $\frac{1}{16}$ inch plus or minus; tolerances in finished rivet heads shall be plus $\frac{1}{16}$ inch over dimensions shown.

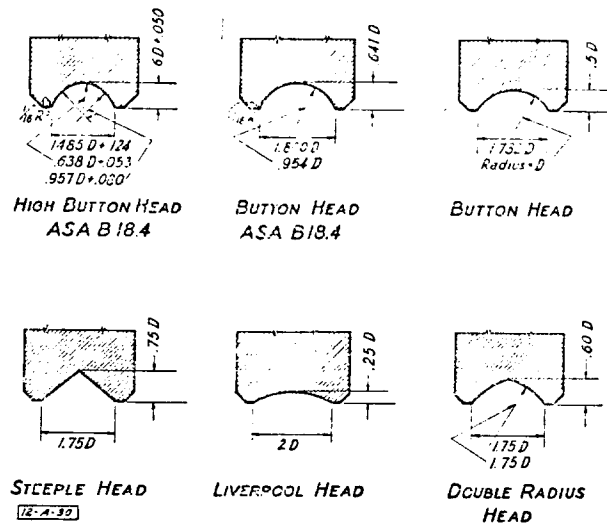


FIG. 5
RIVET SNAPS
"D" = nominal diameter of rivet.

71. Heads shall be as nearly as possible concentric with the rivet body. All rivets shall be driven from the outside of the tank, except that bottom rivets may be driven from the inside. Any burned, loose or defective rivets shall be cut out and re-driven. No foreign substance shall be used in the joints except as noted in Par. 62.

Caulking:

72. Riveted seams shall be made tight by caulking. Roof and shell shall be caulked on outside, bottom on inside. The shell and bottom shall be caulked to bottom angle from the outside. The caulking tools and methods used shall be such that the underlying sheet is not damaged, and the edge of the top sheet not turned under. A round-nosed tool shall be used to upset the metal. This operation shall be followed with a fine square tool. Split caulking on plates over $\frac{1}{2}$ inch thick shall be acceptable. All shell openings shall be caulked outside. The work must be done by experienced men only.

73. The opening between ends of plates and outside butt-strap in butt joints shall be stopped by means of a wedge, or by welding, as specified in the order. In locations subject to earthquakes, the opening may be welded over or if a wedge is used, it is recommended that it be welded over.

74. Inside butt-straps will not ordinarily be caulked; but if specially required by purchaser (in tanks where frequent changes of stock and cleaning are anticipated) this shall be done, and stoppers placed in openings between shell sheets and inside butt-straps as above.

75. Holes punched for erection purposes shall be closed tight, either by welding up, by driving in a "burr" and welding over, both inside and out, or by filling with a driven rivet.