

U S A S T A N D A R D

Unfired Pressure Vessel Flange Dimensions

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USA STANDARD

UNFIRED PRESSURE VESSEL FLANGE DIMENSIONS

1. Scope

1.1 To provide dimensions for unfired pressure vessel flanges based on the ASME Unified Pressure Vessel (UPV) code formulas and specifications and on proportions established by design practices of many large industrial users.

1.2 To provide enough size and pressure choices to include the majority of the vessels used.

1.3 To provide the most economical flanges consistent with satisfactory installation and operation.

1.4 To provide a design which permits the use of a wide variety of gasket materials.

1.5 To establish interchangeability among loose-type (example: ASME UPV code illustration UA-48-1a)* and welded-type (example: ASME UPV illustration UA 48-8a) for equivalent vessel diameters and operating pressures.

2. Sizes, Pressures and Limits

2.1 Flanges for vessels with outside diameters given in inches of 26, 27, 28, 30, 32, 33, 34, 36, 38, 39, 40, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, 72, 75, 78, 81, 84, 87, 90, 93, 96, 99, 102, 105, 108, 111, 114, 117 and 120 are listed for working pressures given in paragraph 2.2 and limited as specified in paragraphs 2.3, 2.4, and 2.5.

2.2 Flanges for vessels with working pressures in pounds per square inch of 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, and 800. 25 and 75 pounds per square inch pressures are included for vessels 48 inches outside diameter and larger.

2.3 Loose-type flanges similar to ASME UPV code illustration UA 48-1a are limited to a maximum vessel wall thickness of 0.50 inches.

2.4 Welded-type flanges similar to ASME UPV code illustration UA 48-8a are limited to a maximum flange thickness of 6 inches.

2.5 All flanges are limited to a bolt diameter range of 5/8 inches through 1-5/8 inches.

2.6 Flanges listed cover the requirements for the listed operating conditions and gasket seating pressure requirements.

Where flanges are subject to other stresses such as bending due to wind load on a tower or in duct work applications, stress calculations must be made and an appropriately heavier flange selected.

3. Allowable Stresses

3.1 The standard is based on an allowable working stress for the flange material of 13,750 pounds per square inch.

3.2 The standard is based on an allowable working stress for the vessel material of 11,687 (13,750 x 85 percent weld factor).

3.3 Vessel shell thicknesses are calculated by the formulas given in the ASME UPV code UG 27.

3.4 Materials which match the stresses used in the standard include such commonly used plate materials as SA-201A, SA-285C, and bar material A 306 Grade 55 in temperature ranges from -20 to 650 F. Some carbon-silicon and stainless alloys are higher in these temperature ranges. Where special alloy or temperature conditions markedly affect the strength it will be necessary to consider this difference in the choice of a flange. Corrosion allowances are normally required in the vessel shell but are not included in the calculations.

*Frequent reference is made to the ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels - 1965 in this text. These references are characterized by the initials "UPV" and to paragraphs carrying the prefix UA, UG, or UNC.

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4. Bolting, Allowable Stress and Specifications for Bolts and Nuts

4.1 The number of bolts used was taken as the largest multiple of 4 contained in the number of inches in the outside diameter of the vessel.

4.2 The bolt circle was selected based on the following considerations.

a) A clearance of 1/8 inches between centered gasket and centered bolts.

b) No interference between outside diameter of wrench socket on centered bolt and toe of ASME UPV Code minimum weld on welded-type flanges (UA 48-8a).

c) A clearance of at least 1/8 inches between centered socket wrench and the corner of the nut on the next centered bolt.

4.3 The standard is based on a maximum bolt stress of 20,000 psi.

Bolting materials which meet the stress requirement include SA-193 Grade B7 for -20 to 800 F.

4.4 The standard is based on bolt threading specified as UNC-2A for 1 inch and smaller and 8N-2A for larger sizes. All threads as per USA Standard B1.1¹. If other threading is used the variation in net effective cross sectional area must be considered.

4.5 Nuts to be A 194 Class 2H or equivalent. The use of washers is optional. Clearance is provided for the use of high strength structural washers ASTM A 325 medium carbon steel, quenched and tempered.

4.6 The flange design bolt load is calculated from UA 49 formula 4 which recognizes that the bolts are usually slightly oversize and provides a margin against abuse of the flange from over bolting.

5. Gaskets

5.1 The standard is based on gasket factor $m = 2.5$ and minimum design seating stress $y = 2,900$.

5.2 The standard is based on gaskets with inside diameters equal to the vessel inside diameters and outside diameters equal to the

outside diameter of the raised face which leaves a clearance of 1/8 inches between gasket outside diameter and inside edge of the centered bolts. See Fig. 1.

5.3 The basic gasket seating width b_0 is taken as $N/2$ with flange facings as shown in the ASME UPV Code Table UA 49.2 1a and 1b. The effective gasket seating width b is calculated from the formula $b = 0.5 \sqrt{b_0}$.

5.4 The use of these standard flanges with other gasket types requires the following adjustments.

a) The dimensions of the alternate gasket are to be adjusted so that the factor $(2b \times 3.14 GmP)$ in UA 49 formula 1 is no greater than it is when $m = 2.5$ as used in this standard.

b) The dimensions of the alternate gasket are to be adjusted so that the minimum initial bolt load required to seat the gasket as determined by UA 49 formula 2 ($W_{m2} = 3.14bGy$) is no greater than it is when $y = 2,900$ as used in this standard.

c) The diameter of the alternate gasket is to be adjusted so that h_C , the radial distance from the gasket load reaction to the bolt circle, is no greater than that used in this Standard. (See 5.3 which establishes b which determines h_C).

d) The dimensions of the gasket are to be adjusted as required by the nature of the gasket contact surfaces as shown in Table UA 49.2 which dictates b_0 , b and h_C .

e) Additional thickness is to be added to the flange thickness given in this standard to compensate for material removed when machining for ring joint or tongue and groove gaskets.

Note that in all cases for loose-type flanges, Fig. UA-48 1 requires that h_C be taken at mid-point of contact between flange and lap independent of gasket location. This must be considered in choosing alternate gasketing to be sure that gasket diameters and widths are appropriately established.

When spiral-wound type gaskets are used, the following proportions are recommended:

Outer guide ring outside diameter (O.D.) equal bolt circle (B.C.) minus one bolt diameter.

Gasket O.D. maximum equal raised face diameter minus 1/2 inch.

Gasket inside diameter (I.D.) maximum equal gasket O.D. minus 1 inch.

¹USA Standard B1.1-1960 Unified Screw Threads, published by The American Society of Mechanical Engineers, New York City.

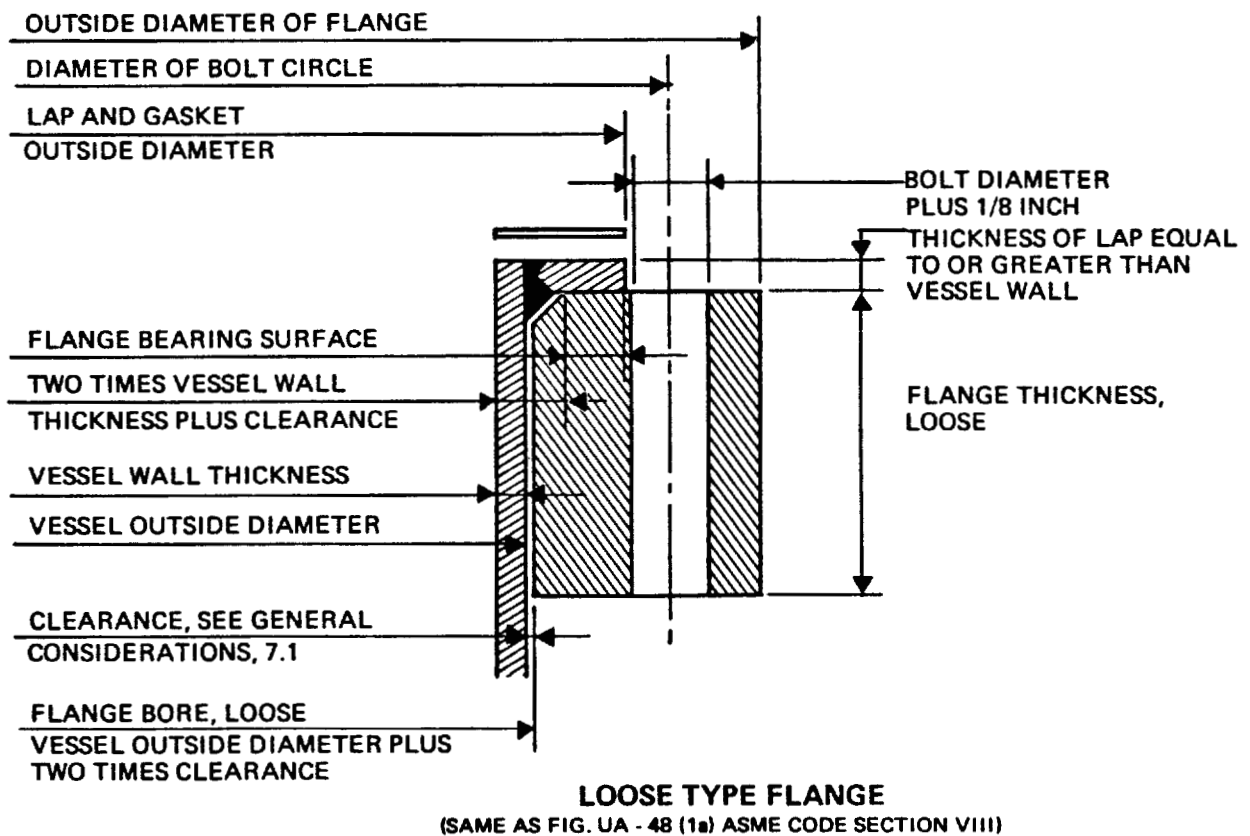
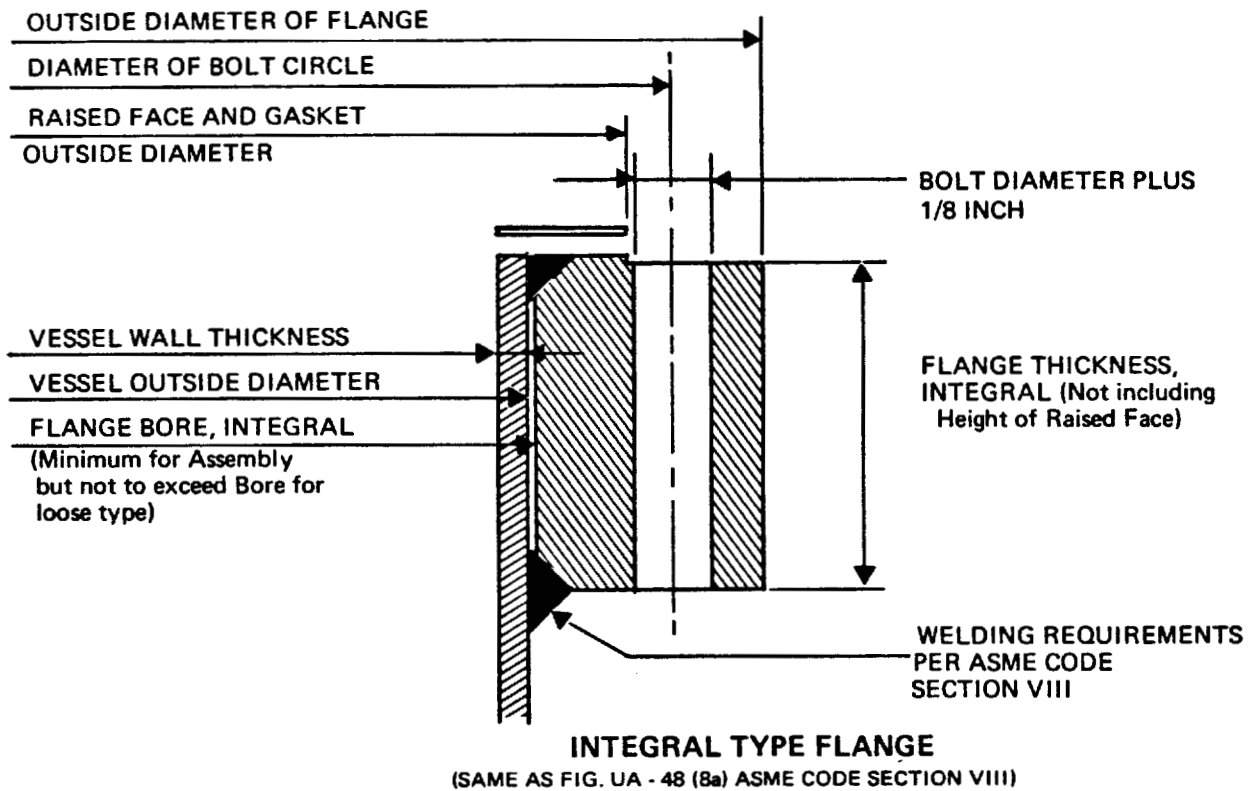


Figure 1.

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Gasket I.D. minimum equal gasket O.D. minus $1\frac{1}{2}$ inches but never less than vessel I.D. plus $\frac{1}{4}$ inch.

Inner ring I.D. maximum equal gasket I.D. minus $\frac{3}{8}$ inches.

Inner ring I.D. minimum equal vessel I.D. plus $\frac{1}{16}$ inches.

5.5 In case of doubt it is recommended that the gasket manufacturer be contacted to determine gasket characteristics and application recommendations.

6. Marking

6.1 Each flange shall be stamped on the edge with figures not less than $\frac{1}{4}$ inch high which gives the following information:

- a) Vessel outside diameter in inches.
- b) Design pressure in pounds per square inch.
- c) Operating temperature limits in degrees F.
- d) Flange material specification number.
- e) Manufacturers name or trademark.

7. General Considerations

7.1 Assembly clearances for loose-type flanges were chosen as 0.06 inches for flanges up to 39 inch vessel outside diameter, 0.09 inches for 39 inches through 66 inches and 0.13 inches above 66 inches; all given as radius clearances. (The differences between flange inside diameter and vessel outside diameter are 0.13 inch, 0.19 inch and 0.25 inch, respectively.)

7.2 The contacting faces between the top of the loose-type flange and the bottom of the vessel lap must both be machined to assure uniform flange to lap contact. Also the top of the vessel lap flange must be machined for uniformity of gasket loading. The top, inner corner of the loose-type flange is to be machined with a bevel or radius to avoid bearing on the radius of the vessel-lap connection.

7.3 To assure satisfactory operation, care must be taken in the welding and machining of the flange, the choice of the proper gasket and the final assembly of gasket and flanges. Bolts should be tightened to the proper loading and a proper sequence of tightening should be observed.

7.4 In all cases bolt circle diameters are kept as small as possible consistent with required wrench clearances and gasket widths adequate for handling and safety from blowout. This minimizes the moment arm h_C and reduces the thickness of the flange, thus assuring an economical design.

7.5 A large selection of vessel sizes and design pressures is given. This permits each user to choose from the large number given a smaller group which will cover his particular needs and which will afford maximum economy and standardization.

7.6 Hub-type flanges which would slip over the outside of the vessel and be used as a loose-type flange (Fig. UA-48 2 and 3) were not included in this standard since wrench clearances required by the existence of the hub forced the bolt circle out and materially increased the size of the flange. Welding neck flanges which have the same inside diameter as the vessel and butt weld to the vessel wall are especially desirable and find wide application in the higher pressure and temperature ranges.

7.7 ASME UPV Code UA-48, paragraph 3, permits flanges which are welded to the vessel to be sized according to the loose-type flange calculations provided none of the following values is exceeded. $g_o = \frac{1}{4}$ inch; $B/g_o = 300$; $P = 300$ psi; operating temperature = 700 F. g_o = thickness of the hub at the small end (in this case the vessel wall thickness); B = inside diameter of the flange (in this case the vessel inside diameter); P = design pressure, pounds per square inch. These optional flanges were not included.

UNFIRED PRESSURE VESSEL FLANGE DIMENSIONS

Unfired Pressure Vessel Flange Dimensions

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 26 Inches, 24 Bolts									
50	30.13	28.63	$\frac{5}{8}$	1.90	1.69	26.13	27.75	25.75	0.13
100	30.13	28.63	$\frac{5}{8}$	2.00	1.81	26.13	27.75	25.75	0.13
150	30.58	28.83	$\frac{3}{4}$	2.38	2.19	26.13	27.83	25.67	0.17
200	31.07	29.07	$\frac{7}{8}$	2.69	2.50	26.13	27.94	25.56	0.22
250	31.18	29.18	$\frac{7}{8}$	2.94	2.81	26.13	28.05	25.45	0.28
300	31.68	29.43	1	3.19	3.06	26.13	28.18	25.34	0.33
350	32.34	29.84	$1\frac{1}{8}$	3.44	3.38	26.13	28.46	25.23	0.38
400	32.49	29.99	$1\frac{1}{8}$	3.69	3.63	26.13	28.62	25.12	0.44
450	33.14	30.39	$1\frac{1}{4}$	3.94	3.94	26.13	28.89	25.01	0.49
500	33.30	30.55	$1\frac{1}{4}$	4.06			29.05	24.91	0.55
550	33.95	30.95	$1\frac{3}{8}$	4.31			29.32	24.80	0.60
600	34.10	31.10	$1\frac{3}{8}$	4.50			29.47	24.69	0.65
650	34.75	31.50	$1\frac{1}{2}$	4.69			29.75	24.59	0.71
700	34.90	31.65	$1\frac{1}{2}$	4.88			29.90	24.48	0.76
750	35.55	32.05	$1\frac{5}{8}$	5.06			30.18	24.37	0.81
800	35.70	32.20	$1\frac{5}{8}$	5.19			30.32	24.27	0.87
Vessel Outside Diameter, 27 Inches, 24 Bolts									
50	31.13	29.63	$\frac{5}{8}$	1.94	1.69	27.13	28.75	26.75	0.13
100	31.13	29.63	$\frac{5}{8}$	2.06	1.88	27.13	28.75	26.75	0.13
150	31.59	29.84	$\frac{3}{4}$	2.44	2.25	27.13	28.84	26.66	0.17
200	32.08	30.08	$\frac{7}{8}$	2.75	2.56	27.13	28.96	26.54	0.23
250	32.57	30.32	1	3.06	2.88	27.13	29.07	26.43	0.29
300	32.72	30.47	1	3.31	3.19	27.13	29.22	26.31	0.34
350	33.38	30.88	$1\frac{1}{8}$	3.56	3.50	27.13	29.51	26.20	0.40
400	33.54	31.04	$1\frac{1}{8}$	3.75	3.81	27.13	29.66	26.09	0.46
450	34.20	31.45	$1\frac{1}{4}$	4.00			29.95	25.98	0.51
500	34.86	31.86	$1\frac{3}{8}$	4.25			30.23	25.86	0.57
550	35.01	32.01	$1\frac{3}{8}$	4.44			30.39	25.75	0.62
600	35.67	32.42	$1\frac{1}{2}$	4.69			30.67	25.64	0.68
650	35.83	32.58	$1\frac{1}{2}$	4.81			30.83	25.53	0.73
700	36.48	32.98	$1\frac{5}{8}$	5.06			31.11	25.42	0.79
750	36.64	33.14	$1\frac{5}{8}$	5.19			31.26	25.31	0.84
Vessel Outside Diameter, 28 Inches, 28 Bolts									
50	32.13	30.63	$\frac{5}{8}$	2.00	1.75	28.13	29.75	27.75	0.13
100	32.13	30.63	$\frac{5}{8}$	2.13	1.94	28.13	29.75	27.75	0.13
150	32.61	30.86	$\frac{3}{4}$	2.50	2.31	28.13	29.86	27.64	0.18
200	33.10	31.10	$\frac{7}{8}$	2.81	2.69	28.13	29.98	27.52	0.24
250	33.22	31.22	$\frac{7}{8}$	3.13	3.00	28.13	30.09	27.41	0.30

USA STANDARD

Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 28 Inches, 28 Bolts (Cont.)									
300	33.76	31.51	1	3.38	3.31	28.13	30.26	27.29	0.36
350	34.42	31.92	1 ¹ / ₈	3.69	3.63	28.13	30.55	27.17	0.41
400	34.59	32.09	1 ¹ / ₈	3.88	3.94	28.13	30.71	27.05	0.47
450	35.25	32.50	1 ¹ / ₄	4.13			31.00	26.94	0.53
500	35.42	32.67	1 ¹ / ₄	4.31			31.17	26.82	0.59
550	36.08	33.08	1 ³ / ₈	4.56			31.45	26.71	0.65
600	36.24	33.24	1 ³ / ₈	4.75			31.62	26.59	0.70
650	36.90	33.65	1 ¹ / ₂	4.94			31.90	26.48	0.76
700	37.07	33.82	1 ¹ / ₂	5.13			32.07	26.36	0.82
750	37.73	34.23	1 ⁵ / ₈	5.31			32.35	26.25	0.88
800	37.89	34.39	1 ⁵ / ₈	5.50			32.51	26.13	0.93
Vessel Outside Diameter, 30 Inches, 28 Bolts									
50	34.13	32.63	⁵ / ₈	2.06	1.81	30.13	31.75	29.75	0.13
100	34.13	32.63	⁵ / ₈	2.25	2.00	30.13	31.76	29.74	0.13
150	34.63	32.88	³ / ₄	2.63	2.44	30.13	31.88	29.62	0.19
200	35.13	33.13	⁷ / ₈	3.00	2.81	30.13	32.01	29.49	0.25
250	35.65	33.40	1	3.31	3.19	30.13	32.15	29.36	0.32
300	35.83	33.58	1	3.56	3.50	30.13	32.33	29.24	0.38
350	36.51	34.01	1 ¹ / ₈	3.88	3.88	30.13	32.63	29.11	0.44
400	37.18	34.43	1 ¹ / ₄	4.13			32.93	28.99	0.51
450	37.36	34.61	1 ¹ / ₄	4.38			33.11	28.86	0.57
500	38.03	35.03	1 ³ / ₈	4.63			33.41	28.74	0.63
550	38.21	35.21	1 ³ / ₈	4.81			33.58	28.61	0.69
600	38.88	35.63	1 ¹ / ₂	5.06			33.88	28.49	0.75
650	39.06	35.81	1 ¹ / ₂	5.19			34.06	28.37	0.82
700	39.73	36.23	1 ⁵ / ₈	5.44			34.36	28.25	0.88
750	39.90	36.40	1 ⁵ / ₈	5.63			34.53	28.12	0.94
Vessel Outside Diameter, 32 Inches, 32 Bolts									
50	36.13	34.63	⁵ / ₈	2.13	1.88	32.13	33.75	31.75	0.13
100	36.15	34.65	⁵ / ₈	2.38	2.13	32.13	33.77	31.73	0.14
150	36.66	34.91	³ / ₄	2.81	2.63	32.13	33.91	31.59	0.20
200	37.17	35.17	⁷ / ₈	3.19	3.00	32.13	34.04	31.46	0.27
250	37.71	35.46	1	3.50	3.38	32.13	34.21	31.32	0.34
300	37.90	35.65	1	3.75	3.75	32.13	34.40	31.19	0.41
350	38.59	36.09	1 ¹ / ₈	4.06	4.06	32.13	34.71	31.05	0.47
400	39.28	36.53	1 ¹ / ₄	4.38			35.03	30.92	0.54
450	39.47	36.72	1 ¹ / ₄	4.56			35.22	30.79	0.61
500	40.15	37.15	1 ³ / ₈	4.88			35.53	30.65	0.67

UNFIRED PRESSURE VESSEL FLANGE DIMENSIONS

Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				

Vessel Outside Diameter, 32 Inches, 32 Bolts (Cont.)

550	40.34	37.34	1 $\frac{1}{8}$	5.06			35.72	30.52	0.74
600	41.03	37.78	1 $\frac{1}{2}$	5.31			36.03	30.39	0.80
650	41.21	37.96	1 $\frac{1}{2}$	5.44			36.21	30.26	0.87
700	41.90	38.40	1 $\frac{5}{8}$	5.69			36.52	30.13	0.94
750	42.08	38.58	1 $\frac{5}{8}$	5.88			36.71	30.00	1.00

Vessel Outside Diameter, 33 Inches, 32 Bolts

50	37.13	35.63	$\frac{5}{8}$	2.13	1.88	33.13	34.75	32.75	0.13
100	37.16	35.66	$\frac{5}{8}$	2.44	2.19	33.13	34.78	32.72	0.14
150	37.67	35.92	$\frac{3}{4}$	2.88	2.69	33.13	34.92	32.58	0.21
200	38.19	36.19	$\frac{7}{8}$	3.25	3.06	33.13	35.06	32.44	0.28
250	38.74	36.49	1	3.56	3.44	33.13	35.24	32.30	0.35
300	39.44	36.94	1 $\frac{1}{8}$	3.88	3.88	33.13	35.56	32.16	0.42
350	39.63	37.13	1 $\frac{1}{8}$	4.19	4.19	33.13	35.76	32.02	0.49
400	40.33	37.58	1 $\frac{1}{4}$	4.44			36.08	31.89	0.56
450	40.52	37.77	1 $\frac{1}{4}$	4.69			36.27	31.75	0.63
500	41.21	38.21	1 $\frac{3}{8}$	4.94			36.59	31.61	0.69
550	41.41	38.41	1 $\frac{3}{8}$	5.13			36.78	31.48	0.76
600	42.10	38.85	1 $\frac{1}{2}$	5.44			37.10	31.34	0.83
650	42.29	39.04	1 $\frac{1}{2}$	5.56			37.29	31.20	0.90
700	42.98	39.48	1 $\frac{5}{8}$	5.81			37.60	31.07	0.97
750	43.17	39.67	1 $\frac{5}{8}$	6.00			37.80	30.94	1.03

Vessel Outside Diameter, 34 Inches, 32 Bolts

50	38.13	36.63	$\frac{5}{8}$	2.19	1.88	34.13	35.75	33.75	0.13
100	38.16	36.66	$\frac{5}{8}$	2.50	2.25	34.13	35.79	33.71	0.14
150	38.68	36.93	$\frac{3}{4}$	2.94	2.75	34.13	35.93	33.57	0.22
200	39.20	37.20	$\frac{7}{8}$	3.31	3.19	34.13	36.08	33.42	0.29
250	39.77	37.52	1	3.63	3.56	34.13	36.27	33.28	0.36
300	40.47	37.97	1 $\frac{1}{8}$	4.00	3.94	34.13	36.60	33.14	0.43
350	40.67	38.17	1 $\frac{1}{8}$	4.25			36.80	32.99	0.50
400	41.37	38.62	1 $\frac{1}{4}$	4.56			37.12	32.85	0.57
450	42.07	39.07	1 $\frac{3}{8}$	4.88			37.45	32.71	0.64
500	42.27	39.27	1 $\frac{3}{8}$	5.06			37.65	32.57	0.72
550	42.97	39.72	1 $\frac{1}{2}$	5.38			37.97	32.43	0.79
600	43.17	39.92	1 $\frac{1}{2}$	5.56			38.17	32.29	0.86
650	43.87	40.37	1 $\frac{5}{8}$	5.81			38.49	32.15	0.92
700	44.06	40.56	1 $\frac{5}{8}$	5.94			38.69	32.01	0.99

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Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 36 Inches, 36 Bolts									
50	40.13	38.63	$\frac{5}{8}$	2.25	2.00	36.13	37.75	35.75	0.13
100	40.18	38.68	$\frac{5}{8}$	2.56	2.38	36.13	37.81	35.69	0.15
150	40.71	38.96	$\frac{3}{4}$	3.06	2.88	36.13	37.96	35.54	0.23
200	41.24	39.24	$\frac{7}{8}$	3.50	3.31	36.13	38.11	35.39	0.31
250	41.83	39.58	1	3.81	3.75	36.13	38.33	35.24	0.38
300	42.54	40.04	$1\frac{1}{8}$	4.19	4.19	36.13	38.67	35.09	0.46
350	42.76	40.26	$1\frac{1}{8}$	4.44			38.88	34.93	0.53
400	43.47	40.72	$1\frac{1}{4}$	4.75			39.22	34.78	0.61
450	43.68	40.93	$1\frac{1}{4}$	5.00			39.43	34.63	0.68
500	44.39	41.39	$1\frac{3}{8}$	5.31			39.77	34.49	0.76
550	45.10	41.85	$1\frac{1}{2}$	5.56			40.10	34.34	0.83
600	45.31	42.06	$1\frac{1}{2}$	5.75			40.31	34.19	0.91
Vessel Outside Diameter, 38 Inches, 36 Bolts									
50	42.13	40.63	$\frac{5}{8}$	2.31	2.00	38.13	39.75	37.75	0.13
100	42.20	40.70	$\frac{5}{8}$	2.69	2.50	38.13	39.82	37.68	0.16
150	42.74	40.99	$\frac{3}{4}$	3.25	3.06	38.13	39.99	37.51	0.24
200	43.27	41.27	$\frac{7}{8}$	3.63	3.50	38.13	40.15	37.35	0.32
250	43.89	41.64	1	4.00	3.94	38.13	40.39	37.19	0.40
300	44.62	42.12	$1\frac{1}{8}$	4.38	4.38	38.13	40.74	37.03	0.48
350	45.34	42.59	$1\frac{1}{4}$	4.69			41.09	36.88	0.56
400	45.56	42.81	$1\frac{1}{4}$	5.00			41.31	36.72	0.64
450	46.29	43.29	$1\frac{3}{8}$	5.31			41.66	36.56	0.72
500	47.01	43.76	$1\frac{1}{2}$	5.56			42.01	36.40	0.80
550	47.23	43.98	$1\frac{1}{2}$	5.81			42.23	36.24	0.88
Vessel Outside Diameter, 39 Inches, 36 Bolts									
50	43.13	41.63	$\frac{5}{8}$	2.31	2.00	39.19	40.75	38.75	0.13
100	43.58	41.83	$\frac{3}{4}$	2.75	2.50	39.19	40.83	38.67	0.17
150	44.12	42.12	$\frac{7}{8}$	3.31	3.06	39.19	41.00	38.50	0.25
200	44.69	42.44	1	3.69	3.56	39.19	41.19	38.34	0.33
250	44.92	42.67	1	4.06	4.00	39.19	41.42	38.17	0.41
300	45.65	43.15	$1\frac{1}{8}$	4.44	4.50	39.19	41.78	38.01	0.50
350	46.38	43.63	$1\frac{1}{4}$	4.81			42.13	37.85	0.58
400	47.11	44.11	$1\frac{3}{8}$	5.13			42.49	37.68	0.66
450	47.34	44.34	$1\frac{3}{4}$	5.38			42.72	37.52	0.74
500	48.07	44.82	$1\frac{1}{2}$	5.69			43.07	37.36	0.82
550	48.30	45.05	$1\frac{1}{2}$	5.94			43.30	37.20	0.90

UNFIRED PRESSURE VESSEL FLANGE DIMENSIONS

Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 40 Inches, 40 Bolts									
50	44.13	42.63	$\frac{5}{8}$	2.38	2.06	40.19	41.75	39.75	0.13
100	44.22	42.72	$\frac{5}{8}$	2.81	2.63	40.19	41.84	39.66	0.17
150	44.76	43.01	$\frac{3}{4}$	3.38	3.19	40.19	42.01	39.49	0.26
200	45.30	43.30	$\frac{7}{8}$	3.75	3.69	40.19	42.18	39.32	0.34
250	45.95	43.70	1	4.19	4.13	40.19	42.45	39.15	0.42
300	46.69	44.19	$1\frac{1}{8}$	4.56			42.81	38.98	0.51
350	47.42	44.67	$1\frac{1}{4}$	4.88			43.17	38.82	0.59
400	47.66	44.91	$1\frac{1}{4}$	5.19			43.41	38.65	0.68
450	48.40	45.40	$1\frac{3}{8}$	5.50			43.77	38.48	0.76
500	48.63	45.63	$1\frac{3}{8}$	5.75			44.00	38.32	0.84
550	49.36	46.11	$1\frac{1}{2}$	6.00			44.36	38.15	0.92
Vessel Outside Diameter, 42 Inches, 40 Bolts									
50	46.13	44.63	$\frac{5}{8}$	2.38	2.06	42.19	43.75	41.75	0.13
100	46.61	44.86	$\frac{3}{4}$	2.94	2.69	42.19	43.86	41.64	0.18
150	47.16	45.16	$\frac{7}{8}$	3.50	3.31	42.19	44.04	41.46	0.27
200	47.76	45.51	1	3.94	3.81	42.19	44.26	41.29	0.36
250	48.51	46.01	$1\frac{1}{8}$	4.38	4.31	42.19	44.63	41.11	0.45
300	48.76	46.26	$1\frac{1}{8}$	4.75			44.88	40.93	0.53
350	49.51	46.76	$1\frac{1}{4}$	5.06			45.26	40.76	0.62
400	50.26	47.26	$1\frac{3}{8}$	5.44			45.63	40.58	0.71
450	50.50	47.50	$1\frac{3}{8}$	5.69			45.88	40.41	0.80
500	51.25	48.00	$1\frac{1}{2}$	6.00			46.25	40.23	0.88
Vessel Outside Diameter, 45 Inches, 44 Bolts									
50	49.13	47.63	$\frac{5}{8}$	2.50	2.13	45.19	46.75	44.75	0.13
100	49.63	47.88	$\frac{3}{4}$	3.13	2.88	45.19	46.88	44.62	0.19
150	50.20	48.20	$\frac{7}{8}$	3.69	3.50	45.19	47.07	44.43	0.29
200	50.83	48.58	1	4.19	4.06	45.19	47.33	44.24	0.38
250	51.60	49.10	$1\frac{1}{8}$	4.63	4.63	45.19	47.72	44.05	0.48
300	51.87	49.37	$1\frac{1}{4}$	5.00			47.99	43.86	0.57
350	52.63	49.88	$1\frac{1}{4}$	5.38			48.38	43.67	0.67
400	53.40	50.40	$1\frac{3}{8}$	5.75			48.77	43.48	0.76
450	53.66	50.66	$1\frac{3}{8}$	6.00			49.04	43.29	0.85
Vessel Outside Diameter, 48 Inches, 48 Bolts									
25	52.13	50.63	$\frac{5}{8}$	2.56	2.25	48.19	49.75	47.75	0.13
50	52.13	50.63	$\frac{5}{8}$	2.56	2.25	48.19	49.75	47.75	0.13
75	52.18	50.68	$\frac{5}{8}$	2.94	2.69	48.19	49.81	47.69	0.15
100	52.66	50.91	$\frac{3}{4}$	3.31	3.06	48.19	49.91	47.59	0.20
150	53.24	51.24	$\frac{7}{8}$	3.88	3.75	48.19	50.11	47.39	0.31

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Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 48 Inches, 48 Bolts (Cont.)									
200	53.90	51.65	1	4.38	4.31	48.19	50.40	47.18	0.41
250	54.69	52.19	1 ¹ / ₈	4.88			50.81	46.98	0.51
300	55.47	52.72	1 ¹ / ₄	5.31			51.22	46.78	0.61
350	55.76	53.01	1 ¹ / ₄	5.63			51.51	46.58	0.71
400	56.54	53.54	1 ³ / ₈	6.00			51.92	46.38	0.81
Vessel Outside Diameter, 51 Inches, 48 Bolts									
25	55.13	53.63	⁵ / ₈	2.63	2.25	51.19	52.75	50.75	0.13
50	55.13	53.63	⁵ / ₈	2.63	2.31	51.19	52.75	50.75	0.13
75	55.20	53.70	⁵ / ₈	3.06	2.81	51.19	52.83	50.67	0.16
100	55.68	53.93	³ / ₄	3.44	3.25	51.19	52.93	50.57	0.22
150	56.28	54.28	⁷ / ₈	4.13	3.94	51.19	53.15	50.35	0.33
200	56.98	54.73	1	4.63	4.63	51.19	53.48	50.13	0.43
250	57.78	55.28	1 ¹ / ₈	5.13			53.90	49.92	0.54
300	58.58	55.83	1 ¹ / ₄	5.56			54.33	49.70	0.65
350	59.38	56.38	1 ³ / ₈	6.00			54.76	49.49	0.75
Vessel Outside Diameter, 54 Inches, 52 Bolts									
25	58.13	56.63	⁵ / ₈	2.69	2.31	54.19	55.75	53.75	0.13
50	58.13	56.63	⁵ / ₈	2.69	2.44	54.19	55.75	53.75	0.13
75	58.22	56.72	⁵ / ₈	3.25	3.00	54.19	55.85	53.65	0.17
100	58.71	56.96	³ / ₄	3.63	3.38	54.19	55.96	53.54	0.23
150	59.31	57.31	⁷ / ₈	4.31	4.19	54.19	56.19	53.31	0.34
200	60.05	57.80	1	4.81	4.88	54.19	56.55	53.08	0.46
250	60.87	58.37	1 ¹ / ₈	5.38			56.99	52.85	0.57
300	61.69	58.94	1 ¹ / ₄	5.81			57.44	52.63	0.69
Vessel Outside Diameter, 57 Inches, 56 Bolts									
25	61.13	59.63	⁵ / ₈	2.75	2.38	57.19	58.75	56.75	0.13
50	61.13	59.63	⁵ / ₈	2.81	2.56	57.19	58.75	56.75	0.13
75	61.24	59.74	⁵ / ₈	3.38	3.13	57.19	58.86	56.64	0.18
100	61.74	59.99	³ / ₄	3.81	3.56	57.19	58.99	56.51	0.24
150	62.35	60.35	⁷ / ₈	4.50	4.38	57.19	59.23	56.27	0.36
200	63.62	61.12	1 ¹ / ₈	5.13	5.13	57.19	59.75	56.03	0.48
250	63.96	61.46	1 ¹ / ₄	5.63			60.08	55.79	0.60
Vessel Outside Diameter, 60 Inches, 60 Bolts									
25	64.13	62.63	⁵ / ₈	2.88	2.50	60.19	61.75	59.75	0.13
50	64.13	62.63	⁵ / ₈	2.94	2.69	60.19	61.76	59.74	0.13
75	64.63	62.88	³ / ₄	3.50	3.25	60.19	61.88	59.62	0.19
100	64.76	63.01	³ / ₄	4.00	3.75	60.19	62.01	59.49	0.26

UNFIRED PRESSURE VESSEL FLANGE DIMENSIONS

Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 60 Inches, 60 Bolts (Cont.)									
150	65.83	63.58	1	4.69	4.56	60.19	62.33	59.23	0.38
200	66.69	64.19	1 ¹ / ₈	5.38			62.82	58.98	0.51
250	67.55	64.80	1 ¹ / ₄	5.94			63.30	58.73	0.64
Vessel Outside Diameter, 63 Inches, 60 Bolts									
25	67.13	65.63	⁵ / ₈	2.88	2.50	63.19	64.75	62.75	0.13
50	67.14	65.64	⁵ / ₈	3.06	2.81	63.19	64.77	62.73	0.13
75	67.65	65.90	³ / ₄	3.69	3.38	63.19	64.90	62.60	0.20
100	68.16	66.16	⁷ / ₈	4.13	3.88	63.19	65.04	62.46	0.27
150	68.89	66.64	1	4.88	4.81	63.19	65.39	62.20	0.40
200	69.76	67.26	1 ¹ / ₈	5.56			65.89	61.93	0.54
Vessel Outside Diameter, 66 Inches, 64 Bolts									
25	70.13	68.63	⁵ / ₈	3.00	2.56	66.19	67.75	65.75	0.13
50	70.16	68.66	⁵ / ₈	3.19	2.94	66.19	67.78	65.72	0.14
75	70.67	68.92	³ / ₄	3.81	3.56	66.19	67.92	65.58	0.21
100	71.19	69.19	⁷ / ₈	4.31	4.06	66.19	68.06	65.44	0.28
150	71.94	69.69	1	5.06	5.06	66.19	68.44	65.16	0.42
200	72.84	70.34	1 ¹ / ₈	5.75			68.96	64.88	0.56
Vessel Outside Diameter, 69 Inches, 68 Bolts									
25	73.13	71.63	⁵ / ₈	3.06	2.63	69.25	70.75	68.75	0.13
50	73.17	71.67	⁵ / ₈	3.31	3.00	69.25	70.79	68.71	0.15
75	73.69	71.94	³ / ₄	4.00	3.69	69.25	70.94	68.56	0.22
100	74.21	72.21	⁷ / ₈	4.50	4.25	69.25	71.09	68.41	0.29
150	75.00	72.75	1	5.25	5.25	69.25	71.50	68.12	0.44
200	75.91	73.41	1 ¹ / ₈	6.00			72.03	67.83	0.59
Vessel Outside Diameter, 72 Inches, 72 Bolts									
25	76.13	74.63	⁵ / ₈	3.13	2.69	72.25	73.75	71.75	0.13
50	76.18	74.68	⁵ / ₈	3.50	3.13	72.25	73.81	71.69	0.15
75	76.71	74.96	³ / ₄	4.13	3.81	72.25	73.96	71.54	0.23
100	77.24	75.24	⁷ / ₈	4.63	4.38	72.25	74.11	71.39	0.31
150	78.05	75.80	1	5.50	5.50	72.25	74.55	71.08	0.46

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Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 75 Inches, 72 Bolts									
25	79.13	77.63	$\frac{5}{8}$	3.13	2.69	75.25	76.75	74.75	0.13
50	79.20	77.70	$\frac{5}{8}$	3.63	3.25	75.25	76.82	74.68	0.16
75	79.73	77.98	$\frac{3}{4}$	4.31	4.00	75.25	76.98	74.52	0.24
100	80.26	78.26	$\frac{7}{8}$	4.81	4.56	75.25	77.14	74.36	0.32
150	81.10	78.85	1	5.69	5.69	75.25	77.60	74.04	0.48
Vessel Outside Diameter, 78 Inches, 76 Bolts									
25	82.13	80.63	$\frac{5}{8}$	3.19	2.75	78.25	79.75	77.75	0.13
50	82.21	80.71	$\frac{5}{8}$	3.75	3.44	78.25	79.83	77.67	0.17
75	82.75	81.00	$\frac{3}{4}$	4.44	4.13	78.25	80.00	77.50	0.25
100	83.29	81.29	$\frac{7}{8}$	4.94	4.75	78.25	80.17	77.33	0.33
150	84.66	82.16	1 $\frac{1}{8}$	5.94	5.94	78.25	80.78	77.00	0.50
Vessel Outside Diameter, 81 Inches, 80 Bolts									
25	85.13	83.63	$\frac{5}{8}$	3.31	2.81	81.25	82.75	80.75	0.13
50	85.22	83.72	$\frac{5}{8}$	3.88	3.56	81.25	82.85	80.65	0.17
75	85.77	84.02	$\frac{3}{4}$	4.56	4.31	81.25	83.02	80.48	0.26
100	86.32	84.32	$\frac{7}{8}$	5.13	4.94	81.25	83.19	80.31	0.35
Vessel Outside Diameter, 84 Inches, 84 Bolts									
25	88.13	86.63	$\frac{5}{8}$	3.38	2.88	84.25	85.75	83.75	0.13
50	88.23	86.73	$\frac{5}{8}$	4.00	3.69	84.25	85.86	83.64	0.18
75	88.79	87.04	$\frac{3}{4}$	4.75	4.44	84.25	86.04	83.46	0.27
100	89.34	87.34	$\frac{7}{8}$	5.25	5.13	84.25	86.22	83.28	0.36
Vessel Outside Diameter, 87 Inches, 84 Bolts									
25	91.13	89.63	$\frac{5}{8}$	3.38	2.88	87.25	88.75	86.75	0.13
50	91.25	89.75	$\frac{5}{8}$	4.13	3.81	87.25	88.87	86.63	0.19
75	91.81	90.06	$\frac{3}{4}$	4.88	4.63	87.25	89.06	86.44	0.28
100	92.37	90.37	$\frac{7}{8}$	5.44	5.31	87.25	89.24	86.26	0.37
Vessel Outside Diameter, 90 Inches, 88 Bolts									
25	94.13	92.63	$\frac{5}{8}$	3.44	2.94	90.25	91.75	89.75	0.13
50	94.26	92.76	$\frac{5}{8}$	4.25	3.94	90.25	91.88	89.62	0.19
75	95.20	93.20	$\frac{7}{8}$	5.00	4.69	90.25	92.08	89.42	0.29
100	95.39	93.39	$\frac{7}{8}$	5.56	5.50	90.25	92.27	89.23	0.38

UNFIRED PRESSURE VESSEL FLANGE DIMENSIONS

Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 93 Inches, 92 Bolts									
25	97.13	95.63	$\frac{5}{8}$	3.50	3.00	93.25	94.75	92.75	0.13
50	97.65	95.90	$\frac{3}{4}$	4.31	4.00	93.25	94.90	92.60	0.20
75	98.22	96.22	$\frac{7}{8}$	5.13	4.88	93.25	95.10	92.40	0.30
100	98.42	96.42	$\frac{7}{8}$	5.75	5.69	93.25	95.29	92.21	0.40
Vessel Outside Diameter, 96 Inches, 96 Bolts									
25	100.13	98.63	$\frac{5}{8}$	3.56	3.06	96.25	97.75	95.75	0.13
50	100.66	98.91	$\frac{3}{4}$	4.44	4.13	96.25	97.91	95.59	0.20
75	101.24	99.24	$\frac{7}{8}$	5.25	5.00	96.25	98.11	95.39	0.31
100	101.91	99.66	1	5.94	5.81	96.25	98.41	95.18	0.41
Vessel Outside Diameter, 99 Inches, 96 Bolts									
25	103.13	101.63	$\frac{5}{8}$	3.63	3.06	99.25	100.75	98.75	0.13
50	103.67	101.92	$\frac{3}{4}$	4.56	4.25	99.25	100.92	98.58	0.21
75	104.26	102.26	$\frac{7}{8}$	5.44	5.19	99.25	101.13	98.37	0.32
100	104.94	102.69	1		6.00	99.25	101.44	98.16	0.42
Vessel Outside Diameter, 102 Inches, 100 Bolts									
25	106.13	104.63	$\frac{5}{8}$	3.69	3.13	102.25	103.75	101.75	0.13
50	106.69	104.94	$\frac{3}{4}$	4.69	4.38	102.25	103.94	101.56	0.22
75	107.28	105.28	$\frac{7}{8}$	5.56	5.31	102.25	104.15	101.35	0.33
Vessel Outside Diameter, 105 Inches, 104 Bolts									
25	109.13	107.63	$\frac{5}{8}$	3.75	3.19	105.25	106.75	104.75	0.13
50	109.70	107.95	$\frac{3}{4}$	4.81	4.50	105.25	106.95	104.55	0.22
75	110.30	108.30	$\frac{7}{8}$	5.69	5.50	105.25	107.17	104.33	0.34
Vessel Outside Diameter, 108 Inches, 108 Bolts									
25	112.13	110.63	$\frac{5}{8}$	3.75	3.25	108.25	109.75	107.75	0.13
50	112.71	110.96	$\frac{3}{4}$	4.94	4.63	108.25	109.96	107.54	0.23
75	113.32	111.32	$\frac{7}{8}$	5.81	5.63	108.25	110.19	107.31	0.35
Vessel Outside Diameter, 111 Inches, 108 Bolts									
25	115.13	113.63	$\frac{5}{8}$	3.81	3.38	111.25	112.75	110.75	0.13
50	115.72	113.97	$\frac{3}{4}$	5.06	4.75	111.25	112.97	110.53	0.24
75	116.34	114.34	$\frac{7}{8}$	5.94	5.81	111.25	113.21	110.29	0.36

USA STANDARD

Unfired Pressure Vessel Flange Dimensions (Cont.)

Pressure	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolts	Flange Thickness		Flange Bore Loose	Raised Face Outside Diameter	Vessel Inside Diameter	Vessel Wall Thickness
				Integral	Loose				
Vessel Outside Diameter, 114 Inches, 112 Bolts									
25	118.13	116.63	$\frac{5}{8}$	3.88	3.44	114.25	115.75	113.75	0.13
50	118.74	116.99	$\frac{3}{4}$	5.19	4.88	114.25	115.99	113.51	0.24
75	119.35	117.35	$\frac{7}{8}$		5.94	114.25	116.23	113.27	0.36
Vessel Outside Diameter, 117 Inches, 116 Bolts									
25	121.13	119.63	$\frac{5}{8}$	3.94	3.50	117.25	118.75	116.75	0.13
50	121.75	120.00	$\frac{3}{4}$	5.31	5.00	117.25	119.00	116.50	0.25
Vessel Outside Diameter, 120 Inches, 120 Bolts									
25	124.13	122.63	$\frac{5}{8}$	4.06	3.63	120.25	121.76	119.74	0.13
50	124.76	123.01	$\frac{3}{4}$	5.44	5.13	120.25	122.01	119.49	0.26

USA STANDARDS FOR PIPING, PIPE FLANGES AND FITTINGS

TITLE OF STANDARD

Pipe Threads (Except Dryseal).....	B2.1-1968
Dryseal Pipe Threads.....	B2.2-1968
Hose Coupling Screw Threads	B2.4-1966
Cast-Iron Pipe Flanges & Flanged Fittings - 25, 125, 250, 800 lb	B16.1-1967
Malleable-Iron Screwed Fittings - 150 and 300 lb	B16.3-1963
Cast-Iron Screwed Fittings - 125 and 250 lb	B16.4-1963
Steel Pipe Flanges and Flanged Fittings - 150, 300, 400, 600, 900, 1500, and 2500 lb (with Appendices)	B16.5-1968
Wrought Steel Buttwelding Fittings	B16.9-1964
Face-to-Face Dimensions of Ferrous Flanged and Welding End Valves	B16.10-1957
Forged-Steel Fittings, Socket Welding and Threaded	B16.11-1966
Cast-Iron Threaded Drainage Fittings.....	B16.12-1965
Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads.....	B16.14-1965
Cast-Bronze Screwed Fittings - 125 and 250 lb	B16.15-1964
Cast-Bronze Solder-Joint Pressure Fittings.....	B16.18-1963 with 1967 Addendum
Ring-Joint Gaskets and Grooves for Steel Pipe Flanges	B16.20-1963
Nonmetallic Gaskets for Pipe Flanges	B16.21-1962
Wrought-Copper and Wrought-Bronze Solder-Joint Pressure Fittings.....	B16.22-1963
Cast-Bronze Solder-Joint Drainage Fittings.....	B16.23-1969
Bronze Flanges & Flanged Fittings 150 and 300 lb	B16.24-1962
Buttwelding Ends	B16.25-1964
Cast-Bronze Fittings for Flared Copper Tubes	B16.26-1967
Plastic Insert Fittings for Flexible Polyethylene Pipe	B16.27-1962
Wrought-Steel Buttwelding Short Radius Elbows and Returns	B16.28-1964
Wrought-Copper and Wrought-Copper Alloy Solder-Joint Drainage Fittings	B16.29-1966
Code for Pressure Piping	
Power Piping	B31.1.0-1967
Fuel Gas Piping.....	B31.2-1968
Petroleum Refinery Piping.....	B31.3-1966
Liquid Petroleum Transportation Piping Systems	B31.4-1966 with 1968 Addendum
Refrigeration Piping.....	B31.5-1966 with 1968 Addendum
Nuclear Power Piping	B31.7 (February 1968 Draft)
Gas Transmission and Distribution Piping Systems	B31.8-1968
Wrought-Steel and Wrought-Iron Pipe	B36.10-1959
Stainless Steel Pipe.....	B36.19-1965

Binders for holding standards are available.

A complete list of USA Standards published by The American Society of Mechanical Engineers obtainable upon request.