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 B1.1[1]. 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_o 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 $b = 0.5\sqrt{b_o}$.

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_G, 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_G).

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_o, b and h_G.

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_G 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.

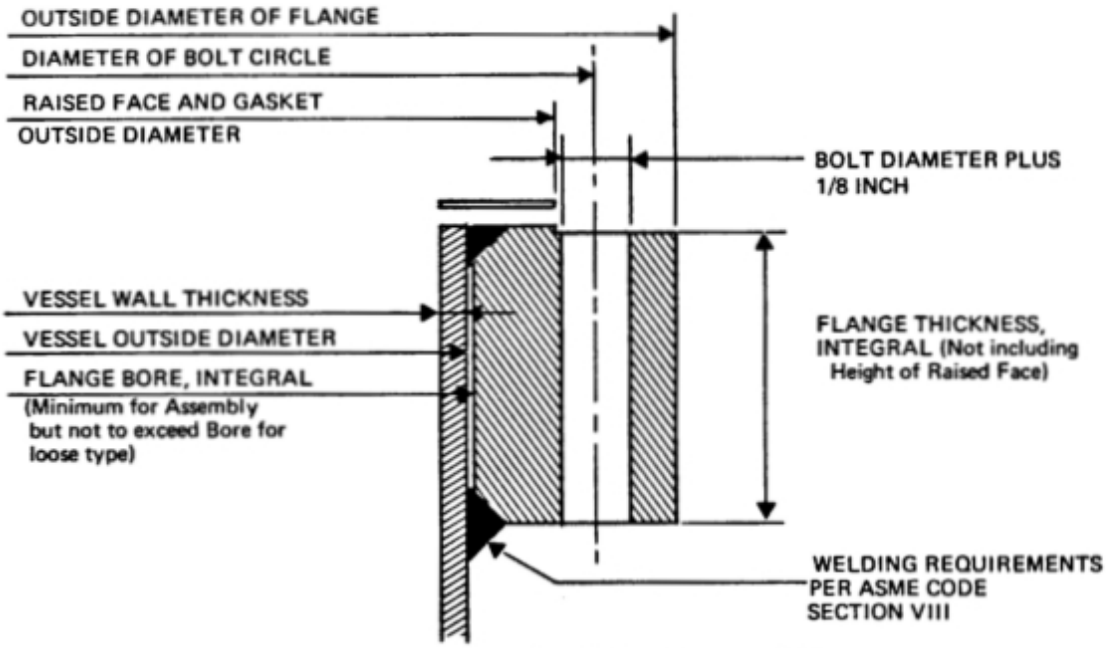
Gasket O.D. maximum equal raised face diameter minus ½ inch.

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

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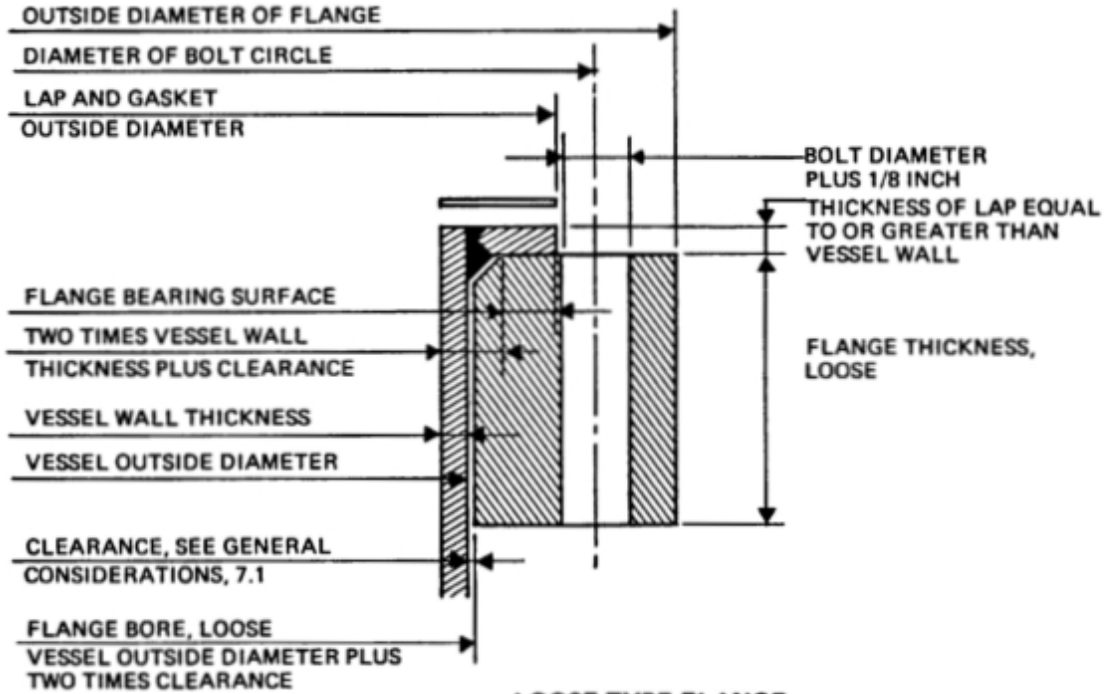
[1] *USA Standard B1.1-1960 Unified Screw Threads*, published by The American Society of Mechanical Engineers, New York City.

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INTEGRAL TYPE FLANGE

(SAME AS FIG. UA - 48 (8a) ASME CODE SECTION VIII)



LOOSE TYPE FLANGE

(SAME AS FIG. UA - 48 (1a) ASME CODE SECTION VIII)

Figure 1.

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Gasket I.D. minimum equal gasket O.D. minus 1½ inches but never less than vessel I.D. plus ¼ inch.

Inner ring I.D. maximum equal gasket I.D. minus ⅜ 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 ¼ 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_G 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_0 = ⅜ inch; B/g_0 = 300; P = 300 psi; operating temperature = 700 F. g_0 = 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.

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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	⅝	1.90	1.69	26.13	27.75	25.75	0.13
100	30.13	28.63	⅝	2.00	1.81	26.13	27.75	25.75	0.13
150	30.58	28.83	¾	2.38	2.19	26.13	27.83	25.67	0.17
200	31.07	29.07	⅞	2.69	2.50	26.13	27.94	25.56	0.22
250	31.18	29.18	⅞	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	1⅛	3.44	3.38	26.13	28.46	25.23	0.38
400	32.49	29.99	1⅛	3.69	3.63	26.13	28.62	25.12	0.44
450	33.14	30.39	1¼	3.94	3.94	26.13	28.89	25.01	0.49
500	33.30	30.55	1¼	4.06			29.05	24.91	0.55
550	33.95	30.95	1⅜	4.31			29.32	24.80	0.60
600	34.10	31.10	1⅜	4.50			29.47	24.69	0.65
650	34.75	31.50	1½	4.69			29.75	24.59	0.71
700	34.90	31.65	1½	4.88			29.90	24.48	0.76
750	35.55	32.05	1⅝	5.06			30.18	24.37	0.81
800	35.70	32.20	1⅝	5.19			30.32	24.27	0.87
Vessel Outside Diameter, 27 Inches, 24 Bolts									
50	31.13	29.63	⅝	1.94	1.69	27.13	28.75	26.75	0.13
100	31.13	29.63	⅝	2.06	1.88	27.13	28.75	26.75	0.13
150	31.59	29.84	¾	2.44	2.25	27.13	28.84	26.66	0.17
200	32.08	30.08	⅞	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	1⅛	3.56	3.50	27.13	29.51	26.20	0.40
400	33.54	31.04	1⅛	3.75	3.81	27.13	29.66	26.09	0.46
450	34.20	31.45	1¼	4.00			29.95	25.98	0.51
500	34.86	31.86	1¼	4.25			30.23	25.86	0.57
550	35.01	32.01	1⅜	4.44			30.39	25.75	0.62
600	35.67	32.42	1½	4.69			30.67	25.64	0.68
650	35.83	32.58	1½	4.81			30.83	25.53	0.73
700	36.48	32.98	1⅝	5.06			31.11	25.42	0.79
750	36.64	33.14	1⅝	5.19			31.26	25.31	0.84
Vessel Outside Diameter, 28 Inches, 28 Bolts									
50	32.13	30.63	⅝	2.00	1.75	28.13	29.75	27.75	0.13
100	32.13	30.63	⅝	2.13	1.94	28.13	29.75	27.75	0.13
150	32.61	30.86	¾	2.50	2.31	28.13	29.86	27.64	0.18
200	33.10	31.10	⅞	2.81	2.69	28.13	29.98	27.52	0.24
250	33.22	31.22	⅞	3.13	3.00	28.13	30.09	27.41	0.30

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