AN AMERICAN NATIONAL STANDARD

ASME B16.5a-1998

ADDENDA

to

ASME B16.5-1996
PIPE FLANGES AND FLANGED FITTINGS
NPS ½ Through NPS 24

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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ASME B16.5a–1998

Following approval by the ASME B16 Committee and ASME, and after public review, ASME B16.5a-1998 was approved by the American National Standards Institute on February 20, 1998.

Addenda to the 1996 edition of ASME B16.5 are issued in the form of replacement pages. Revisions, additions, and deletions are incorporated directly into the affected pages. It is advisable, however, that this page, the Addenda title and copyright pages, and all replaced pages be retained for reference.

SUMMARY OF CHANGES

This is the first Addenda to be published to ASME B16.5-1996.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **(a)**, placed next to the affected area. The pages not listed are the reverse sides of the listed pages and contain no changes.

Page	*Location*	*Change*
v	Foreword	ASME address updated
vii	Committee Roster	Updated
x	Contents	Updated to reflect Addenda changes
1	1.2.1	In the third and seventh lines, *Annex G* corrected by Errata to read *Annex H*
	2.1	Revised
8	7.2.1	*PS* corrected by Errata to read *NPS*
9	7.6	Overall length for NPS 4 and smaller revised
	8.1	Title corrected by Errata
10–12	Table 1A	(1) A 350 Gr. LF6 Cl. 1 added to material group 1.1 (2) A 350 Gr. LF6 Cl. 2 added to material group 1.2 (3) A 351 Gr. CE8MN, A 351 Gr. CD4MCu, A 351 Gr. CD3MWCuN, A 182 Gr. F55, and A 240 Gr. S32760 added to material group 2.8 (4) New material groups 1.15 and 3.17 added (5) A 351 Gr. CN7M deleted from material group 3.1 (6) General Notes added
15	Table 2-1.1	(1) A 350 Gr. LF6 Cl. 1 added (2) Note (4) added

Page	*Location*	*Change*
16	Table 2-1.2	(1) A 350 Gr. LF6 Cl. 2 added (2) Note (3) added
19	Table 2-1.5	First line of Note (1) corrected by Errata
20	Table 2-1.7	First line of Note (1) corrected by Errata
24.1	Table 2-1.15	Added
25	Table 2-2.1	Working pressure for Class 600 at 1400°F corrected by Errata to read *90*
28	Table 2-2.4	Working pressure for Class 600 at 1150°F corrected by Errata to read *475*
31	Table 2-2.7	(1) Working pressure for Class 2500 at 400°F corrected by Errata to read *4460* (2) Working pressure for Class 400 at 850°F corrected by Errata to read *570*
32	Table 2-2.8	A 351 Gr. CE8MN, A 351 Gr. CD4MCu, A 351 Gr. CD3MWCuN, A 182 Gr. F55, and A 240 Gr. S32760 added
33	Table 2-3.1	Revised in its entirety
35	Table 2-3.3	Working pressure for Class 600 at 900°F corrected by Errata to read *280*
36	Table 2-3.4	Working pressure for Class 400 at 900°F revised
37	Table 2-3.5	Working pressure for Class 900 at 800°F corrected by Errata to read *1520*
38	Table 2-3.6	Working pressure for Class 1500 at 750°F corrected by Errata to read *2650*
39	Table 2-3.7	Working pressure for Class 900 at 800°F corrected by Errata to read *1520*
40	Table 2-3.8	Working pressure for Class 900 at 800°F corrected by Errata to read *1520*
48	Table 2-3.16	Working pressure for Class 2500 at 1150°F corrected by Errata to read *1545*
48.1	Table 2-3.17	Added
53, 54	Fig. 7	(1) Top left sketch for Classes 150 and 300 revised (2) Top left sketch for Classes 400 and Higher revised
72	Table 9	In column 10, value for NPS 4 corrected by Errata to read *4.57*
84	Table 13	Note (19) renumbered to Note (18) by Errata

Page	*Location*	*Change*
150	Annex H	ASME address updated
153	Interpretations	ASME address updated

SPECIAL NOTE:

The Interpretations to ASME B16.5 are included in this Addenda as a separate section for the user's convenience. This section, however, is not part of the Addenda or the edition.

revisions. Following approval by the Standards Committee and ASME, approval as an American National Standard was given by ANSI on October 3, 1996 with the new designation ASME B16.5-1996.

(a) Requests for interpretations or suggestions for revision should be sent to the Secretary, B16 Committee, The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

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(a)

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PIPE FLANGES AND FLANGED FITTINGS

1 SCOPE

1.1 General

This Standard covers pressure–temperature ratings, materials, dimensions, tolerances, marking, testing, and methods of designating openings for pipe flanges and flanged fittings in sizes NPS ½ through NPS 24 and in rating Classes 150, 300, 400, 600, 900, 1500, and 2500. Flanges and flanged fittings may be cast, forged, or (for blind flanges and certain reducing flanges only) plate materials as listed in Table 1A.

Requirements and recommendations regarding bolting and gaskets are also included.

1.2 References

(a) **1.2.1 Referenced Standards.** Standards and specifications adopted by reference in this Standard are shown in Annex H, which is part of this Standard. It is not considered practical to identify the specific edition of each standard and specification in the individual references. Instead, the specific edition reference is identified in Annex H. A flange or flanged fitting manufactured in accordance with earlier editions of the referenced standards and in all other respects conforming to this Standard will be considered to be in conformance with this Standard.

1.2.2 Codes and Regulations. A flange or flanged fitting used under the jurisdiction of the ASME Boiler and Pressure Vessel Code, the ASME Code for Pressure Piping, or a governmental regulation is subject to any limitation of that code or regulation. This includes any maximum temperature limitation, or rule governing the use of a material at low temperature, or provisions for operation at a pressure exceeding the pressure–temperature ratings in this Standard.

1.3 Applicable Ratings

The pressure–temperature ratings in this Standard are applicable upon its publication to all flanges and flanged fittings within its scope which otherwise meet its requirements. For unused flanges or flanged fittings maintained in inventory, the manufacturer of the flange or flanged fittings may certify conformance to this Edition provided he can demonstrate that all requirements of this Edition have been met. Where such components were installed in accordance with the pressure–temperature ratings of an earlier edition of this Standard, those ratings are applicable except as may be governed by the applicable code or regulation (see para. 1.2.2).

1.4 User Accountability

This Standard cites duties and responsibilities that are to be assumed by the user in the areas of application, installation, hydrostatic testing, operation, and material selection.

1.5 Quality Systems

Nonmandatory requirements relating to the product manufacturer's Quality System Program are described in Annex G.

2 PRESSURE–TEMPERATURE RATINGS

2.1 Ratings Basis (a)

Ratings are maximum allowable working gage pressures at the temperatures shown in Table 2 for the applicable material and rating. For intermediate temperatures, linear interpolation is permitted. See Annex D for methods of establishing pressure–temperature ratings.

2.2 Ratings of Flanged Joints

A flanged joint is composed of three separate and independent, although interrelated components: the flanges, the gasket, and the bolting, which are assembled by yet another influence, the assembler. Proper controls must be exercised in the selection and application for all these elements to attain a joint which has acceptable leak tightness. Special techniques, such as controlled bolt tightening, may be necessary to achieve a tight joint in service.

Ratings in this Standard apply to flanged joints which conform to the limitations on bolting in para. 5.3 and on gaskets in para. 5.4, and which are made up in accordance with good practice for alignment and assembly. See also para. 2.4. Use of the ratings for flanged joints not conforming to these limitations is the responsibility of the user. Requirements for alignment and assembly of joints are not given in this Standard.

If the two flanges in a flanged joint do not have the same pressure–temperature ratings, the rating of the joint at any temperature is the lower of the two flange ratings at that temperature.

2.3 Rating Temperature

The temperature shown for a corresponding pressure rating is the temperature of the pressure-containing shell of the flange or flanged fitting. In general, this temperature is the same as that of the contained fluid. Use of a pressure rating corresponding to a temperature other than that of the contained fluid is the responsibility of the user, subject to the requirements of the applicable code or regulation. For any temperature below −20°F, the rating shall be no greater than the rating shown for −20°F.

2.4 Temperature Considerations

Application of the ratings in this Standard to flanged joints at both high and low temperatures shall take into consideration the risk of leakage due to forces and moments developed in the connected piping or equipment. The following provisions are intended to minimize these risks.

2.4.1 Flange Attachment. Socket welding and threaded flanges are not recommended for service above 500°F or below −50°F if severe thermal gradients or thermal cycling are involved.

2.4.2 High Temperature Service. At temperatures in the creep range, gradual relaxation of flanges, bolts, and gaskets may progressively reduce bolt loads. It may be necessary to arrange for periodic tightening of bolts to prevent leakage. Joints subject to substantial thermal gradients may require the same attention.

When used above 400°F, Class 150 flanged joints may develop leakage unless care is taken to avoid imposing severe external loads and/or severe thermal gradients. For other classes, similar consideration should be given above 750°F.

2.4.3 Low Temperature Service. The user should recognize that some of the material listed in the rating tables undergo sufficient decrease in toughness at low temperatures that they cannot safely sustain shock loadings, sudden changes of stress or temperature, or high stress concentrations.

2.5 System Hydrostatic Test

Flanged joints and flanged fittings may be subjected to system hydrostatic tests at a pressure not to exceed 1.5 times the 100°F rating rounded off to the next higher 25 psi. Testing at any higher pressure is the responsibility of the user, subject to the requirements of the applicable code or regulation.

2.6 Welding Neck Flanges

Ratings for welding neck flanges covered by this Standard are based upon their hubs at the welding end having thickness at least equal to that calculated for pipe having 40.0 ksi specified minimum yield strength. (For higher strength pipe with thinner wall, see MSS SP-44.) The ratings also apply to such flanges used with components of unequal strength and unequal wall thickness when the attachment weld is made in accordance with the applicable code or regulation. See Figs. 12, 13, and 14.

2.7 Multiple Material Grades

Materials for flanges and flanged fittings may meet the requirements for more than one specification or grade of a specification listed in Table 1A. In that event, the pressure–temperature ratings for any of these specifications or grades may be used provided that marking is in accordance with para. 4.1.2(d).

3 SIZE

3.1 Nominal Size

The size of a flange or flanged fitting covered by this Standard is its nominal pipe size, NPS. The diameter of a bolt is its nominal size. Use of "nominal" indicates that the stated size or dimension is only for designation, not measurement. The actual dimension may or may not be the nominal size and is subject to established tolerances.

3.2 Reducing Fittings

Reducing fittings shall be designated by the size of the openings in their proper sequence as indicated in the sketches of Fig. 2.

3.3 Reducing Flanges

Reducing flanges shall be designated by the two nominal pipe sizes. See examples in Note (4) of Table 7.

6.8.2 Hub Dimensions

6.8.2.1 Threaded, Socket Weld, and Slip-On Flanges. The hub dimensions shall be at least as large as those of the standard flange of the size to which the reduction is being made. The hub may be larger or omitted as detailed in Table 7.

6.8.2.2 Welding Neck Flanges. The hub dimensions shall be the same as those of the standard flange of the size to which the reduction is being made.

6.9 Threads for Threaded Flanges

Except as provided in Note (5), Fig. 7, and Note (5), Table 4, threaded flanges shall have an American National Standard taper pipe thread conforming to ASME B1.20.1. The thread shall be concentric with the axis of the flange, and variations in alignment shall not exceed 0.06 in./ft (0.5%).

6.9.1 Class 150 flanges are made without a counterbore. The threads shall be chamfered approximately to the major diameter of the thread at the back of the flange at an angle of approximately 45 deg. with the axis of the thread. The chamfer shall be concentric with the thread and shall be included in the measurement of the thread length.

6.9.2 Class 300 and higher pressure flanges are made with a counterbore at the back of the flange. The threads shall be chamfered to the diameter of the counterbore at an angle of approximately 45 deg. with the axis of the threads. The counterbore and chamfer shall be concentric with the thread.

6.9.3 The minimum length of effective thread in reducing flanges shall be at least equal to dimension *T* of the corresponding class of threaded flange as shown in the tables. Threads do not necessarily extend to the face of the flange. See Table 7 for reducing threaded flanges.

6.9.4 The gaging notch of the working gage shall come flush with the bottom of the chamfer in all threaded flanges and shall be considered as being the intersection of the chamfer cone and the pitch cone of the thread. This depth of chamfer is approximately equal to one-half the pitch of the thread. The maximum allowable thread variation is one turn large or small from the gaging notch.

6.9.5 Annex A indicates the distance and number of turns that external pipe threads may be made longer than regular for use with the higher pressure flanges to bring the small end of the thread close to the face of the flange when the parts are assembled by power equipment. Annex A applies to ASME B1.20.1 and is considered part of this Standard.

6.10 Flange Bolting Dimensions

6.10.1 Dimensional Standards. Stud bolts threaded at both ends or full length, or bolts may be used. Dimensional recommendations for bolts, stud bolts, and nuts are shown in Table 1C. See para. 5.3 for bolting material recommendations.

6.10.2 Bolt Lengths. Stud bolts with a nut at each end are recommended for high temperature service. Stud bolt lengths are specified in Tables 8, 11, 14, 17, 20, 23, and 26, and include the thickness of two nuts. The stud bolt length does not include the height of any point. A point is that part of a stud bolt or a bolt beyond the thread and may be chamfered, rounded, or sheared. For the method of calculating bolt lengths, see Annex F.

These lengths are established for the convenience of industry to simplify the assembly of these parts on construction work, but users may select combinations of these bolt lengths to suit their needs. Hence, Annex F is not considered part of this Standard.

6.10.3 The end flange bolting is based on a stress on the effective tensile stress area of the bolts not to exceed 7.0 ksi, assuming a pressure in psi equal to the pressure rating class designation to act upon an area circumscribed by the outside diameter of the raised face, dimension *R*, Table 4.

6.11 Gaskets for Line Flanges

6.11.1 Ring joint gasket dimensions shall conform to ASME B16.20.

6.11.2 For flanges with raised face, or with large male-and-female face, gaskets shall conform to limiting dimensions of Annex E.

6.11.3 For flanges having large or small tongue-and-groove faces, all gaskets except solid flat metal gaskets shall cover the bottom of the groove, with minimum clearance. (See para. 7.2.1 for tolerance applicable to groove.) Solid flat metal gaskets shall have contact width not greater than for Group No. III gaskets.

6.11.4 For flanges with small male-and-female face, care must be taken to insure that adequate bearing surface is provided for the gaskets. This applies particularly where the joint is made on the end of pipe. See Fig. 7.

6.12 Auxiliary Connections

No auxiliary connections, or openings therefore, will be provided except as specified by the purchaser. If assembly is required, the purchaser shall also specify the applicable code or regulation. Welded auxiliary connections shall be made by a qualified welder using a qualified weld procedure.

6.12.1 Pipe Thread Tapping. Holes may be tapped in the wall of a fitting if the metal is thick enough to allow the effective thread length specified in Fig. 3. Where thread length is insufficient or the tapped hole needs reinforcement, a boss shall be added.

6.12.2 Welded Connections

6.12.2.1 Sockets. Sockets (socket welding) may be provided in the wall of a fitting if the metal is thick enough to afford the depth of socket and retaining wall specified in Fig. 4. Where the wall thickness is insufficient, or the size of the connection requires opening reinforcement, a boss shall be added.

6.12.2.2 Butt Weld. Connections may be attached by butt welding directly to the wall of the fitting (see Fig. 5). Where the size of an opening requires reinforcement, a boss shall be added.

6.12.3 Bosses. Where bosses are required, the diameters shall be not less than those shown in Fig. 6, and the height shall provide lengths as specified in Fig. 3 or 4.

6.12.4 Size. Unless otherwise specified, auxiliary connections shall be of the pipe sizes given below.

Fitting Size, NPS	Connection, NPS
2–4	½
5–8	¾
10 and up	1

6.12.5 Designating Locations. This means of designating the locations for auxiliary connections in fittings are shown in Fig. 1.

Each possible location is designated by a letter so that the desired locations for the various types of fittings may be specified without using further sketches or description.

7 TOLERANCES[2]

7.1 General

For the purpose of determining conformance with this Standard, the convention for fixing significant digits where limits, maximum or minimum values are specified, shall be the rounding-off method defined in ASTM Practice E 29. This requires that an observed or calculated value shall be rounded to the nearest unit in the last right hand digit used for expressing the limit.

The listing of decimal tolerances does not imply a particular method of measurement.

7.2 Center-to-Contact Surfaces and Center-to-End

7.2.1 Center-to-Contact Surfaces Other Than Ring Joint (a)

NPS 10 and smaller	0.03 in.
NPS 12 and larger	0.06 in.

7.2.2 Center-to-End (Ring Joint)

NPS 10 and smaller	0.03 in.
NPS 12 and larger	0.06 in.

7.2.3 Contact Surface-to-Contact Surface Other Than Ring Joint

NPS 10 and smaller	0.06 in.
NPS 12 and larger	0.12 in.

7.2.4 End-to-End (Ring Joint)

NPS 10 and smaller	0.06 in.
NPS 12 and larger	0.12 in.

7.3 Facings

7.3.1 Inside and outside diameter of large and small tongue and groove and female, 0.02 in.

7.3.2 Outside diameter, 0.06 in. raised face, 0.03 in.

7.3.3 Outside diameter, 0.25 in. raised face, 0.02 in.

7.3.4 Ring joint groove tolerances are shown in Table 5.

7.4 Flange Thickness

NPS 18 and smaller	+0.12 in., –zero
NPS 20 and larger	+0.19 in., –zero

[2] Unless otherwise stated, tolerances are equal plus and minus.

7.5 Hub Dimensions and Welding Ends

7.5.1 Nominal outside diameter of welding end of welding neck flanges (dimension *A* of Figs. 8 and 9).

NPS 5 and smaller	+0.09 in., −0.03 in.
NPS 6 and larger	+0.16 in., −0.03 in.

7.5.2 Nominal inside diameter of welding ends of welding neck flanges and smaller bore of socket welding flanges (dimension *B* in the referenced figures).

Figs. 8 and 9:

NPS 10 and smaller	0.03 in.
NPS 12 to 18, inclusive	0.06 in.
NPS 20 and larger	+0.12 in., −0.06 in.

Fig. 10:

NPS 10 and smaller	+zero, −0.03 in.
NPS 12 and larger	+zero, −0.06 in.

7.5.3 Bore of backing ring of welding neck flanges (dimension *C* of Figs. 10 and 11).

All sizes	+0.010 in., − zero

7.5.4 Thickness of Hub. Regardless of tolerances specified for dimensions *A* and *B*, the thickness of hub at the welding end shall never be less than 87½% of the nominal thickness of the pipe to which the flange is to be attached.

(a) 7.6 Overall Length Through Hub on Welding Neck Flanges

NPS 4 and smaller	0.06 in.
NPS 5 to 10, inclusive	+0.06 in., −0.12 in.
NPS 12 and larger	+0.12 in., −0.18 in.

7.7 Bore of Flanges

7.7.1 Lapped, Slip-On, and Socket Welding Flanges

NPS 10 and smaller	+0.03 in., −zero
NPS 12 and larger	+0.06 in., −zero

7.7.2 Counterbore, Threaded Flanges

NPS 10 and smaller	+0.03 in., −zero
NPS 12 and larger	+0.06 in., −zero

7.8 Drilling and Facing

7.8.1 Bolt circle diameter, 0.06 in.

7.8.2 Center-to-center of adjacent bolt holes, 0.03 in.

7.8.3 Eccentricity between bolt circle diameter and machined facing diameters.

NPS 2½ and smaller	0.03 in.
NPS 3 and larger	0.06 in.

8 TEST

8.1 Flanged Fitting Testing (a)

Each flanged fitting shall be given a hydrostatic shell test as specified in para. 8.3.

8.2 Flange Testing

Flanges are not required to be hydrostatically tested.

8.3 Hydrostatic Shell Test

The hydrostatic shell test for flanged fittings shall be no less than 1.5 times the 100°F rating rounded off to the next higher 25 psi increment.

8.3.1 The test shall be made with water, which may contain a corrosion inhibitor, with kerosene, or with another suitable fluid provided its viscosity is no greater than that of water, at a test temperature not above 125°F.

8.3.2 The test duration shall be a minimum of 1 min for fittings NPS 2 and smaller, 2 min for fittings NPS 2½–NPS 8, and 3 min for fittings NPS 10 and larger.

8.3.3 No visible leakage is permitted through the pressure boundary wall.

(a)

TABLE 1A LIST OF MATERIAL SPECIFICATIONS

Material Group	Nominal Designation	Pressure-Temperature Rating Table	Applicable ASTM Specifications[1]		
			Forgings	Castings	Plates
1.1	C-Si C-Mn-Si C-Mn-Si-V	2-1.1	A 105 A 350 Gr. LF2 A 350 Gr. LF6 Cl. 1	A 216 Gr. WCB	A 515 Gr. 70 A 516 Gr. 70 A 537 Cl. 1
1.2	C-Mn-Si C-Mn-Si-V 2½Ni 3½Ni	2-1.2	 A 350 Gr. LF6 Cl. 2 A 350 Gr. LF3	A 216 Gr. WCC A 352 Gr. LCC A 352 Gr. LC2 A 352 Gr. LC3	 A 203 Gr. B A 203 Gr. E
1.3	C-Si C-Mn-Si 2½Ni 3½Ni	2-1.3		A 352 Gr. LCB	A 515 Gr. 65 A 516 Gr. 65 A 203 Gr. A A 203 Gr. D
1.4	C-Si C-Mn-Si	2-1.4	 A 350 Gr. LF1 Cl. 1		A 515 Gr. 60 A 516 Gr. 60
1.5	C-½Mo	2-1.5	A 182 Gr. F1	A 217 Gr. WC1 A 352 Gr. LC1	A 204 Gr. A A 204 Gr. B
1.7	C-½Mo ½Cr-½Mo Ni-½Cr-½Mo ¾Ni-¾Cr-1Mo	2-1.7	 A 182 Gr. F2	 A 217 Gr. WC4 A 217 Gr. WC5	A 204 Gr. C
1.9	1Cr-½Mo 1¼Cr-½Mo 1¼Cr-½Mo-Si	2-1.9	A 182 Gr. F12 Cl. 2 A 182 Gr. F11 Cl. 2	 A 217 Gr. WC6	 A 387 Gr. 11 Cl. 2
1.10	2¼Cr-1Mo	2-1.10	A 182 Gr. F22 Cl. 3	A 217 Gr. WC9	A 387 Gr. 22 Cl. 2
1.13	5Cr-½Mo	2-1.13	A 182 Gr. F5 A 182 Gr. F5a	 A 217 Gr. C5	
1.14	9Cr-1Mo	2-1.14	A 182 Gr. F9	A 217 Gr. C12	
1.15	9Cr-1Mo-V	2-1.15	A 182 Gr. F91	A 217 Gr. C12A	A 387 Gr. 91 Cl. 2
2.1	18Cr-8Ni	2-2.1	A 182 Gr. F304 A 182 Gr. F304H	A 351 Gr. CF3 A 351 Gr. CF8	A 240 Gr. 304 A 240 Gr. 304H
2.2	16Cr-12Ni-2Mo 18Cr-13Ni-3Mo 19Cr-10Ni-3Mo	2-2.2	A 182 Gr. F316 A 182 Gr. F316H	A 351 Gr. CF3M A 351 Gr. CF8M A 351 Gr. CG8M	A 240 Gr. 316 A 240 Gr. 316H A 240 Gr. 317
2.3	18Cr-8Ni 16Cr-12Ni-2Mo	2-2.3	A 182 Gr. F304L A 182 Gr. F316L		A 240 Gr. 304L A 240 Gr. 316L
2.4	18Cr-10Ni-Ti	2-2.4	A 182 Gr. F321 A 182 Gr. F321H		A 240 Gr. 321 A 240 Gr. 321H

(a)

TABLE 1A LIST OF MATERIAL SPECIFICATIONS (CONT'D)

Material Group	Nominal Designation	Pressure–Temperature Rating Table	Applicable ASTM Specifications[1]		
			Forgings	Castings	Plates
2.5	18Cr–10Ni–Cb	2-2.5	A 182 Gr. F347 A 182 Gr. F347H A 182 Gr. F348 A 182 Gr. F348H	A 351 Gr. CF8C	A 240 Gr. 347 A 240 Gr. 347H A 240 Gr. 348 A 240 Gr. 348H
2.6	25Cr–12Ni 23Cr–12Ni	2-2.6		A 351 Gr. CH8 A 351 Gr. CH20	 A 240 Gr. 309S A 240 Gr. 309H
2.7	25Cr–20Ni	2-2.7	A 182 Gr. F310	A 351 Gr. CK20	A 240 Gr. 310S A 240 Gr. 310H
2.8	20Cr–18Ni–6Mo 22Cr–5Ni–3Mo–N 25Cr–7Ni–4Mo–N 24Cr–10Ni–4Mo–V 25Cr–5Ni–2Mo–3Cu 25Cr–7Ni–3.5Mo–W–Cb 25Cr–7Ni–3.5Mo–N–Cu–W	2-2.8	A 182 Gr. F44 A 182 Gr. F51 A 182 Gr. F53 A 182 Gr. F55	A 351 Gr. CK3MCuN A 351 Gr. CE8MN A 351 Gr. CD4MCu A 351 Gr. CD3MWCuN	A 240 Gr. S31254 A 240 Gr. S31803 A 240 Gr. S32750 A 240 Gr. S32760
3.1	35Ni–35Fe–20Cr–Cb	2-3.1	B 462 Gr. N08020		B 463 Gr. N08020
3.2	99.0Ni	2-3.2	B 160 Gr. N02200		B 162 Gr. N02200
3.3	99.0Ni–Low C	2-3.3	B 160 Gr. N02201		B 162 Gr. N02201
3.4	67Ni–30Cu 67Ni–30Cu–S	2-3.4	B 564 Gr. N04400 B 164 Gr. N04405		B 127 Gr. N04400
3.5	72Ni–15Cr–8Fe	2-3.5	B 564 Gr. N06600		B 168 Gr. N06600
3.6	33Ni–42Fe–21Cr	2-3.6	B 564 Gr. N08800		B 409 Gr. N08800
3.7	65Ni–28Mo–2Fe	2-3.7	B 335 Gr. N10665		B 333 Gr. N10665
3.8	54Ni–16Mo–15Cr 60Ni–22Cr–9Mo–3.5Cb 62Ni–28Mo–5Fe 70Ni–16Mo–7Cr–5Fe 61Ni–16Mo–16Cr 42Ni–21.5Cr–3Mo–2.3Cu	2-3.8	B 564 Gr. N10276 B 564 Gr. N06625 B 335 Gr. N10001 B 573 Gr. N10003 B 574 Gr. N06455 B 564 Gr. N08825		B 575 Gr. N10276 B 443 Gr. N06625 B 333 Gr. N10001 B 434 Gr. N10003 B 575 Gr. N06455 B 424 Gr. N08825
3.9	47Ni–22Cr–9Mo–18Fe	2-3.9	B 572 Gr. N06002		B 435 Gr. N06002
3.10	25Ni–46Fe–21Cr–5Mo	2-3.10	B 672 Gr. N08700		B 599 Gr. N08700
3.11	44Fe–25Ni–21Cr–Mo	2-3.11	B 649 Gr. N08904		B 625 Gr. N08904
3.12	26Ni–43Fe–22Cr–5Mo 47Ni–22Cr–20Fe–7Mo	2-3.12	B 621 Gr. N08320 B 581 Gr. N06985		B 620 Gr. N08320 B 582 Gr. N06985

(Table 1A continues on next page; Notes follow at end of Table)

(a)

TABLE 1A LIST OF MATERIAL SPECIFICATIONS (CONT'D)

Material Group	Nominal Designation	Pressure-Temperature Rating Table	Applicable ASTM Specifications[1]		
			Forgings	Castings	Plates
3.13	49Ni-25Cr-18Fe-6Mo Ni-Fe-Cr-Mo-Low Cu	2-3.13	B 581 Gr. N06975 B 564 Gr. N08031		B 582 Gr. N06975 B 625 Gr. N08031
3.14	47Ni-22Cr-19Fe-6Mo	2-3.14	B 581 Gr. N06007		B 582 Gr. N06007
3.15	33Ni-42Fe-21Cr	2-3.15	B 564 Gr. N08810		B 409 Gr. N08810
3.16	35Ni-19Cr-1¼Si	2-3.16	B 511 Gr. N08330		B 536 Gr. N08330
3.17	29Ni-20.5Cr-3.5Cu-2.5Mo	2-3.17		A 351 Gr. CN7M	

GENERAL NOTES:

(a) For temperature limitations, see Notes in Table 2.

(b) Plate materials are listed only for use as blind flanges (see para. 5.1). Additional plate materials listed in ASME B16.34 may also be used with corresponding B16.34 Standard Class ratings.

(c) Material Groups not listed in Table 1A are intended for use in valves. See ASME B16.34.

NOTE:

(1) ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the listed ASTM specifications, may also be used.

TABLES 2
PRESSURE–TEMPERATURE RATINGS FOR GROUPS 1.1 THROUGH 3.17 MATERIALS

TABLE 2-1.1 RATINGS FOR GROUP 1.1 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
C–Si	A 105 (1)	A 216 Gr. WCB (1)	A 515 Gr. 70 (1)
C–Mn–Si	A 350 Gr. LF2 (1)		A 516 Gr. 70 (1)(2) A 537 Cl. 1 (3)
C–Mn–Si–V	A 350 Gr. LF6 Cl. 1 (4)		

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 850°F.
(3) Not to be used over 700°F.
(4) Not to be used over 500°F.

	WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	285	740	990	1480	2220	3705	6170
200	260	675	900	1350	2025	3375	5625
300	230	655	875	1315	1970	3280	5470
400	200	635	845	1270	1900	3170	5280
500	170	600	800	1200	1795	2995	4990
600	140	550	730	1095	1640	2735	4560
650	125	535	715	1075	1610	2685	4475
700	110	535	710	1065	1600	2665	4440
750	95	505	670	1010	1510	2520	4200
800	80	410	550	825	1235	2060	3430
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

(a)

TABLE 2-1.2 RATINGS FOR GROUP 1.2 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C–Mn–Si		A 216 Gr. WCC (1) A 352 Gr. LCC (2)	
C–Mn–Si–V	A 350 Gr. LF6 Cl. 2 (3)		
2½Ni		A 352 Gr. LC2	A 203 Gr. B (1)
3½Ni	A 350 Gr. LF3	A 352 Gr. LC3	A 203 Gr. E (1)

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 650°F.
(3) Not to be used over 500°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	505	670	1010	1510	2520	4200
800	80	410	550	825	1235	2060	3430
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

TABLE 2-1.5 RATINGS FOR GROUP 1.5 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
C-½Mo	A 182 Gr. F1 (1)	A 217 Gr. WC1 (1)(2) A 352 Gr. LC1 (3)	A 204 Gr. A (1) A 204 Gr. B (1)

NOTES:
(1) Upon prolonged exposure to temperatures above 875°F, the carbide phase of carbon-molybdenum steel may be converted to graphite. Permissible, but not recommended for prolonged use above 875°F.
(2) Use normalized and tempered material only.
(3) Not to be used over 650°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	265	695	925	1390	2085	3470	5785
200	260	680	905	1360	2035	3395	5660
300	230	655	870	1305	1955	3260	5435
400	200	640	855	1280	1920	3200	5330
500	170	620	830	1245	1865	3105	5180
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	280	375	560	845	1405	2345
1000	20	165	220	330	495	825	1370

(a)

TABLE 2-1.7 RATINGS FOR GROUP 1.7 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C-½Mo			A 204 Gr. C (1)
½Cr-½Mo	A 182 Gr. F2 (3)		
Ni-½Cr-½Mo		A 217 Gr. WC4 (2)(3)	
¾Ni-¾Cr-1Mo		A 217 Gr. WC5 (2)	

NOTES:
(1) Upon prolonged exposure to temperatures above 875°F, the carbide phase of carbon-molybdenum steel may be converted to graphite. Permissible, but not recommended for prolonged use above 875°F.
(2) Use normalized and tempered material only.
(3) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	720	965	1445	2165	3610	6015
400	200	695	925	1385	2080	3465	5775
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	315	420	630	945	1575	2630
1000	20	200	270	405	605	1010	1685
1050	...	160	210	315	475	790	1315

TABLE 2-1.15 RATINGS FOR GROUP 1.15 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
9Cr–1Mo–V	A 182 Gr. F91	A 217 Gr. C12A	A 387 Gr. 91 Cl. 2

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	300	400	605	905	1510	2515
1150	...	225	295	445	670	1115	1855
1200	...	145	190	290	430	720	1200

TABLE 2-2.1 RATINGS FOR GROUP 2.1 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
18Cr–8Ni	A 182 Gr. F304 (1)	A 351 Gr. CF3 (2)	A 240 Gr. 304 (1)
	A 182 Gr. F304H	A 351 Gr. CF8 (1)	A 240 Gr. 304H

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 800°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	275	720	960	1440	2160	3600	6000
200	230	600	800	1200	1800	3000	5000
300	205	540	720	1080	1620	2700	4500
400	190	495	660	995	1490	2485	4140
500	170	465	620	930	1395	2330	3880
600	140	435	580	875	1310	2185	3640
650	125	430	575	860	1290	2150	3580
700	110	425	565	850	1275	2125	3540
750	95	415	555	830	1245	2075	3460
800	80	405	540	805	1210	2015	3360
850	65	395	530	790	1190	1980	3300
900	50	390	520	780	1165	1945	3240
950	35	380	510	765	1145	1910	3180
1000	20	320	430	640	965	1605	2675
1050	...	310	410	615	925	1545	2570
1100	...	255	345	515	770	1285	2145
1150	...	200	265	400	595	995	1655
1200	...	155	205	310	465	770	1285
1250	...	115	150	225	340	565	945
1300	...	85	115	170	255	430	715
1350	...	60	80	125	185	310	515
1400	...	50	65	90	145	240	400
1450	...	35	45	70	105	170	285
1500	...	25	35	55	80	135	230

TABLE 2-2.2 RATINGS FOR GROUP 2.2 MATERIALS

Nominal Designation	Forgings	Castings	Plates
16Cr–12Ni–2Mo	A 182 Gr. F316 (1) A 182 Gr. F316H	A 351 Gr. CF3M (2) A 351 Gr. CF8M (1)	A 240 Gr. 316 (1) A 240 Gr. 316H
18Cr–13Ni–3Mo			A 240 Gr. 317 (1)
19Cr–10Ni–3Mo		A 351 Gr. CG8M (3)	

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 850°F.
(3) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	275	720	960	1440	2160	3600	6000
200	235	620	825	1240	1860	3095	5160
300	215	560	745	1120	1680	2795	4660
400	195	515	685	1025	1540	2570	4280
500	170	480	635	955	1435	2390	3980
600	140	450	600	900	1355	2255	3760
650	125	445	590	890	1330	2220	3700
700	110	430	580	870	1305	2170	3620
750	95	425	570	855	1280	2135	3560
800	80	420	565	845	1265	2110	3520
850	65	420	555	835	1255	2090	3480
900	50	415	555	830	1245	2075	3460
950	35	385	515	775	1160	1930	3220
1000	20	350	465	700	1050	1750	2915
1050	...	345	460	685	1030	1720	2865
1100	...	305	405	610	915	1525	2545
1150	...	235	315	475	710	1185	1970
1200	...	185	245	370	555	925	1545
1250	...	145	195	295	440	735	1230
1300	...	115	155	235	350	585	970
1350	...	95	130	190	290	480	800
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

TABLE 2-2.3 RATINGS FOR GROUP 2.3 MATERIALS

Nominal Designation	Forgings	Castings	Plates
16Cr–12Ni–2Mo	A 182 Gr. F316L		A 240 Gr. 316L
18Cr–8Ni	A 182 Gr. F304L (1)		A 240 Gr. 304L (1)

NOTE:
(1) Not to be used over 800°F.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	230	600	800	1200	1800	3000	5000
200	195	505	675	1015	1520	2530	4220
300	175	455	605	910	1360	2270	3780
400	160	415	550	825	1240	2065	3440
500	145	380	510	765	1145	1910	3180
600	140	360	480	720	1080	1800	3000
650	125	350	470	700	1050	1750	2920
700	110	345	460	685	1030	1715	2860
750	95	335	450	670	1010	1680	2800
800	80	330	440	660	985	1645	2740
850	65	320	430	645	965	1610	2680

(a)

TABLE 2-2.4 RATINGS FOR GROUP 2.4 MATERIALS

Nominal Designation	Forgings	Castings	Plates
18Cr–10Ni–Ti	A 182 Gr. F321 (2) A 182 Gr. F321H (1)		A 240 Gr. 321 (2) A 240 Gr. 321H (1)

NOTES:
(1) At temperatures over 1000°F, use only if the material is heat treated by heating to a minimum temperature of 2000°F.
(2) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	275	720	960	1440	2160	3600	6000
200	245	645	860	1290	1935	3230	5380
300	230	595	795	1190	1785	2975	4960
400	200	550	735	1105	1655	2760	4600
500	170	515	685	1030	1545	2570	4285
600	140	485	650	975	1460	2435	4060
650	125	480	635	955	1435	2390	3980
700	110	465	620	930	1395	2330	3880
750	95	460	610	915	1375	2290	3820
800	80	450	600	900	1355	2255	3760
850	65	445	595	895	1340	2230	3720
900	50	440	590	885	1325	2210	3680
950	35	385	515	775	1160	1930	3220
1000	20	355	475	715	1070	1785	2970
1050	. . .	315	415	625	940	1565	2605
1100	. . .	270	360	545	815	1360	2265
1150	. . .	235	315	475	710	1185	1970
1200	. . .	185	245	370	555	925	1545
1250	. . .	140	185	280	420	705	1170
1300	. . .	110	145	220	330	550	915
1350	. . .	85	115	170	255	430	715
1400	. . .	65	85	130	195	325	545
1450	. . .	50	70	105	155	255	430
1500	. . .	40	50	75	115	190	315

TABLE 2-2.7 RATINGS FOR GROUP 2.7 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
25Cr–20Ni	A 182 Gr. F310 (1)(3)	A 351 Gr. CK20 (1)	A 240 Gr. 310S (1)(2)(3) A 240 Gr. 310H

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) For temperatures above 1000°F, use only if the material is heat treated by heating it to a temperature of at least 1900°F and quenching in water or rapidly cooling by other means.
(3) Service temperatures of 1050°F and above should be used only when assurance is provided that grain size is not finer than ASTM 6.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	260	670	895	1345	2015	3360	5600
200	235	605	810	1215	1820	3035	5060
300	220	570	760	1140	1705	2845	4740
400	200	535	715	1070	1605	2675	4460
500	170	505	675	1015	1520	2530	4220
600	140	480	640	960	1440	2400	4000
650	125	470	625	935	1405	2340	3900
700	110	455	610	910	1370	2280	3800
750	95	450	600	900	1345	2245	3740
800	80	435	580	875	1310	2185	3640
850	65	425	570	855	1280	2135	3560
900	50	420	555	835	1255	2090	3480
950	35	385	515	775	1160	1930	3220
1000	20	345	460	685	1030	1720	2865
1050	...	335	450	670	1010	1680	2800
1100	...	260	345	520	780	1305	2170
1150	...	190	250	375	565	945	1570
1200	...	135	185	275	410	685	1145
1250	...	105	135	205	310	515	855
1300	...	75	100	150	225	375	630
1350	...	60	80	115	175	290	485
1400	...	45	60	90	135	225	370
1450	...	35	45	65	100	165	275
1500	...	25	35	50	75	130	215

(a)

TABLE 2-2.8 RATINGS FOR GROUP 2.8 MATERIALS

Nominal Designation	Forgings	Castings	Plates
20Cr–18Ni–6Mo	A 182 Gr. F44	A 351 Gr. CK3MCuN	A 240 Gr. S31254
22Cr–5Ni–3Mo–N	A 182 Gr. F51 (1)		A 240 Gr. S31803 (1)
25Cr–7Ni–4Mo–N	A 182 Gr. F53 (1)		A 240 Gr. S32750 (1)
24Cr–10Ni–4Mo–V		A 351 Gr. CE8MN (1)	
25Cr–5Ni–2Mo–3Cu		A 351 Gr. CD4MCu (1)	
25Cr–7Ni–3.5Mo–W–Cb		A 351 Gr. CD3MWCuN (1)	
25Cr–7Ni–3.5Mo–N–Cu–W	A 182 Gr. F55 (1)		A 240 Gr. S32760 (1)

NOTE:
(1) This steel may become brittle after service at moderately elevated temperatures. Not to be used over 600°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	290	750	1000	1500	2250	3750	6250
200	260	720	960	1440	2160	3600	6000
300	230	665	885	1330	1995	3325	5540
400	200	615	820	1230	1845	3070	5120
500	170	575	770	1150	1730	2880	4800
600	140	555	740	1115	1670	2785	4640
650	125	550	735	1100	1650	2750	4580
700	110	540	725	1085	1625	2710	4520
750	95	530	710	1065	1595	2660	4430

TABLE 2-3.1 RATINGS FOR GROUP 3.1 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
35Ni–35Fe–20Cr–Cb	B 462 Gr. N08020 (1)		B 463 Gr. N08020 (1)

NOTE:
(1) Use annealed material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	290	750	1000	1500	2250	3750	6250
200	260	720	960	1440	2160	3600	6000
300	230	715	950	1425	2140	3565	5940
400	200	675	900	1345	2020	3365	5610
500	170	655	875	1310	1965	3275	5460
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230

TABLE 2-3.2 RATINGS FOR GROUP 3.2 MATERIALS

Nominal Designation	Forgings	Castings	Plates
99.0Ni	B 160 Gr. N02200 (1)(2)		B 162 Gr. N02200 (1)

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	140	360	480	720	1080	1800	3000
200	140	360	480	720	1080	1800	3000
300	140	360	480	720	1080	1800	3000
400	140	360	480	720	1080	1800	3000
500	140	360	480	720	1080	1800	3000
600	140	360	480	720	1080	1800	3000

TABLE 2-3.3 RATINGS FOR GROUP 3.3 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
99.0Ni–Low C	B 160 Gr. N02201 (1)(2)		B 162 Gr. N02201 (1)

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	90	240	320	480	720	1200	2000
200	85	230	305	455	685	1140	1900
300	85	225	300	445	670	1115	1860
400	85	215	290	430	650	1080	1800
500	85	215	290	430	650	1080	1800
600	85	215	290	430	650	1080	1800
650	85	215	290	430	650	1080	1800
700	85	215	290	430	650	1080	1800
750	80	210	280	420	635	1055	1760
800	80	205	270	410	610	1020	1700
850	65	205	270	410	610	1020	1700
900	50	140	185	280	415	695	1155
950	35	115	150	230	345	570	950
1000	20	95	125	185	280	465	770
1050	...	75	100	150	220	370	615
1100	...	60	80	125	185	310	515
1150	...	45	60	95	140	230	385
1200	...	35	50	75	110	185	310

(a)

TABLE 2-3.4 RATINGS FOR GROUP 3.4 MATERIALS

Nominal Designation	Forgings	Castings	Plates
67Ni–30Cu	B 564 Gr. N04400 (1)		B 127 Gr. N04400 (1)
67Ni–30Cu–S	B 164 Gr. N04405 (1)(2)		

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	230	600	800	1200	1800	3000	5000
200	200	530	705	1055	1585	2640	4400
300	190	495	660	990	1485	2470	4120
400	185	480	635	955	1435	2390	3980
500	170	475	635	950	1435	2375	3960
600	140	475	635	950	1435	2375	3960
650	125	475	635	950	1435	2375	3960
700	110	475	635	950	1435	2375	3960
750	95	470	625	935	1405	2340	3900
800	80	460	610	915	1375	2290	3820
850	65	340	455	680	1020	1695	2830
900	50	245	330	495	740	1235	2055

TABLE 2-3.5 RATINGS FOR GROUP 3.5 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
72Ni–15Cr–8Fe	B 564 Gr. N06600 (1)		B 168 Gr. N06600 (1)

NOTE:
(1) Use annealed material only.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1520	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	325	435	655	980	1635	2725
1000	20	215	290	430	650	1080	1800
1050	...	140	185	280	415	695	1155
1100	...	95	125	185	280	465	770
1150	...	70	90	135	205	340	565
1200	...	60	80	125	185	310	515

(a)

TABLE 2-3.6 RATINGS FOR GROUP 3.6 MATERIALS

Nominal Designation	Forgings	Castings	Plates
33Ni-42Fe-21Cr	B 564 Gr. N08800 (1)		B 409 Gr. N08800 (1)

NOTE:
(1) Use annealed material only.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	275	720	960	1440	2160	3600	6000
200	255	660	885	1325	1990	3310	5520
300	230	625	830	1250	1870	3120	5200
400	200	600	800	1200	1800	3000	5000
500	170	580	770	1155	1735	2890	4820
600	140	575	765	1145	1720	2870	4780
650	125	570	760	1140	1705	2845	4740
700	110	565	750	1130	1690	2820	4700
750	95	530	710	1065	1595	2650	4430
800	80	505	675	1015	1520	2535	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	205	270	405	610	1020	1695
1250	...	130	175	260	390	650	1080
1300	...	60	80	125	185	310	515
1350	...	50	65	100	150	245	410
1400	...	35	45	70	100	170	285
1450	...	30	40	60	95	155	255
1500	...	25	35	50	75	125	205

TABLE 2-3.7 RATINGS FOR GROUP 3.7 MATERIALS (a)

Nominal Designation	Forgings	Castings	Plates
65Ni–28Mo–2Fe	B 335 Gr. N10665 (1)(2)		B 333 Gr. N10665 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1520	2540	4230

(a)

TABLE 2-3.8 RATINGS FOR GROUP 3.8 MATERIALS

Nominal Designation	Forgings	Castings	Plates
54Ni-16Mo-15Cr	B 564 Gr. N10276 (1)(4)		B 575 Gr. N10276 (1)(4)
60Ni-22Cr-9Mo-3.5Cb	B 564 Gr. N06625 (3)(5)		B 443 Gr. N06625 (3)(5)
62Ni-28Mo-5Fe	B 335 Gr. N10001 (1)(2)(6)		B 333 Gr. N10001 (1)(6)
70Ni-16Mo-7Cr-5Fe	B 573 Gr. N10003 (2)(3)		B 434 Gr. N10003 (3)
61Ni-16Mo-16Cr	B 574 Gr. N06455 (1)(2)(6)		B 575 Gr. N06455 (1)(6)
42Ni-21.5Fe-3Cr-2.3Cu	B 564 Gr. N08825 (3)(7)		B 424 Gr. N08825 (3)(7)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.
(3) Use annealed material only.
(4) Not to be used over 1250°F.
(5) Not to be used over 1200°F. Alloy N06625 in the annealed condition is subject to severe loss of impact strength at room temperatures after exposure in the range of 1000°F to 1400°F.
(6) Not to be used over 800°F.
(7) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
-20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1520	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	185	245	370	555	925	1545
1250	...	145	195	295	440	735	1220
1300	...	110	145	215	325	540	900

TABLE 2-3.15 RATINGS FOR GROUP 3.15 MATERIALS

Nominal Designation	Forgings	Castings	Plates
33Ni–42Fe–21Cr	B 564 Gr. N08810 (1)		B 409 Gr. N08810 (1)

NOTE:
(1) Use solution annealed material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	230	600	800	1200	1800	3000	5000
200	205	540	720	1080	1620	2700	4500
300	195	505	675	1015	1520	2530	4220
400	185	480	640	960	1440	2400	4000
500	170	455	610	910	1370	2280	3800
600	140	440	585	880	1320	2195	3660
650	125	425	565	850	1275	2125	3540
700	110	420	560	840	1260	2100	3500
750	95	415	550	825	1240	2065	3440
800	80	410	545	815	1225	2040	3400
850	65	400	530	795	1195	1990	3320
900	50	395	530	790	1190	1980	3300
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	325	435	650	975	1625	2710
1100	...	320	430	640	965	1605	2675
1150	...	275	365	550	825	1370	2285
1200	...	205	275	410	620	1030	1715
1250	...	180	245	365	545	910	1515
1300	...	140	185	275	410	685	1145
1350	...	105	140	205	310	515	860
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

(a)

TABLE 2-3.16 RATINGS FOR GROUP 3.16 MATERIALS

Nominal Designation	Forgings	Castings	Plates
35Ni–19Cr–1¼Si	B 511 Gr. N08330 (1)(2)		B 536 Gr. N08330 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	275	720	960	1440	2160	3600	6000
200	245	635	850	1270	1910	3180	5300
300	225	590	785	1175	1765	2940	4900
400	200	550	735	1105	1655	2760	4600
500	170	525	700	1050	1575	2630	4380
600	140	500	670	1005	1505	2510	4180
650	125	490	655	980	1470	2450	4080
700	110	480	645	965	1445	2410	4020
750	95	470	625	940	1410	2350	3920
800	80	465	620	925	1390	2315	3860
850	65	455	605	905	1360	2270	3780
900	50	445	590	885	1330	2215	3690
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	310	410	615	925	1545	2570
1100	...	240	320	480	720	1205	2005
1150	...	185	245	370	555	925	1545
1200	...	145	195	290	435	725	1210
1250	...	115	155	235	350	585	975
1300	...	95	130	190	285	480	795
1350	...	75	100	150	220	370	615
1400	...	55	75	110	165	280	465
1450	...	45	60	95	140	230	385
1500	...	35	45	70	100	170	285

TABLE 2-3.17 RATINGS FOR GROUP 3.17 MATERIAL (a)

Nominal Designation	Forgings	Castings	Plates
29Ni–20.5Cr–3.5Cu–2.5Mo		A 351 Gr. CN7M (1)	

NOTE:
(1) Use solution annealed material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	230	600	800	1200	1800	3000	5000
200	200	520	690	1035	1555	2590	4320
300	180	465	620	930	1395	2330	3880
400	160	420	565	845	1265	2110	3520
500	150	390	520	780	1165	1945	3240
600	140	360	480	720	1080	1800	3000

END FLANGE FACINGS
Flange Thickness and Center-to-End Dimensions
Classes 150 and 300

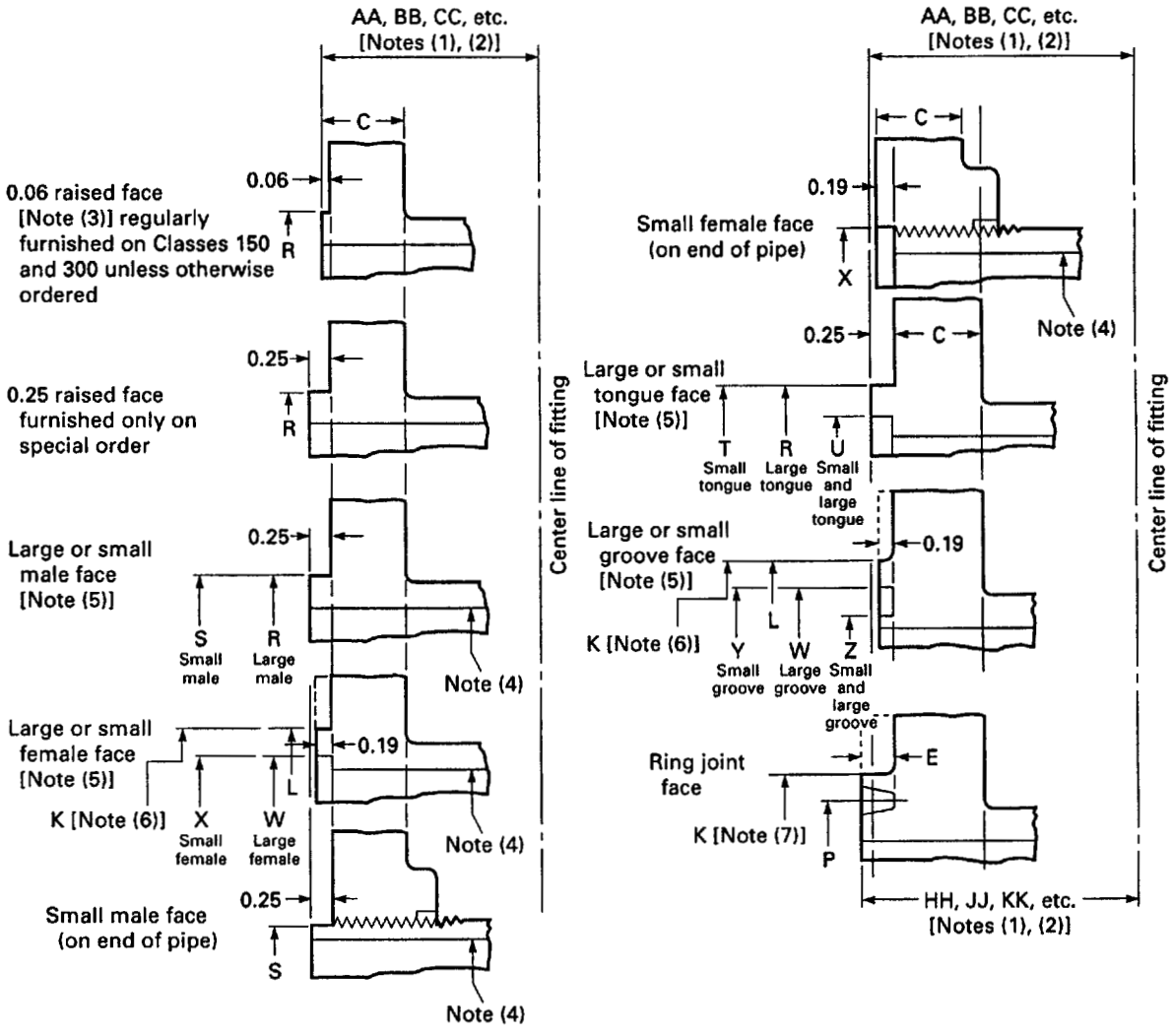
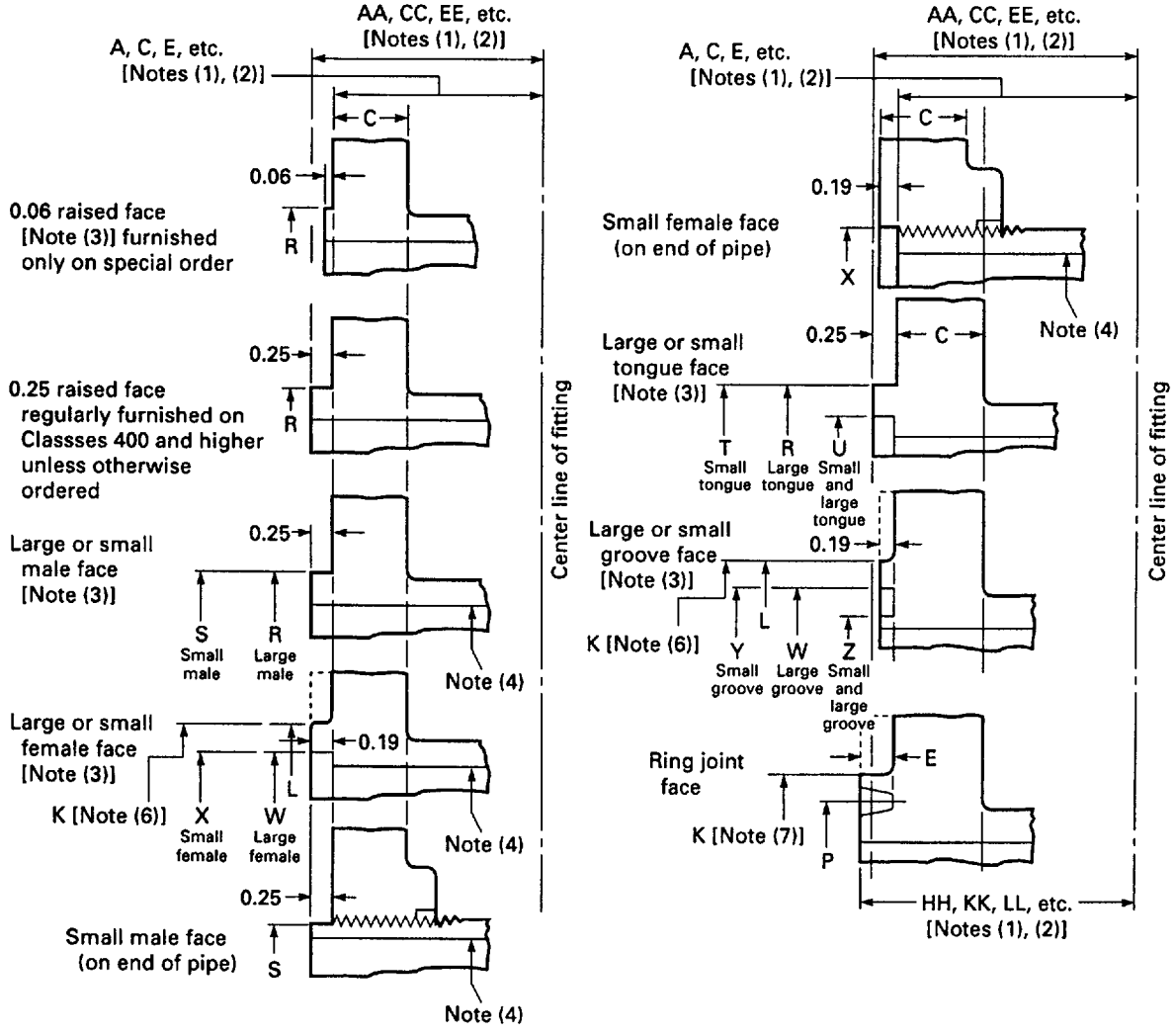


FIG. 7 END FLANGE FACINGS AND THEIR RELATIONSHIP TO FLANGE THICKNESS AND CENTER-TO-END AND END-TO-END DIMENSIONS[1,3] (a)

(Figure continues on next page; Notes follow at end of Figure)

END FLANGE FACINGS
Flange Thickness and Center-to-End Dimensions
Classes 400 and Higher

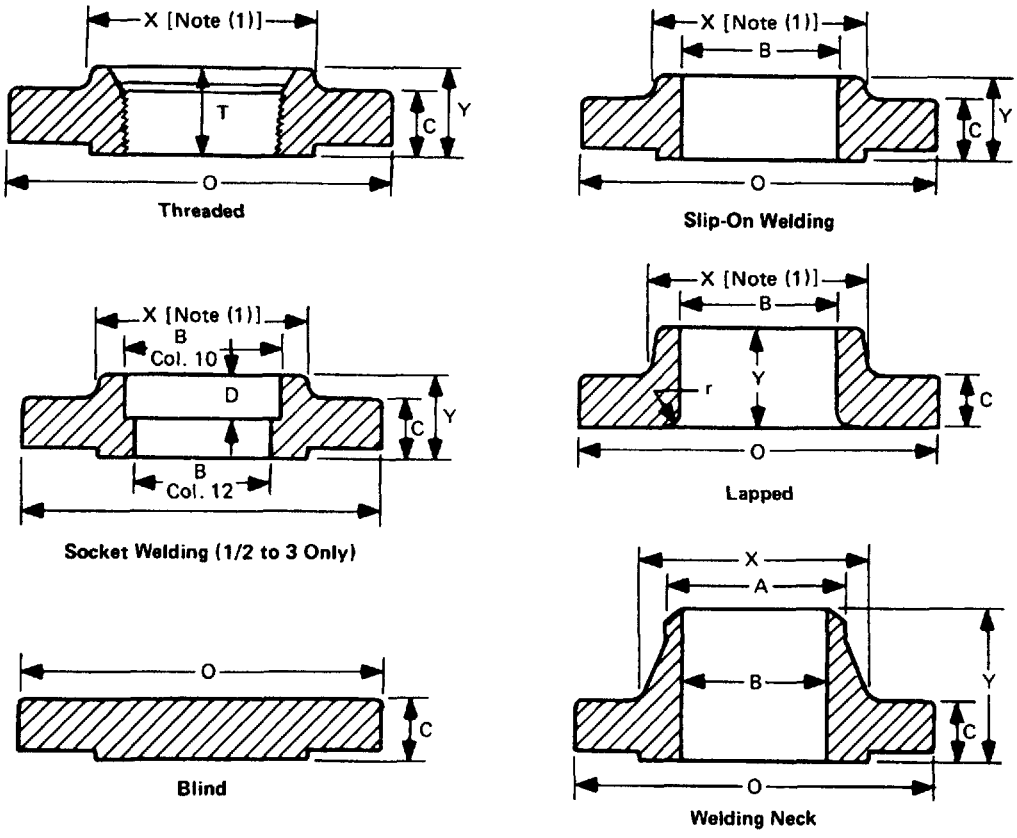


(a) FIG. 7 END FLANGE FACINGS AND THEIR RELATIONSHIP TO FLANGE THICKNESS AND CENTER-TO-END AND END-TO-END DIMENSIONS[1,3] (CONT'D)

TABLE 8 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 9 and 10.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.



(a) **TABLE 9 DIMENSIONS OF CLASS 150 FLANGES[2-8]**

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Length Through Hub				Bore				
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange [(9)–(11)], Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (12) A	Threaded Slip-On Socket Welding Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (13), Min. T	Slip-On Socket Welding, Min. B	Lapped, Min. B	Welding Neck Socket Welding (14) B	Corner Radius of Bore of Lapped Flange and Pipe r	Depth of Socket D
½	3.50	0.44	1.19	0.84	0.62	0.62	1.88	0.62	0.88	0.90	0.62	0.12	0.38
¾	3.88	0.50	1.50	1.05	0.62	0.62	2.06	0.62	1.09	1.11	0.82	0.12	0.44
1	4.25	0.56	1.94	1.32	0.69	0.69	2.19	0.69	1.36	1.38	1.05	0.12	0.50
1¼	4.62	0.62	2.31	1.66	0.81	0.81	2.25	0.81	1.70	1.72	1.38	0.19	0.56
1½	5.00	0.69	2.56	1.90	0.88	0.88	2.44	0.88	1.95	1.97	1.61	0.25	0.62
2	6.00	0.75	3.06	2.38	1.00	1.00	2.50	1.00	2.44	2.46	2.07	0.31	0.69
2½	7.00	0.88	3.56	2.88	1.12	1.12	2.75	1.12	2.94	2.97	2.47	0.31	0.75
3	7.50	0.94	4.25	3.50	1.19	1.19	2.75	1.19	3.57	3.60	3.07	0.38	0.81
3½	8.50	0.94	4.81	4.00	1.25	1.25	2.81	1.25	4.07	4.10	3.55	0.38	...
4	9.00	0.94	5.31	4.50	1.31	1.31	3.00	1.31	4.57	4.60	4.03	0.44	...
5	10.00	0.94	6.44	5.56	1.44	1.44	3.50	1.44	5.66	5.69	5.05	0.44	...
6	11.00	1.00	7.56	6.63	1.56	1.56	3.50	1.56	6.72	6.75	6.07	0.50	...
8	13.50	1.12	9.69	8.63	1.75	1.75	4.00	1.75	8.72	8.75	7.98	0.50	...
10	16.00	1.19	12.00	10.75	1.94	1.94	4.00	1.94	10.88	10.92	10.02	0.50	...
12	19.00	1.25	14.38	12.75	2.19	2.19	4.50	2.19	12.88	12.92	12.00	0.50	...
14	21.00	1.38	15.75	14.00	2.25	3.12	5.00	2.25	14.14	14.18	To be specified by purchaser	0.50	...
16	23.50	1.44	18.00	16.00	2.50	3.44	5.00	2.50	16.16	16.19		0.50	...
18	25.00	1.56	19.88	18.00	2.69	3.81	5.50	2.69	18.18	18.20		0.50	...
20	27.50	1.69	22.00	20.00	2.88	4.06	5.69	2.88	20.20	20.25		0.50	...
24	32.00	1.88	26.12	24.00	3.25	4.38	6.00	3.25	24.25	24.25		0.50	...

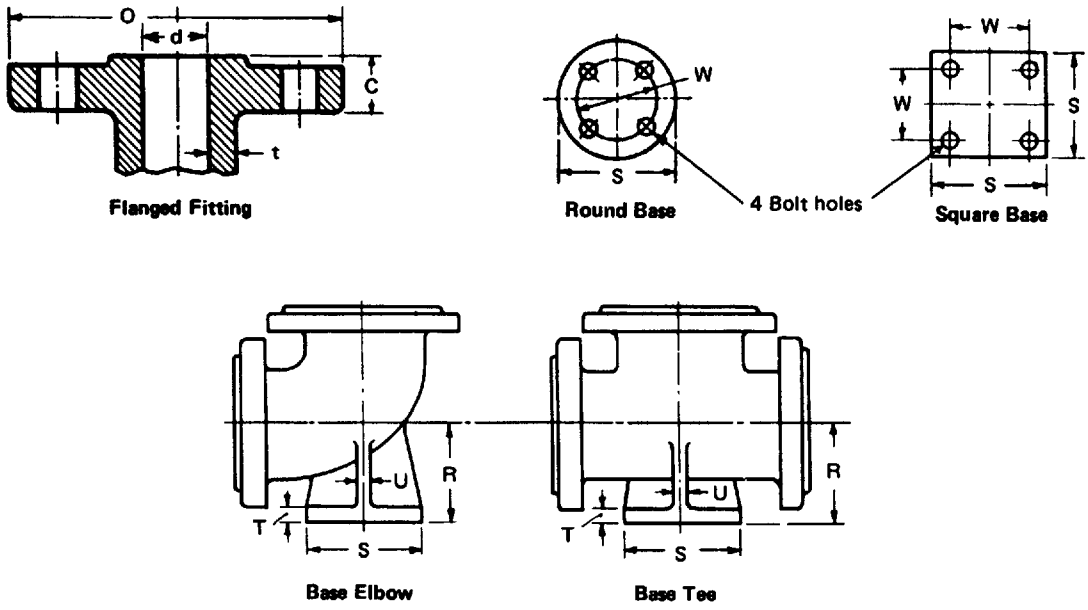


TABLE 13 DIMENSIONS OF CLASS 300 FLANGED FITTINGS[1-9] (CONT'D)

13	14	15	16	17	18	19	20	21	22	23	1
Ring Joint (12)									Base Drilling (18)		
Center-to-End Long Radius Elbow (13) JJ	Center-to-End 45 deg. Elbow (13) KK	Long Center-to-End Lateral (13) LL	Short Center-to-End Lateral and True "Y" (13) MM	End-to-End Reducer NN	Center-to-Base [(14)–(16)] R	Diameter of Round Base or Width of Square Base (14) S	Thickness of Base [(14)–(17)] T	Thickness of Ribs (14) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
5.25	2.50	6.75	2.25	See Notes (12) and (13)	...	...	...	...	...	...	1
5.75	2.75	7.50	2.50		...	...	...	...	...	...	1¼
6.25	3.00	8.75	2.75		...	...	...	...	...	...	1½
6.81	3.31	9.31	2.81		4.50	5.25	0.75	0.50	3.88	0.75	2
7.31	3.81	10.81	2.81		4.75	5.25	0.75	0.50	3.88	0.75	2½
8.06	3.81	11.31	3.31		5.25	6.12	0.81	0.62	4.50	0.88	3
8.81	4.31	12.81	3.31		5.62	6.12	0.81	0.62	4.50	0.88	3½
9.31	4.88	13.81	3.31		6.00	6.50	0.88	0.62	5.00	0.75	4
10.56	5.31	15.31	3.81		6.75	7.50	1.00	0.75	5.88	0.88	5
11.81	5.81	17.81	4.31		7.50	7.50	1.00	0.75	5.88	0.88	6
14.31	6.31	20.81	5.31		9.00	10.00	1.25	0.88	7.88	0.88	8
16.81	7.31	24.31	5.81		10.50	10.00	1.25	0.88	7.88	0.88	10
19.31	8.31	27.81	6.31		12.00	12.50	1.44	1.00	10.62	0.88	12
21.81	8.81	31.31	6.81		13.50	12.50	1.44	1.00	10.62	0.88	14
24.31	9.81	34.81	7.81		14.75	12.50	1.44	1.12	10.62	0.88	16
26.81	10.31	37.81	8.31		16.25	15.00	1.62	1.12	13.00	1.00	18
29.38	10.88	40.88	8.88		17.88	15.00	1.62	1.25	13.00	1.00	20
34.44	12.44	47.94	10.44		20.75	17.50	1.88	1.25	15.25	1.12	24

(Notes follow on next page)

TABLE 13 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 11.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) When these fittings are required with flat face flange, either the full thickness or thickness with raised face removed may be furnished. Users are reminded that removing the raised face will make the center-to-face dimension nonstandard. See para. 6.4.1.1 for additional restrictions.
(10) The thickness of flange dimension illustrated is for regularly furnished 0.06 in. raised face (except lapped); for thickness requirement of other facings, see Fig. 7.
(11) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(12) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(13) These dimensions apply to straight sizes only. See paras. 6.2.3 and 6.4.1.3. For center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-contact surface or contact surface-to-contact surface dimensions of 0.06 in. raised face (flange edge) for largest opening and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.
(14) The base dimensions apply to all straight and reducing sizes.
(15) For reducing fittings, the size and center-to-face dimension of base are determined by the size of the largest opening of fittings. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(16) Bases shall be plain faced unless otherwise specified, and the center-to-base dimension R shall be the finished dimension.
(17) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(a) (18) The bolt hole template for round base is the same as for Class 300 flanges, Table 11, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

B 333-95	Nickel-Molybdenum Alloy Plate, Sheet and Strip
B 335-95	Nickel-Molybdenum Alloy Rod
B 408-95	Nickel-Iron-Chromium Alloy Plate, Sheet and Strip
B 409-95	Nickel-Iron-Chromium Alloy Plate, Sheet, and Strip
B 424-93	Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and N08821) Plate, Sheet and Strip
B 425-93	Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221) Rod and Bar
B 434-95	Nickel-Molybdenum-Chromium-Iron Alloy (UNS N10003) Plate, Sheet and Strip
B 435-94	UNS N06002, UNS N06230, and UNS R30556 Plate, Sheet, and Strip
B 443-93	Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Plate, Sheet, and Strip
B 446-93	Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Rod and Bar
B 462-95	Forged or Rolled UNS N08020, UNS N00824, UNS N08026, and UNS N08367 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service
B 463-93	UNS N08020, UNS N08024 and UNS N08026 Alloy Plate Sheet and Strip
B 473-95	UNS N08020, UNS N08026, and UNS N08024 Nickel Alloy Bar and Wire
B 511-93	Nickel-Iron-Chromium-Silicon Alloy Bars and Shapes
B 536-95	Nickel-Iron Chromium-Silicon Alloys (UNS N08830 and N08332) Plate, Sheet, and Strip
B 564-95a$^{\epsilon 1}$	Nickel Alloy Forgings
B 572-94	UNS N06002, UNS N06230, and UNS R30556 Rod
B 573-95	Nickel-Molybdenum-Chromium-Iron Alloy (UNS N10003) Rod
B 574-94$^{\epsilon 1}$	Low-Carbon Nickel-Molybdenum-Chromium and Low-Carbon Nickel-Chromium-Molybdenum Alloy Rod
B 575-94	Low-Carbon Nickel-Molybdenum-Chromium and Low-Carbon Nickel-Chromium-Molybdenum Alloy Plate, Sheet, and Strip
B 581-94$^{\epsilon 1}$	Nickel-Chromium-Iron-Molybdenum-Copper Alloy Rod
B 582-93	Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip
B 599-93b	Nickel-Iron-Chromium-Molybdenum-Columbium Stabilized Alloy (UNS N08700) Plate, Sheet and Strip
B 620-93	Nickel-Iron-Chromium-Molybdenum Alloy (UNS N08320) Plate, Sheet, and Strip
B 621-95	Nickel-Iron-Chromium-Molybdenum Alloy (UNS N08320) Rod
B 625-93a	UNS N08904, UNS N08925, UNS N08031, UNS N08932, and UNS N08925 Plate, Sheet and Strip

B 649-93	Ni-Fe-Cr-Mo-Cu Low Carbon Alloy (UNS N08904) and Ni-Fe-Cr-Mo-Cu-N Low Carbon Alloys (UNS N08925, UNS N08031, and UNS N08926) Bar and Wire
B 672-95	Nickel-Iron-Chromium-Molybdenum-Columbium Stabilized Alloy (UNS N08700) Bar and Wire
E 29-93	Using Significant Digits in Test Data to Determine Conformance with Specifications

International Standards Organization (ISO)

ISO 9000-1: 1994	Quality management and quality assurance standards — Part 1: Guidelines for selection and use
ISO 9000-2: 1993	Quality management and quality assurance standard — Part 2: Generic guidelines for the application of ISO 9001, ISO 9002, and ISO 9003
ISO 9000-3: 1991	Quality management and quality assurance standards — Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software
ISO 9001: 1994	Quality systems — Model for quality assurance in design, development, production, installation, and servicing
ISO 9002: 1994	Quality systems — Model for quality assurance in production and servicing
ISO 9003: 1994	Quality systems — Model for quality assurance in final inspection and test

MSS Publications

MSS SP-9-1992	Spot Facing for Bronze, Iron, and Steel Flanges
MSS SP-25-1978(R1985)	Standard Marking System for Valves, Fittings, Flanges, and Unions
MSS SP-44-1991	Steel Pipe Line Flanges
MSS SP-45-1992	Bypass and Drain Connections
MSS SP-61-1992	Pressure Testing of Steel Valves

Publications of the following organizations appear in the above list:

(a) ASME — The American Society of Mechanical Engineers
Three Park Avenue, New York, New York 10016-5990

ASME Order Department
22 Law Drive, Box 2300, Fairfield, New Jersey 07007-2300

ASME B16.5-1996
(Revision of ASME/ANSI B16.5-1988)

PIPE FLANGES AND FLANGED FITTINGS

NPS 1/2 Through NPS 24

AN AMERICAN NATIONAL STANDARD

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ASME B16.5-1996

(Revision of ASME/ANSI B16.5-1988)

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The 1996 edition of this Standard is being issued with an automatic addenda subscription service. The use of an addenda allows revisions made in response to public review comments or committee actions to be published as necessary; revisions published in addenda will become effective 6 months after the Date of Issuance of the addenda. The next edition of this Standard is scheduled for publication in 2001.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. The interpretations will be included with the above addenda service. Interpretations are not part of the addenda to the Standard.

The American Society of Mechanical Engineers
345 East 47th Street, New York, NY 10017

FOREWORD

(This Foreword is not part of ASME B16.5-1996)

In 1920, the American Engineering Standards Committee [later the American Standards Association (ASA)] organized Sectional Committee B16 to unify and further develop standards for pipe flanges and fittings (and later for valves and gaskets). Cosponsors of the B16 Committee were the American Society of Mechanical Engineers (ASME), the Heating and Piping Contractors National Association [now Mechanical Contractors Association of America (MCAA)], and the Manufacturers Standardization Society of the Valve and Fittings Industry (MSS). Cosponsors were later designated as cosecretariat organizations.

The Committee soon recognized the need for standardization of steel pipe flanges. In May 1923, Subcommittee 3 was organized to develop such standards for pressures in the 250 psi to 3200 psi range and for elevated temperatures. Active work began in October, including steel flanged fittings. The first proposed standard was submitted to the Committee in April 1926 and approved by letter ballot in December. After favorable review by the three sponsor organizations, the Standard was approved as American Tentative Standard B16e in June 1927.

Experience in using the Standard showed the need for hub dimensions of companion flanges and for other changes, including rerating of 250 lb and 1350 lb flanges and development of flanged fittings with integral bases. An investigation was made into the factors determining stiffness of flanges and flange hubs. The revised edition was approved as ASA B16e-1932.

A revision was initiated in 1936, stimulated by suggestions from Committee members and industrial users. The resulting 1939 edition contained standards for welding neck flanges (completed in March 1937), 1500 lb flanges in the 14 in. through 24 in. range, 2500 lb flanges and flanged fittings in the ½ in. through 12 in. range, and dimensions for a full line of ring joint flanges developed by the American Petroleum Institute. Pressure-temperature ratings for alloy steel flanges and fittings, developed by Subcommittee 4, were included for the first time.

In August 1942, the War Production Board requested a review of measures to conserve vital materials in piping components. A special War Committee of B16 was appointed and, operating under War Standards Procedure, developed revised pressure-temperature ratings for all materials and all pressure classes. The ratings were published as American War Standard B16e5-1943. In 1945, under normal procedures, Subcommittees 3 and 4 reviewed the 1939 Standard and the 1943 ratings, and recommended adoption of the wartime ratings. Their report was approved as Supplement No. 1 to B16e-1939 and published as ASA B16e6-1949. In addition to ratings, the supplement updated material specification references and added a table of metal wall thicknesses for welding-end valves.

Subcommittee 3 then began a revision of the entire standard. Technically, the 1949 Supplement was absorbed, new materials were recognized, a general rating method was developed and added as an appendix, and welding end preparations were expanded. Editorially, a new style of presentation was worked out, including tables rearranged for easier use. Approval by Sectional Committee, cosponsors, and ASA resulted in publication of ASA B16.5-1953 (designation changed from B16e).

Work soon began on further revisions. Class B ratings were deleted and Class A ratings were clarified as the standard. An appendix defined qualifications for gaskets, other than ring joint, which would merit the ratings. Another appendix defined the method for calculating bolt lengths (including measurement of the length of stud bolts between thread ends instead of between points). Pressure-temperature ratings for several new materials were added, the table of welding end dimensions was expanded, and the temperature used in determining ratings were redefined. The resulting new edition, after approval, was published as ASA B16.5-1957.

The more modest revision approved as ASA B16.5-1961 changed the text to clarify the intent or to make requirements easier to administer. The next revision began in 1963 with nearly 100 comments and suggestions. No fundamental changes were made, but the text was further clarified and wall thicknesses less than $\frac{1}{4}$ in. for flanged fittings were recognized in the 1968 edition.

A new joint study of ratings between Subcommittees 3 and 4 was initiated before the next revision. Based on Subcommittee 4's report, the rating procedure was revised and a rating basis for Class 150 (150 lb) flanges was developed. New product forms, bar and plate, were added for special applications, including fabricated flanged valves and fittings. Reference to welding-end valves was deleted because a separate standard for them was in preparation. Bolt length calculations based on worst case tolerances led to a revision of tabulated lengths. Testing of valve closure members was added to the test requirements. Following final approval on October 23, the Standard was published as ANSI B16.5-1973.

Subcommittee N was assigned responsibility for all valve standards in late 1973. Subcommittee C (formerly 3) continues to have responsibility for flange standards. A revision was accordingly initiated to remove all references to valves. At the same time, comments from users and changes in the ASME Boiler and Pressure Vessel Code led to significant revisions in the Class 150 rating basis, and in the ratings of stainless steel and certain alloy steel flanges and flanged fittings in all rating classes. Extensive public review comments led to addition of considerations for flanged joints, for bolting and gaskets, and of marking requirements. To avoid frequent and confusing changes in ratings as further changes in Code allowable stresses are made, it was agreed with Subcommittee N to leave ratings alone unless the relevant Code stress values are changed by more than 10%. After final approval by Standards Committee, cosponsors, and ANSI, ANSI B16.5-1977 Steel Pipe Flanges and Flanged Fittings, was published on June 16, 1977.

In 1979, work began on another new edition. Materials coverage was expanded by the addition of nickel and nickel alloys. Bolting rules were revised to cover nickel alloy bolts. Bolt hole and bolting were changed to provide interchangeability between inch and metric dimensions. Metric dimensional tables were made informational rather than alternative requirements of the Standard. Final approval was granted for ANSI B16.5-1981, Pipe Flanges and Flanged Fittings on August 14.

In 1982, American National Standards Committee B16 was reorganized as an ASME Committee operating under procedures accredited by ANSI. The 1988 edition of the Standard extended nickel alloy ratings to higher temperatures, clarified flat face flange requirements, and included other minor revisions. The Committee determined that any metric standard for flanges will stand alone, with metric bolting and gaskets; hence metric equivalents have been deleted. Following approval by the Standards Committee and ASME, approval as American National Standard was given by ANSI on April 7, 1988, with the new designation ASME/ANSI B16.5-1988.

This 1996 Edition allows flanges marked with more than one material grade or specification, revises flange facing finish requirements, has revised pressure–temperature ratings for several material groups, adds a nonmandatory quality system annex, and includes several other

revisions. Following approval by the Standards Committee and ASME, approval as an American National Standard was given by ANSI on October 3, 1996 with the new designation ASME B16.5-1996.

Requests for interpretations or suggestions for revision should be sent to the Secretary, B16 Committee, The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

ASME B16 COMMITTEE
Standardization of Valves, Flanges, Fittings, Gaskets, and Valve Actuators

(The following is a roster of the Committee at the time of approval of this Standard.)

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PIPE FLANGES AND FLANGED FITTINGS

1 SCOPE

1.1 General

This Standard covers pressure–temperature ratings, materials, dimensions, tolerances, marking, testing, and methods of designating openings for pipe flanges and flanged fittings in sizes NPS ½ through NPS 24 and in rating Classes 150, 300, 400, 600, 900, 1500, and 2500. Flanges and flanged fittings may be cast, forged, or (for blind flanges and certain reducing flanges only) plate materials as listed in Table 1A.

Requirements and recommendations regarding bolting and gaskets are also included.

1.2 References

1.2.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Annex G, which is part of this Standard. It is not considered practical to identify the specific edition of each standard and specification in the individual references. Instead, the specific edition reference is identified in Annex G. A flange or flanged fitting manufactured in accordance with earlier editions of the referenced standards and in all other respects conforming to this Standard will be considered to be in conformance with this Standard.

1.2.2 Codes and Regulations. A flange or flanged fitting used under the jurisdiction of the ASME Boiler and Pressure Vessel Code, the ASME Code for Pressure Piping, or a governmental regulation is subject to any limitation of that code or regulation. This includes any maximum temperature limitation, or rule governing the use of a material at low temperature, or provisions for operation at a pressure exceeding the pressure–temperature ratings in this Standard.

1.3 Applicable Ratings

The pressure–temperature ratings in this Standard are applicable upon its publication to all flanges and flanged fittings within its scope which otherwise meet its requirements. For unused flanges or flanged fittings maintained in inventory, the manufacturer of the flange or flanged fittings may certify conformance to this Edition provided he can demonstrate that all requirements of this Edition have been met. Where such components were installed in accordance with the pressure–temperature ratings of an earlier edition of this Standard, those ratings are applicable except as may be governed by the applicable code or regulation (see para. 1.2.2).

1.4 User Accountability

This Standard cites duties and responsibilities that are to be assumed by the user in the areas of application, installation, hydrostatic testing, operation, and material selection.

1.5 Quality Systems

Nonmandatory requirements relating to the product manufacturer's Quality System Program are described in Annex G.

2 PRESSURE–TEMPERATURE RATINGS

2.1 Ratings Basis

Ratings are maximum allowable working gage pressures at the temperatures shown in Table 2 for the applicable material and rating. For intermediate temperatures, linear interpolation is permitted. See Annex D, which is part of this Standard, for methods of establishing pressure–temperature ratings.

2.2 Ratings of Flanged Joints

A flanged joint is composed of three separate and independent, although interrelated components: the flanges, the gasket, and the bolting, which are assembled by yet another influence, the assembler. Proper controls must be exercised in the selection and application for all these elements to attain a joint which has acceptable leak tightness. Special techniques, such as controlled bolt tightening, may be necessary to achieve a tight joint in service.

Ratings in this Standard apply to flanged joints which conform to the limitations on bolting in para. 5.3 and on gaskets in para. 5.4, and which are made up in accordance with good practice for alignment and assembly. See also para. 2.4. Use of the ratings for flanged joints not conforming to these limitations is the responsi-

bility of the user. Requirements for alignment and assembly of joints are not given in this Standard.

If the two flanges in a flanged joint do not have the same pressure–temperature ratings, the rating of the joint at any temperature is the lower of the two flange ratings at that temperature.

2.3 Rating Temperature

The temperature shown for a corresponding pressure rating is the temperature of the pressure-containing shell of the flange or flanged fitting. In general, this temperature is the same as that of the contained fluid. Use of a pressure rating corresponding to a temperature other than that of the contained fluid is the responsibility of the user, subject to the requirements of the applicable code or regulation. For any temperature below –20°F, the rating shall be no greater than the rating shown for –20°F.

2.4 Temperature Considerations

Application of the ratings in this Standard to flanged joints at both high and low temperatures shall take into consideration the risk of leakage due to forces and moments developed in the connected piping or equipment. The following provisions are intended to minimize these risks.

2.4.1 Flange Attachment. Socket welding and threaded flanges are not recommended for service above 500°F or below –50°F if severe thermal gradients or thermal cycling are involved.

2.4.2 High Temperature Service. At temperatures in the creep range, gradual relaxation of flanges, bolts, and gaskets may progressively reduce bolt loads. It may be necessary to arrange for periodic tightening of bolts to prevent leakage. Joints subject to substantial thermal gradients may require the same attention.

When used above 400°F, Class 150 flanged joints may develop leakage unless care is taken to avoid imposing severe external loads and/or severe thermal gradients. For other classes, similar consideration should be given above 750°F.

2.4.3 Low Temperature Service. The user should recognize that some of the material listed in the rating tables undergo sufficient decrease in toughness at low temperatures that they cannot safely sustain shock loadings, sudden changes of stress or temperature, or high stress concentrations.

2.5 System Hydrostatic Test

Flanged joints and flanged fittings may be subjected to system hydrostatic tests at a pressure not to exceed 1.5 times the 100°F rating rounded off to the next higher 25 psi. Testing at any higher pressure is the responsibility of the user, subject to the requirements of the applicable code or regulation.

2.6 Welding Neck Flanges

Ratings for welding neck flanges covered by this Standard are based upon their hubs at the welding end having thickness at least equal to that calculated for pipe having 40.0 ksi specified minimum yield strength. (For higher strength pipe with thinner wall, see MSS SP-44.) The ratings also apply to such flanges used with components of unequal strength and unequal wall thickness when the attachment weld is made in accordance with the applicable code or regulation. See Figs. 12, 13, and 14.

2.7 Multiple Material Grades

Materials for flanges and flanged fittings may meet the requirements for more than one specification or grade of a specification listed in Table 1A. In that event, the pressure–temperature ratings for any of these specifications or grades may be used provided that marking is in accordance with para. 4.1.2(d).

3 SIZE

3.1 Nominal Size

The size of a flange or flanged fitting covered by this Standard is its nominal pipe size, NPS. The diameter of a bolt is its nominal size. Use of "nominal" indicates that the stated size or dimension is only for designation, not measurement. The actual dimension may or may not be the nominal size and is subject to established tolerances.

3.2 Reducing Fittings

Reducing fittings shall be designated by the size of the openings in their proper sequence as indicated in the sketches of Fig. 2.

3.3 Reducing Flanges

Reducing flanges shall be designated by the two nominal pipe sizes. See examples in Note (4) of Table 7.

4 MARKING

4.1 General

Except as modified herein, flanges and flanged fittings shall be marked as required in MSS SP-25.

4.1.1 Name. The manufacturer's name or trademark shall be applied.

4.1.2 Material

(a) Cast flanges and flanged fittings shall be marked with the ASTM specification,[1] grade identification symbol, and the melt number or melt identification.

(b) Plate flanges, forged flanges, and flanged fittings shall be marked with the ASTM specification number[1] and grade identification symbol.

(c) A manufacturer may supplement these mandatory material indications with his trade designation for the material grade, but confusion of symbols shall be avoided.

(d) Flanges and flanged fittings manufactured from material which meets the requirements for more than one specification or grade of a specification listed in Table 1A may be marked with more than one of the applicable specification or grade symbols. The symbols shall be placed to avoid confusion in identification.

4.1.3 Rating Class. The marking shall be the applicable pressure rating class: 150, 300, 400, 600, 900, 1500, or 2500.

4.1.4 Designation. The designation B16 shall be applied, preferably located adjacent to the class designation, to indicate conformance to this Standard.

4.1.5 Temperature. No temperature markings are required on flanges and flanged fittings, but if marked, the temperature shall be shown with its corresponding tabulated pressure rating for the material.

4.1.6 Size. The nominal pipe size shall be given, but may be omitted from reducing flanges and reducing flanged fittings.

4.1.7 Ring Joint Flange. The edge (periphery) of each ring joint flange shall be marked with the letter R and the corresponding ring groove number.

[1] The ASME Boiler and Pressure Vessel Code, Section II specification number may be substituted provided the material is covered by Section II.

5 MATERIALS

5.1 General

Flanges and flanged fittings covered by this Standard shall be castings, forgings, and (for blind flanges only) plate as listed in Table 1A. Recommended bolting materials are listed in Table 1B. (See also para. 5.3.) ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the specifications listed in Tables 1A, 1B, and 1C, may also be used.

5.1.1 Application. Criteria for the selection of materials are not within the scope of this Standard. The possibility of material deterioration in service should be considered by the user. Carbide phase conversion to graphite and excessive oxidation of ferritic materials, susceptibility to intergranular corrosion of austenitic materials, or grain boundary attack of nickel base alloys are among those items requiring attention. A detailed discussion of precautionary considerations can be found in Appendix F of ASME/ANSI B31.3.

5.1.2 Toughness. Some of the materials listed in Table 1A undergo a decrease in toughness when used at low temperatures, to the extent that Codes referencing this Standard may require impact tests for application even at temperatures higher than +20°F. It is the responsibility of the user to assure that such testing is performed.

5.1.3 Responsibility. When service conditions dictate the implementation of special material requirements, e.g., using a Group 2 material above 1000°F, it is the users responsibility to so specify to the manufacturer in order to ensure compliance with metallurgical requirements listed in the notes in Table 2.

5.2 Mechanical Properties

Mechanical properties shall be obtained from test specimens that represent the final heat treated condition of the material required by the material specification.

5.3 Bolting

Bolting listed in Table 1B is recommended for use in flanged joints covered by this Standard. Bolting of other material may be used if permitted by the applicable code or government regulation. All bolting materials are subject to the following limitations.

5.3.1 High Strength Bolting. Bolting materials having allowable stresses not less than those for ASTM A 193 Grade B7 are listed as high strength in Table 1B. These and other materials of comparable strength may be used in any flanged joint.

5.3.2 Intermediate Strength Bolting. Bolting materials listed as intermediate strength in Table 1B, and other bolting of comparable strength, may be used in any flanged joint, provided the user verifies their ability to seat the selected gasket and maintain a sealed joint under expected operating conditions.

5.3.3 Low Strength Bolting. Bolting materials having not more than 30 ksi specified minimum yield strength are listed as low strength in Table 1B. These materials and others of comparable strength shall be used only in Classes 150 and 300 joints, and only with gaskets described in para. 5.4.1. Flanged joints using low strength carbon steel bolts shall not be used above 400°F or below −20°F.

5.3.4 Bolting to Gray Cast Iron Flanges. The following recommendations are made in recognition of the low ductility of gray cast iron.

(a) Alignment of flange faces is essential along with control of assembly bolt torque so as not to over-stress the cast iron flanges. Care must also be exercised to ensure that piping loads transmitted to cast iron flanges are controlled, taking into account its lack of ductility and recognizing that cast iron flanges should not be used where suddenly applied loads such as rapid pressure fluctuation may occur.

(b) Where Class 150 steel flanges are bolted to Class 125 cast iron flanges, the gaskets should be made of Group No. Ia materials, the steel flanges should have flat faces, and:

(1) low strength bolting within the limitations of para. 5.3.3 should be used with ring gaskets extending to the bolt holes; or

(2) bolting of low (para. 5.3.3), intermediate (para. 5.3.2), or high (para. 5.3.1) strength may be used with full face gaskets extending to the outside diameters of the flanges.

(c) Where Class 300 steel flanges are bolted to Class 250 cast iron flanges, the gaskets should be made of Group No. Ia materials, and:

(1) low strength bolting within the limitations of para. 5.3.3 should be used with gaskets extending to the bolt holes and with the flanges having either raised or flat faces; or

(2) bolting of low (para. 5.3.3), intermediate (para. 5.3.2), or high (para. 5.3.1) strength may be used with full face gaskets extending to the outside diameters of the flanges and with both the Class 300 steel and Class 250 cast iron flanges having flat faces.

5.4 Gaskets

Ring joint gasket materials shall conform to ASME B16.20. Materials for other gaskets are described in Annex E, which is part of this Standard. The user is responsible for selection of gasket materials which will withstand the expected bolt loading without injurious crushing, and which are suitable for the service conditions. Particular attention should be given to gasket selection if a system hydrostatic test approaches or exceeds the test pressure specified in para. 2.5.

5.4.1 Gaskets for Low Strength Bolting. If bolting listed as low strength in Table 1B is used, gaskets shown in Fig. E1, Group No. Ia, shall be used.

5.4.2 Gaskets for Class 150 Flanged Joints. It is recommended that only Fig. E1, Group No. I, gaskets be used for Class 150 flanged joints. When the ring joint or spiral wound gasket is selected, it is recommended that line flanges be of the welding neck or lapped joint type.

6 DIMENSIONS

6.1 Wall Thickness

For inspection purposes the minimum wall thickness t_m of flanged fittings at the time of manufacture shall be as shown in Tables 10, 13, 16, 19, 22, 25, and 28, except as provided in para. 6.1.1. See Annex D for the basis used to establish values of t_m.

Additional metal thickness needed to withstand assembly stresses, shapes other than circular, and stress concentrations must be determined by the manufacturer, since these factors vary widely. In particular, 45 deg. laterals, true Y's, and crosses may require additional reinforcement to compensate for inherent weaknesses in these shapes.

6.1.1 Local Areas. Local areas having less than minimum wall thickness will be acceptable provided that:

(a) the area of subminimum thickness can be enclosed by a circle whose diameter is no greater than $0.35\sqrt{dt_m}$ where d is the inside diameter as defined above and t_m is the minimum wall thickness as shown in the tables listed in para. 6.1; and

(b) measured thickness is not less than 0.75 t_m; and,

(c) enclosure circles are separated from each other by an edge-to-edge distance of more than 1.75 $\sqrt{dt_m}$.

6.2 Center-to-Center Surface and Center-to-End

6.2.1 Design. A principle of design in this Standard is to maintain a fixed position for the flange edge with reference to the body of the fitting. The addition of any facing is beyond the outside edge of the flange except for the 0.06 in. raised face in the Classes 150 and 300 Standards. (See para. 6.4.)

6.2.2 Standard Fittings. Center-to-contact surface, center-to-flange edge, and center-to-end (ring joint) dimensions are shown in Tables 10, 13, 16, 19, 22, 25, and 28.

6.2.3 Reducing Fittings. Center-to-contact surface or center-to-flange edge dimensions for all openings shall be the same as those of straight size fittings of the largest opening. The contact surface-to-contact surface or flange edge-to-flange edge dimensions for all combinations of reducers and eccentric reducers shall be as listed for the larger opening.

6.2.4 Side Outlet Fittings. Side outlet elbows, side outlet tees, and side outlet crosses shall have all openings on intersecting center lines, and the center-to-contact surface dimensions of the side outlet shall be the same as for the largest opening. Long radius elbows with side outlet shall have the side outlet on the radial center line of the elbow, and the center-to-contact surface dimension of the side outlet shall be the same as for the regular 90 deg. elbow of the largest opening.

6.2.5 Special Degree Elbows. Special degree elbows ranging from 1 deg. to 45 deg., inclusive, shall have the same center-to-contact surface dimensions as 45 deg. elbows and those over 45 deg. and up to 90 deg., inclusive, shall have the same center-to-contact surface dimensions as 90 deg. elbows. The angle designation of an elbow is its deflection from straight line flow and is also the angle between the flange faces.

6.3 Flat Face Flanges

This Standard permits flat face flanges in all classes, by providing flanges having either the full thickness or the thickness with the raised face removed, without reduction of the pressure–temperature ratings subject to the following provisions.

6.3.1 The thickness of a Class 150 or 300 flange from which the raised face has been removed shall be no less than the applicable dimension *C* of Tables 9, 10, 12, and 13 minus 0.06 in.

6.3.2 The thickness of a flange of Class 400 or higher from which the raised face has been removed shall be no less than the applicable dimension *C* of Tables 15, 16, 18, 19, 21, 22, 24, 25, 27, and 28.

6.3.3 A gasket of Group No. Ia material (see Fig. E1) is recommended for all joints having two flat faced flanges using a gasket which has a larger diameter than the raised face shown in Table 4.

6.3.4 The flange facing shall conform with para. 6.4.4 for the full width of seating of the gasket.

6.4 Facings

6.4.1 For Other Than Lapped Joints. Table 4 gives dimensions for facings other than ring joint. Table 5 gives dimensions for ring joint facings. Figure 7 shows application of facings. Classes 150 and 300 fittings and companion flanges are regularly furnished with a 0.06 in. raised face which is included in the minimum flange thickness *C*. Classes 400, 600, 900, 1500, and 2500 fittings and companion flanges are regularly furnished with 0.25 in. raised face which is additional to the minimum flange thickness *C*. Any other facing than the above, when required for any class, shall be furnished as follows.

6.4.1.1 No metal shall be cut from the minimum flange thickness specified herein except as permitted in para. 6.3.

6.4.1.2 In the case of the 0.25 in. raised face, tongue or male face (other than 0.06 in. raised face for Classes 150 and 300), the minimum flange thickness *C* shall be first provided and then the raised face, tongue or male face shall be added thereto.

6.4.1.3 With ring joint, groove, or female face, the minimum flange thickness shall be first provided and then sufficient metal added thereto so that the bottom of the ring joint groove, or the contact face of the groove or female face is in the same plane as the flange edge of a full thickness flange.

6.4.2 For Lapped Joints. Facings shall be furnished as follows.

6.4.2.1 Raised Face. Finished height of face shall be no less than nominal pipe wall thickness.

6.4.2.2 Large Male and Female. Finished height of a male face shall be no less than wall thickness of pipe used or 0.25 in., whichever is greater. Thickness of lap remaining after matching the female face shall be no less than the nominal wall thickness of pipe used.

6.4.2.3 Tongue and Groove. Thickness of lap remaining after matching tongue or groove face shall be no less than the nominal wall thickness of the pipe used.

6.4.2.4 Ring Joint. Thickness of lap remaining after machining the ring groove shall be no less than the nominal wall thickness of pipe used.

6.4.2.5 The outside diameters of laps for ring joints are shown in Table 5, dimension *K*. The outside diameters of laps for large female, large tongue and groove, and small tongue and groove are shown in Table 4. Small male and female facings are not used with lapped joints.

6.4.3 Blind flanges need not be faced in the center if, when this center part is raised, its diameter is at least 1 in. smaller than the inside diameter of fittings of the corresponding pressure class, as given in the tables. When the center part is depressed, its diameter shall not be greater than the inside diameter of the corresponding pressure class fittings, as given in the tables. Machining of the depressed center is not required.

6.4.4 Flange Facing Finish. The finish of contact faces of pipe flanges and connecting end flanges of fittings shall be judged by visual comparison with Ra standards (see ASME B46.1) and not by instruments having stylus tracers and electronic amplification. The finishes required are given below. Other finishes may be furnished by agreement between user and manufacturer.

6.4.4.1 Tongue and Groove and Small Male and Female. The gasket contact surface shall not exceed 125 μin. roughness.

6.4.4.2 Ring Joint. The side wall surface of gasket groove shall not exceed 63 μin. roughness.

6.4.4.3 Other Flange Facings. Either a serrated concentric or serrated spiral finish having a resultant surface finish from 125 μin. to 250 μin. average roughness shall be furnished. The cutting tool employed should have an approximate 0.06 in. or larger radius, and there should be from 45 grooves/in. through 55 grooves/in.

6.4.5 Flange Facing Finish Imperfections. Imperfections in the flange facing finish shall not exceed the dimensions shown in Table 3. Adjacent imperfections shall be separated by a distance of at least four times the maximum radial projection. A radial projection shall be measured by the difference between an outer radius and an inner radius encompassing the imperfection where the radii are struck from the centerline of the bore. Imperfections less than half the depth of the serrations shall not be considered cause for rejection. Protrusions above the serrations are not permitted.

6.5 Flange Bolt Holes

Bolt holes are in multiples of four. Bolt holes shall be equally spaced and pairs of bolt holes shall straddle fitting center lines.

6.6 Spot Facing

All cast and forged flanges and flanged fittings shall have bearing surfaces for bolting which shall be parallel to the flange face from within 1 deg. Any back facing or spot facing required to accomplish parallelism shall not reduce the flange thickness *C* below the dimensions given in Tables 9, 10, 12, 13, 15, 16, 18, 19, 21, 22, 24, 25, 27, and 28. Any spot facing or back facing shall be in accordance with MSS SP-9.

6.7 Welding End Preparation for Welding Neck Flanges

6.7.1 Welding ends are shown in Figs. 8 through 14.

6.7.2 The contours of the outside of the welding neck beyond the welding groove are shown in Figs. 8, 9, 12, and 14.

6.7.3 Straight through bores shown in Figs. 8 and 9 are standard unless otherwise specifically order to suit the special conditions illustrated in Figs. 10, 11, 13, and 14.

6.7.4 Other welding end preparations furnished by agreement of purchaser and manufacturer do not invalidate compliance with this Standard.

6.8 Reducing Flanges

6.8.1 Drilling, Outside Diameter, Thickness, and Facing Dimensions. Flange drilling, outside diameter, thickness, and facing are the same as those of the standard flange of the size from which the reduction is being made.

6.8.2 Hub Dimensions

6.8.2.1 Threaded, Socketweld, and Slip-On Flanges. The hub dimensions shall be at least as large as those of the standard flange of the size to which the reduction is being made. The hub may be larger or omitted as detailed in Table 7.

6.8.2.2 Welding Neck Flanges. The hub dimensions shall be the same as those of the standard flange of the size to which the reduction is being made.

6.9 Threads for Threaded Flanges

Except as provided in Note (5), Fig. 7, and Note (5), Table 4, threaded flanges shall have an American National Standard taper pipe thread conforming to ASME B1.20.1. The thread shall be concentric with the axis of the flange, and variations in alignment shall not exceed 0.06 in./ft (0.5%).

6.9.1 Class 150 flanges are made without a counterbore. The threads shall be chamfered approximately to the major diameter of the thread at the back of the flange at an angle of approximately 45 deg. with the axis of the thread. The chamfer shall be concentric with the thread and shall be included in the measurement of the thread length.

6.9.2 Class 300 and higher pressure flanges are made with a counterbore at the back of the flange. The threads shall be chamfered to the diameter of the counterbore at an angle of approximately 45 deg. with the axis of the threads. The counterbore and chamfer shall be concentric with the thread.

6.9.3 The minimum length of effective thread in reducing flanges shall be at least equal to dimension *T* of the corresponding class of threaded flange as shown in the tables. Threads do not necessarily extend to the face of the flange. See Table 7 for reducing threaded flanges.

6.9.4 The gaging notch of the working gage shall come flush with the bottom of the chamfer in all threaded flanges and shall be considered as being the intersection of the chamfer cone and the pitch cone of the thread. This depth of chamfer is approximately equal to one-half the pitch of the thread. The maximum allowable thread variation is one turn large or small from the gaging notch.

6.9.5 Annex A indicates the distance and number of turns that external pipe threads may be made longer than regular for use with the higher pressure flanges to bring the small end of the thread close to the face of the flange when the parts are assembled by power equipment. Annex A applies to ASME B1.20.1 and is considered part of this Standard.

6.10 Flange Bolting Dimensions

6.10.1 Dimensional Standards. Stud bolts threaded at both ends or full length, or bolts may be used. Dimensional recommendations for bolts, stud bolts, and nuts are shown in Table 1C. See para. 5.3 for bolting material recommendations.

6.10.2 Bolt Lengths. Stud bolts with a nut at each end are recommended for high temperature service. Stud bolt lengths are specified in Tables 8, 11, 14, 17, 20, 23, and 26, and include the thickness of two nuts. The stud bolt length does not include the height of any point. A point is that part of a stud bolt or a bolt beyond the thread and may be chamfered, rounded, or sheared. For the method of calculating bolt lengths, see Annex F.

These lengths are established for the convenience of industry to simplify the assembly of these parts on construction work, but users may select combinations of these bolt lengths to suit their needs. Hence, Annex F is not considered part of this Standard.

6.10.3 The end flange bolting is based on a stress on the effective tensile stress area of the bolts not to exceed 7.0 ksi, assuming a pressure in psi equal to the pressure rating class designation to act upon an area circumscribed by the outside diameter of the raised face, dimension *R*, Table 4.

6.11 Gaskets for Line Flanges

6.11.1 Ring joint gasket dimensions shall conform to ASME B16.20.

6.11.2 For flanges with raised face, or with large male-and-female face, gaskets shall conform to limiting dimensions of Annex E.

6.11.3 For flanges having large or small tongue-and-groove faces, all gaskets except solid flat metal gaskets shall cover the bottom of the groove, with minimum clearance. (See para. 7.2.1 for tolerance applicable to groove.) Solid flat metal gaskets shall have contact width not greater than for Group No. III gaskets.

6.11.4 For flanges with small male-and-female face, care must be taken to insure that adequate bearing surface is provided for the gaskets. This applies particularly where the joint is made on the end of pipe. See Fig. 7.

6.12 Auxiliary Connections

No auxiliary connections, or openings therefore, will be provided except as specified by the purchaser. If assembly is required, the purchaser shall also specify the applicable code or regulation. Welded auxiliary connections shall be made by a qualified welder using a qualified weld procedure.

6.12.1 Pipe Thread Tapping. Holes may be tapped in the wall of a fitting if the metal is thick enough to allow the effective thread length specified in Fig. 3. Where thread length is insufficient or the tapped hole needs reinforcement, a boss shall be added.

6.12.2 Welded Connections

6.12.2.1 Sockets. Sockets (socket welding) may be provided in the wall of a fitting if the metal is thick enough to afford the depth of socket and retaining wall specified in Fig. 4. Where the wall thickness is insufficient, or the size of the connection requires opening reinforcement, a boss shall be added.

6.12.2.2 Butt Weld. Connections may be attached by butt welding directly to the wall of the fitting (see Fig. 5). Where the size of an opening requires reinforcement, a boss shall be added.

6.12.3 Bosses. Where bosses are required, the diameters shall be not less than those shown in Fig. 6, and the height shall provide lengths as specified in Fig. 3 or 4.

6.12.4 Size. Unless otherwise specified, auxiliary connections shall be of the pipe sizes given below.

Fitting Size, NPS	Connection, NPS
2–4	½
5–8	¾
10 and up	1

6.12.5 Designating Locations. This means of designating the locations for auxiliary connections in fittings are shown in Fig. 1.

Each possible location is designated by a letter so that the desired locations for the various types of fittings may be specified without using further sketches or description.

7 TOLERANCES[2]

7.1 General

For the purpose of determining conformance with this Standard, the convention for fixing significant digits where limits, maximum or minimum values are specified, shall be the rounding-off method defined in ASTM Practice E 29. This requires that an observed or calculated value shall be rounded to the nearest unit in the last right hand digit used for expressing the limit.

The listing of decimal tolerances does not imply a particular method of measurement.

7.2 Center-to-Contact Surfaces and Center-to-End

7.2.1 Center-to-Contact Surfaces Other Than Ring Joint

PS 10 and smaller	0.03 in.
NPS 12 and larger	0.06 in.

7.2.2 Center-to-End (Ring Joint)

NPS 10 and smaller	0.03 in.
NPS 12 and larger	0.06 in.

7.2.3 Contact Surface-to-Contact Surface Other Than Ring Joint

NPS 10 and smaller	0.06 in.
NPS 12 and larger	0.12 in.

7.2.4 End-to-End (Ring Joint)

NPS 10 and smaller	0.06 in.
NPS 12 and larger	0.12 in.

7.3 Facings

7.3.1 Inside and outside diameter of large and small tongue and groove and female, 0.02 in.

7.3.2 Outside diameter, 0.06 in. raised face, 0.03 in.

7.3.3 Outside diameter, 0.25 in. raised face, 0.02 in.

7.3.4 Ring joint groove tolerances are shown in Table 5.

7.4 Flange Thickness

NPS 18 and smaller	+0.12 in., –zero
NPS 20 and larger	+0.19 in., –zero

[2] Unless otherwise stated, tolerances are equal plus and minus.

7.5 Hub Dimensions and Welding Ends

7.5.1 Nominal outside diameter of welding end of welding neck flanges (dimension *A* of Figs. 8 and 9).

NPS 5 and smaller	+0.09 in., −0.03 in.
NPS 6 and larger	+0.16 in., −0.03 in.

7.5.2 Nominal inside diameter of welding ends of welding neck flanges and smaller bore of socket welding flanges (dimension *B* in the referenced figures).

Figs. 8 and 9:

NPS 10 and smaller	0.03 in.
NPS 12 to 18, inclusive	0.06 in.
NPS 20 and larger	+0.12 in., −0.06 in.

Fig. 10:

NPS 10 and smaller	+zero, −0.03 in.
NPS 12 and larger	+zero, −0.06 in.

7.5.3 Bore of backing ring of welding neck flanges (dimension *C* of Figs. 10 and 11).

All sizes	+0.010 in., − zero

7.5.4 Thickness of Hub. Regardless of tolerances specified for dimensions *A* and *B*, the thickness of hub at the welding end shall never be less than 87½% of the nominal thickness of the pipe to which the flange is to be attached.

7.6 Overall Length Through Hub on Welding Neck Flanges

NPS 4 and smaller	+0.06
NPS 5 to 10, inclusive	+0.06, −0.12
NPS 12 and larger	+0.12, −0.18

7.7 Bore of Flanges

7.7.1 Lapped, Slip-On, and Socket Welding Flanges

NPS 10 and smaller	+0.03 in., −zero
NPS 12 and larger	+0.06 in., −zero

7.7.2 Counterbore, Threaded Flanges

NPS 10 and smaller	+0.03 in., −zero
NPS 12 and larger	+0.06 in., −zero

7.8 Drilling and Facing

7.8.1 Bolt circle diameter, 0.06 in.

7.8.2 Center-to-center of adjacent bolt holes, 0.03 in.

7.8.3 Eccentricity between bolt circle diameter and machined facing diameters.

NPS 2½ and smaller	0.03 in.
NPS 3 and larger	0.06 in.

8 TEST

8.1 Flanged Fitting Training

Each flanged fitting shall be given a hydrostatic shell test as specified in para. 8.3.

8.2 Flange Testing

Flanges are not required to be hydrostatically tested.

8.3 Hydrostatic Shell Test

The hydrostatic shell test for flanged fittings shall be no less than 1.5 times the 100°F rating rounded off to the next higher 25 psi increment.

8.3.1 The test shall be made with water, which may contain a corrosion inhibitor, with kerosene, or with another suitable fluid provided its viscosity is no greater than that of water, at a test temperature not above 125°F.

8.3.2 The test duration shall be a minimum of 1 min for fittings NPS 2 and smaller, 2 min for fittings NPS 2½–NPS 8, and 3 min for fittings NPS 10 and larger.

8.3.3 No visible leakage is permitted through the pressure boundary wall.

TABLE 1A LIST OF MATERIAL SPECIFICATIONS

Material Group	Nominal Designation	Pressure–Temperature Rating Table	Applicable ASTM Specifications[1]		
			Forgings	Castings	Plates
1.1	C–Si C–Mn–Si	2-1.1	A 105 A 350 Gr. LF2	A 216 Gr. WCB	A 515 Gr. 70 A 516 Gr. 70 A 537 Cl. 1
1.2	C–Mn–Si 2½Ni 3½Ni	2-1.2	 A 350 Gr. LF3	A 216 Gr. WCC A 352 Gr. LCC A 352 Gr. LC2 A 352 Gr. LC3	 A 203 Gr. B A 203 Gr. E
1.3	C–Si C–Mn–Si 2½Ni 3½Ni	2-1.3		A 352 Gr. LCB	A 515 Gr. 65 A 516 Gr. 65 A 203 Gr. A A 203 Gr. D
1.4	C–Si C–Mn–Si	2-1.4	 A 350 Gr. LF1 Cl. 1		A 515 Gr. 60 A 516 Gr. 60
1.5	C–½Mo	2-1.5	A 182 Gr. F1	A 217 Gr. WC1 A 352 Gr. LC1	A 204 Gr. A A 204 Gr. B
1.7	C–½Mo ½Cr–½Mo Ni–½Cr–½Mo ¾Ni–¾Cr–1Mo	2-1.7	 A 182 Gr. F2	 A 217 Gr. WC4 A 217 Gr. WC5	A 204 Gr. C
1.9	1Cr–½Mo 1¼Cr–½Mo 1¼Cr–½Mo–Si	2-1.9	A 182 Gr. F12 Cl. 2 A 182 Gr. F11 Cl. 2	 A 217 Gr. WC6	 A 387 Gr. 11 Cl. 2
1.10	2¼Cr–1Mo	2-1.10	A 182 Gr. F22 Cl. 3	A 217 Gr. WC9	A 387 Gr. 22 Cl. 2
1.13	5Cr–½Mo	2-1.13	A 182 Gr. F5 A 182 Gr. F5a	 A 217 Gr. C5	
1.14	9Cr–1Mo	2-1.14	A 182 Gr. F9	A 217 Gr. C12	
2.1	18Cr–8Ni	2-2.1	A 182 Gr. F304 A 182 Gr. F304H	A 351 Gr. CF3 A 351 Gr. CF8	A 240 Gr. 304 A 240 Gr. 304H
2.2	16Cr–12Ni–2Mo 18Cr–13Ni–3Mo 19Cr–10Ni–3Mo	2-2.2	A 182 Gr. F316 A 182 Gr. F316H	A 351 Gr. CF3M A 351 Gr. CF8M A 351 Gr. CG8M	A 240 Gr. 316 A 240 Gr. 316H A 240 Gr. 317
2.3	18Cr–8Ni 16Cr–12Ni–2Mo	2-2.3	A 182 Gr. F304L A 182 Gr. F316L		A 240 Gr. 304L A 240 Gr. 316L
2.4	18Cr–10Ni–Ti	2-2.4	A 182 Gr. F321 A 182 Gr. F321H		A 240 Gr. 321 A 240 Gr. 321H

TABLE 1A LIST OF MATERIAL SPECIFICATIONS (CONT'D)

Material Group	Nominal Designation	Pressure–Temperature Rating Table	Applicable ASTM Specifications[1]		
			Forgings	Castings	Plates
2.5	18Cr–10Ni–Cb	2-2.5	A 182 Gr. F347 A 182 Gr. F347H A 182 Gr. F348 A 182 Gr. F348H	A 351 Gr. CF8C	A 240 Gr. 347 A 240 Gr. 347H A 240 Gr. 348 A 240 Gr. 348H
2.6	25Cr–12Ni 23Cr–12Ni	2-2.6		A 351 Gr. CH8 A 351 Gr. CH20	 A 240 Gr. 309S A 240 Gr. 309H
2.7	25Cr–20Ni	2-2.7	A 182 Gr. F310	A 351 Gr. CK20	A 240 Gr. 310S A 240 Gr. 310H
2.8	20Cr–18Ni–6Mo 22Cr–5Ni–3Mo–N 25Cr–7Ni–4Mo–N	2-2.8	A 182 Gr. F44 A 182 Gr. F51 A 182 Gr. F53	A 351 Gr. CK3MCuN	A 240 Gr. S31254 A 240 Gr. S31803 A 240 Gr. S32750
3.1	35Ni–35Fe–20Cr–Cb 28Ni–19Cr–Cu–Mo	2-3.1	B 462 Gr. N08020	A 351 Gr. CN7M	B 463 Gr. N08020
3.2	99.0Ni	2-3.2	B 160 Gr. N02200		B 162 Gr. N02200
3.3	99.0Ni–Low C	2-3.3	B 160 Gr. N02201		B 162 Gr. N02201
3.4	67Ni–30Cu 67Ni–30Cu–S	2-3.4	B 564 Gr. N04400 B 164 Gr. N04405		B 127 Gr. N04400
3.5	72Ni–15Cr–8Fe	2-3.5	B 564 Gr. N06600		B 168 Gr. N06600
3.6	33Ni–42Fe–21Cr	2-3.6	B 564 Gr. N08800		B 409 Gr. N08800
3.7	65Ni–28Mo–2Fe	2-3.7	B 335 Gr. N10665		B 333 Gr. N10665
3.8	54Ni–16Mo–15Cr 60Ni–22Cr–9Mo–3.5Cb 62Ni–28Mo–5Fe 70Ni–16Mo–7Cr–5Fe 61Ni–16Mo–16Cr 42Ni–21.5Cr–3Mo–2.3Cu	2-3.8	B 564 Gr. N10276 B 564 Gr. N06625 B 335 Gr. N10001 B 573 Gr. N10003 B 574 Gr. N06455 B 564 Gr. N08825		B 575 Gr. N10276 B 443 Gr. N06625 B 333 Gr. N10001 B 434 Gr. N10003 B 575 Gr. N06455 B 424 Gr. N08825
3.9	47Ni–22Cr–9Mo–18Fe	2-3.9	B 572 Gr. N06002		B 435 Gr. N06002
3.10	25Ni–46Fe–21Cr–5Mo	2-3.10	B 672 Gr. N08700		B 599 Gr. N08700
3.11	44Fe–25Ni–21Cr–Mo	2-3.11	B 649 Gr. N08904		B 625 Gr. N08904
3.12	26Ni–43Fe–22Cr–5Mo 47Ni–22Cr–20Fe–7Mo	2-3.12	B 621 Gr. N08320 B 581 Gr. N06985		B 620 Gr. N08320 B 582 Gr. N06985

(Table 1A continues on next page; Notes follow at end of Table)

TABLE 1A LIST OF MATERIAL SPECIFICATIONS (CONT'D)

Material Group	Nominal Designation	Pressure–Temperature Rating Table	Applicable ASTM Specifications[1]		
			Forgings	Castings	Plates
3.13	49Ni–25Cr–18Fe–6Mo Ni–Fe–Cr–Mo–Low Cu	2-3.13	B 581 Gr. N06975 B 564 Gr. N08031		B 582 Gr. N06975 B 625 Gr. N08031
3.14	47Ni–22Cr–19Fe–6Mo	2-3.14	B 581 Gr. N06007		B 582 Gr. N06007
3.15	33Ni–42Fe–21Cr	2-3.15	B 564 Gr. N08810		B 409 Gr. N08810
3.16	35Ni–19Cr–1¼Si	2-3.16	B 511 Gr. N08330		B 536 Gr. N08330

NOTE:
(1) ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the listed ASTM specifications, may also be used.

TABLE 1B LIST OF BOLTING SPECIFICATIONS
Applicable ASTM Specifications[15]

Bolting Materials [Note (1)]												
High Strength [Note (2)]			Intermediate Strength [Note (3)]			Low Strength [Note (4)]			Nickel and Special Alloy [Note (5)]		
Spec. No.	Grade	Notes	Spec. No.	Grade	Notes	Spec. No.	Grade	Notes	Spec. No.	Grade	Notes
A193	B7	...	A 193	B5	...	A 193	B8 Cl.1	(6)	B 164	...	(7)(8)(9)
A193	B16	...	A 193	B6	...	A 193	B8C Cl.1	(6)			
			A 193	B6X	...	A 193	B8M Cl.1	(6)	B 166	...	(7)(8)(9)
A 320	L7	(10)	A 193	B7M	...	A 193	B8T Cl.1	(6)			
A 320	L7A	(10)	A 193	B8 Cl.2	(11)	A 193	B8A	(6)	B 335	N10665	(7)
A 320	L7B	(10)	A 193	B8C Cl.2	(11)	A 193	B8CA	(6)			
A 320	L7C	(10)	A 193	B8M Cl.2	(11)	A 193	B8MA	(6)	B 408	...	(7)(8)(9)
A 320	L43	(10)	A 193	B8T Cl.2	(11)	A 193	B8TA	(6)			
									B 473	...	(7)
A 354	BC	...	A 320	B8 Cl.2	(11)	A 307	B	(12)			
A 354	BD	...	A 320	B8C Cl.2	(11)				B 574	N10276	(7)
			A 320	B8F Cl.2	(11)	A 320	B8 Cl.1	(6)			
A 540	B21	...	A 320	B8M Cl.2	(11)	A 320	B8C Cl.1	(6)			
A 540	B22	...	A 320	B8T Cl.2	(11)	A 320	B8M Cl.1	(6)			
A 540	B23	...				A 320	B8T Cl.1	(6)			
A 540	B24	...	A 449	...	(13)						
			A 453	651	(14)						
			A 453	660	(14)						

GENERAL NOTE: Bolting material shall not be used beyond temperature limits specified in the governing code.

NOTES:
(1) Repair welding of bolting material is prohibited.
(2) These bolting materials may be used with all listed materials and gaskets.
(3) These bolting materials may be used with all listed materials and gaskets, provided it has been varified that a sealed joint can be maintained under rated working pressure and temperature.
(4) These bolting materials may be used with all listed materials but are limited to Classes 150 and 300 joints. See para. 5.4.1 for required gasket practices.
(5) These materials may be used as bolting with comparable nickel and special alloy parts.
(6) This austenitic stainless material has been carbide solution treated but not strain hardened. Use A 194 nuts of corresponding material.
(7) Nuts may be machined from the same material or may be of a compatible grade of ASTM A 194.
(8) Maximum operating temperature is arbitrarily set at 500°F, unless material has been annealed, solution annealed, or hot finished because hard temper adversely affects design stress in the creep rupture range.
(9) Forging quality not permitted unless the producer last heating or working these parts tests them as required for other permitted conditions in the same specification and certifies their final tensile, yield, and elongation properties to equal or exceed the requirements for one of the other permitted conditions.
(10) This ferritic material is intended for low temperature service. Use A 194 Grade 4 or Grade 7 nuts.
(11) This austenitic stainless material has been carbide solution treated and strain hardened. Use A 194 nuts of corresponding material.
(12) This carbon steel fastener shall not be used above 400°F or below −20°F. See also Note (4). Bolts with drilled or undersized heads shall not be used.
(13) Acceptable nuts for use with quenched and tempered bolts are A 194 Grades 2 and 2H. Mechanical property requirements for studs shall be the same as those for bolts.
(14) This special alloy is intended for high temperature service with austenitic stainless steel.
(15) ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the listed ASTM specifications, may also be used.

TABLE 1C FLANGE BOLTING DIMENSIONAL RECOMMENDATIONS

Product	Carbon Steel	Alloy Steel
Stud bolts	ASME B18.2.1	ASME B18.2.1
Bolts smaller than 3/4 in.	ASME B18.2.1, square or heavy hex head	ASME B18.2.1, heavy hex head
Bolts equal to or larger than 3/4 in.	ASME B18.2.1, square or hex head	ASME B18.2.1, heavy hex head
Nuts smaller than 3/4 in.	ASME B18.2.2, heavy hex	ASME B18.2.2, heavy hex
Nuts equal to or larger than 3/4 in.	ASME B18.2.2, hex or heavy hex	ASME B18.2.2, heavy hex
Male threads	ASME B1.1, Cl. 2A course series	ASME B1.1, Cl. 2A course series up through 1 in.; eight thread series for larger bolts
Female threads	ASME B1.1, Cl. 2B course series	ASME B1.1, Cl. 2B course series up through 1 in.; eight thread series for larger bolts

TABLES 2
PRESSURE–TEMPERATURE RATINGS FOR GROUPS 1.1 THROUGH 3.16 MATERIALS

TABLE 2-1.1 RATINGS FOR GROUP 1.1 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C–Si	A 105 (1)	A 216 Gr. WCB (1)	A 515 Gr. 70 (1)
C–Mn–Si	A 350 Gr. LF2 (1)		A 516 Gr. 70 (1)(2) A 537 Cl. 1 (3)

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 850°F.
(3) Not to be used over 700°F.

	WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	285	740	990	1480	2220	3705	6170
200	260	675	900	1350	2025	3375	5625
300	230	655	875	1315	1970	3280	5470
400	200	635	845	1270	1900	3170	5280
500	170	600	800	1200	1795	2995	4990
600	140	550	730	1095	1640	2735	4560
650	125	535	715	1075	1610	2685	4475
700	110	535	710	1065	1600	2665	4440
750	95	505	670	1010	1510	2520	4200
800	80	410	550	825	1235	2060	3430
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

TABLE 2-1.2 RATINGS FOR GROUP 1.2 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C–Mn–Si		A 216 Gr. WCC (1) A 352 Gr. LCC (2)	
2½Ni		A 352 Gr. LC2	A 203 Gr. B (1)
3½Ni	A 350 Gr. LF3	A 352 Gr. LC3	A 203 Gr. E (1)

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 650°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	505	670	1010	1510	2520	4200
800	80	410	550	825	1235	2060	3430
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

TABLE 2-1.3 RATINGS FOR GROUP 1.3 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C–Si		A 352 Gr. LCB (3)	A 515 Gr. 65 (1)
C–Mn–Si			A 516 Gr. 65 (1)(2)
2½Ni			A 203 Gr. A (1)
3½Ni			A 203 Gr. D (1)

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 850°F.
(3) Not to be used over 650°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	265	695	925	1390	2085	3470	5785
200	250	655	875	1315	1970	3280	5470
300	230	640	850	1275	1915	3190	5315
400	200	620	825	1235	1850	3085	5145
500	170	585	775	1165	1745	2910	4850
600	140	535	710	1065	1600	2665	4440
650	125	525	695	1045	1570	2615	4355
700	110	520	690	1035	1555	2590	4320
750	95	475	630	945	1420	2365	3945
800	80	390	520	780	1175	1955	3260
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

TABLE 2-1.4 RATINGS FOR GROUP 1.4 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C–Si			A 515 Gr. 60 (1)
C–Mn–Si	A 350 Gr. LF1, Cl. 1 (1)		A 516 Gr. 60 (1)(2)

NOTES:
(1) Upon prolonged exposure to temperatures above 800°F, the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800°F.
(2) Not to be used over 850°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	235	620	825	1235	1850	3085	5145
200	215	560	750	1125	1685	2810	4680
300	210	550	730	1095	1640	2735	4560
400	200	530	705	1060	1585	2645	4405
500	170	500	665	995	1495	2490	4150
600	140	455	610	915	1370	2285	3805
650	125	450	600	895	1345	2245	3740
700	110	450	600	895	1345	2245	3740
750	95	445	590	885	1325	2210	3685
800	80	370	495	740	1110	1850	3085
850	65	270	355	535	805	1340	2230
900	50	170	230	345	515	860	1430
950	35	105	140	205	310	515	860
1000	20	50	70	105	155	260	430

TABLE 2-1.5 RATINGS FOR GROUP 1.5 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C-½Mo	A 182 Gr. F1 (1)	A 217 Gr. WC1 (1)(2) A 352 Gr. LC1 (3)	A 204 Gr. A (1) A 204 Gr. B (1)

NOTES:
(1) Upon prolonged exposure to temperatures above 875°F, the carbide phase of Carbon-molybdenum steel may be converted to graphite. Permissible, but not recommended for prolonged use above 875°F.
(2) Use normalized and tempered material only.
(3) Not to be used over 650°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	265	695	925	1390	2085	3470	5785
200	260	680	905	1360	2035	3395	5660
300	230	655	870	1305	1955	3260	5435
400	200	640	855	1280	1920	3200	5330
500	170	620	830	1245	1865	3105	5180
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	280	375	560	845	1405	2345
1000	20	165	220	330	495	825	1370

TABLE 2-1.7 RATINGS FOR GROUP 1.7 MATERIALS

Nominal Designation	Forgings	Castings	Plates
C-½Mo			A 204 Gr. C (1)
½Cr-½Mo	A 182 Gr. F2 (3)		
Ni-½Cr-½Mo		A 217 Gr. WC4 (2)(3)	
¾Ni-¾Cr-1Mo		A 217 Gr. WC5 (2)	

NOTES:
(1) Upon prolonged exposure to temperatures above 875°F, the carbide phose of carbon-molybdenum steel may be converted to graphite. Permissible, but not recommended for prolonged use above 875°F.
(2) Use normalized and tempered material only.
(3) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	720	965	1445	2165	3610	6015
400	200	695	925	1385	2080	3465	5775
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	315	420	630	945	1575	2630
1000	20	200	270	405	605	1010	1685
1050	...	160	210	315	475	790	1315

TABLE 2-1.9 RATINGS FOR GROUP 1.9 MATERIALS

Nominal Designation	Forgings	Castings	Plates
1Cr–½Mo	A 182 Gr. F12 Cl. 2 (1)(2)		
1¼Cr–½Mo		A 217 Gr. WC6 (1)(3)	
1¼Cr–½Mo	A 182 Gr. F11 Cl. 2 (1)(2)		A 387 Gr. 11 Cl. 2 (2)

NOTES:
(1) Use normalized and tempered material only.
(2) Permissible, but not recommended for prolonged use above 1100°F.
(3) Not to be used over 1100°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	720	965	1445	2165	3610	6015
400	200	695	925	1385	2080	3465	5775
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	320	425	640	955	1595	2655
1000	20	215	290	430	650	1080	1800
1050	. . .	145	190	290	430	720	1200
1100	. . .	95	130	190	290	480	800
1150	. . .	60	80	125	185	310	515
1200	. . .	40	50	75	115	190	315

TABLE 2-1.10 RATINGS FOR GROUP 1.10 MATERIALS

Nominal Designation	Forgings	Castings	Plates
2¼Cr–1Mo	A 182 Gr. F22 Cl. 3 (2)	A 217 Gr. WC9 (1)(3)	A 387 Gr. 22 Cl. 2 (2)

NOTES:
(1) Use normalized and tempered material only.
(2) Permissible, but not recommended for prolonged use above 1100°F.
(3) Not to be used over 1100°F.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	375	505	755	1130	1885	3145
1000	20	260	345	520	780	1305	2170
1050	...	175	235	350	525	875	1455
1100	...	110	145	220	330	550	915
1150	...	70	90	135	205	345	570
1200	...	40	55	80	125	205	345

TABLE 2-1.13 RATINGS FOR GROUP 1.13 MATERIALS

Nominal Designation	Forgings	Castings	Plates
5Cr–½Mo	A 182 Gr. F5 A 182 Gr. F5a	A 217 Gr. C5 (1)	

NOTE:
(1) Use normalized and tempered material only.

	WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	745	995	1490	2235	3725	6205
300	230	715	955	1430	2150	3580	5965
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	705	1055	1585	2640	4400
800	80	510	675	1015	1525	2540	4230
850	65	485	645	965	1450	2415	4030
900	50	370	495	740	1110	1850	3085
950	35	275	365	550	825	1370	2285
1000	20	200	265	400	595	995	1655
1050	. . .	145	190	290	430	720	1200
1100	. . .	100	135	200	300	495	830
1150	. . .	60	80	125	185	310	515
1200	. . .	35	45	70	105	170	285

TABLE 2-1.14 RATINGS FOR GROUP 1.14 MATERIALS

Nominal Designation	Forgings	Castings	Plates
9Cr–1Mo	A 182 Gr. F9	A 217 Gr. C12 (1)	

NOTE:
(1) Use normalized and tempered material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	375	505	755	1130	1885	3145
1000	20	255	340	505	760	1270	2115
1050	. . .	170	230	345	515	855	1430
1100	. . .	115	150	225	340	565	945
1150	. . .	75	100	150	225	375	630
1200	. . .	50	70	105	155	255	430

TABLE 2-2.1 RATINGS FOR GROUP 2.1 MATERIALS

Nominal Designation	Forgings	Castings	Plates
18Cr–8Ni	A 182 Gr. F304 (1)	A 351 Gr. CF3 (2)	A 240 Gr. 304 (1)
	A 182 Gr. F304H	A 351 Gr. CF8 (1)	A 240 Gr. 304H

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 800°F.

	WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	230	600	800	1200	1800	3000	5000
300	205	540	720	1080	1620	2700	4500
400	190	495	660	995	1490	2485	4140
500	170	465	620	930	1395	2330	3880
600	140	435	580	875	1310	2185	3640
650	125	430	575	860	1290	2150	3580
700	110	425	565	850	1275	2125	3540
750	95	415	555	830	1245	2075	3460
800	80	405	540	805	1210	2015	3360
850	65	395	530	790	1190	1980	3300
900	50	390	520	780	1165	1945	3240
950	35	380	510	765	1145	1910	3180
1000	20	320	430	640	965	1605	2675
1050	...	310	410	615	925	1545	2570
1100	...	255	345	515	770	1285	2145
1150	...	200	265	400	595	995	1655
1200	...	155	205	310	465	770	1285
1250	...	115	150	225	340	565	945
1300	...	85	115	170	255	430	715
1350	...	60	80	125	185	310	515
1400	...	50	65	95	145	240	400
1450	...	35	45	70	105	170	285
1500	...	25	35	55	80	135	230

TABLE 2-2.2 RATINGS FOR GROUP 2.2 MATERIALS

Nominal Designation	Forgings	Castings	Plates
16Cr–12Ni–2Mo	A 182 Gr. F316 (1) A 182 Gr. F316H	A 351 Gr. CF3M (2) A 351 Gr. CF8M (1)	A 240 Gr. 316 (1) A 240 Gr. 316H
18Cr–13Ni–3Mo			A 240 Gr. 317 (1)
19Cr–10Ni–3Mo		A 351 Gr. CG8M (3)	

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) Not to be used over 850°F.
(3) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	235	620	825	1240	1860	3095	5160
300	215	560	745	1120	1680	2795	4660
400	195	515	685	1025	1540	2570	4280
500	170	480	635	955	1435	2390	3980
600	140	450	600	900	1355	2255	3760
650	125	445	590	890	1330	2220	3700
700	110	430	580	870	1305	2170	3620
750	95	425	570	855	1280	2135	3560
800	80	420	565	845	1265	2110	3520
850	65	420	555	835	1255	2090	3480
900	50	415	555	830	1245	2075	3460
950	35	385	515	775	1160	1930	3220
1000	20	350	465	700	1050	1750	2915
1050	...	345	460	685	1030	1720	2865
1100	...	305	405	610	915	1525	2545
1150	...	235	315	475	710	1185	1970
1200	...	185	245	370	555	925	1545
1250	...	145	195	295	440	735	1230
1300	...	115	155	235	350	585	970
1350	...	95	130	190	290	480	800
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

TABLE 2-2.3 RATINGS FOR GROUP 2.3 MATERIALS

Nominal Designation	Forgings	Castings	Plates
16Cr–12Ni–2Mo	A 182 Gr. F316L		A 240 Gr. 316L
18Cr–8Ni	A 182 Gr. F304L (1)		A 240 Gr. 304L (1)

NOTE:
(1) Not to be used over 800°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	230	600	800	1200	1800	3000	5000
200	195	505	675	1015	1520	2530	4220
300	175	455	605	910	1360	2270	3780
400	160	415	550	825	1240	2065	3440
500	145	380	510	765	1145	1910	3180
600	140	360	480	720	1080	1800	3000
650	125	350	470	700	1050	1750	2920
700	110	345	460	685	1030	1715	2860
750	95	335	450	670	1010	1680	2800
800	80	330	440	660	985	1645	2740
850	65	320	430	645	965	1610	2680

TABLE 2-2.4 RATINGS FOR GROUP 2.4 MATERIALS

Nominal Designation	Forgings	Castings	Plates
18Cr–10Ni–Ti	A 182 Gr. F321 (2) A 182 Gr. F321H (1)		A 240 Gr. 321 (2) A 240 Gr. 321H (1)

NOTES:
(1) At temperatures over 1000°F, use only if the material is heat treated by heating to a minimum temperature of 2000°F.
(2) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	245	645	860	1290	1935	3230	5380
300	230	595	795	1190	1785	2975	4960
400	200	550	735	1105	1655	2760	4600
500	170	515	685	1030	1545	2570	4285
600	140	485	650	975	1460	2435	4060
650	125	480	635	955	1435	2390	3980
700	110	465	620	930	1395	2330	3880
750	95	460	610	915	1375	2290	3820
800	80	450	600	900	1355	2255	3760
850	65	445	595	895	1340	2230	3720
900	50	440	590	885	1325	2210	3680
950	35	385	515	775	1160	1930	3220
1000	20	355	475	715	1070	1785	2970
1050	. . .	315	415	625	940	1565	2605
1100	. . .	270	360	545	815	1360	2265
1150	. . .	235	315	465	710	1185	1970
1200	. . .	185	245	370	555	925	1545
1250	. . .	140	185	280	420	705	1170
1300	. . .	110	145	220	330	550	915
1350	. . .	85	115	170	255	430	715
1400	. . .	65	85	130	195	325	545
1450	. . .	50	70	105	155	255	430
1500	. . .	40	50	75	115	190	315

TABLE 2-2.5 RATINGS FOR GROUP 2.5 MATERIALS

Nominal Designation	Forgings	Castings	Plates
18Cr–10Ni–Cb	A 182 Gr. F347 (2) A 182 Gr. F347H (1) A 182 Gr. F348 (2) A 182 Gr. F348H (1)	A 351 Gr. CF8C (3)	A 240 Gr. 347 (2) A 240 Gr. 347H (1) A 240 Gr. 348 (2) A 240 Gr. 348H (1)

NOTES:
(1) For temperatures over 1000°F, use only if the material is heat treated by heating to a minimum temperature of 2000°F.
(2) Not to be used over 1000°F.
(3) At temperatures over 1000°F, use the material only when the carbon content is 0.04% or higher.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	255	660	880	1320	1980	3300	5500
300	230	615	820	1230	1845	3070	5120
400	200	575	765	1145	1720	2870	4780
500	170	540	720	1080	1620	2700	4500
600	140	515	685	1025	1540	2570	4280
650	125	505	670	1010	1510	2520	4200
700	110	495	660	990	1485	2470	4120
750	95	490	655	985	1475	2460	4100
800	80	485	650	975	1460	2435	4060
850	65	485	645	970	1455	2425	4040
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	170	230	345	515	855	1430
1250	...	125	165	245	370	615	1030
1300	...	95	125	185	280	465	770
1350	...	70	90	135	205	345	570
1400	...	55	75	110	165	275	455
1450	...	40	55	80	125	205	345
1500	...	35	45	70	105	170	285

TABLE 2-2.6 RATINGS FOR GROUP 2.6 MATERIALS

Nominal Designation	Forgings	Castings	Plates
23Cr–12Ni			A 240 Gr. 309S (1)(2)(3) A 240 Gr. 309H
25Cr–12Ni		A 351 Gr. CH8 (1) A 351 Gr. CH20 (1)	

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) For temperatures above 1000°F, use only if the material solution is heat treated to the minimum temperature specified in the specification but not lower than 1900°F, and quenching in water or rapidly cooling by other means.
(3) This material should be used for service temperatures 1050°F and above only when assurance is provided that grain size is not finer than ASTM 6.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	260	670	895	1345	2015	3360	5600
200	230	605	805	1210	1815	3025	5040
300	220	570	760	1140	1705	2845	4740
400	200	535	710	1065	1600	2665	4440
500	170	505	670	1010	1510	2520	4200
600	140	480	635	955	1435	2390	3980
650	125	465	620	930	1395	2330	3880
700	110	455	610	910	1370	2280	3800
750	95	445	595	895	1340	2230	3720
800	80	435	580	870	1305	2170	3620
850	65	425	565	850	1275	2125	3540
900	50	415	555	830	1245	2075	3460
950	35	385	515	775	1160	1930	3220
1000	20	335	450	670	1010	1680	2800
1050	...	290	390	585	875	1460	2430
1100	...	225	300	445	670	1115	1860
1150	...	170	230	345	515	860	1430
1200	...	130	175	260	390	650	1085
1250	...	100	135	200	300	495	830
1300	...	80	105	160	235	395	660
1350	...	60	80	115	175	290	485
1400	...	45	60	90	135	225	370
1450	...	30	40	60	95	155	260
1500	...	25	30	50	70	120	200

TABLE 2-2.7 RATINGS FOR GROUP 2.7 MATERIALS

Nominal Designation	Forgings	Castings	Plates
25Cr–20Ni	A 182 Gr. F310 (1)(3)	A 351 Gr. CK20 (1)	A 240 Gr. 310S (1)(2)(3) A 240 Gr. 310H

NOTES:
(1) At temperatures over 1000°F, use only when the carbon content is 0.04% or higher.
(2) For temperatures above 1000°F, use only if the material is heat treated by heating it to a temperature of at least 1900°F and quenching in water or rapidly cooling by other means.
(3) Service temperatures of 1050°F and above should be used only when assurance is provided that grain size is not finer than ASTM 6.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	260	670	895	1345	2015	3360	5600
200	235	605	810	1215	1820	3035	5060
300	220	570	760	1140	1705	2845	4740
400	200	535	715	1070	1605	2675	4260
500	170	505	675	1015	1520	2530	4220
600	140	480	640	960	1440	2400	4000
650	125	470	625	935	1405	2340	3900
700	110	455	610	910	1370	2280	3800
750	95	450	600	900	1345	2245	3740
800	80	435	580	875	1310	2185	3640
850	65	425	575	855	1280	2135	3560
900	50	420	555	835	1255	2090	3480
950	35	385	515	775	1160	1930	3220
1000	20	345	460	685	1030	1720	2865
1050	. . .	335	450	670	1010	1680	2800
1100	. . .	260	345	520	780	1305	2170
1150	. . .	190	250	375	565	945	1570
1200	. . .	135	185	275	410	685	1145
1250	. . .	105	135	205	310	515	855
1300	. . .	75	100	150	225	375	630
1350	. . .	60	80	115	175	290	485
1400	. . .	45	60	90	135	225	370
1450	. . .	35	45	65	100	165	275
1500	. . .	25	35	50	75	130	215

TABLE 2-2.8 RATINGS FOR GROUP 2.8 MATERIALS

Nominal Designation	Forgings	Castings	Plates
20Cr–18Ni–6Mo	A 182 Gr. F44	A 351 Gr. CK3MCuN	A 240 Gr. S31254
22Cr–5Ni–3Mo–N	A 182 Gr. F51 (1)		A 240 Gr. S31803 (1)
25Cr–7Ni–4Mo–N	A 182 Gr. F53 (1)		A 240 Gr. S32750 (1)

NOTE:
(1) This steel may become brittle after service at moderately elevated temperatures. Not to be used over 600°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	720	960	1440	2160	3600	6000
300	230	665	885	1330	1995	3325	5540
400	200	615	820	1230	1845	3070	5120
500	170	575	770	1150	1730	2880	4800
600	140	555	740	1115	1670	2785	4640
650	125	550	735	1100	1650	2750	4580
700	110	540	725	1085	1625	2710	4520
750	95	530	710	1065	1595	2660	4430

TABLE 2-3.1 RATINGS FOR GROUP 3.1 MATERIALS

Nominal Designation	Forgings	Castings	Plates
28Ni–19Cr–Cu–Mo		A 351 Gr. CN7M (2)(3)	
35Ni–35Fe–20Cr–Cb	B 462 Gr. N08020 (1)		B 463 Gr. N08020 (1)

NOTES:
(1) Use annealed material only.
(2) Use solution annealed material only.
(3) Ratings apply for 300°F and lower.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	230	600	800	1200	1800	3000	5000
200	200	520	695	1045	1565	2610	4350
300	190	490	655	980	1470	2450	4080
400	190	490	655	980	1470	2450	4080
500	170	490	655	980	1470	2450	4080
600	140	490	655	980	1470	2450	4080
650	125	490	655	980	1470	2450	4080
700	110	490	655	980	1470	2450	4080
750	95	490	655	980	1470	2450	4080
800	80	490	655	980	1470	2450	4080

TABLE 2-3.2 RATINGS FOR GROUP 3.2 MATERIALS

Nominal Designation	Forgings	Castings	Plates
99.0Ni	B 160 Gr. N02200 (1)(2)		B 162 Gr. N02200 (1)

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	140	360	480	720	1080	1800	3000
200	140	360	480	720	1080	1800	3000
300	140	360	480	720	1080	1800	3000
400	140	360	480	720	1080	1800	3000
500	140	360	480	720	1080	1800	3000
600	140	360	480	720	1080	1800	3000

TABLE 2-3.3 RATINGS FOR GROUP 3.3 MATERIALS

Nominal Designation	Forgings	Castings	Plates
99.0Ni–Low C	B 160 Gr. N02201 (1)(2)		B 162 Gr. N02201 (1)

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	90	240	320	480	720	1200	2000
200	85	230	305	455	685	1140	1900
300	85	225	300	445	670	1115	1860
400	85	215	290	430	650	1080	1800
500	85	215	290	430	650	1080	1800
600	85	215	290	430	650	1080	1800
650	85	215	290	430	650	1080	1800
700	85	215	290	430	650	1080	1800
750	80	210	280	420	635	1055	1760
800	80	205	270	410	610	1020	1700
850	65	205	270	410	610	1020	1700
900	50	140	185	380	415	695	1155
950	35	115	150	230	345	570	950
1000	20	95	125	185	280	465	770
1050	. . .	75	100	150	220	370	615
1100	. . .	60	80	125	185	310	515
1150	. . .	45	60	95	140	230	385
1200	. . .	35	50	75	110	185	310

TABLE 2-3.4 RATINGS FOR GROUP 3.4 MATERIALS

Nominal Designation	Forgings	Castings	Plates
67Ni–30Cu	B 564 Gr. N04400 (1)		B 127 Gr. N04400 (1)
67Ni–30Cu–S	B 164 Gr. N04405 (1)(2)		

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	230	600	800	1200	1800	3000	5000
200	200	530	705	1055	1585	2640	4400
300	190	495	660	990	1485	2470	4120
400	185	480	635	955	1435	2390	3980
500	170	475	635	950	1435	2375	3960
600	140	475	635	950	1435	2375	3960
650	125	475	635	950	1435	2375	3960
700	110	475	635	950	1435	2375	3960
750	95	470	625	935	1405	2340	3900
800	80	460	610	915	1375	2290	3820
850	65	340	455	680	1020	1695	2830
900	50	245	340	495	740	1235	2055

TABLE 2-3.5 RATINGS FOR GROUP 3.5 MATERIALS

Nominal Designation	Forgings	Castings	Plates
72Ni–15Cr–8Fe	B 564 Gr. N06600 (1)		B 168 Gr. N06600 (1)

NOTE:
(1) Use annealed material only.

	WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	325	435	655	980	1635	2725
1000	20	215	290	430	650	1080	1800
1050	...	140	185	280	415	695	1155
1100	...	95	125	185	280	465	770
1150	...	70	90	135	205	340	565
1200	...	60	80	125	185	310	515

TABLE 2-3.6 RATINGS FOR GROUP 3.6 MATERIALS

Nominal Designation	Forgings	Castings	Plates
33Ni–42Fe–21Cr	B 564 Gr. N08800 (1)		B 409 Gr. N08800 (1)

NOTE:
(1) Use annealed material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	255	660	885	1325	1990	3310	5520
300	230	625	830	1250	1870	3120	5200
400	200	600	800	1200	1800	3000	5000
500	170	580	770	1155	1735	2890	4820
600	140	575	765	1145	1720	2870	4780
650	125	570	760	1140	1705	2845	4740
700	110	565	750	1130	1690	2820	4700
750	95	530	710	1065	1595	2660	4430
800	80	505	675	1015	1520	2535	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	. . .	360	480	720	1080	1800	3000
1100	. . .	325	430	645	965	1610	2685
1150	. . .	275	365	550	825	1370	2285
1200	. . .	205	270	405	610	1020	1695
1250	. . .	130	175	260	390	650	1080
1300	. . .	60	80	125	185	310	515
1350	. . .	50	65	100	150	245	410
1400	. . .	35	45	70	100	170	285
1450	. . .	30	40	60	95	155	255
1500	. . .	25	35	50	75	125	205

TABLE 2-3.7 RATINGS FOR GROUP 3.7 MATERIALS

Nominal Designation	Forgings	Castings	Plates
65Ni–28Mo–2Fe	B 335 Gr. N10665 (1)(2)		B 333 Gr. N10665 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230

TABLE 2-3.8 RATINGS FOR GROUP 3.8 MATERIALS

Nominal Designation	Forgings	Castings	Plates
54Ni-16Mo-15Cr	B 564 Gr. N10276 (1)(4)		B 575 Gr. N10276 (1)(4)
60Ni-22Cr-9Mo-3.5Cb	B 564 Gr. N06625 (3)(5)		B 443 Gr. N06625 (3)(5)
62Ni-28Mo-5Fe	B 335 Gr. N10001 (1)(2)(6)		B 333 Gr. N10001 (1)(6)
70Ni-16Mo-7Cr-5Fe	B 573 Gr. N10003 (2)(3)		B 434 Gr. N10003 (3)
61Ni-16Mo-16Cr	B 574 Gr. N06455 (1)(2)(6)		B 575 Gr. N06455 (1)(6)
42Ni-21.5Fe-3Cr-2.3Cu	B 564 Gr. N08825 (3)(7)		B 424 Gr. N08825 (3)(7)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.
(3) Use annealed material only.
(4) Not to be used over 1250°F.
(5) Not to be used over 1200°F. Alloy N06625 in the annealed condition is subject to severe loss of impact strength at room temperatures after exposure in the range of 1000°F to 1400°F.
(6) Not to be used over 800°F.
(7) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	185	245	370	555	925	1545
1250	...	145	195	295	440	735	1220
1300	...	110	145	215	325	540	900

TABLE 2-3.9 RATINGS FOR GROUP 3.9 MATERIALS

Nominal Designation	Forgings	Castings	Plates
47Ni-22Cr-9Mo-18Fe	B 572 Gr. N06002 (1)(2)		B 435 Gr. N06002 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	680	905	1360	2040	3395	5660
400	200	600	795	1195	1795	2990	4980
500	170	575	770	1150	1730	2880	4800
600	140	560	745	1120	1680	2795	4660
650	125	560	745	1120	1680	2795	4660
700	110	560	745	1120	1680	2795	4660
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	205	275	410	620	1030	1715
1250	...	180	245	365	545	910	1515
1300	...	140	185	275	410	685	1145
1350	...	105	140	205	310	515	860
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

TABLE 2-3.10 RATINGS FOR GROUP 3.10 MATERIALS

Nominal Designation	Forgings	Castings	Plates
25Ni–46Fe–21Cr–5Mo	B 672 Gr. N08700 (1)(2)		B 599 Gr. N08700 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig							
Class Temp., °F	150	300	400	600	900	1500	2500
–20 to 100	275	720	960	1440	2160	3600	6000
200	260	720	960	1440	2160	3600	6000
300	230	680	905	1360	2040	3400	5670
400	200	640	855	1280	1920	3205	5340
500	170	610	815	1225	1835	3060	5100
600	140	595	790	1190	1780	2970	4950
650	125	570	760	1140	1705	2845	4740

TABLE 2-3.11 RATINGS FOR GROUP 3.11 MATERIALS

Nominal Designation	Forgings	Castings	Plates
44Fe-25Ni-21Cr-Mo	B 649 Gr. N08904 (1)(2)		B 625 Gr. N08904 (1)

NOTES:
(1) Use annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	245	640	855	1280	1920	3205	5340
200	230	600	800	1200	1805	3005	5010
300	210	545	725	1085	1630	2720	4530
400	190	495	660	995	1490	2485	4140
500	170	455	610	915	1370	2285	3810
600	140	430	575	865	1295	2160	3600
650	125	420	560	840	1265	2105	3510
700	110	410	545	820	1230	2050	3420

TABLE 2-3.12 RATINGS FOR GROUP 3.12 MATERIALS

Nominal Designation	Forgings	Castings	Plates
26Ni–43Fe–22Cr–5Mo	B 621 Gr. N08320 (1)(2)		B 620 Gr. N08320 (1)
47Ni–22Cr–20Fe–7Mo	B 581 Gr. N06985 (1)(2)		B 582 Gr. N06985 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	260	670	895	1345	2015	3360	5600
200	240	625	830	1245	1870	3115	5190
300	225	585	780	1175	1760	2935	4890
400	200	535	715	1075	1610	2680	4470
500	170	500	665	1000	1500	2500	4170
600	140	475	635	950	1425	2375	3960
650	125	465	620	930	1395	2320	3870
700	110	450	600	900	1350	2250	3750
750	95	445	590	885	1330	2215	3690
800	80	430	575	865	1295	2160	3600

TABLE 2-3.13 RATINGS FOR GROUP 3.13 MATERIALS

Nominal Designation	Forgings	Castings	Plates
49Ni-25Cr-18Fe-6Mo	B 581 Gr. N06975 (1)(2)		B 582 Gr. N06975 (1)
Ni-Fe-Cr-Mo-Low Cu	B 564 Gr. N08031 (3)		B 625 Gr. N08031 (3)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.
(3) Use annealed material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	705	940	1410	2115	3530	5880
300	230	660	885	1325	1985	3310	5520
400	200	635	845	1265	1900	3170	5280
500	170	595	790	1190	1780	2970	4950
600	140	560	750	1125	1685	2810	4680
650	125	555	735	1105	1660	2765	4605
700	110	545	725	1085	1630	2720	4530
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230

TABLE 2-3.14 RATINGS FOR GROUP 3.14 MATERIALS

Nominal Designation	Forgings	Castings	Plates
47Ni-22Cr-19Fe-6	MoB 581 Gr. N06007 (1)(2)		B 582 Gr. N06007 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	245	645	860	1290	1935	3230	5380
300	230	600	795	1195	1795	2990	4980
400	200	560	750	1125	1685	2810	4680
500	170	535	715	1070	1605	2675	4460
600	140	520	690	1035	1555	2590	4320
650	125	510	680	1020	1535	2555	4260
700	110	505	675	1015	1520	2530	4220
750	95	500	670	1005	1505	2510	4180
800	80	495	660	995	1490	2485	4140
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030

TABLE 2-3.15 RATINGS FOR GROUP 3.15 MATERIALS

Nominal Designation	Forgings	Castings	Plates
33Ni–42Fe–21Cr	B 564 Gr. N08810 (1)		B 409 Gr. N08810 (1)

NOTE:
(1) Use solution annealed material only.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	230	600	800	1200	1800	3000	5000
200	205	540	720	1080	1620	2700	4500
300	195	505	675	1015	1520	2530	4220
400	185	480	640	960	1440	2400	4000
500	170	455	610	910	1370	2280	3800
600	140	440	585	880	1320	2195	3660
650	125	425	565	850	1275	2125	3540
700	110	420	560	840	1260	2100	3500
750	95	415	550	825	1240	2065	3440
800	80	410	545	815	1225	2040	3400
850	65	400	530	795	1195	1990	3320
900	50	395	530	790	1190	1980	3300
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	325	435	650	975	1625	2710
1100	...	320	430	640	965	1605	2675
1150	...	275	365	550	825	1370	2285
1200	...	205	275	410	620	1030	1715
1250	...	180	245	365	545	910	1515
1300	...	140	185	275	410	685	1145
1350	...	105	140	205	310	515	860
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

TABLE 2-3.16 RATINGS FOR GROUP 3.16 MATERIALS

Nominal Designation	Forgings	Castings	Plates
35Ni–19Cr–1¼Si	B 511 Gr. N08330 (1)(2)		B 536 Gr. N08330 (1)

NOTES:
(1) Use solution annealed material only.
(2) The chemical composition, mechanical properties, heat treating requirements, and grain size requirements shall conform to the applicable ASTM specification. The manufacturing procedures, tolerances, tests, certification, and markings shall be in accordance with ASTM B 564.

WORKING PRESSURES BY CLASSES, psig

Class Temp., °F	150	300	400	600	900	1500	2500
−20 to 100	275	720	960	1440	2160	3600	6000
200	245	635	850	1270	1910	3180	5300
300	225	590	785	1175	1765	2940	4900
400	200	550	735	1105	1655	2760	4600
500	170	525	700	1050	1575	2630	4380
600	140	500	670	1005	1505	2510	4180
650	125	490	655	980	1470	2450	4080
700	110	480	645	965	1445	2410	4020
750	95	470	625	940	1410	2350	3920
800	80	465	620	925	1390	2315	3860
850	65	455	605	905	1360	2270	3780
900	50	445	590	885	1330	2215	3690
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	310	410	615	925	1545	2570
1100	...	240	320	480	720	1205	2005
1150	...	185	245	370	555	925	2545
1200	...	145	195	290	435	725	1210
1250	...	115	155	235	350	585	975
1300	...	95	130	190	285	480	795
1350	...	75	100	150	220	370	615
1400	...	55	75	110	165	280	465
1450	...	45	60	95	140	230	385
1500	...	35	45	70	100	170	285

TABLE 3 PERMISSIBLE IMPERFECTIONS IN FLANGE FACING FINISH FOR RAISED FACE AND LARGE MALE AND FEMALE FLANGES

NPS	Maximum Radial Projection of Imperfections Which Are No Deeper Than the Bottom of the Serrations, in.	Maximum Depth and Radial Projection of Imperfections Which Are Deeper Than the Bottom of the Serrations, in.
½	0.12	0.06
¾	0.12	0.06
1	0.12	0.06
1¼	0.12	0.06
1½	0.12	0.06
2	0.12	0.06
2½	0.12	0.06
3	0.18	0.06
3½	0.25	0.12
4	0.25	0.12
5	0.25	0.12
6	0.25	0.12
8	0.31	0.18
10	0.31	0.18
12	0.31	0.18
14	0.31	0.18
16	0.38	0.18
18	0.50	0.25
20	0.50	0.25
24	0.50	0.25

FLANGED FITTINGS

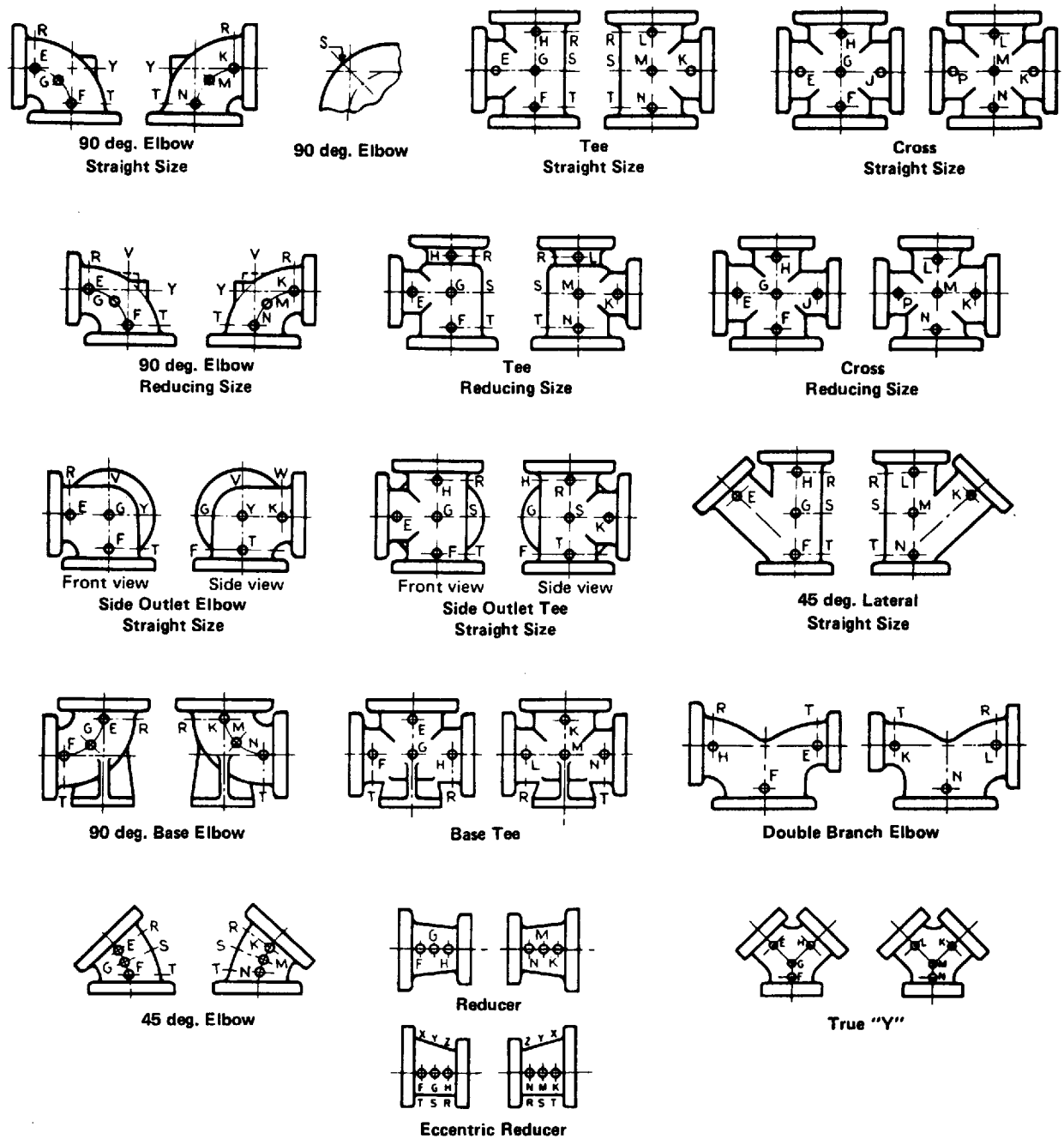


FIG. 1 METHOD OF DESIGNATING LOCATION OF AUXILIARY CONNECTIONS WHEN SPECIFIED[1]

NOTE:
(1) The above sketches show views of the same fitting and represent fittings with symmetrcial shapes, with the exception of the side outlet elbow and the side outlet tee (straight sizes). Sketches are illustrative only and do not imply required design (see para. 6.12).

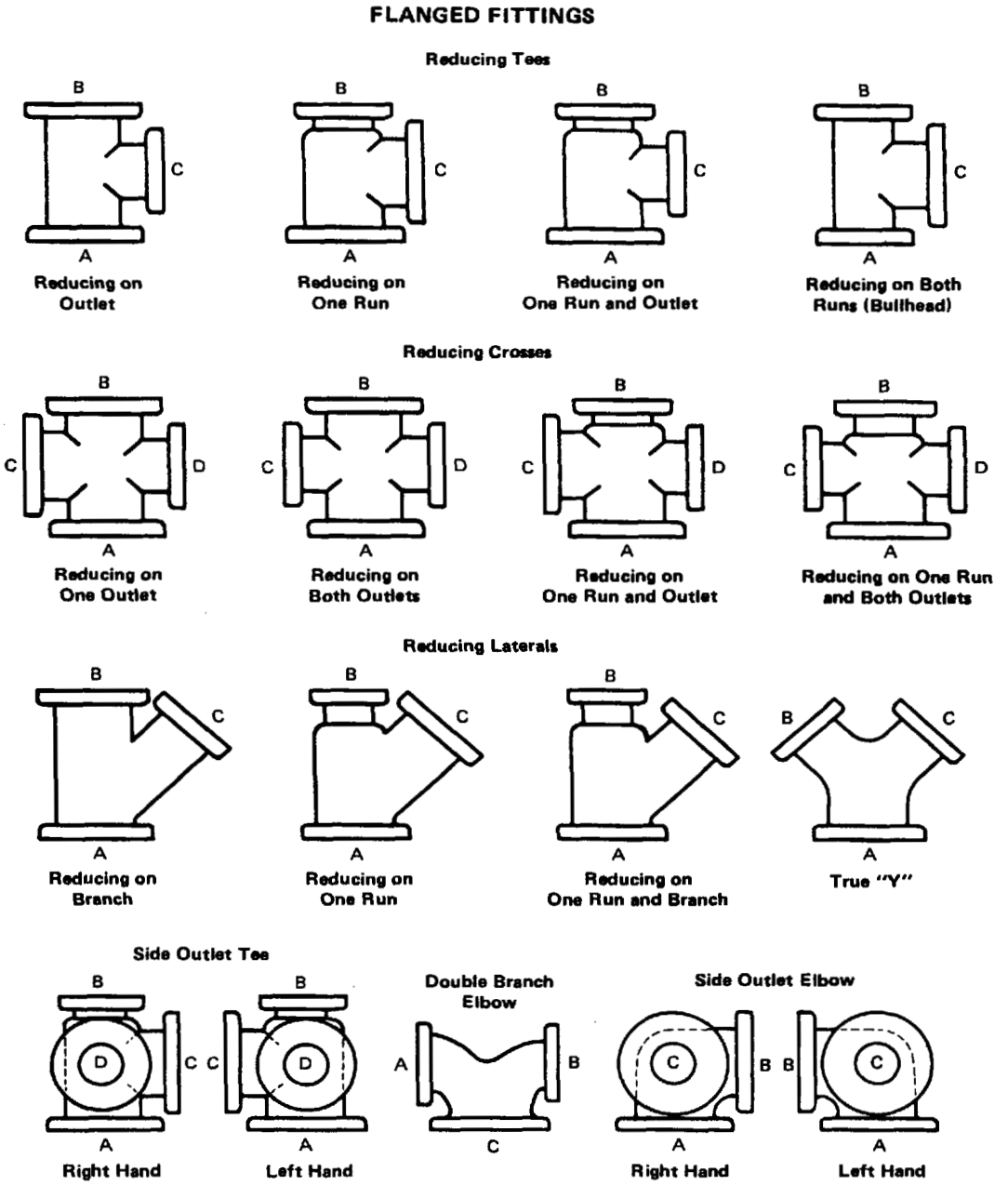


FIG. 2 METHOD OF DESIGNATING OUTLETS OF REDUCING FITTINGS IN SPECIFICATIONS[1-3]

NOTES:

(1) The largest opening establishes the basic size of a reducing fitting. The largest opening is named first, except that for bull head tees which are reducing on both runs and for double branch elbows where both branches are reducing, the outlet is the largest opening and named last in both cases.

(2) In designating the openings of reducing fittings, they should be read in the order indicated by the sequence of the letters A, B, C, and D. In designating the outlets of side outlet reducing fittings, the side outlet is named last, and in the case of the cross which is not shown, the side outlet is designated by the letter E.

(3) Sketches are illustrative only and do not imply required design (see para. 3.2).

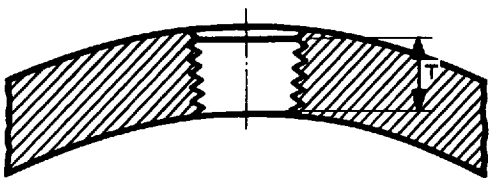


FIG. 3 THREAD LENGTH FOR CONNECTION TAPPING[1]

Connection size, NPS	3/8	1/2	3/4	1	1 1/4	1 1/2	2
Thread length T, in. [Note (2)]	0.41	0.53	0.55	0.68	0.71	0.72	0.76

NOTES:
(1) See paras. 6.12.1, 6.12.3, and 6.12.4.
(2) In no case shall the effective length of thread T be less than that shown in Table above. These lengths are equal to the effective thread length of external pipe threads (ASME B1.20.1).

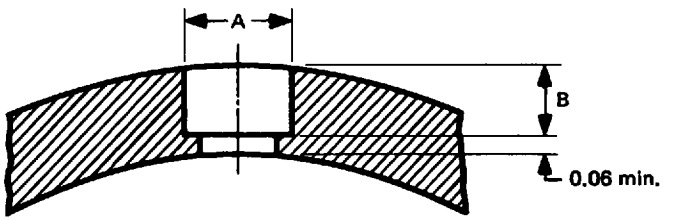


FIG. 4 SOCKET WELDING FOR CONNECTIONS[1]

Connection size, NPS	3/8	1/2	3/4	1	1 1/4	1 1/2	2
Minimum diameter of socket A, in.	0.69	0.86	1.06	1.33	1.68	1.92	2.41
Minimum depth B, in.	0.19	0.19	0.25	0.25	0.25	0.25	0.31

NOTE:
(1) See paras. 6.12.2.1, 6.12.3, and 6.12.4.

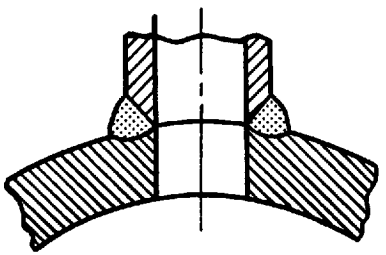


FIG. 5 BUTT WELDING FOR CONNECTIONS[1]

NOTE:
(1) See paras. 6.12.2.2, and 6.12.4.

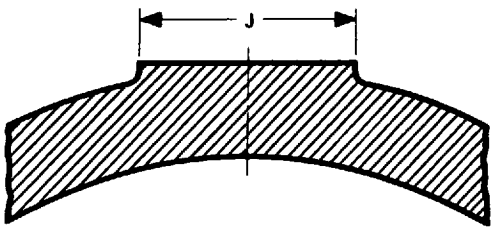


FIG. 6 BOSSES FOR CONNECTIONS[1]

Connection size, NPS	3/8	1/2	3/4	1	1 1/4	1 1/2	2
Minimum boss diameter J, in.	1.25	1.50	1.75	2.12	2.50	2.75	3.38

NOTE:
(1) See para. 6.12.3.

END FLANGE FACINGS
Flange Thickness and Center-to-End Dimensions
Classes 150 and 300

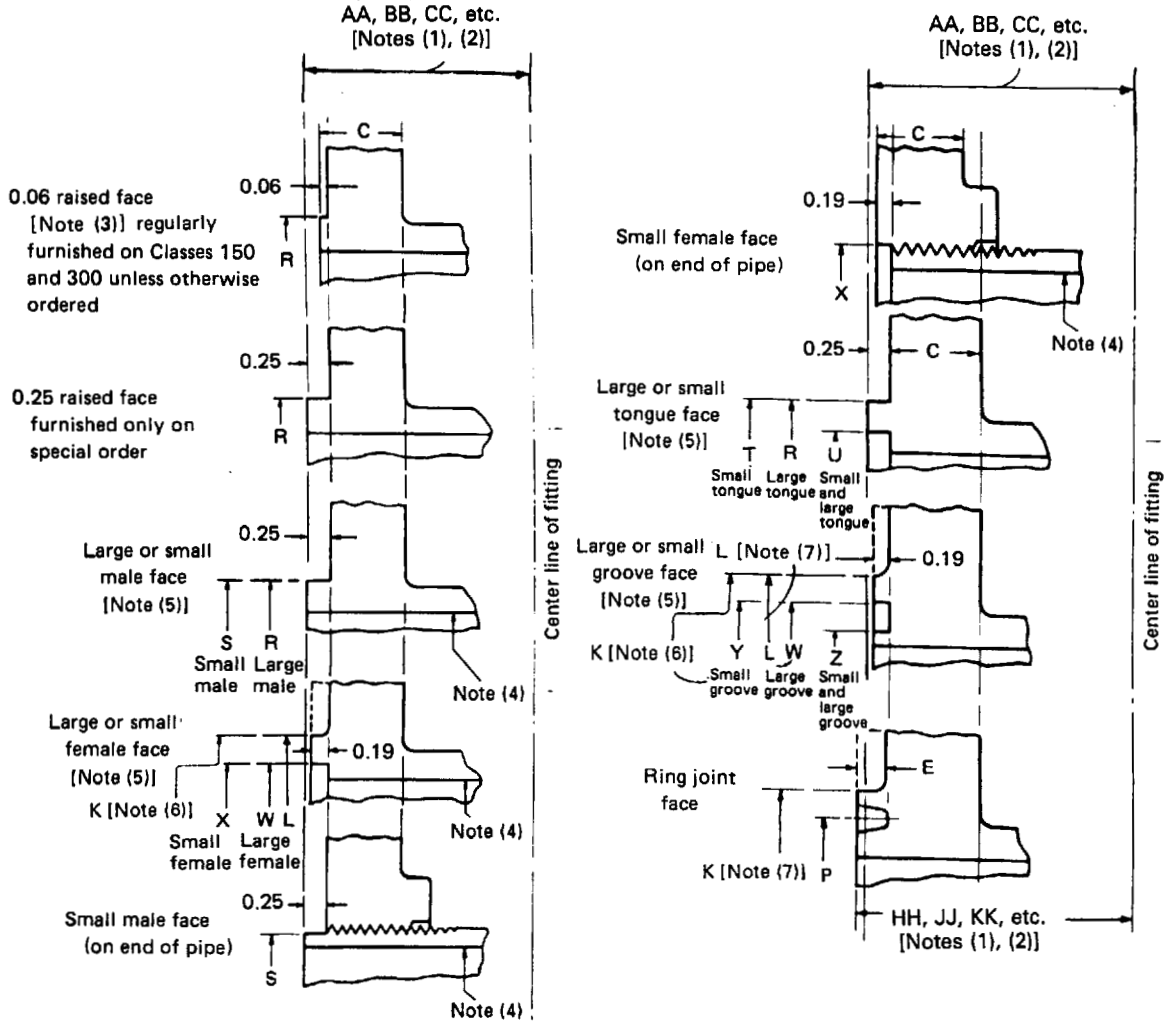


FIG. 7 END FLANGE FACINGS AND THEIR RELATIONSHIP TO FLANGE THICKNESS AND CENTER-TO-END AND END-TO-END DIMENSIONS[1,3]

(Figure continues on next page; Notes follow at end of Figure)

END FLANGE FACINGS
Flange Thickness and Center-to-End Dimensions
Classes 400 and Higher

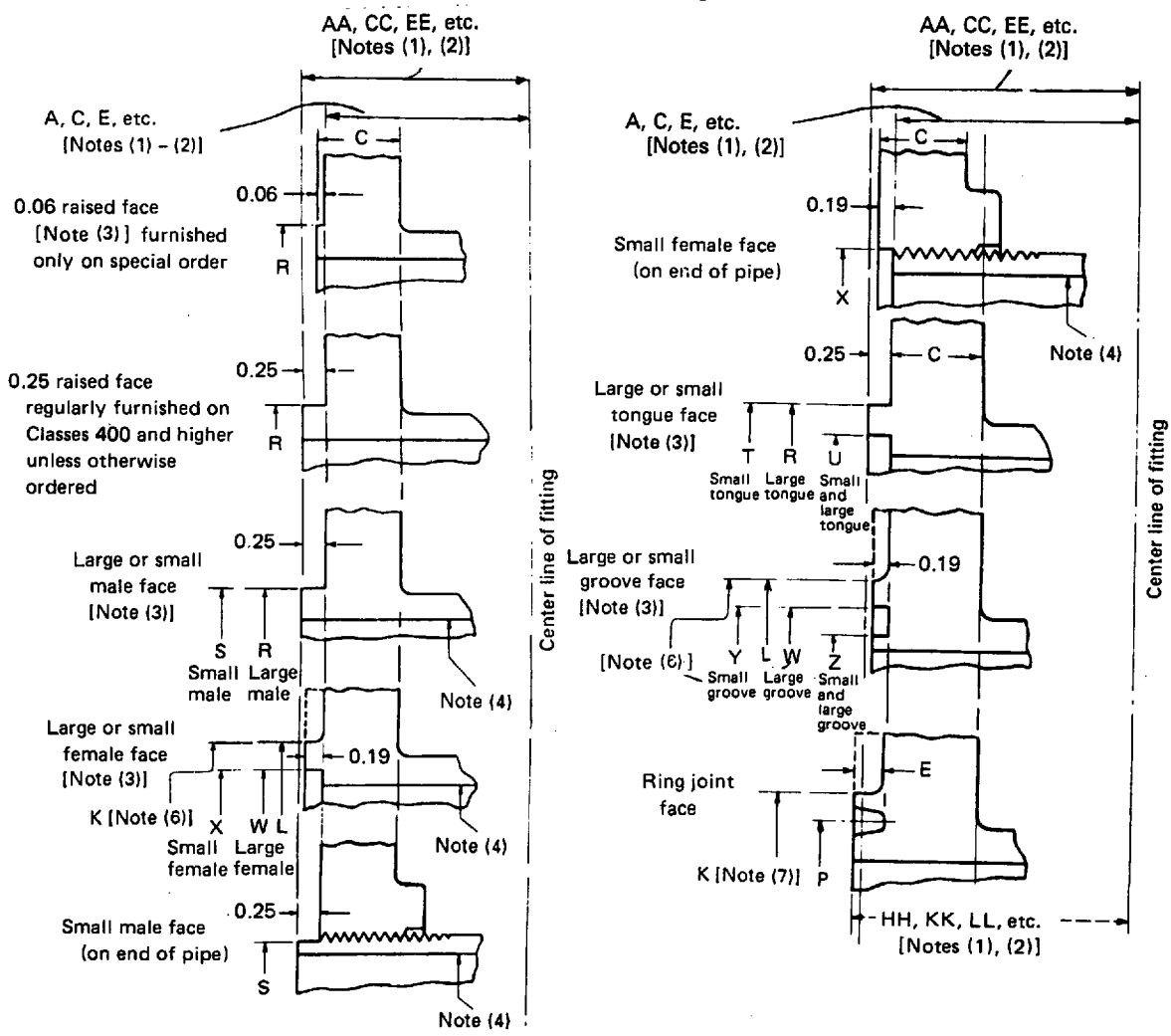


FIG. 7 END FLANGE FACINGS AND THEIR RELATIONSHIP TO FLANGE THICKNESS AND CENTER-TO-END AND END-TO-END DIMENSIONS[1,3] (CONT'D)

END FLANGE FACINGS
Flange Thickness and End-to-End Dimensions
Lapped Joints

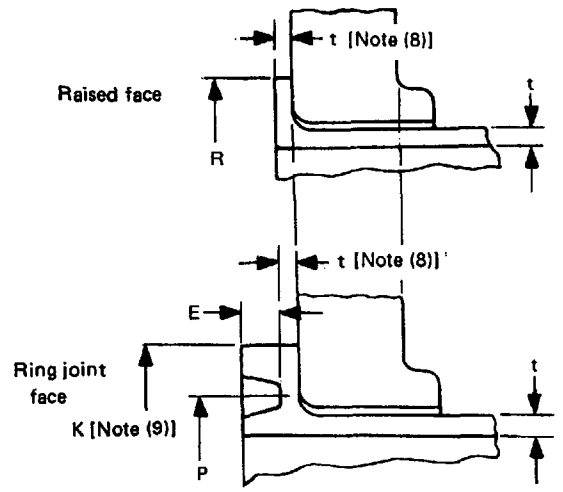


FIG. 7 END FLANGE FACINGS AND THEIR RELATIONSHIP TO FLANGE THICKNESS AND CENTER-TO-END AND END-TO-END DIMENSIONS[1,3] (CONT'D)

NOTES:
(1) See paras. 6.2 and 6.4.1.
(2) See Tables 10, 13, 16, 19, 22, 25, and 28.
(3) See Table 4 for dimensions of facings (other than ring joint) and Table 5 for ring joint facing.
(4) For small male and female joints, care should be taken in the use of these dimensions to insure that the inside diameter of fitting or pipe is small enough to permit sufficient bearing surface to prevent the crushing of the gasket. (See Table 4.) This applies particularly on lines where the joint is made on the end of the pipe. Threaded companion flanges for small male and female joints are furnished with plain face and are threaded with American National Standard Locknut Thread (NPSL).
(5) Large male and female faces and large tongue and groove are not applicable to Class 150 because of potential dimensional conflicts.
(6) See Table 4.
(7) See Table 5.
(8) See para. 6.4.2.
(9) See para. 6.4.2.5 and Table 5.

TABLE 4 DIMENSIONS OF FACINGS[1–4] (OTHER THAN RING JOINTS, ALL PRESSURE RATING CLASSES)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	1
	Outside Diameter					Outside Diameter				Height			Minimum [(6), (7)] Outside Diameter of Raised Portion		
Nominal Pipe Size	Raised Face Large Male and Large Tongue R	Small Male (5) S	Small Tongue T	Inside Diameter of Large and Small Tongue U	Inside Diameter of Small Male	Large Female and Large Groove W	Small Female (5) X	Small Groove Y	Inside Diameter of Large and Small Groove Z	Raised Face	Large and Small Male and Tongue	Depth of Groove or Female	Small Female and Groove K	Large Female and Groove L	Nominal Pipe Size
½	1.38	0.72	1.38	1.00		1.44	0.78	1.44	0.94				1.75	1.81	½
¾	1.69	0.94	1.69	1.31		1.75	1.00	1.75	1.25				2.06	2.12	¾
1	2.00	1.19	1.88	1.50		2.06	1.25	1.94	1.44				2.25	2.44	1
1¼	2.50	1.50	2.25	1.88		2.56	1.56	2.31	1.81				2.62	2.94	1¼
1½	2.88	1.75	2.50	2.12		2.94	1.81	2.56	2.06				2.88	3.31	1½
2	3.62	2.25	3.25	2.88		3.69	2.31	3.31	2.81				3.62	4.06	2
2½	4.12	2.69	3.75	3.38		4.19	2.75	3.81	3.31				4.12	4.56	2½
3	5.00	3.31	4.62	4.25		5.06	3.38	4.69	4.19				5.00	5.44	3
3½	5.50	3.81	5.12	4.75		5.56	3.88	5.19	4.69				5.50	5.94	3½
4	6.19	4.31	5.69	5.19		6.25	4.38	5.75	5.12				6.19	6.62	4
5	7.31	5.38	6.81	6.31		7.38	5.44	6.88	6.25				7.31	7.75	5
6	8.50	6.38	8.00	7.50		8.56	6.44	8.06	7.44				8.50	8.94	6
8	10.62	8.38	10.00	9.38		10.69	8.44	10.06	9.31				10.62	11.06	8
10	12.75	10.50	12.00	11.25		12.81	10.56	12.06	11.19				12.75	13.19	10
12	15.00	12.50	14.25	13.50		15.06	12.56	14.31	13.44				15.00	15.44	12
14	16.25	13.75	15.50	14.75		16.31	13.81	15.56	14.69				16.25	16.69	14
16	18.50	15.75	17.62	16.75		18.56	15.81	17.69	16.69				18.50	18.94	16
18	21.00	17.75	20.12	19.25		21.06	17.81	20.19	19.19				21.00	21.44	18
20	23.00	19.75	22.00	21.00		23.06	19.81	22.06	20.94				23.00	23.44	20
24	27.25	23.75	26.25	25.25		27.31	23.81	26.31	25.19				27.25	27.69	24

See Note (5) — Inside Diameter of Small Male

See Notes (4) and (8) — Raised Face

See Notes (4) and (9) — Large and Small Male and Tongue

See Notes (4) and (10) — Depth of Groove or Female

TABLE 4 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) For facing requirements for flanges and flanged fittings, see paras. 6.3 and 6.4 and Fig. 7.
(2) For facing requirements for lapped joints, see para. 6.4.2 and Fig.7.
(3) For facing tolerances, see para. 7.2.
(4) See para. 6.4.2 and Fig. 7 for thickness and outside diameters of laps.
(5) For small male and female joints, care should be taken in the use of these dimensions to insure that the inside diameter of fitting or pipe is small enough to permit sufficient bearing surface to prevent the crushing of the gasket. This applies particularly on lines where the joint is made on the end of the pipe. Inside diameter of fitting should match inside diamter of pipe as specified by purchaser. Threaded companion flanges for small male and female joints are furnished with plain face and are threaded with American National Standard Locknut Thread (NPSL).
(6) Raised portion of full face may be furnished unless otherwise specified on order.
(7) Large male and female faces and large tongue and groove are not applicable to Class 150 because of potential dimensional conflicts.
(8) Height of raised face is either 0.06 in. or 0.25 in. See para. 6.4.1.
(9) Height of large and small male and tongue is 0.25 in.
(10) Depth of groove or female is 0.19 in.

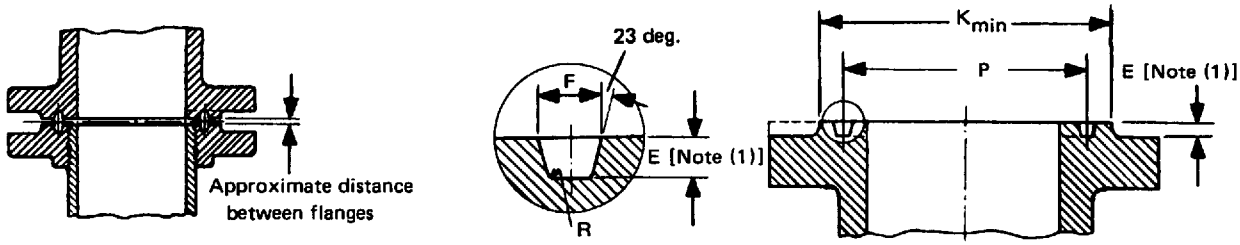
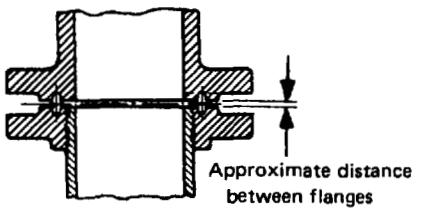
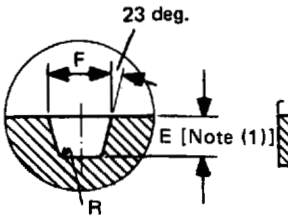


TABLE 5 DIMENSIONS OF RING JOINT FACINGS[2-4] ALL PRESSURE RATING CLASSES)

1	2	3	4	5	6	7	8	9	10	11	12
Nominal Pipe Size								Groove Dimensions			
150	300	400 (5)	600	900 (6)	1500	2500	Groove Number	Pitch Diameter P	Depth E(1)	Width F	Radius at Bottom R
...	1/2	...	1/2	...	...	...	R11	1.344	0.219	0.281	0.03
...	...	...	...	...	1/2	...	12	1.562	0.250	0.344	0.03
...	3/4	...	3/4	...	...	1/2	13	1.688	0.250	0.344	0.03
...	...	...	...	...	3/4	...	14	1.750	0.250	0.344	0.03
1	...	...	...	...	...	...	15	1.875	0.250	0.344	0.03
...	1	...	1	...	1	3/4	16	2.000	0.250	0.344	0.03
1 1/4	...	...	...	...	...	...	17	2.250	0.250	0.344	0.03
...	1 1/4	...	1 1/4	...	1 1/4	1	18	2.375	0.250	0.344	0.03
1 1/2	...	...	...	...	...	...	19	2.562	0.250	0.344	0.03
...	1 1/2	...	1 1/2	...	1 1/2	...	20	2.688	0.250	0.344	0.03
...	...	...	...	...	...	1 1/4	21	2.844	0.312	0.469	0.03
2	...	...	...	...	...	...	22	3.250	0.250	0.344	0.03
...	2	...	2	...	...	1 1/2	23	3.250	0.312	0.469	0.03
...	...	...	...	...	2	...	24	3.750	0.312	0.469	0.03
2 1/2	...	...	...	...	...	...	25	4.000	0.250	0.344	0.03
...	2 1/2	...	2 1/2	...	...	2	26	4.000	0.312	0.469	0.03
...	...	...	...	...	2 1/2	...	27	4.250	0.312	0.469	0.03
...	...	...	...	...	...	2 1/2	28	4.375	0.375	0.531	0.06
3	...	...	...	...	...	...	29	4.500	0.250	0.344	0.03
...	(7)	...	(7)	...	...	...	30	4.625	0.312	0.469	0.03
...	3 (7)	...	3 (7)	3	...	...	31	4.875	0.312	0.469	0.03
...	...	...	...	...	...	3	32	5.000	0.375	0.531	0.06
3 1/2	...	...	...	...	...	...	33	5.188	0.250	0.344	0.03
...	3 1/2	...	3 1/2	...	...	...	34	5.188	0.312	0.469	0.03
...	...	...	...	...	3	...	35	5.375	0.312	0.469	0.03
4	...	...	...	...	...	...	36	5.875	0.250	0.344	0.03
...	4	4	4	4	...	...	37	5.875	0.312	0.469	0.03
...	...	...	...	...	...	4	38	6.188	0.438	0.656	0.06
...	...	...	...	...	4	...	39	6.375	0.312	0.469	0.03
5	...	...	...	...	...	...	40	6.750	0.250	0.344	0.03
...	5	5	5	5	...	...	41	7.125	0.312	0.469	0.03
...	...	...	...	...	...	5	42	7.500	0.500	0.781	0.06
6	...	...	...	...	...	...	43	7.625	0.250	0.344	0.03
...	...	...	...	...	5	...	44	7.625	0.312	0.469	0.03
...	6	6	6	6	...	...	45	8.312	0.312	0.469	0.03





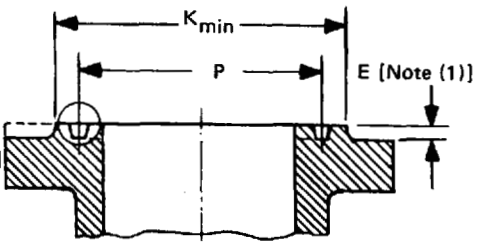


TABLE 5 DIMENSIONS OF RING JOINT FACINGS[2-4] (ALL PRESSURE RATING CLASSES) (CONT'D)

13	14	15	16	17	18	19	20	21	22	23	24
Diameter of Raised Portion K					Approximate Distance Between Flanges						
150	300, 400, 600	900	1500	2500	150	300	400	600	900	1500	2500
...	2.00	...	...	...	...	0.12	...	0.12	...	...	...
...	...	...	2.38	...	...	...	...	...	...	0.16	...
...	2.50	...	...	2.56	...	0.16	...	0.16	...	...	0.16
...	...	...	2.62	...	...	...	...	...	...	0.16	...
2.50	...	...	...	...	0.16	...	...	...	...	...	...
...	2.75	...	2.81	2.88	...	0.16	...	0.16	...	0.16	0.16
2.88	...	...	...	...	0.16	...	...	...	...	...	...
...	3.12	...	3.19	3.25	...	0.16	...	0.16	...	0.16	0.16
3.25	...	...	...	...	0.16	...	...	...	...	...	...
...	3.56	...	3.62	...	...	0.16	...	0.16	...	0.16	...
...	...	...	...	4.00	...	...	...	...	...	...	0.12
4.00	...	...	...	...	0.16	...	...	...	...	...	...
...	4.25	...	...	4.50	...	0.22	...	0.19	...	...	0.12
...	...	...	4.88	...	...	...	...	...	...	0.12	...
4.75	...	...	...	...	0.16	...	...	...	...	...	...
...	5.00	...	...	5.25	...	0.22	...	0.19	...	...	0.12
...	...	...	5.38	...	...	...	...	...	...	0.12	...
...	...	...	...	5.88	...	...	...	...	...	...	0.12
5.25	...	...	...	...	0.16	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...
...	5.75	6.12	...	...	...	0.22	...	0.19	0.16	...	...
...	...	...	...	6.62	...	...	...	...	...	...	0.12
6.06	...	...	...	...	0.16	...	...	...	...	...	...
...	6.25	...	...	...	...	0.22	...	0.19	...	...	...
...	...	...	6.62	...	...	...	...	...	...	0.12	...
6.75	...	...	...	...	0.16	...	...	...	...	...	...
...	6.88	7.12	...	...	...	0.22	0.22	0.19	0.16	...	...
...	...	...	...	8.00	...	...	...	...	...	...	0.16
...	...	...	7.62	...	...	...	...	...	...	0.12	...
7.62	...	...	...	...	0.16	...	...	...	...	...	...
...	8.25	8.50	...	...	...	0.22	0.22	0.19	0.16	...	...
...	...	...	...	9.50	...	...	...	...	...	...	0.16
8.62	...	...	...	...	0.16	...	...	...	...	...	...
...	...	...	9.00	...	...	...	...	...	...	0.12	...
...	9.50	9.50	...	...	...	0.22	0.22	0.19	0.16	...	...

(Table 5 continues on next page; Notes and tolerances follow at end of Table)

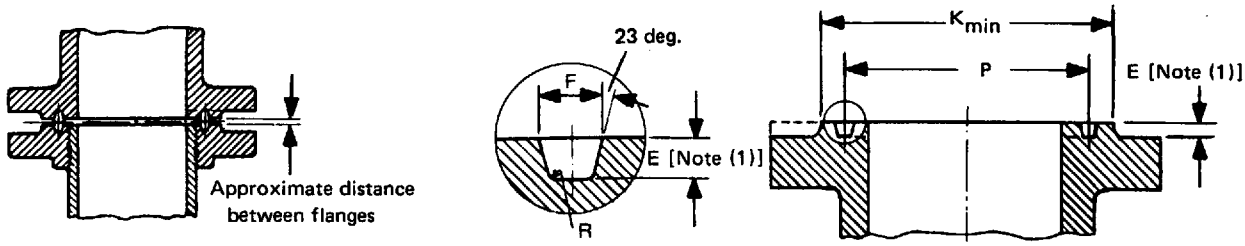
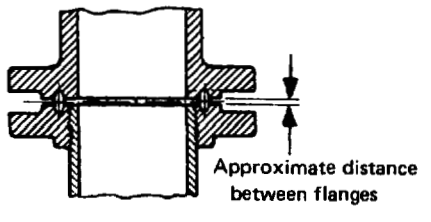
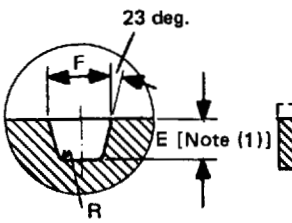


TABLE 5 DIMENSIONS OF RING JOINT FACINGS[2–4] (ALL PRESSURE RATING CLASSES)

1	2	3	4	5	6	7	8	9	10	11	12
Nominal Pipe Size								Groove Dimensions			
150	300	400 (5)	600	900 (6)	1500	2500	Groove Number	Pitch Diameter P	Depth E(1)	Width F	Radius at Bottom R
...	...	...	...	...	6	...	46	8.312	0.375	0.531	0.06
...	...	...	...	...	...	6	47	9.000	0.500	0.781	0.06
8	...	...	...	...	...	...	48	9.750	0.250	0.344	0.03
...	8	8	8	8	...	...	49	10.625	0.312	0.469	0.03
...	...	...	...	...	8	...	50	10.625	0.438	0.656	0.06
...	...	...	...	...	...	8	51	11.000	0.562	0.906	0.06
10	...	...	...	...	...	...	52	12.000	0.250	0.344	0.03
...	10	10	10	10	...	...	53	12.750	0.312	0.469	0.03
...	...	...	...	...	10	...	54	12.750	0.438	0.656	0.06
...	...	...	...	...	...	10	55	13.500	0.688	1.188	0.09
12	...	...	...	...	...	...	56	15.000	0.250	0.344	0.03
...	12	12	12	12	...	...	57	15.000	0.312	0.469	0.03
...	...	...	...	...	12	...	58	15.000	0.562	0.906	0.06
14	...	...	...	...	...	...	59	15.625	0.250	0.344	0.03
...	...	...	...	...	...	12	60	16.000	0.688	1.312	0.09
...	14	14	14	...	...	...	61	16.500	0.312	0.469	0.03
...	...	...	...	14	...	...	62	16.500	0.438	0.656	0.06
...	...	...	...	...	14	...	63	16.500	0.625	1.062	0.09
16	...	...	...	...	...	...	64	17.875	0.250	0.344	0.03
...	16	16	16	...	...	...	65	18.500	0.312	0.469	0.03
...	...	...	...	16	...	...	66	18.500	0.438	0.656	0.06
...	...	...	...	...	16	...	67	18.500	0.688	1.188	0.09
18	...	...	...	...	...	...	68	20.375	0.250	0.344	0.03
...	18	18	18	...	...	...	69	21.000	0.312	0.469	0.03
...	...	...	...	18	...	...	70	21.000	0.500	0.781	0.06
...	...	...	...	...	18	...	71	21.000	0.688	1.188	0.09
20	...	...	...	...	...	...	72	22.000	0.250	0.344	0.03
...	20	20	20	...	...	...	73	23.000	0.375	0.531	0.06
...	...	...	...	20	...	...	74	23.000	0.500	0.781	0.06
...	...	...	...	...	20	...	75	23.000	0.688	1.312	0.09
24	...	...	...	...	...	...	76	26.500	0.250	0.344	0.03
...	24	24	24	...	...	...	77	27.250	0.438	0.656	0.06
...	...	...	...	24	...	...	78	27.250	0.625	1.062	0.09
...	...	...	...	...	24	...	79	27.250	0.812	1.438	0.09





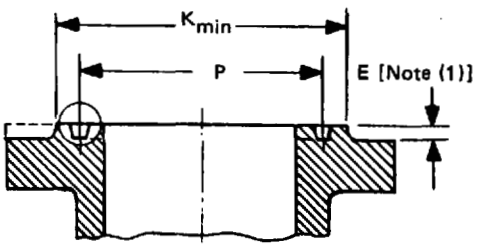


TABLE 5 DIMENSIONS OF RING JOINT FACINGS[2-4] (ALL PRESSURE RATING CLASSES) (CONT'D)

13	14	15	16	17	18	19	20	21	22	23	24
Diameter of Raised Portion K					Approximate Distance Between Flanges						
150	300, 400, 600	900	1500	2500	150	300	400	600	900	1500	2500
...	...	...	9.75	...	...	...	...	...	...	0.12	
...	...	...	...	11.00	...	...	...	...	...	...	0.16
10.75	...	...	...	...	0.16	...	...	...	...	...	...
...	11.88	12.12	...	...	...	0.22	0.22	0.19	0.16	...	...
...	...	...	12.50	...	...	...	...	...	...	0.16	...
...	...	...	...	13.38	...	...	...	...	...	...	0.19
13.00	...	...	...	...	0.16	...	...	...	...	...	...
...	14.00	14.25	...	...	...	0.22	0.22	0.19	0.16	...	...
...	...	...	14.62	...	...	...	...	...	...	0.16	...
...	...	...	...	16.75	...	...	...	...	...	...	0.25
16.00	...	...	...	...	0.16	...	...	...	...	...	...
...	16.25	16.50	...	...	...	0.22	0.22	0.19	0.16	...	...
...	...	...	17.25	...	...	...	...	...	...	0.19	...
16.75	...	...	...	...	0.12	...	...	...	...	...	...
...	...	...	...	19.50	...	...	...	...	...	...	0.31
...	18.00	...	...	...	...	0.22	0.22	0.19	...	...	...
...	...	18.38	...	...	...	...	...	...	0.16	...	...
...	...	...	19.25	...	...	...	...	...	...	0.22	...
19.00	...	...	...	...	0.12	...	...	...	...	...	...
...	20.00	...	...	...	...	0.22	0.22	0.19	...	...	...
...	...	20.62	...	...	...	...	...	...	0.16	...	...
...	...	...	21.50	...	...	...	...	...	...	0.31	...
21.50	...	...	...	...	0.12	...	...	...	...	...	...
...	22.62	...	...	...	...	0.22	0.22	0.19	...	...	...
...	...	23.38	...	...	...	...	...	...	0.19	...	...
...	...	...	24.12	...	...	...	...	...	...	0.31	...
23.50	...	...	...	...	0.12	...	...	...	...	...	...
...	25.00	...	...	...	...	0.22	0.22	0.19	...	...	...
...	...	25.50	...	...	...	...	...	...	0.19	...	...
...	...	...	26.50	...	...	...	...	...	...	0.38	...
28.00	...	...	...	...	0.12	...	...	...	...	...	...
...	29.50	...	...	...	...	0.25	0.25	0.22	...	...	...
...	...	30.38	...	...	...	...	...	...	0.22	...	...
...	...	...	31.25	...	...	...	...	...	...	0.44	...

(Notes and tolerances follow on next page)

TABLE 5 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Height of raised portion is equal to the depth of groove dimension E, but is not subjected to the tolerances for E. Former full-face contour may be used.
(2) For facing requirements for flanges and flanged fittings, see para. 6.4.1 and Fig. 7.
(3) For facing requirements for lapped joints, see para. 6.4.2 and Fig. 7.
(4) See para. 4.1.7 for marking requirements.
(5) Use Class 600 in sizes NPS ½ to NPS 3½ for Class 400.
(6) Use Class 1500 in sizes NPS ½ to NPS 2½ for Class 900.
(7) For ring joints with lapped flanges in Classes 300 and 600, ring and groove number R30 are used instead of R31.

TOLERANCES:

E	(depth) +0.016, −0
F	(width) ±0.008
P	(pitch diameter) ±0.005
R	(radius at bottom)
	$R \leq 0.06$ +0.03, −0
	$R > 0.06$ ±0.03
23 deg.	(angle) ± ½ deg.

WELDING ENDS
(Welding Neck Flanges, No Backing Rings)

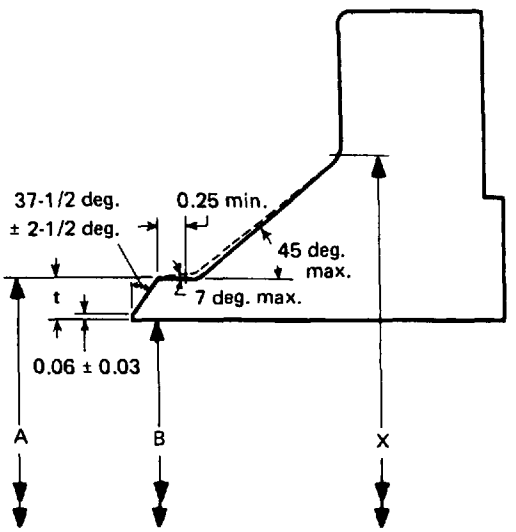


FIG. 8 BEVEL FOR WALL THICKNESSES t FROM 0.19 in. TO 0.88 in., INCLUSIVE[1-3]

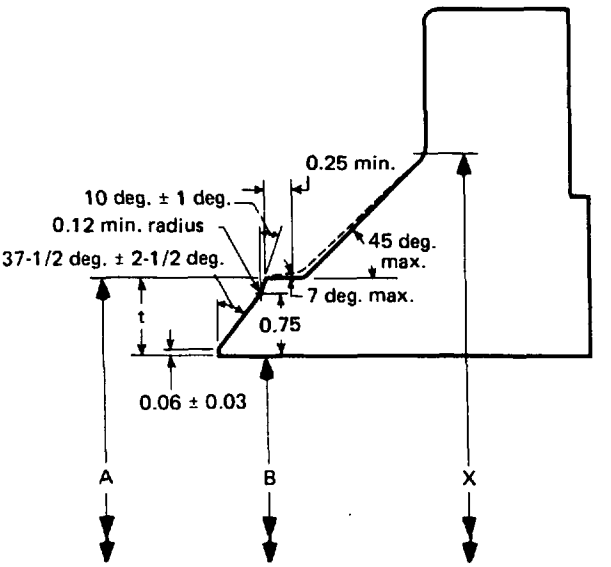


FIG. 9 BEVEL FOR WALL THICKNESSES t GREATER THAN 0.88 in.[1-3]

A = nominal outside diameter of pipe, in.
B = nominal inside diameter of pipe, in.
t = nominal wall thickness of pipe, in.

NOTES:
(1) See paras. 6.7, 6.8, and 7.4 for details and tolerances.
(2) See Figs. 10 and 11 for additional details of welding ends.
(3) When the thickness of the hub at the bevel is greater than that of the pipe to which the flange is joined and the additional thickness is provided on the outside diameter, a taper weld having a slope not exceeding 1 to 3 may be employed or, alternatively, the greater outside diameter may be tapered, at the same maximum slope or less, from a point on the welding bevel equal to the outside diameter of the mating pipe. Similarly, when the greater thickness is provided on the inside of the flange, it shall be taper-bored from the welding end at a slope not exceeding 1 to 3.

When flanges covered by this Standard are intended for services with light wall, higher strength pipe, the thickness of the hub at the bevel may be greater than that of the pipe to which the flange is joined. Under these conditions a single taper hub may be provided, and the outside diameter of the hub at the base (dimension X) may also be modified.

The additional thickness may be provided on either inside or outside or partially on each side, but the total additional thickness shall not exceed one-half times the nominal wall thickness of intended mating pipe. See Figs. 12, 13, and 14.

WELDING ENDS
(Welding Neck Flanges With Backing Rings)

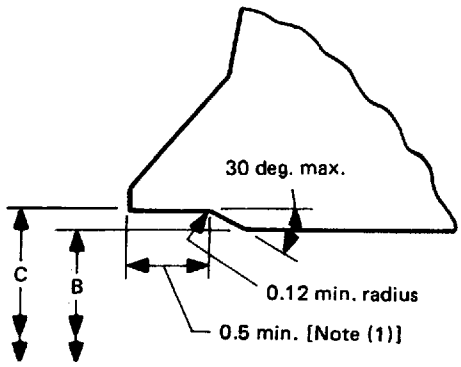


FIG. 10 INSIDE CONTOUR FOR USE WITH RECTANGULAR BACKING RING[1–4]

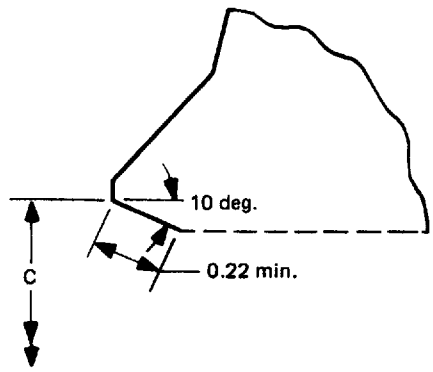


FIG. 11 INSIDE CONTOUR FOR USE WITH TAPER BACKING RING[1–4]

A = nominal outside diameter of welding end, in.
B = nominal inside diameter of pipe, in.
= A − 2t
C = A − 0.031 − 1.75t − 0.010 in.
t = nominal wall thickness of pipe, in.
0.031 = minus tolerance on outside diameter of pipe, in., to ASTM A 106, etc.
1.75t = 87½% of nominal wall (permitted by ASTM A 106, etc.) multiplied by two to convert into terms of diameter
0.010 = plus tolerance on diameter C, in. See para. 7.5.3.

NOTES:
(1) 0.5 in. depth based on use of 0.75 in. wide backing ring.
(2) See paras. 6.7, 6.8, and 7.5 for details and tolerances.
(3) See Figs. 8 and 9 for welding end details of welding neck flanges.
(4) For dimensions, see Table 6.

WELDING ENDS
(Welding Neck Flanges)
ADDITIONAL THICKNESS FOR WELDING TO HIGHER STRENGTH PIPE

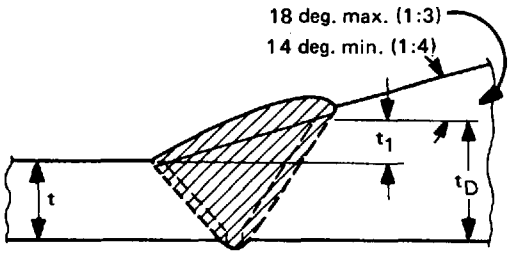


FIG. 12 BEVEL FOR OUTSIDE THICKNESS[1-4]

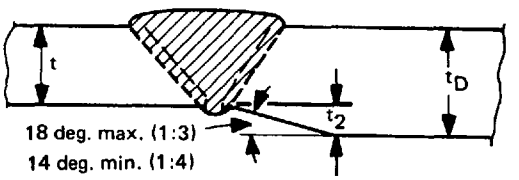


FIG. 13 BEVEL FOR INSIDE THICKNESS[1-3]

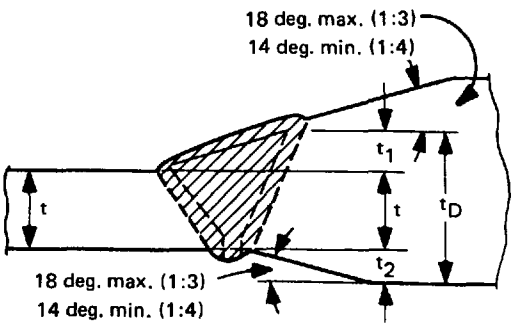


FIG. 14 BEVEL FOR COMBINED THICKNESS[1-4]

NOTES:
(1) When the materials joined have equal minimum specified yield strength, there shall be no restriction on the minimum slope.
(2) Neither t_1, t_2, nor their sum $t_1 + t_2$ shall exceed 0.5t.
(3) When the minimum specified yield strengths of the sections to be joined are unequal, the value of t_D shall at least equal times the ratio of minimum specified yield strength of the pipe to minimum specified yield strength of the flange.
(4) Welding shall be in accordance with the applicable code.

TABLE 6 DIMENSIONS OF WELDING ENDS
(See Figs. 8 Through 14, Inclusive)

1	2	3	4	5	6
Nominal Pipe Size	Wall Thickness (1) or Schedule	A (2)	B (2)	C [(2)–(4)]	t [(2),(4)]
	40		2.469	2.479	0.203
2½	80	2.88	2.323	2.351	0.276
	160		2.125	2.178	0.375
	XXS		1.771	1.868	0.552
	40		3.068	3.081	0.216
3	80	3.50	2.900	2.934	0.300
	160		2.624	2.692	0.438
	XXS		2.300	2.409	0.600
3½	40	4.00	3.548	3.564	0.226
	80		3.364	3.402	0.316
	40		4.026	4.044	0.237
	80		3.826	3.869	0.337
4	120	4.50	3.624	3.692	0.438
	160		3.438	3.530	0.531
	XXS		3.152	3.279	0.674
	40		5.047	5.070	0.258
	80		4.813	4.866	0.375
5	120	5.56	4.563	4.647	0.500
	160		4.313	4.428	0.625
	XXS		4.063	4.209	0.750
	40		6.065	6.094	0.280
	80		5.761	5.828	0.432
6	120	6.62	5.501	5.600	0.562
	160		5.189	5.327	0.718
	XXS		4.897	5.072	0.864
	40		7.981	8.020	0.322
	60		7.813	7.873	0.406
	80		7.625	7.709	0.500
8	100	8.62	7.439	7.546	0.593
	120		7.189	7.327	0.718
	140		7.001	7.163	0.812
	XXS		6.875	7.053	0.875
	160		6.813	6.998	0.906
	40		10.020	10.070	0.365
	60		9.750	9.834	0.500
	80		9.564	9.671	0.593
10	100	10.75	9.314	9.452	0.718
	120		9.064	9.234	0.843
	140		8.750	8.959	1.000
	160		8.500	8.740	1.125
	STD		12.000	12.053	0.375
	40		11.938	11.999	0.406
	XS		11.750	11.834	0.500
	60		11.626	11.725	0.562
12	80	12.75	11.376	11.507	0.687
	100		11.064	11.234	0.843
	120		10.750	10.959	1.000
	140		10.500	10.740	1.125
	160		10.126	10.413	1.312

TABLE 6 DIMENSIONS OF WELDING ENDS (CONT'D)
(See Figs. 8 Through 14, Inclusive)

1	2	3	4	5	6
Nominal Pipe Size	Wall Thickness (1) or Schedule	A (2)	B (2)	C [(2)–(4)]	t [(2),(4)]
	STD		13.250	13.303	0.375
	40		13.124	13.192	0.438
	XS		13.000	13.064	0.500
	60		12.814	12.921	0.593
14	80	14.00	12.500	12.646	0.750
	100		12.126	12.319	0.937
	120		11.814	12.046	1.093
	140		11.500	11.771	1.250
	160		11.188	11.498	1.406
	STD		15.250	15.303	0.375
	40		15.000	15.084	0.500
	60		14.688	14.811	0.656
	80		14.314	14.484	0.843
16	100	16.00	13.938	14.155	1.031
	120		13.564	13.827	1.218
	140		13.124	13.442	1.438
	160		12.814	13.171	1.593
	STD		17.250	17.303	0.375
	XS		17.000	17.084	0.500
	40		16.876	16.975	0.562
	60		16.500	16.646	0.750
18	80	18.00	16.126	16.319	0.937
	100		15.688	15.936	1.156
	120		16.250	15.553	1.375
	140		14.876	15.225	1.562
	160		14.438	14.842	1.781
	STD		19.250	19.303	0.375
	XS		19.000	19.084	0.500
	40		18.814	18.921	0.593
	60		18.376	18.538	0.812
20	80	20.00	17.938	18.155	1.031
	100		17.438	17.717	1.281
	120		17.000	17.334	1.500
	140		16.500	16.896	1.750
	160		16.064	16.515	1.968
	STD		23.250	23.303	0.375
	XS		23.000	23.084	0.500
	30		22.876	22.975	0.562
	40		22.626	22.757	0.687
	60		22.064	22.265	0.968
24	80	24.00	21.564	21.827	1.218
	100		20.938	21.280	1.531
	120		20.376	20.788	1.812
	140		19.876	20.350	2.062
	160		19.314	19.859	2.343

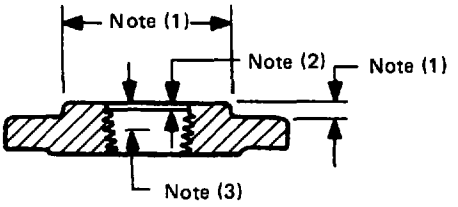
(Notes follow on next page)

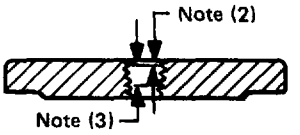
TABLE 6 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Designations per Annexes B and C and ASME B36.10:
STD = standard wall thickness
XS = extra-strong wall thickness
XXS = double extra-strong wall thickness
(2) For tolerances, see para. 7.4.
(3) There is no fixed relation between ASME B16.5 pressure classes and pipe schedules.
(4) When the wall thickness is less than 0.562 in., it may be necessary to provide additional material by weld deposition in order to be able to machine to the dimension C.

REDUCING THREADED AND SLIP-ON PIPE FLANGES





Blind Flange

TABLE 7 REDUCING THREADED AND SLIP-ON FLANGES FOR CLASSES 150 TO 2500

1	2	3	4	5	6
Nominal Pipe Size (4)	Smallest Size (1) of Reducing Outlet Requiring Hub Flanges	Nominal Pip Size (4)	Smallest Size (1) of Reducing Outlet Requiring Hub Flanges	Nominal Pipe Size (4)	Smallest Size (1) of Reducing Outlet Requiring Hub Flanges
1	½	3½	1½	12	3½
1¼	½	4	1½	14	3½
1½	½	5	1½	16	4
2	1	6	2½	18	4
2½	1¼	8	3	20	4
3	1¼	10	3½	24	4

NOTES:

(1) The hub dimensions shall be at least as large as those of the standard flanges of the size to which the reduction is being made, except flanges reducing to a size smaller than those of Columns 2, 4, and 6 may be made from blind flanges. See Example 2.

(2) Class 150 flanges do not have a counterbore. Class 300 and higher pressure flanges will have depth of counterbore q of 0.25 in. for NPS 2 and smaller tapping and 0.38 in. for NPS 2½ and larger. The diameter Q of counterbore is the same as that given in the tables of threaded flanges for the corresponding tapping.

(3) Minimum length of effective threads shall be at least equal to dimension T of the corresponding pressure class threaded flange as shown in tables but does not necessarily extend for the face of the flange. For thread of threaded flanges, see para. 6.9.

(4) For method of designating reducing threaded flanges, see para. 3.3 and Examples below.

EXAMPLES:

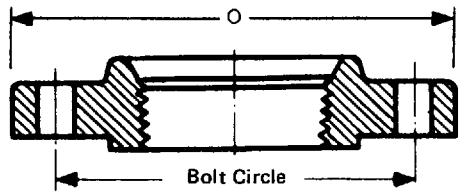
(1) The size designation is NPS 6 × 2½ — Class 300 reducing threaded flange. This flange has the following dimensions:

NPS 2½ = taper pipe thread tapping (ASME B1.20.1)
12.5 in. = diameter of regular NPS 6 Class 300 threaded flange
1.44 in. = thickness of regular NPS 6 Class 300 threaded flange
7.0 in. = diameter of hub for regular NPS 5 Class 300 threaded flange
0.62 in. = height of hub for regular NPS 5 Class 300 thread flange

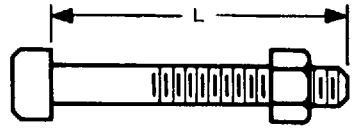
Other dimensions the same as for regular NPS 6 Class 300 threaded flange, Table 12.

(2) The size designation is NPS 6 × 2 — Class 300 reducing threaded flange. Use regular NPS 6 Class 300 blind flange tapped with NPS 2 taper pipe thread (ASME B1.20.1).

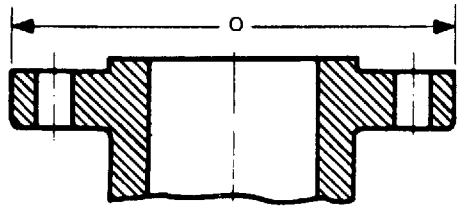
CLASS 150 PIPE FLANGES, AND FLANGED FITTINGS



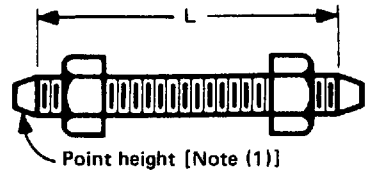
Flange



Machine Bolt With Nut



Flanged Fitting



Stud Bolt With Nuts

TABLE 8 TEMPLATES FOR DRILLING CLASS 150 FLANGES[2]

1	2	3	4	5	6	7	8	9
		Drilling [(3),(4)]				Length of Bolts (5) L		
						Stud Bolts (1)		Machine Bolts
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.06 in. Raised Face	Ring Joint	0.06 in. Raised Face
1/2	3.50	2.38	0.62	4	1/2	2.25	...	2.00
3/4	3.88	2.75	0.62	4	1/2	2.50	...	2.00
1	4.25	3.12	0.62	4	1/2	2.50	3.00	2.25
1 1/4	4.62	3.50	0.62	4	1/2	2.75	3.25	2.25
1 1/2	5.00	3.88	0.62	4	1/2	2.75	3.25	2.50
2	6.00	4.75	0.75	4	5/8	3.25	3.75	2.75
2 1/2	7.00	5.50	0.75	4	5/8	3.50	4.00	3.00
3	7.50	6.00	0.75	4	5/8	3.50	4.00	3.00
3 1/2	8.50	7.00	0.75	8	5/8	3.50	4.00	3.00
4	9.00	7.50	0.75	8	5/8	3.50	4.00	3.00
5	10.00	8.50	0.88	8	3/4	3.75	4.25	3.25
6	11.00	9.50	0.88	8	3/4	4.00	4.50	3.25
8	13.50	11.75	0.88	8	3/4	4.25	4.75	3.50
10	16.00	14.25	1.00	12	7/8	4.50	5.00	4.00
12	19.00	17.00	1.00	12	7/8	4.75	5.25	4.00
14	21.00	18.75	1.12	12	1	5.25	5.75	4.50
16	23.50	21.25	1.12	16	1	5.25	5.75	4.50
18	25.00	22.75	1.25	16	1 1/8	5.75	6.25	5.00
20	27.50	25.00	1.25	20	1 1/8	6.25	6.75	5.50
24	32.00	29.50	1.38	20	1 1/4	6.75	7.25	6.00

TABLE 8 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 9 and 10.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.

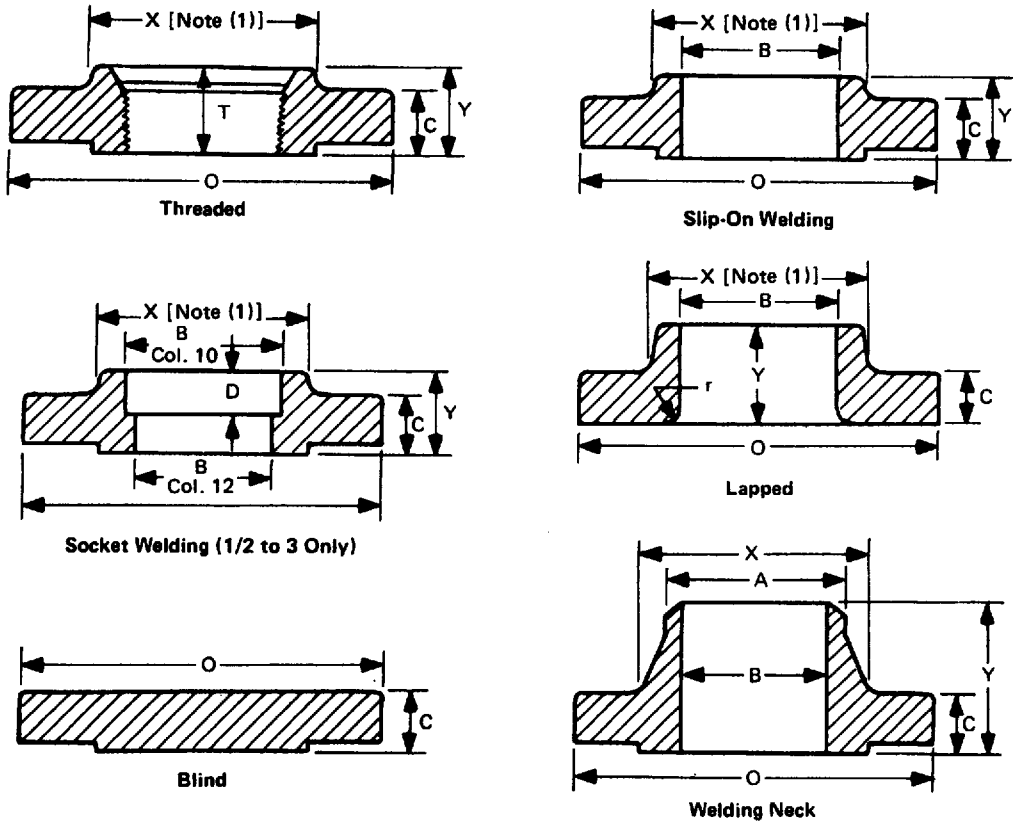


TABLE 9 DIMENSIONS OF CLASS 150 FLANGES[2–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Length Through Hub				Bore				
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange [(9)–(11)], Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (12) A	Threaded Slip-On Socket Welding Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (13), Min. T	Slip-On Socket Welding, Min. B	Lapped, Min. B	Welding Neck Socket Welding (14) B	Corner Radius of Bore of Lapped Flange and Pipe r	Depth of Socket D
½	3.50	0.44	1.19	0.84	0.62	0.62	1.88	0.62	0.88	0.90	0.62	0.12	0.38
¾	3.88	0.50	1.50	1.05	0.62	0.62	2.06	0.62	1.09	1.11	0.82	0.12	0.44
1	4.25	0.56	1.94	1.32	0.69	0.69	2.19	0.69	1.36	1.38	1.05	0.12	0.50
1¼	4.62	0.62	2.31	1.66	0.81	0.81	2.25	0.81	1.70	1.72	1.38	0.19	0.56
1½	5.00	0.69	2.56	1.90	0.88	0.88	2.44	0.88	1.95	1.97	1.61	0.25	0.62
2	6.00	0.75	3.06	2.38	1.00	1.00	2.50	1.00	2.44	2.46	2.07	0.31	0.69
2½	7.00	0.88	3.56	2.88	1.12	1.12	2.75	1.12	2.94	2.97	2.47	0.31	0.75
3	7.50	0.94	4.25	3.50	1.19	1.19	2.75	1.19	3.57	3.60	3.07	0.38	0.81
3½	8.50	0.94	4.81	4.00	1.25	1.25	2.81	1.25	4.07	4.10	3.55	0.38	...
4	9.00	0.94	5.31	4.50	1.31	1.31	3.00	1.31	4.60	4.60	4.03	0.44	...
5	10.00	0.94	6.44	5.56	1.44	1.44	3.50	1.44	5.66	5.69	5.05	0.44	...
6	11.00	1.00	7.56	6.63	1.56	1.56	3.50	1.56	6.72	6.75	6.07	0.50	...
8	13.50	1.12	9.69	8.63	1.75	1.75	4.00	1.75	8.72	8.75	7.98	0.50	...
10	16.00	1.19	12.00	10.75	1.94	1.94	4.00	1.94	10.88	10.92	10.02	0.50	...
12	19.00	1.25	14.38	12.75	2.19	2.19	4.50	2.19	12.88	12.92	12.00	0.50	...
14	21.00	1.38	15.75	14.00	2.25	3.12	5.00	2.25	14.14	14.18	To be specified by purchaser	0.50	...
16	23.50	1.44	18.00	16.00	2.50	3.44	5.00	2.50	16.16	16.19		0.50	...
18	25.00	1.56	19.88	18.00	2.69	3.81	5.50	2.69	18.18	18.20		0.50	...
20	27.50	1.69	22.00	20.00	2.88	4.06	5.69	2.88	20.20	20.25		0.50	...
24	32.00	1.88	26.12	24.00	3.25	4.38	6.00	3.25	24.25	24.25		0.50	...

TABLE 9 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, socket-welding, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 8.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the manufacturer's option.
(8) For reducing welding neck flanges, see para. 6.8.
(9) The minimum thickness of these loose flanges, in sizes NPS $3\frac{1}{2}$ and smaller, is slightly greater than the thickness of flanges on fittings, Table 10, which are reinforced by being cast integral with the body of the fitting.
(10) When these flanges are required with flat face, either the full thickness or thickness with raised face removed may be furnished. Users are reminded that removing the raised face will make the length through the hub nonstandard. See para. 6.4.1.1 for additional restrictions.
(11) The flange dimensions illustrated are for regularly furnished 0.06 in. raised face (except lapped); for requirements of other facings, see Fig. 7.
(12) For welding end bevel, see para. 6.7.
(13) For thread of threaded flanges, see para. 6.9.
(14) Dimensions in Column 12 correspond to the inside diameters of pipe as given in ASME B36.10M for Standard Wall pipe. Thickness of Standard Wall is the same as Schedule 40 in sizes NPS 10 and smaller. Tolerances in para. 7.4.2 apply. These bore sizes are furnished unless otherwise specified by the purchaser.

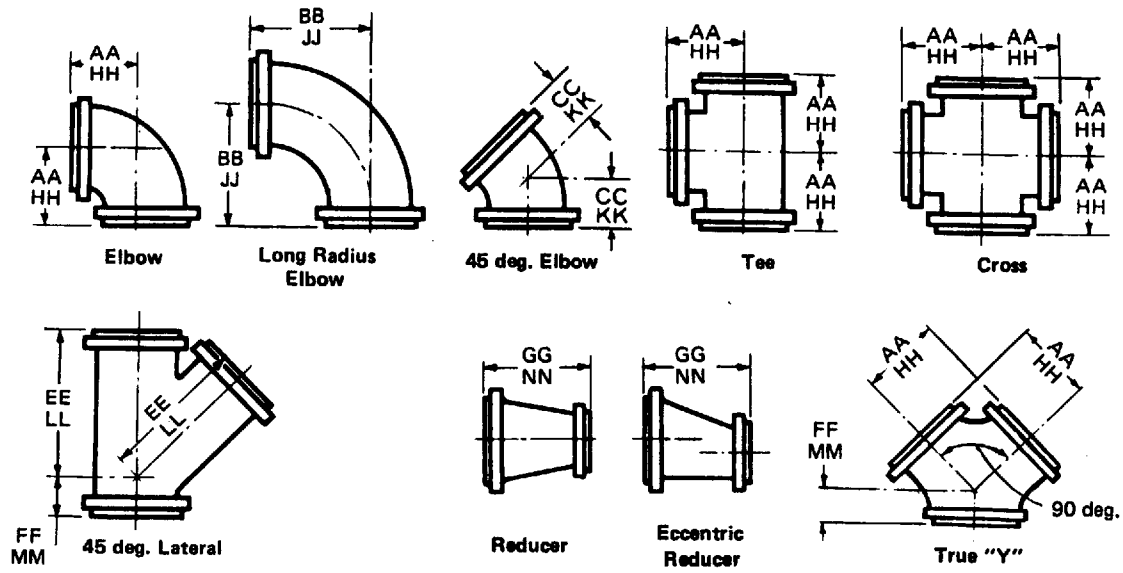


TABLE 10 DIMENSIONS OF CLASS 150 FLANGED FITTINGS[1-8]

1	2	3	4	5	6	7	8	9	10	11	12
					0.06 in. Raised Face (Flange Edge) (12)						Ring Joint (12)
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange [(9)–(11)], Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting, d	Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face Long Radius Elbow BB	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF	Contact Surface-to-Contact Surface of Raised Face Reducer (13) GG	Center-to-End Elbow Tee, Cross, and True "Y" (14) HH
½	3.5	0.38	0.11	0.60	...	...	...	...	...	...	...
¾	3.88	0.41	0.12	0.75	...	...	...	...	...	...	...
1	4.25	0.44	0.16	1.00	3.50	5.00	1.75	5.75	1.75	4.50	3.75
1¼	4.62	0.50	0.19	1.25	3.75	5.50	2.00	6.25	1.75	4.50	4.00
1½	5.00	0.56	0.19	1.50	4.00	6.00	2.25	7.00	2.00	4.50	4.25
2	6.00	0.62	0.22	2.00	4.50	6.50	2.50	8.00	2.50	5.00	4.75
2½	7.00	0.69	0.22	2.50	5.00	7.00	3.00	9.50	2.50	5.50	5.25
3	7.50	0.75	0.22	3.00	5.50	7.75	3.00	10.00	3.00	6.00	5.75
3½	8.50	0.81	0.25	3.50	6.00	8.50	3.50	11.50	3.00	6.50	6.25
4	9.00	0.94	0.25	4.00	6.50	9.00	4.00	12.00	3.00	7.00	6.75
5	10.00	0.94	0.28	5.00	7.50	10.25	4.50	13.50	3.50	8.00	7.75
6	11.00	1.00	0.28	6.00	8.00	11.50	5.00	14.50	3.50	9.00	8.25
8	13.50	1.12	0.31	8.00	9.00	14.00	5.50	17.50	4.50	11.00	9.25
10	16.00	1.19	0.34	10.00	11.00	16.50	6.50	20.50	5.00	12.00	11.25
12	19.00	1.25	0.38	12.00	12.00	19.00	7.50	24.50	6.50	14.00	12.25
14	21.00	1.38	0.41	13.25	14.00	21.50	7.50	27.00	6.00	16.00	14.25
16	23.50	1.44	0.44	15.25	15.00	24.00	8.00	30.00	6.50	18.00	15.25
18	25.00	1.56	0.47	17.25	16.50	26.50	8.50	32.00	7.00	19.00	16.75
20	27.50	1.69	0.50	19.25	18.00	29.00	9.50	35.00	8.00	20.00	18.25
24	32.00	1.88	0.57	23.25	22.00	34.00	11.00	40.50	9.00	24.00	22.25

(Figure continues on next page; Notes follow Table)

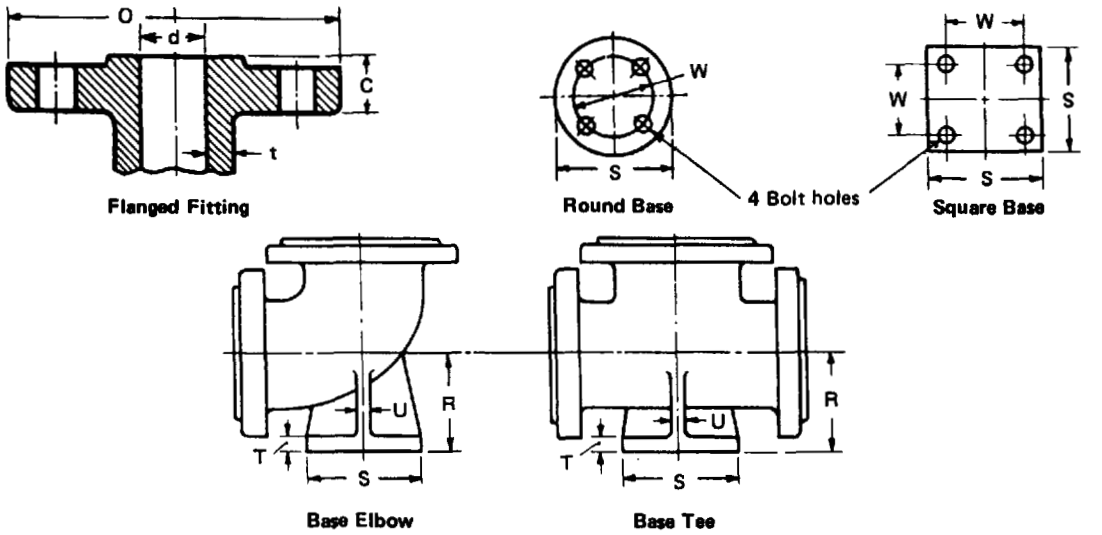


TABLE 10 DIMENSIONS OF CLASS 150 FLANGED FITTINGS[1-8] (CONT'D)

13	14	15	16	17	18	19	20	21	22	23	1
Ring Joint (12)									Base Drilling (19)		
Center-to-End Long Radius Elbow (14) JJ	Center-to-End 45 deg. Elbow (14) KK	Long Center-to-End Lateral (14) LL	Short Center-to-End Lateral and True "Y" (14) MM	End-to-End Reducer NN	Center-to-Base [(15)–(17)] R	Diameter of Round Base or Width of Square Base (15) S	Thickness of Base [(15)–(18)] T	Thickness of Ribs (15) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
...	...	...	...	See Notes (13) and (14)	...	...	...	...	...	...	½
...	...	...	...		...	...	...	...	...	...	¾
5.25	2.00	6.00	2.00		...	...	...	...	...	...	1
5.75	2.25	6.50	2.00		...	...	...	...	...	...	1¼
6.25	2.50	7.25	2.25		...	...	...	...	...	...	1½
6.75	2.75	8.25	2.75		4.12	4.62	0.50	0.50	3.50	0.62	2
7.25	3.25	9.75	2.75		4.50	4.62	0.50	0.50	3.50	0.62	2½
8.00	3.25	10.25	3.25		4.88	5.00	0.56	0.56	3.88	0.62	3
8.75	3.75	11.75	3.25		5.25	5.00	0.56	0.56	3.88	0.62	3½
9.25	4.25	12.25	3.25		5.50	6.00	0.62	0.62	4.75	0.75	4
10.50	4.75	13.75	3.75		6.25	7.00	0.69	0.65	5.50	0.75	5
11.75	5.25	14.75	3.75		7.00	7.00	0.69	0.65	5.50	0.75	6
14.25	5.75	17.75	4.75		8.38	9.00	0.94	0.94	7.50	0.75	8
16.75	6.75	20.75	5.25		9.75	9.00	0.94	0.94	7.50	0.75	10
19.25	7.75	24.75	5.75		11.25	11.00	1.00	1.00	9.50	0.88	12
21.75	7.75	27.25	6.25		12.50	11.00	1.00	1.00	9.50	0.88	14
24.25	8.25	30.25	6.75		13.75	11.00	1.00	1.00	9.50	0.88	16
26.75	8.75	32.25	7.25		15.00	13.50	1.12	1.12	11.75	0.86	18
29.25	9.75	35.25	8.25		16.00	13.50	1.12	1.12	11.75	0.88	20
34.25	11.25	40.75	9.25		18.50	13.50	1.12	1.12	11.75	0.88	24

(Notes follow on next page)

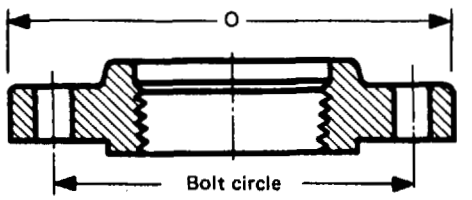
TABLE 10 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

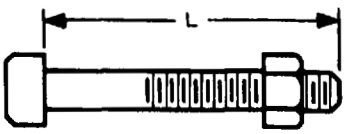
NOTES:

(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 8.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) The thickness of flange minimum dimensions for loose flanges, Table 9, sizes $3\frac{1}{2}$ in. and smaller, are slightly heavier than for flanges on these fittings which are reinforced by being cast integral with the body of the fitting.
(10) When these fittings are required with flat face flange, either the full thickness or thickness with raised face removed may be furnished. Users are reminded that removing the raised face will make the center-to-face dimension nonstandard. See para. 6.4.1.1 for additional restrictions.
(11) The thickness of flange dimension illustrated is for regularly furnished 0.06 in. raised face (except lapped); for thickness requirements of other facings, see Fig. 7.
(12) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(13) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(14) These dimensions apply to straight sizes only. See paras. 6.2.3 and 6.4.1.3. For center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-contact surface or contact surface-to-contact surface dimensions of 0.06 in. raised face (flange edge) for largest opening and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.
(15) The base dimensions apply to all straight and reducing sizes.
(16) The reducing fittings, the size and center-to-face dimension of base are determined by the size of the largest opening of fittings. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(17) Bases shall be plain faced unless otherwise specified, and the center-to-base dimension R shall be the finished dimension.
(18) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(19) The bolt hole template is the same as for Class 150 flanges, Table 8, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle centerlines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

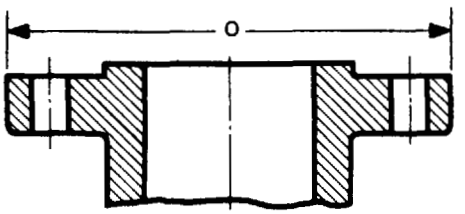
CLASS 300 PIPE FLANGES, AND FLANGED FITTINGS



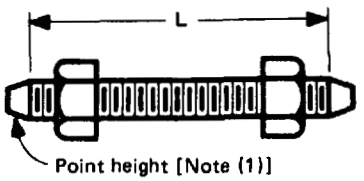
Flange



Machine Bolt With Nut



Flanged Fitting



Stud Bolt With Nuts

TABLE 11 TEMPLATES FOR DRILLING CLASS 300 FLANGES[2]

1	2	3	4	5	6	7	8	9
		Drilling [(3),(4)]				Length of Bolts (5) L		
						Stud Bolts (1)		Machine Bolts
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.06 in. Raised Face	Ring Joint	0.06 in. Raised Face
1/2	3.75	2.62	0.62	4	1/2	2.50	3.00	2.25
3/4	4.62	3.25	0.75	4	5/8	3.00	3.50	2.50
1	4.88	3.50	0.75	4	5/8	3.00	3.50	2.50
1 1/4	5.25	3.88	0.75	4	5/8	3.25	3.75	2.75
1 1/2	6.12	4.50	0.88	4	3/4	3.50	4.00	3.00
2	6.50	5.00	0.75	8	5/8	3.50	4.00	3.00
2 1/2	7.50	5.88	0.88	8	3/4	4.00	4.50	3.25
3	8.25	6.62	0.88	8	3/4	4.25	4.75	3.50
3 1/2	9.00	7.25	0.88	8	3/4	4.25	5.00	3.75
4	10.00	7.88	0.88	8	3/4	4.50	5.00	3.75
5	11.00	9.25	0.88	8	3/4	4.75	5.25	4.25
6	12.50	10.62	0.88	12	3/4	4.75	5.50	4.25
8	15.00	13.00	1.00	12	7/8	5.50	6.00	4.75
10	17.50	15.25	1.12	16	1	6.25	6.75	5.50
12	20.50	17.75	1.25	16	1 1/8	6.75	7.25	5.75
14	23.00	20.25	1.25	20	1 1/8	7.00	7.50	6.25
16	25.50	22.50	1.38	20	1 1/4	7.50	8.00	6.50
18	28.00	24.75	1.38	24	1 1/4	7.75	8.25	6.75
20	30.50	27.00	1.38	24	1 1/4	8.00	8.75	7.25
24	36.00	32.00	1.62	24	1 1/2	9.00	10.00	8.00

(Notes follow on next page)

TABLE 11 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 12 and 13.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.

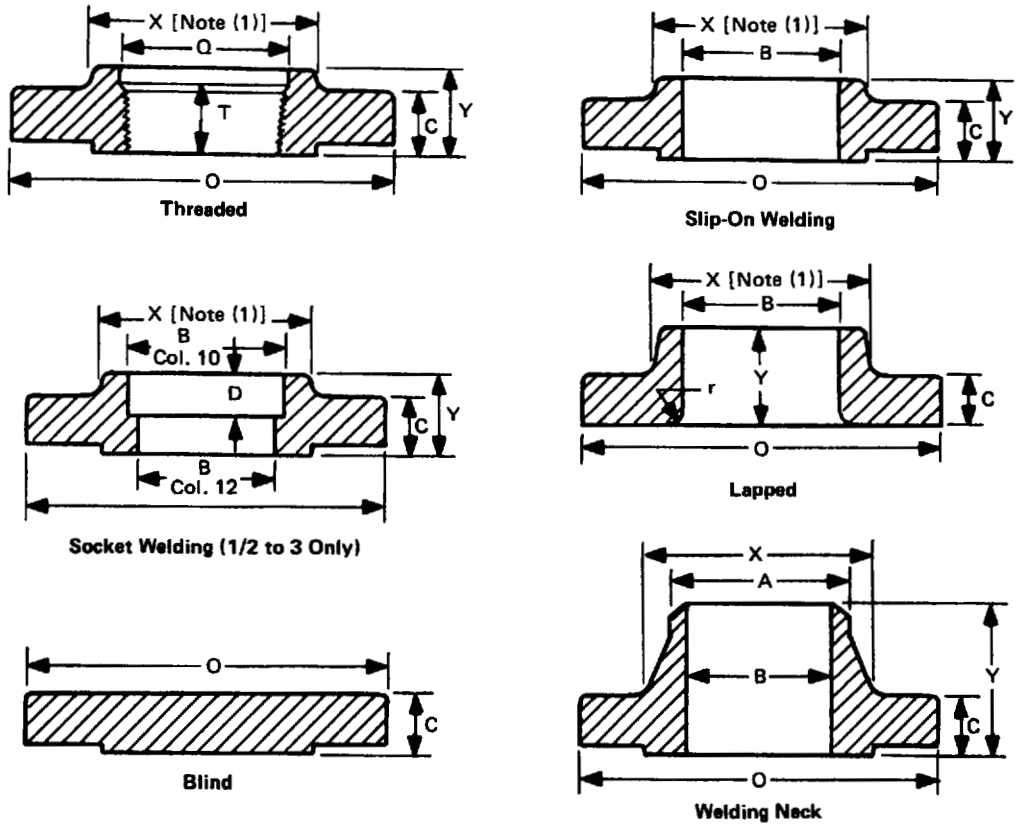


TABLE 12 DIMENSIONS OF CLASS 300 FLANGES[2–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Hub Diameter Beginning of Chamfer Welding Neck (11)	Length Through Hub				Bore			Corner Radius of Bore of Lapped Flange and Pipe		
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange [(9)–(11)], Min. C	Diameter of Hub X	A	Threaded Slip-On Socket Welding Y	Lapped Y	Welding Neck Y	Thread Length Threaded (12), Min. T	Slip-On Socket Welding, Min. B	Lapped, Min. B	Welding Neck Socket Welding (13) B	r	Counterbore Threaded Flange, Min. Q	Depth of Socket D
½	3.75	0.56	1.50	0.84	0.88	0.88	2.06	0.62	0.88	0.90	0.62	0.12	0.93	0.38
¾	4.62	0.62	1.88	1.05	1.00	1.00	2.25	0.62	1.09	1.11	0.82	0.12	1.14	0.44
1	4.88	0.69	2.12	1.32	1.06	1.06	2.44	0.69	1.36	1.38	1.05	0.12	1.41	0.50
1¼	5.25	0.75	2.50	1.66	1.06	1.06	2.56	0.81	1.70	1.72	1.38	0.19	1.75	0.56
1½	6.12	0.81	2.75	1.90	1.19	1.19	2.69	0.88	1.95	1.97	1.61	0.25	1.98	0.62
2	6.50	0.88	3.31	2.38	1.31	1.31	2.75	1.12	2.44	2.46	2.07	0.31	2.50	0.69
2½	7.50	1.00	3.94	2.88	1.50	1.50	3.00	1.25	2.94	2.97	2.47	0.31	3.00	0.75
3	8.25	1.12	4.62	3.50	1.69	1.69	3.12	1.25	3.57	3.60	3.07	0.38	3.63	0.81
3½	9.00	1.19	5.25	4.00	1.75	1.75	3.19	1.44	4.07	4.10	3.55	0.38	4.13	...
4	10.00	1.25	5.75	4.50	1.88	1.88	3.38	1.44	4.57	4.60	4.03	0.44	4.63	...
5	11.00	1.38	7.00	5.56	2.00	2.00	3.88	1.69	5.66	5.69	5.05	0.44	5.69	...
6	12.50	1.44	8.12	6.63	2.06	2.06	3.88	1.81	6.72	6.75	6.07	0.50	6.75	...
8	15.00	1.62	10.25	8.63	2.44	2.44	4.38	2.00	8.72	8.75	7.98	0.50	8.75	...
10	17.50	1.88	12.62	10.75	2.62	3.75	4.62	2.19	10.88	10.92	10.02	0.50	10.88	...
12	20.50	2.00	14.75	12.75	2.88	4.00	5.12	2.38	12.88	12.92	12.00	0.50	12.94	...
14	23.00	2.12	16.75	14.00	3.00	4.38	5.62	2.50	14.14	14.18	To be specified by purchaser	0.50	14.19	...
16	25.50	2.25	19.00	16.00	3.25	4.75	5.75	2.69	16.16	16.19		0.50	16.19	...
18	28.00	2.38	21.00	18.00	3.50	5.12	6.25	2.75	18.18	18.20		0.50	18.19	...
20	30.50	2.50	23.12	20.00	3.75	5.50	6.38	2.88	20.20	20.25		0.50	20.19	...
24	36.00	2.75	27.62	24.00	4.19	6.00	6.62	3.25	24.25	24.25		0.50	24.19	...

(Notes follow on next page)

TABLE 12 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, socket-welding, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 11.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the option of the manufacturer.
(8) For reducing welding neck flanges, see para. 6.8.
(9) When these flanges are required with flat face, either the full thickness or thickness with raised face removed may be furnished. Users are reminded that removing the raised face will make the length through the hub nonstandard. See para. 6.4.1.1 for additional restrictions.
(10) The flange dimensions illustrated are for regularly furnished 0.06 in. raised face (except lapped); for requirements of other facings, see Fig. 7.
(11) For welding end and bevel, see para. 6.7.
(12) For thread of threaded flanges, see para. 6.9.
(13) Dimensions in Column 12 correspond to the inside diameters of pipe as given in ASME B36.10M for Standard Wall Pipe. Standard Wall dimensions are the same as Schedule 40 in sizes NPS 10 and smaller. Tolerances in para. 7.5.2 apply. These bore sizes are furnished unless otherwise specified by the purchaser.

Table 13 begins on next page

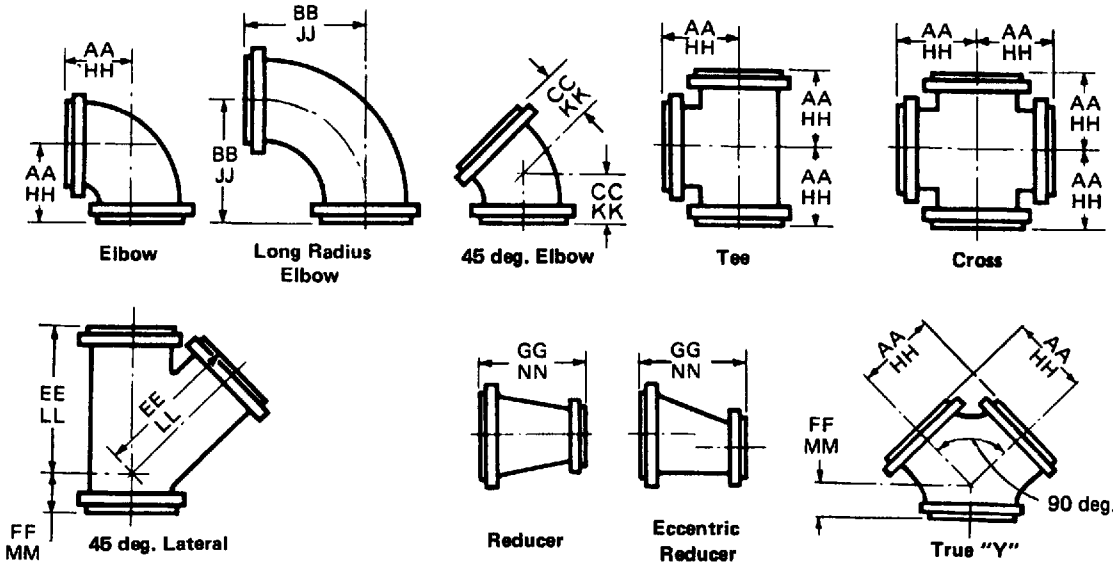


TABLE 13 DIMENSIONS OF CLASS 300 FLANGED FITTINGS[1-9]

1	2	3	4	5	6	7	8	9	10	11	12
					0.06 in. Raised Face (Flange Edge) (11)						Ring Joint (11)
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange [(9)-(11)], Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting, d	Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face Long Radius Elbow BB	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF	Contact Surface-to-Contact Surface of Raised Face Reducer (12) GG	Center-to-End Elbow Tee, Cross, and True "Y" (13) HH
1	4.88	0.69	0.19	1.00	4.00	5.00	2.25	6.50	2.00	4.50	4.25
1¼	5.25	0.75	0.19	1.25	4.25	5.50	2.50	7.25	2.25	4.50	4.50
1½	6.12	0.81	0.19	1.50	4.50	6.00	2.75	8.50	2.50	4.50	4.75
2	6.50	0.88	0.25	2.00	5.00	6.50	3.00	9.00	2.50	5.00	5.31
2½	7.50	1.00	0.25	2.50	5.50	7.00	3.50	10.50	2.50	5.50	5.81
3	8.25	1.12	0.28	3.00	6.00	7.75	3.50	11.00	3.00	6.00	6.31
3½	9.00	1.19	0.29	3.50	6.50	8.50	4.00	12.50	3.00	6.50	6.81
4	10.00	1.25	0.31	4.00	7.00	9.00	4.50	13.50	3.00	7.00	7.31
5	11.00	1.38	0.38	5.00	8.00	10.25	5.00	15.00	3.50	8.00	8.31
6	12.50	1.44	0.38	6.00	8.50	11.50	5.50	17.50	4.00	9.00	8.81
8	15.00	1.62	0.44	8.00	10.00	14.00	6.00	20.50	5.00	11.00	10.31
10	17.50	1.88	0.50	10.00	11.50	16.50	7.00	24.00	5.50	12.00	11.81
12	20.50	2.00	0.56	12.00	13.00	19.00	8.00	27.50	6.00	14.00	13.31
14	23.00	2.12	0.62	13.25	15.00	21.50	8.50	31.00	8.50	16.00	15.31
16	25.50	2.25	0.69	15.25	16.50	24.00	9.50	34.50	7.50	18.00	16.81
18	28.00	2.38	0.75	17.00	18.00	26.50	10.00	37.50	8.00	19.00	18.31
20	30.50	2.50	0.81	19.00	19.50	29.00	10.50	40.50	8.50	20.00	19.88
24	36.00	2.75	0.94	23.00	22.50	34.00	12.00	47.50	10.00	24.00	22.94

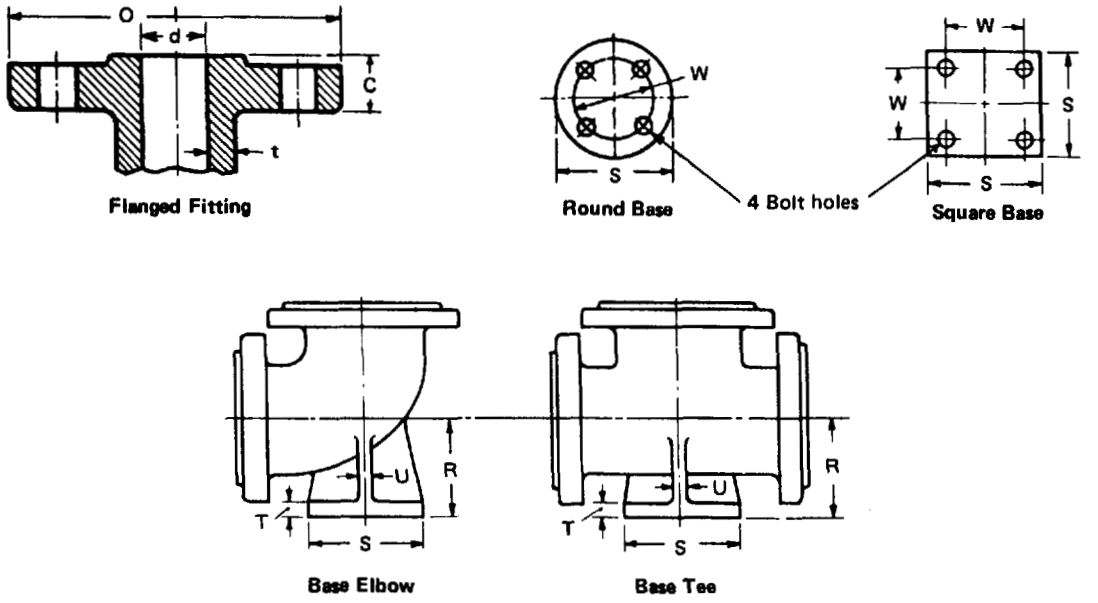


TABLE 13 DIMENSIONS CLASS OF 300 FLANGED FITTINGS[1–9] (CONT'D)

13	14	15	16	17	18	19	20	21	22	23	1
Ring Joint (12)									Base Drilling (18)		
Center-to-End Long Radius Elbow (13) JJ	Center-to-End 45 deg. Elbow (13) KK	Long Center-to-End Lateral (13) LL	Short Center-to-End Lateral and True "Y" (13) MM	End-to-End Reducer NN	Center-to-Base [(14)–(16)] R	Diameter of Round Base or Width of Square Base (14) S	Thickness of Base [(14)–(17)] T	Thickness of Ribs (14) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
5.25	2.50	6.75	2.25	See Notes (12) and (13)	...	...	...	...	...	...	1
5.75	2.75	7.50	2.50		...	...	...	...	...	...	1¼
6.25	3.00	8.75	2.75		...	...	...	...	...	...	1½
6.81	3.31	9.31	2.81		4.50	5.25	0.75	0.50	3.88	0.75	2
7.31	3.81	10.81	2.81		4.75	5.25	0.75	0.50	3.88	0.75	2½
8.06	3.81	11.31	3.31		5.25	6.12	0.81	0.62	4.50	0.88	3
8.81	4.31	12.81	3.31		5.62	6.12	0.81	0.62	4.50	0.88	3½
9.31	4.88	13.81	3.31		6.00	6.50	0.88	0.62	5.00	0.75	4
10.56	5.31	15.31	3.81		6.75	7.50	1.00	0.75	5.88	0.88	5
11.81	5.81	17.81	4.31		7.50	7.50	1.00	0.75	5.88	0.88	6
14.31	6.31	20.81	5.31		9.00	10.00	1.25	0.88	7.88	0.88	8
16.81	7.31	24.31	5.81		10.50	10.00	1.25	0.88	7.88	0.88	10
19.31	8.31	27.81	6.31		12.00	12.50	1.44	1.00	10.62	0.88	12
21.81	8.81	31.31	6.81		13.50	12.50	1.44	1.00	10.62	0.88	14
24.31	9.81	34.81	7.81		14.75	12.50	1.44	1.12	10.62	0.88	16
26.81	10.31	37.81	8.31		16.25	15.00	1.62	1.12	13.00	1.00	18
29.38	10.88	40.88	8.88		17.88	15.00	1.62	1.25	13.00	1.00	20
34.44	12.44	47.94	10.44		20.75	17.50	1.88	1.25	15.25	1.12	24

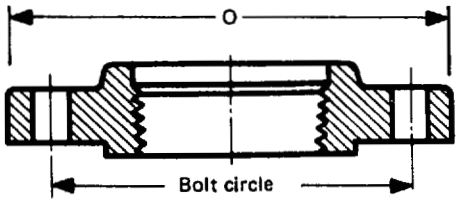
(Notes follow on next page)

TABLE 13 (CONT'D)

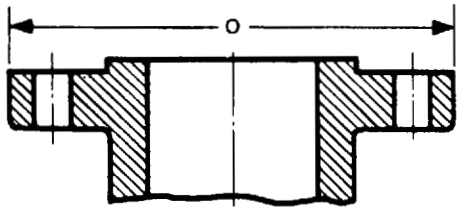
GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 11.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) When these fittings are required with flat face flange, either the full thickness or thickness with raised face removed may be furnished. Users are reminded that removing the raised face will make the center-to-face dimension nonstandard. See para. 6.4.1.1 for additional restrictions.
(10) The thickness of flange dimension illustrated is for regularly furnished 0.06 in. raised face (except lapped); for thickness requirement of other facings, see Fig. 7.
(11) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(12) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(13) These dimensions apply to straight sizes only. See paras. 6.2.3 and 6.4.1.3. For center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-contact surface or contact surface-to-contact surface dimensions of 0.06 in. raised face (flange edge) for largest opening and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.
(14) The base dimensions apply to all straight and reducing sizes.
(15) For reducing fittings, the size and center-to-face dimension of base are determined by the size of the largest opening of fittings. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(16) Bases shall be plain faced unless otherwise specified, and the center-to-base dimension R shall be the finished dimension.
(17) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(19) The bolt hole template for round base is the same as for Class 300 flanges, Table 11, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

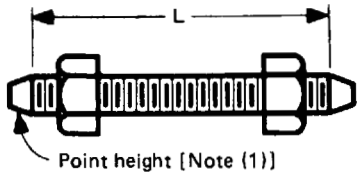
CLASS 400 PIPE FLANGES, AND FLANGED FITTINGS



Flange



Flanged Fitting



Stud Bolt With Nuts

TABLE 14 TEMPLATES FOR DRILLING CLASS 400 FLANGES[2]

1	2	3	4	5	6	7	8	9
		Drilling [(3), (4)]				Length of Bolts [(1), (5)] L		
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.25 in. Raised Face	Male and Female; also Tongue and Groove	Ring Joint
½ ¾ 1 1¼ 1½ 2 2½ 3 3½	Use Class 600 dimensions in these sizes.							
4	10.00	7.88	1.00	8	⅞	5.50	5.25	5.50
5	11.00	9.25	1.00	8	⅞	5.75	5.25	5.75
6	12.50	10.62	1.00	12	⅞	6.00	5.75	6.00
8	15.00	13.00	1.12	12	1	6.75	6.50	6.75
10	17.50	15.25	1.25	16	1⅛	7.50	7.25	7.50
12	20.50	17.75	1.38	16	1¼	8.00	7.75	8.00
14	23.00	20.25	1.38	20	1¼	8.25	8.00	8.25
16	25.50	22.50	1.50	20	1⅜	8.75	8.50	8.75
18	28.00	24.75	1.50	24	1⅜	9.00	8.75	9.00
20	30.50	27.00	1.62	24	1½	9.50	9.25	9.75
24	36.00	32.00	1.88	24	1¾	10.50	10.25	11.00

(Notes follow on next page)

TABLE 14 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 15 and 16.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.

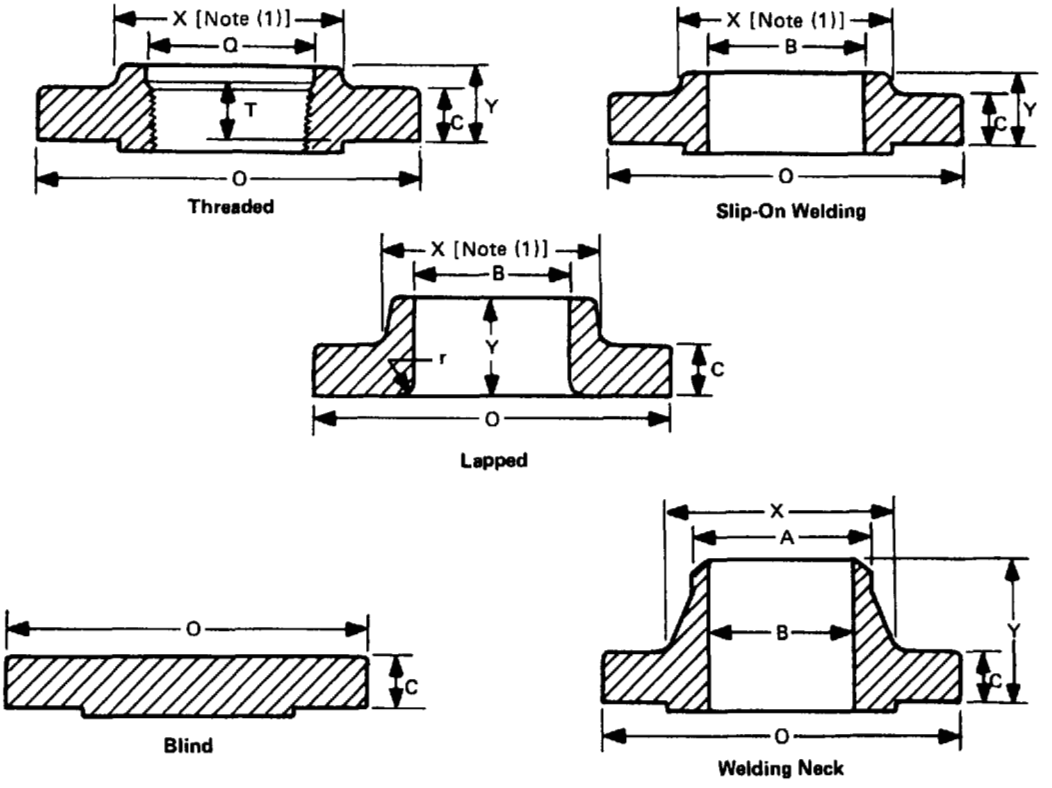


TABLE 15 DIMENSIONS OF CLASS 400 FLANGES[2–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Length Through Hub				Bore				
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (9) A	Threaded Slip-On Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (10), Min. T	Slip-On Min. B	Lapped, Min. B	Welding Neck B	Corner Radius of Bore of Lapped Flange and Pipe r	Counter-bore Threaded Flange, Min. Q
½ ¾ 1 1¼ 1½ 2 2½ 3 3½	Use Class 600 dimensions in these sizes (11).												
4	10.00	1.38	5.75	4.50	2.00	2.00	3.50	1.44	4.57	4.60	To be specified by purchaser	0.44	4.63
5	11.00	1.50	7.00	5.56	2.12	2.12	4.00	1.69	5.66	5.69		0.44	5.69
6	12.50	1.62	8.12	6.63	2.25	2.25	4.06	1.81	6.72	6.75		0.50	6.75
8	15.00	1.88	10.25	8.63	2.69	2.69	4.62	2.00	8.72	8.75		0.50	8.75
10	17.50	2.12	12.62	10.75	2.88	4.00	4.88	2.19	10.88	10.92		0.50	10.88
12	20.50	2.25	14.75	12.75	3.12	4.25	5.38	2.38	12.88	12.92		0.50	12.94
14	23.00	2.38	16.75	14.00	3.31	4.62	5.88	2.50	14.14	14.18		0.50	14.19
16	25.50	2.50	19.00	16.00	3.69	5.00	6.00	2.69	16.16	16.19		0.50	16.19
18	28.00	2.62	21.00	18.00	3.88	5.38	6.50	2.75	18.18	18.20		0.50	18.19
20	30.50	2.75	23.12	20.00	4.00	5.75	6.62	2.88	20.20	20.25		0.50	20.19
24	36.00	3.00	27.62	24.00	4.50	6.25	6.88	3.25	24.25	24.25		0.50	24.19

(Notes follow on next page)

TABLE 15 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 14.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the manufacturer's option.
(8) For reducing welding neck flanges, see para. 6.8.
(9) For welding end bevel, see para. 6.7.
(10) For threads in threaded flanges, see para. 6.9.
(11) Socket welding flanges may be provided in NPS ½ through 2½ using Class 600 dimensions.

Table 16 begins on next page

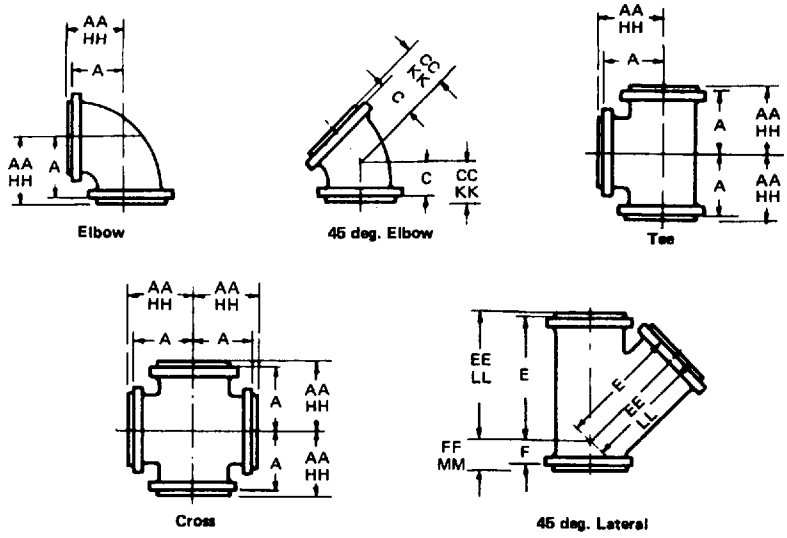


TABLE 16 DIMENSIONS OF CLASS 400 FLANGED FITTINGS[1-8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Flange Edge					0.25 in. Raised Face (9)			
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting d	Center-to-Flange Edge Elbow, Tee, Cross, and True "Y" A	Center-to-Flange Edge 45 deg. Elbow C	Long Center-to-Flange Edge Lateral E	Short Center-to-Flange Edge Lateral and True "Y" F	Flange Edge-to-Flange Edge Reducer G	Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF
½ ¾ 1 1¼ 1½ 2 2½ 3 3½	Use Class 600 dimensions in these sizes.												
4	10.00	1.38	0.38	4.00	7.75	5.25	15.75	4.25	7.75	8.00	5.50	16.00	4.50
5	11.00	1.50	0.44	5.00	8.75	5.75	16.50	4.75	8.75	9.00	6.00	16.75	5.00
6	12.50	1.62	0.44	6.00	9.50	6.00	18.50	5.00	9.50	9.75	6.25	18.75	5.25
8	15.00	1.88	0.56	8.00	11.50	6.50	22.00	5.50	11.50	11.75	6.75	22.25	5.75
10	17.50	2.12	0.69	10.00	13.00	7.50	25.50	6.00	13.00	13.25	7.75	25.75	6.25
12	20.50	2.25	0.75	12.00	14.75	8.50	29.50	6.25	14.75	15.00	8.75	29.75	6.50
14	23.00	2.38	0.81	13.12	16.00	9.00	32.50	6.75	16.00	16.25	9.25	32.75	7.00
16	25.50	2.50	0.88	15.00	17.50	10.00	36.00	7.75	18.00	17.75	10.25	36.25	8.00
18	28.00	2.62	0.94	17.00	19.00	10.50	39.00	8.25	19.00	19.25	10.75	39.25	8.50
20	30.50	2.75	1.06	18.88	20.50	11.00	42.50	8.75	20.50	20.75	11.25	42.75	9.00
24	36.00	3.00	1.19	22.62	24.00	12.50	50.00	10.25	24.00	24.25	12.75	50.25	10.50

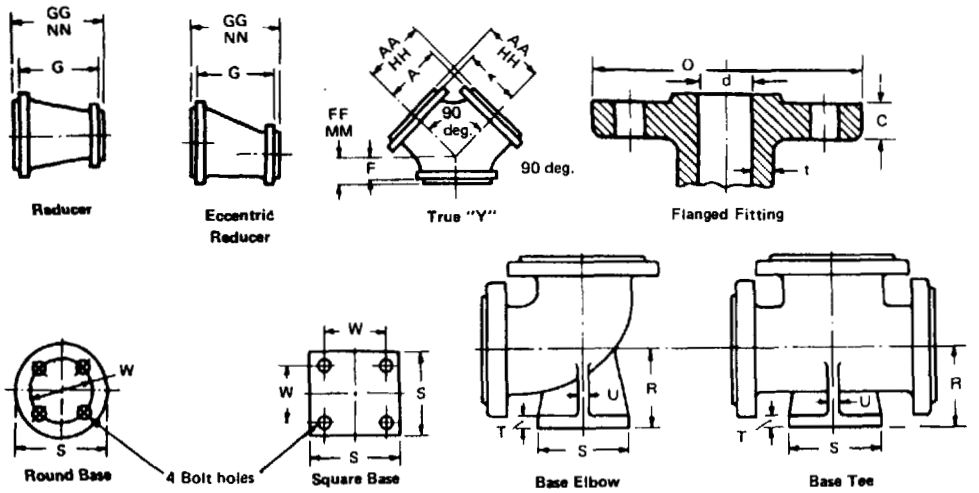


TABLE 16 DIMENSIONS CLASS OF 400 FLANGED FITTINGS[1-8] (CONT'D)

15	16	17	18	19	20	21	22	23	24	25	26	1
0.25 in. Raised Face (9)	Ring Joint (9)									Base Drilling (16)		
Contact Surface-to-Contact Surface of Raised Face Reducer (10) GG	Center-to-End Elbow, Tee, Cross, and True "Y" (11) HH	Center-to-End 45 deg. Elbow (11) KK	Long Center-to-End Lateral (11) LL	Short Center-to-End Lateral and True "Y" (11) MM	End-to-End Reducer NN	Center-to-Base [(12)-(14)] R	Diameter of Round Base or Width of Square Base (12) S	Thickness of Base [(12), (15)] T	Thickness of Ribs (12) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
Use Class 600 dimensions in these sizes.												½ ¾ 1 1¼ 1½ 2 2½ 3 3½
8.25	8.06	5.56	16.06	4.56	See Notes (10) and (11).	6.00	6.50	0.88	0.62	5.00	0.75	4
9.25	9.06	6.06	16.81	5.06		6.75	7.50	1.00	0.75	5.88	0.88	5
10.00	9.81	6.31	18.81	5.31		7.50	7.50	1.00	0.75	5.88	0.88	6
12.00	11.81	6.81	22.31	5.81		9.00	10.00	1.25	0.88	7.88	0.88	8
13.50	13.31	7.81	25.81	6.31		10.50	10.00	1.25	0.88	7.88	0.88	10
15.25	15.06	8.81	29.81	6.56		12.00	12.50	1.44	1.00	10.62	0.88	12
16.50	16.31	9.31	32.81	7.06		13.50	12.50	1.44	1.00	10.62	0.88	14
18.50	17.81	10.31	36.31	8.06		14.75	12.50	1.44	1.12	10.62	0.88	16
19.50	19.31	10.81	39.31	8.56		16.25	15.00	1.62	1.12	13.00	1.00	18
21.00	20.88	11.38	42.88	9.12		17.88	15.00	1.62	1.25	13.00	1.00	20
24.50	24.44	12.94	50.44	10.69		20.75	17.50	1.88	1.25	15.25	1.12	24

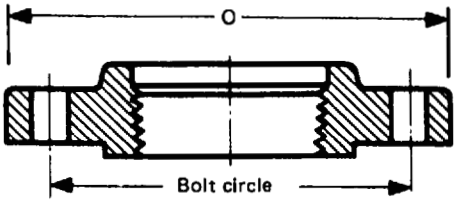
(Notes follow on next page)

TABLE 16 (CONT'D)

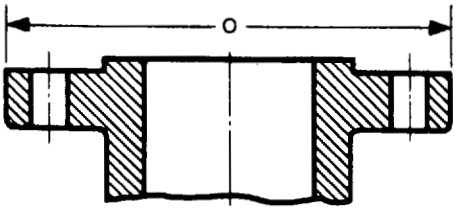
GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 14.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(10) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(11) These dimensions apply to straight sizes only. (See paras. 6.2.3 and 6.4.1.3.) For the center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-flange edge or flange edge-to-flange edge dimensions for largest opening, and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.
(12) The base dimensions apply to all straight and reducing sizes.
(13) For reducing fittings, the size and center-to-face dimensions of base are determined by the size of the largest opening of fitting. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(14) Bases shall be plain faced unless otherwise specified, and the center-to-base face dimension R shall be the finished dimension.
(15) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(16) The bolt hole template for round base is the same as for Class 300 flanges, Table 11, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

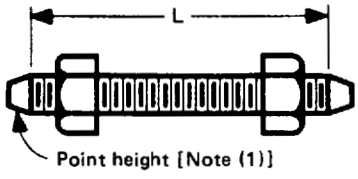
CLASS 600 PIPE FLANGES, AND FLANGED FITTINGS



Flange



Flanged Fitting



Stud Bolt With Nuts

TABLE 17 TEMPLATES FOR DRILLING CLASS 600 FLANGES[2]

1	2	3	4	5	6	7	8	9
		Drilling [(3), (4)]				Length of Bolts [(1), (5)] L		
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.25 in. Raised Face	Male and Female; also Tongue and Groove	Ring Joint
1/2	3.75	2.62	0.62	4	1/2	3.00	2.75	3.00
3/4	4.62	3.25	0.75	4	5/8	3.50	3.25	3.50
1	4.88	3.50	0.75	4	5/8	3.50	3.25	3.50
1 1/4	5.25	3.88	0.75	4	5/8	3.75	3.50	3.75
1 1/2	6.12	4.50	0.88	4	3/4	4.25	4.00	4.25
2	6.50	5.00	0.75	8	5/8	4.25	4.00	4.25
2 1/2	7.50	5.88	0.88	8	3/4	4.75	4.50	4.75
3	8.25	6.62	0.88	8	3/4	5.00	4.75	5.00
3 1/2	9.00	7.25	1.00	8	7/8	5.50	5.25	5.50
4	10.75	8.50	1.00	8	7/8	5.75	5.50	5.75
5	13.00	10.50	1.12	8	1	6.50	6.25	6.50
6	14.00	11.50	1.12	12	1	6.75	6.50	6.75
8	16.50	13.75	1.25	12	1 1/8	7.50	7.25	7.75
10	20.00	17.00	1.38	16	1 1/4	8.50	8.25	8.50
12	22.00	19.25	1.38	20	1 1/4	8.75	8.50	8.75
14	23.75	20.75	1.50	20	1 3/8	9.25	9.00	9.25
16	27.00	23.75	1.62	20	1 1/2	10.00	9.75	10.00
18	29.25	25.75	1.75	20	1 5/8	10.75	10.50	10.75
20	32.00	28.50	1.75	24	1 5/8	11.25	11.00	11.50
24	37.00	33.00	2.00	24	1 7/8	13.00	12.75	13.25

(Notes follow on next page)

TABLE 17 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 18 and 19.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.

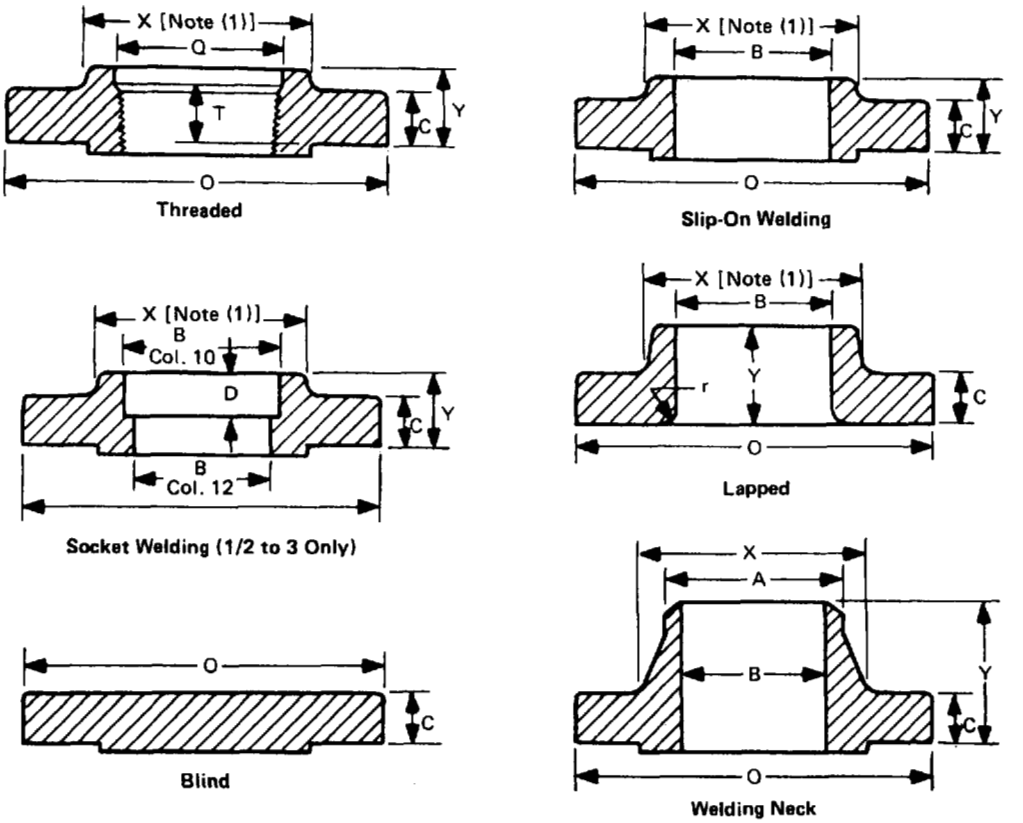


TABLE 18 DIMENSIONS OF CLASS 600 FLANGES[2-8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Length Through Hub				Bore					
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (9) A	Threaded Slip-On Socket Welding Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (10), Min. T	Slip-On Socket Welding, Min. B	Lapped, Min. B	Welding Neck Socket Welding B	Corner Radius of Bore of Lapped Flange and Pipe r	Counterbore Threaded Flange, Min. Q	Depth of Socket D
½	3.75	0.56	1.50	0.84	0.88	0.88	2.06	0.62	0.88	0.90		0.12	0.93	0.38
¾	4.62	0.62	1.88	1.05	1.00	1.00	2.25	0.62	1.09	1.11		0.12	1.14	0.44
1	4.88	0.69	2.12	1.32	1.06	1.06	2.44	0.69	1.36	1.38		0.12	1.41	0.50
1¼	5.25	0.81	2.50	1.66	1.12	1.12	2.62	0.81	1.70	1.72		0.19	1.75	0.56
1½	6.12	0.88	2.75	1.90	1.25	1.25	2.75	0.88	1.95	1.97		0.25	1.99	0.62
2	6.50	1.00	3.31	2.38	1.44	1.44	2.88	1.12	2.44	2.46		0.31	2.50	0.69
2½	7.50	1.12	3.94	2.88	1.62	1.62	3.12	1.25	2.94	2.97		0.31	3.00	0.75
3	8.25	1.25	4.62	3.50	1.81	1.81	3.25	1.38	3.57	3.60		0.38	3.63	0.81
3½	9.00	1.38	5.25	4.00	1.94	1.94	3.38	1.56	4.07	4.10		0.38	4.13	...
4	10.75	1.50	6.00	4.50	2.12	2.12	4.00	1.62	4.57	4.60		0.44	4.63	...
5	13.00	1.75	7.44	5.56	2.38	2.38	4.50	1.88	5.66	5.69		0.44	5.69	...
6	14.00	1.88	8.75	6.63	2.62	2.62	4.62	2.00	6.72	6.75		0.50	6.75	...
8	16.50	2.19	10.75	8.63	3.00	3.00	5.25	2.25	8.72	8.75		0.50	8.75	...
10	20.00	2.50	13.50	10.75	3.38	4.38	6.00	2.56	10.88	10.92		0.50	10.88	...
12	22.00	2.62	15.75	12.75	3.62	4.62	6.12	2.75	12.88	12.92		0.50	12.94	...
14	23.75	2.75	17.00	14.00	3.69	5.00	6.50	2.88	14.14	14.18		0.50	14.19	...
16	27.00	3.00	19.50	16.00	4.19	5.50	7.00	3.06	16.16	16.19		0.50	16.19	...
18	29.25	3.25	21.50	18.00	4.62	6.00	7.25	3.12	18.18	18.20		0.50	18.19	...
20	32.00	3.50	24.00	20.00	5.00	6.50	7.50	3.25	20.20	20.25		0.50	20.19	...
24	37.00	4.00	28.25	24.00	5.50	7.25	8.00	3.62	24.25	24.25		0.50	24.19	...

To be specified by purchaser.

(Notes follow on next page)

TABLE 18 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, socket welding, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 17.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the manufacturer's option.
(8) For reducing welding neck flanges, see para. 6.8.
(9) For welding end bevel, see para. 6.7.
(10) For threads in threaded flanges, see para. 6.9.

Table 19 begins on next page

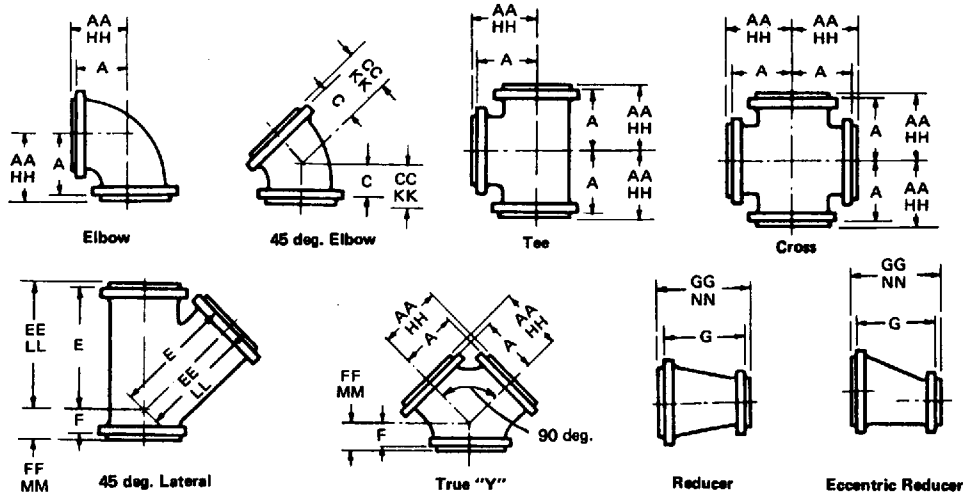


TABLE 19 DIMENSIONS OF CLASS 600 FLANGED FITTINGS[1–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Flange Edge					0.25 in. Raised Face (9)			
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting, d	Center-to-Flange Edge Elbow, Tee, Cross, and True "Y" A	Center-to-Flange Edge 45 deg. Elbow C	Long Center-to-Flange Edge Lateral E	Short Center-to-Flange Edge Lateral and True "Y" F	Flange Edge-to-Flange Edge Reducer G	Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF
½	3.75	0.56	0.16	0.50	3.00	1.75	5.50	1.50	4.50	3.25	2.00	5.75	1.75
¾	4.62	0.62	0.16	0.75	3.50	2.25	6.50	1.75	4.50	3.75	2.50	6.75	2.00
1	4.88	0.69	0.19	1.00	4.00	2.25	7.00	2.00	4.50	4.25	2.50	7.25	2.25
1¼	5.25	0.81	0.19	1.25	4.25	2.50	7.75	2.25	4.50	4.50	2.75	8.00	2.50
1½	6.12	0.88	0.22	1.50	4.50	2.75	8.75	2.50	4.50	4.75	3.00	9.00	2.75
2	6.50	1.00	0.25	2.00	5.50	4.00	10.00	3.25	5.50	5.75	4.25	10.25	3.50
2½	7.50	1.12	0.28	2.50	6.25	4.25	11.25	3.25	6.25	6.50	4.50	11.50	3.50
3	8.25	1.25	0.31	3.00	6.75	4.75	12.50	3.75	6.75	7.00	5.00	12.75	4.00
3½	9.00	1.38	0.34	3.50	7.25	5.25	13.75	4.25	7.25	7.50	5.50	14.00	4.50
4	10.75	1.50	0.38	4.00	8.25	5.75	16.25	4.25	8.25	8.50	6.00	16.50	4.50
5	13.00	1.75	0.44	5.00	9.75	6.75	19.25	5.75	9.75	10.00	7.00	19.50	6.00
6	14.00	1.88	0.50	6.00	10.75	7.25	20.75	6.25	10.75	11.00	7.50	21.00	6.50
8	16.50	2.19	0.62	7.88	12.75	8.25	24.25	6.75	12.75	13.00	8.50	24.50	7.00
10	20.00	2.50	0.75	9.75	15.25	9.25	29.25	7.75	15.25	15.50	9.50	29.50	8.00
12	22.00	2.62	0.91	11.75	16.25	9.75	31.25	8.25	16.25	16.50	10.00	31.50	8.50
14	23.75	2.75	0.97	12.88	17.25	10.50	34.00	8.75	17.25	17.50	10.75	34.25	9.00
16	27.00	3.00	1.09	14.75	19.25	11.50	38.25	9.75	19.25	19.50	11.75	38.50	10.00
18	29.25	3.25	1.22	16.50	21.25	12.00	41.75	10.25	21.25	21.50	12.25	42.00	10.50
20	32.00	3.50	1.34	18.25	23.25	12.75	45.25	10.75	23.25	23.50	13.00	45.50	11.00
24	37.00	4.00	1.59	22.00	27.25	14.50	52.75	12.75	27.25	27.50	14.75	53.00	13.00

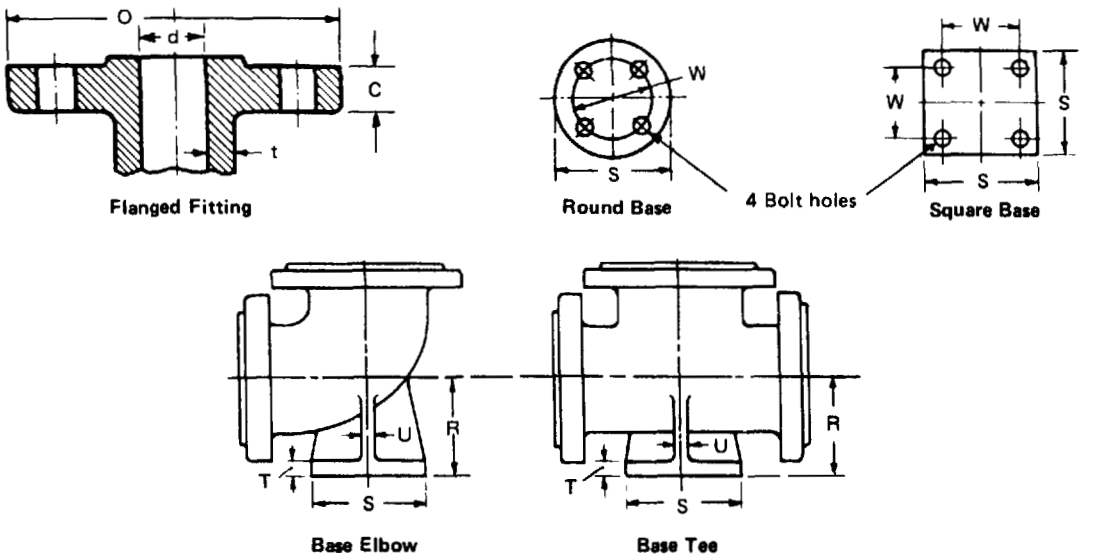


TABLE 19 DIMENSIONS OF CLASS 600 FLANGED FITTINGS[1-8] (CONT'D)

15	16	17	18	19	20	21	22	23	24	25	26	1
0.25 in. Raised Face (9)	Ring Joint (9)									Base Drilling (16)		
Contact Surface-to-Contact Surface of Raised Face Reducer (10) GG	Center-to-End Elbow Tee Cross and True "Y" (11) HH	Center-to-End 45 deg. Elbow (11) KK	Long Center-to-End Lateral (11) LL	Short Center-to-End Lateral and True "Y" (11) MM	End-to-End Reducer NN	Center-to-Base [(12)–(14)] R	Diameter of Round Base or Width of Square Base (12) S	Thickness of Base [(12), (15)] T	Thickness of Ribs (12) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
5.00	3.22	1.97	5.72	1.72		...	...	...	...	...	...	½
5.00	3.75	2.50	6.75	2.00		...	...	...	...	...	...	¾
5.00	4.25	2.50	7.25	2.25		...	...	...	...	...	...	1
5.00	4.50	2.75	8.00	2.50		...	...	...	...	...	...	1¼
5.00	4.75	3.00	9.00	2.75		...	...	...	...	...	...	1½
6.00	5.81	4.31	10.31	3.56		4.75	6.12	0.81	0.62	4.50	0.88	2
6.75	6.56	4.56	11.56	3.56		5.25	6.12	0.81	0.62	4.50	0.88	2½
7.25	7.06	5.06	12.81	4.06		5.75	6.50	0.88	0.75	5.00	0.75	3
7.75	7.56	5.56	14.06	4.56		6.50	6.50	0.88	0.75	5.00	0.75	3½
8.75	8.56	6.06	16.56	4.56		7.00	7.50	1.00	0.75	5.88	0.88	4
10.25	10.06	7.06	19.56	6.06		8.25	10.00	1.25	0.75	7.88	0.88	5
11.25	11.06	7.56	21.06	6.56		9.00	10.00	1.25	0.75	7.88	0.88	6
13.25	13.06	8.56	24.56	7.06		11.00	12.50	1.44	1.00	10.62	0.88	8
15.75	15.56	9.56	29.56	8.06		12.50	12.50	1.44	1.00	10.62	0.88	10
16.75	16.56	10.06	31.56	8.56		13.25	15.00	1.62	1.12	13.00	1.00	12
17.75	17.56	10.81	34.31	9.06		14.75	15.00	1.62	1.12	13.00	1.00	14
19.75	19.56	11.81	38.56	10.06		16.00	15.00	1.62	1.25	13.00	1.00	16
21.75	21.56	12.31	42.06	10.56		...	...	...	...	...	...	18
23.75	23.62	13.12	45.62	11.12		...	...	...	...	...	...	20
27.75	27.69	14.94	53.19	13.19		...	...	...	...	...	...	24

See Notes (10) and (11)

(Notes follow on next page)

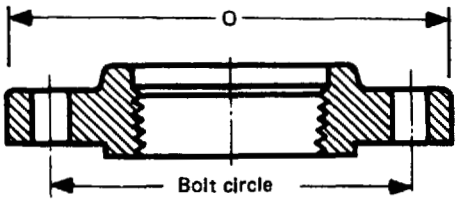
TABLE 19 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

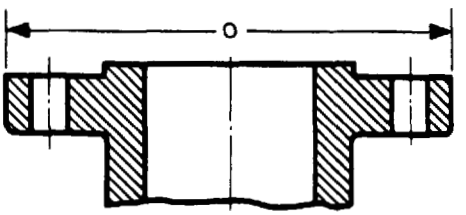
NOTES:

(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 17.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(10) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(11) These dimensions apply to straight sizes only. (See paras. 6.2.3 and 6.3.1.3.) For the center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-flange edge or flange edge-to-flange edge dimensions for largest opening, and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.
(12) The base dimensions apply to all straight and reducing sizes.
(13) For reducing fittings the size and center-to-face dimensions of base are determined by the size of the largest opening of fitting. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(14) Bases shall be plain faced unless otherwise specified, and the center-to-base face dimension R shall be the finished dimensions.
(15) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(16) The bolt hole template for round base is the same as for Class 300 flanges, Table 11, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

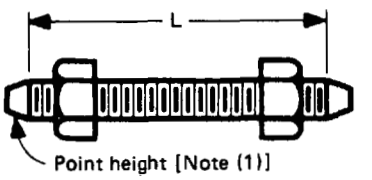
CLASS 900 PIPE FLANGES, AND FLANGED FITTINGS



Flange



Flanged Fitting



Stud Bolt With Nuts

TABLE 20 TEMPLATES FOR DRILLING CLASS 900 FLANGES[2]

1	2	3	4	5	6	7	8	9
		Drilling [(3), (4)]				Length of Bolts [(1), (5)] L		
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.25 in. Raised Face	Male and Female; also Tongue and Groove	Ring Joint
½ ¾ 1 1¼ 1½ 2 2½	Use Class 1500 dimensions in these sizes.							
3	9.50	7.50	1.00	8	⅞	5.75	5.50	5.75
4	11.50	9.25	1.25	8	1⅛	6.75	6.50	6.75
5	13.75	11.00	1.38	8	1¼	7.50	7.25	7.50
6	15.00	12.50	1.25	12	1⅛	7.50	7.25	7.75
8	18.50	15.50	1.50	12	1⅜	8.75	8.50	8.75
10	21.50	18.50	1.50	16	1⅜	9.25	9.00	9.25
12	24.00	21.00	1.50	20	1⅜	10.00	9.75	10.00
14	25.25	22.00	1.62	20	1½	10.75	10.50	11.00
16	27.75	24.25	1.75	20	1⅝	11.25	11.00	11.50
18	31.00	27.00	2.00	20	1⅞	12.75	12.50	13.25
20	33.75	29.50	2.12	20	2	13.75	13.50	14.25
24	41.00	35.50	2.62	20	2½	17.25	17.00	18.00

(Notes follow on next page)

TABLE 20 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 21 and 22.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.

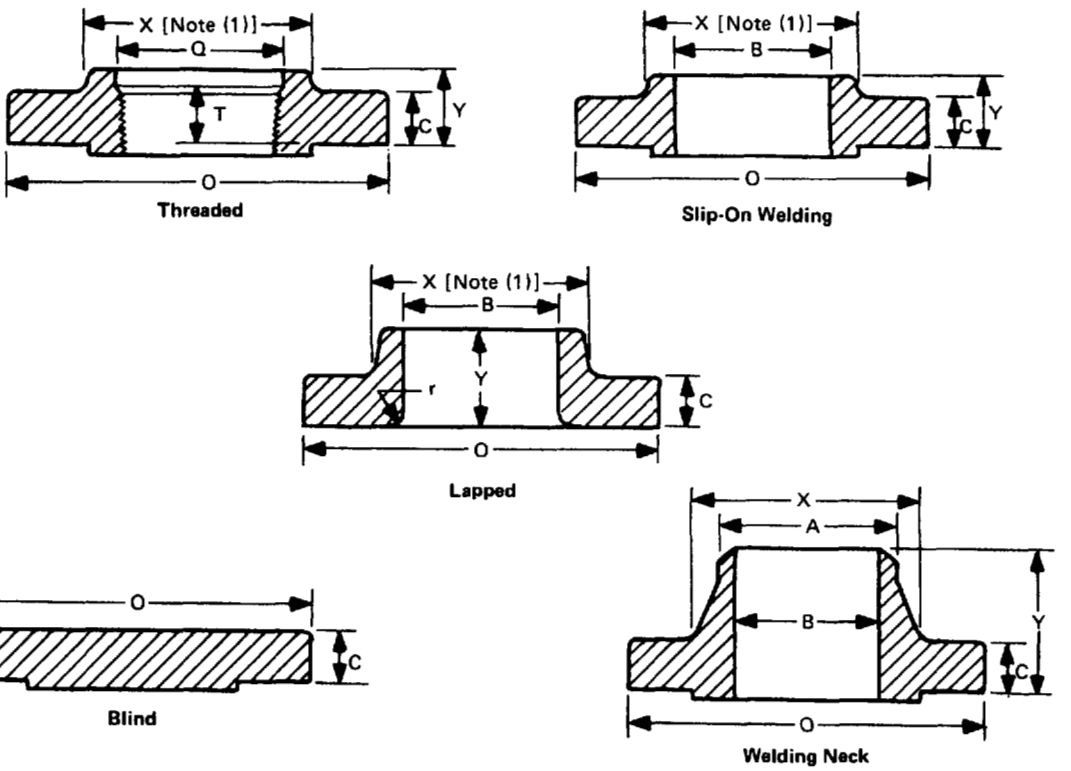


TABLE 21 DIMENSIONS OF CLASS 900 FLANGES[2–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Length Through Hub				Bore				
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (9) A	Threaded Slip-On Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (10), Min. T	Slip-On Min. B	Lapped, Min. B	Welding Neck B	Corner Radius of Bore of Lapped Flange and Pipe r	Counterbore Threaded Flange, Min. Q
½ ¾ 1 1¼ 1½ 2 2½	Use Class 1500 dimensions in these sizes (11).												
3	9.50	1.50	5.00	3.50	2.12	2.12	4.00	1.62	3.57	3.60	To be specified by purchaser.	0.38	3.63
4	11.50	1.75	6.25	4.50	2.75	2.75	4.50	1.88	4.57	4.60		0.44	4.63
5	13.75	2.00	7.50	5.56	3.12	3.12	5.00	2.12	5.66	5.69		0.44	5.69
6	15.00	2.19	9.25	6.63	3.38	3.38	5.50	2.25	6.72	6.75		0.50	6.75
8	18.50	2.50	11.75	8.63	4.00	4.50	6.38	2.50	8.72	8.75		0.50	8.75
10	21.50	2.75	14.50	10.75	4.25	5.00	7.25	2.81	10.88	10.92		0.50	10.88
12	24.00	3.12	16.50	12.75	4.62	5.62	7.88	3.00	12.88	12.92		0.50	12.94
14	25.25	3.38	17.75	14.00	5.12	6.12	8.38	3.25	14.14	14.18		0.50	14.19
16	27.75	3.50	20.00	16.00	5.25	6.50	8.50	3.38	16.16	16.19		0.50	16.19
18	31.00	4.00	22.25	18.00	6.00	7.50	9.00	3.50	18.18	18.20		0.50	18.19
20	33.75	4.25	24.50	20.00	6.25	8.25	9.75	3.62	20.20	20.25		0.50	20.19
24	41.00	5.50	29.50	24.00	8.00	10.50	11.50	4.00	24.25	24.25		0.50	24.19

(Notes follow on next page)

TABLE 21 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, socket welding, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 20.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the manufacturer's option.
(8) For reducing welding neck flanges, see para. 6.8.
(9) For welding end bevel, see para. 6.7.
(10) For threads in threaded flanges, see para. 6.9.
(11) Socket welding flanges may be provided in NPS ½ through 2½ using Class 1500 dimensions.

Table 22 begins on next page

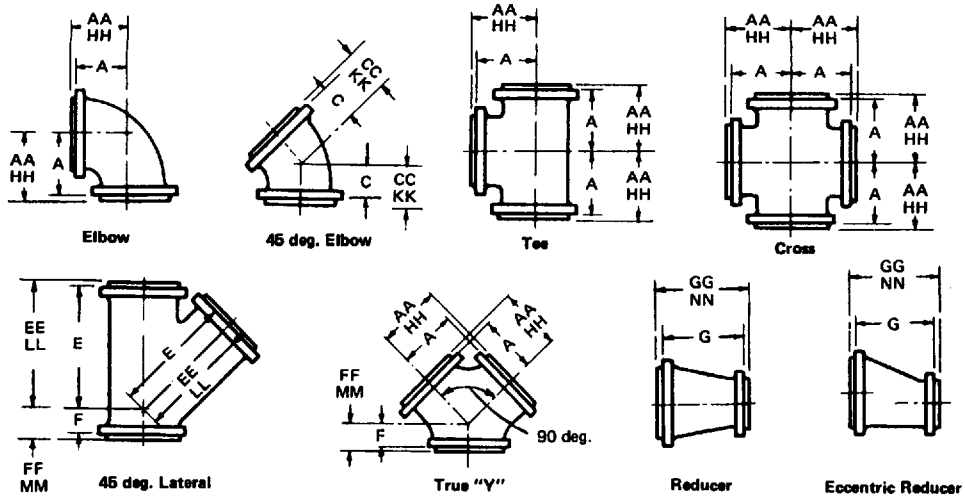
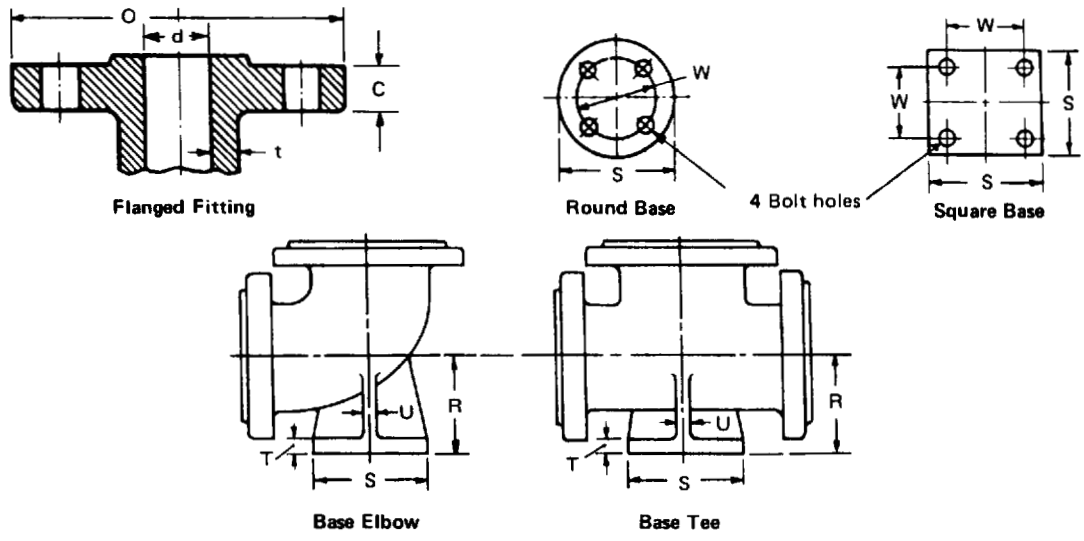


TABLE 22 DIMENSIONS OF CLASS 900 FLANGED FITTINGS[1–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Flange Edge					0.25 in. Rasied Face (9)			
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting d	Center-to-Flange Edge Elbow, Tee, Cross, and True "Y" A	Center-to-Flange Edge 45 deg. Elbow C	Long Center-to-Flange Edge Lateral E	Short Center-to-Flange Edge Lateral and True "Y" F	Flange Edge-to-Flange Edge Reducer G	Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF
½	4.75	0.88	0.16	0.50									
¾	5.12	1.00	0.19	0.69									
1	5.88	1.12	0.22	0.88									
1¼	6.25	1.12	0.25	1.12									
					Use Class 1500 dimensions in these sizes.								
1½	7.00	1.25	0.28	1.38									
2	8.50	1.50	0.31	1.88									
2½	9.62	1.62	0.34	2.25									
3	9.50	1.50	0.41	2.88	7.25	5.25	14.25	4.25	7.25	7.50	5.50	14.50	4.50
4	11.50	1.75	0.50	3.88	8.75	6.25	17.25	5.25	8.75	9.00	6.50	17.50	5.50
5	13.75	2.00	0.59	4.75	10.75	7.25	20.75	6.25	10.75	11.00	7.50	21.00	6.50
6	15.00	2.19	0.72	5.75	11.75	7.75	22.25	6.25	11.75	12.00	8.00	22.50	6.50
8	18.50	2.50	0.88	7.50	14.25	8.75	27.25	7.25	14.25	14.50	9.00	27.50	7.50
10	21.50	2.75	1.06	9.38	16.25	9.75	31.25	8.25	16.25	16.50	10.00	31.50	8.50
12	24.00	3.12	1.25	11.12	18.75	10.75	34.25	8.75	17.25	19.00	11.00	34.50	9.00
14	25.25	3.38	1.38	12.25	20.00	11.25	36.25	9.25	18.50	20.25	11.50	36.50	9.50
16	27.75	3.50	1.56	14.00	22.00	12.25	40.50	10.25	20.50	22.25	12.50	40.75	10.25
18	31.00	4.00	1.75	15.75	23.75	13.00	45.25	11.75	24.00	24.00	13.25	45.50	12.00
20	33.75	4.25	1.91	17.50	25.75	14.25	50.00	12.75	26.00	26.00	14.50	50.25	13.00
24	41.00	5.50	2.28	21.00	30.25	17.75	59.75	15.25	30.00	30.50	18.00	60.00	15.50



Flanged Fitting | Round Base | Square Base | Base Elbow | Base Tee

TABLE 22 DIMENSIONS OF CLASS 900 FLANGED FITTINGS[1-8] (CONT'D)

15	16	17	18	19	20	21	22	23	24	25	26	1
0.25 in. Raised Face (9)	Ring Joint (9)									Base Drilling (16)		
Contact Surface-to-Contact Surface of Raised Face Reducer (10) GG	Center-to-End Elbow, Tee, Cross, and True "Y" (11) HH	Center-to-End 45 deg. Elbow (11) KK	Long Center-to-End Lateral (11) LL	Short Center-to-End Lateral and True "Y" (11) MM	End-to-End Reducer NN	Center-to-Base [(12)–(13)] R	Diameter of Round Base or Width of Square Base (14) S	Thickness of Base [(14), (15)] T	Thickness of Ribs (14) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
Use Class 1500 dimensions in these sizes.												½ ¾ 1 1¼ 1½ 2 2½
7.75	7.56	5.56	14.56	4.56	See Notes (10) and (11).	5.75	6.50	0.88	0.75	5.00	0.75	3
9.25	9.06	6.56	17.56	5.56		7.00	7.50	1.00	0.75	5.88	0.88	4
11.25	11.06	7.56	21.06	6.56		8.25	10.00	1.25	0.75	7.88	0.88	5
12.25	12.06	8.06	22.56	6.56		9.00	10.00	1.25	0.75	7.88	0.88	6
14.75	14.56	9.06	27.56	7.56		11.00	12.50	1.44	1.00	10.62	0.88	8
16.75	16.56	10.06	31.56	8.56		12.50	12.50	1.44	1.00	10.62	0.88	10
17.75	19.06	11.06	34.56	9.06		13.25	15.00	1.62	1.12	13.00	1.00	12
19.00	20.44	11.69	36.69	9.69		14.75	15.00	1.62	1.12	13.00	1.00	14
21.00	22.44	12.69	40.94	10.69		16.00	15.00	1.62	1.25	13.00	1.00	16
24.50	24.25	13.50	45.75	12.25		...	...	...	...	...	...	18
26.50	26.25	14.75	50.50	13.25		...	...	...	...	...	...	20
30.50	30.88	18.38	60.38	15.88		...	...	...	...	...	...	24

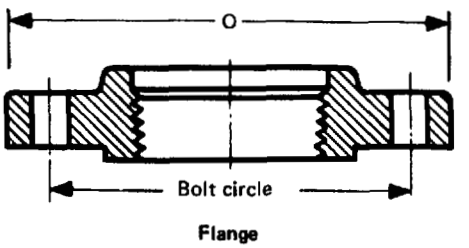
(Notes follow on next page)

TABLE 22 (CONT'D)

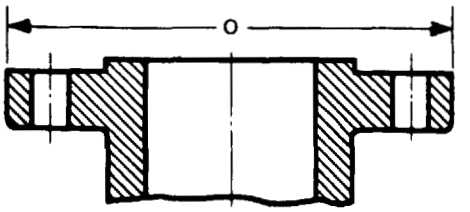
GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 20.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(10) For contact surface-to-contact surface and center-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(11) These dimensions apply to straight sizes only. (See paras. 6.2.3 and 6.3.1.3.) For the center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-flange edge or flange edge-to-flange edge dimensions for largest opening, and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.
(12) For reducing fittings, the size and center-to-face dimensions of base are determined by the size of the largest opening of fitting. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(13) Bases shall be plain faced unless otherwise specified, and the center-to-base face dimension R shall be the finished dimension.
(14) The base dimensions apply to all straight and reducing sizes.
(15) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(16) The bolt hole template for round base is the same as for Class 300 flanges, Table 11, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

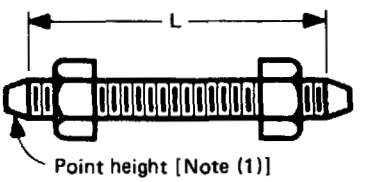
CLASS 1500 PIPE FLANGES, AND FLANGED FITTINGS



Flange



Flanged Fitting



Stud Bolt With Nuts

TABLE 23 TEMPLATES FOR DRILLING CLASS 1500 FLANGES[2]

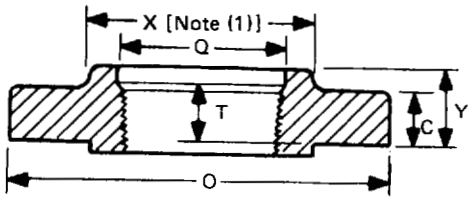
1	2	3	4	5	6	7	8	9
		Drilling [(3), (4)]				Length of Bolts [(1), (5)] L		
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.25 in. Raised Face	Male and Female; also Tongue and Groove	Ring Joint
1/2	4.75	3.25	0.88	4	3/4	4.25	4.00	4.25
3/4	5.12	3.50	0.88	4	3/4	4.50	4.25	4.50
1	5.88	4.00	1.00	4	7/8	5.00	4.75	5.00
1 1/4	6.25	4.38	1.00	4	7/8	5.00	4.75	5.00
1 1/2	7.00	4.88	1.12	4	1	5.50	5.25	5.50
2	8.50	6.50	1.00	8	7/8	5.75	5.50	5.75
2 1/2	9.62	7.50	1.12	8	1	6.25	6.00	6.25
3	10.50	8.00	1.25	8	1 1/8	7.00	6.75	7.00
4	12.25	9.50	1.38	8	1 1/4	7.75	7.50	7.75
5	14.75	11.50	1.62	8	1 1/2	9.75	9.50	9.75
6	15.50	12.50	1.50	12	1 3/8	10.25	10.00	10.50
8	19.00	15.50	1.75	12	1 5/8	11.50	11.25	12.75
10	23.00	19.00	2.00	12	1 7/8	13.25	13.00	13.50
12	26.50	22.50	2.12	16	2	14.75	14.50	15.25
14	29.50	25.00	2.38	16	2 1/4	16.00	15.75	16.75
16	32.50	27.75	2.62	16	2 1/2	17.50	17.25	18.50
18	36.00	30.50	2.88	16	2 3/4	19.50	19.25	20.75
20	38.75	32.75	3.12	16	3	21.25	21.00	22.25
24	46.00	39.00	3.62	16	3 1/2	24.25	24.00	25.50

(Notes follow on next page)

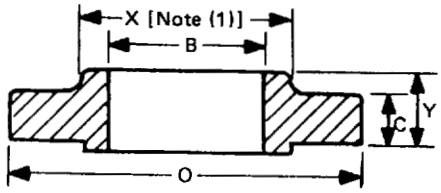
TABLE 23 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

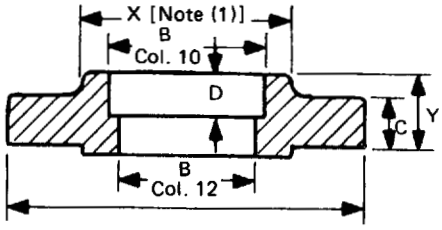
NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 24 and 25.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.



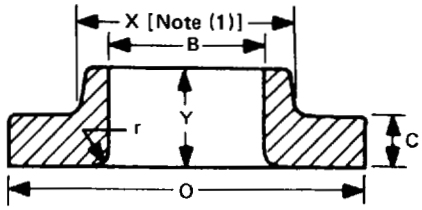
Threaded (1/2 to 2-1/2 only)



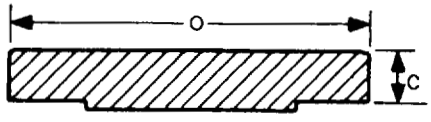
Slip-On-Welding (1/2 to 2-1/2 only)



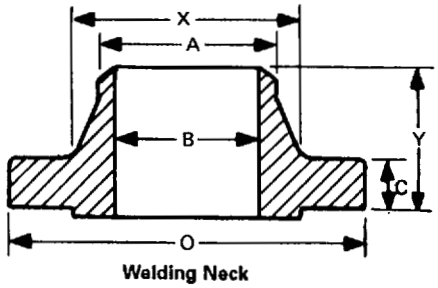
Socket Welding (1/2 to 2-1/2 only)



Lapped



Blind



Welding Neck

TABLE 24 DIMENSIONS OF CLASS 1500 FLANGES[2-8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
					Length Through Hub				Bore					
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (9) A	Threaded Slip-On Socket Welding Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (10), Min. T	Slip-On Socket Welding, Min. B	Lapped, Min. B	Welding Neck Socket Welding B	Corner Radius of Bore of Lapped Flange and Pipe r	Counterbore Threaded Flange, Min. Q	Depth of Socket D
½	4.75	0.88	1.50	0.84	1.25	1.25	2.38	0.88	0.88	0.90		0.12	0.93	0.38
¾	5.12	1.00	1.75	1.05	1.38	1.38	2.75	1.00	1.09	1.11		0.12	1.14	0.44
1	5.88	1.12	2.06	1.32	1.62	1.62	2.88	1.12	1.36	1.38		0.12	1.41	0.50
1¼	6.25	1.12	2.50	1.66	1.62	1.62	2.88	1.19	1.70	1.72		0.19	1.75	0.56
1½	7.00	1.25	2.75	1.90	1.75	1.75	3.25	1.25	1.95	1.97		0.25	1.99	0.62
2	8.50	1.50	4.12	2.38	2.25	2.25	4.00	1.50	2.44	2.46		0.31	2.50	0.69
2½	9.62	1.62	4.88	2.88	2.50	2.50	4.12	1.88	2.94	2.97		0.31	3.00	0.75
3	10.50	1.88	5.25	3.50	...	2.88	4.62	...	...	3.60		0.38	...	...
4	12.25	2.12	6.38	4.50	...	3.56	4.88	...	...	4.60		0.44	...	...
5	14.75	2.88	7.75	5.56	...	4.12	6.12	...	...	5.69		0.44	...	...
6	15.50	3.25	9.00	6.63	...	4.69	6.75	...	...	6.75		0.50	...	...
8	19.00	3.62	11.50	8.63	...	5.62	8.38	...	...	8.75		0.50	...	...
10	23.00	4.25	14.50	10.75	...	7.00	10.00	...	...	10.92		0.50	...	...
12	26.50	4.88	17.75	12.75	...	8.62	11.12	...	...	12.92		0.50	...	...
14	29.50	5.25	19.50	14.00	...	9.50	11.75	...	...	14.18		0.50	...	...
16	32.50	5.75	21.75	16.00	...	10.25	12.25	...	...	16.19		0.50	...	...
18	36.00	6.38	23.50	18.00	...	10.88	12.88	...	...	18.20		0.50	...	...
20	38.75	7.00	25.25	20.00	...	11.50	14.00	...	...	20.25		0.50	...	...
24	46.00	8.00	30.00	24.00	...	13.00	16.00	...	...	24.25		0.50	...	...

To be specified by purchaser.

(Notes follow on next page)

TABLE 24 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, socket welding, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 23.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the manufacturer's option.
(8) For reducing welding neck flanges, see para. 6.8.
(9) For welding end bevel, see para. 6.7.
(10) For threads in threaded flanges, see para. 6.9.

Table 25 begins on next page

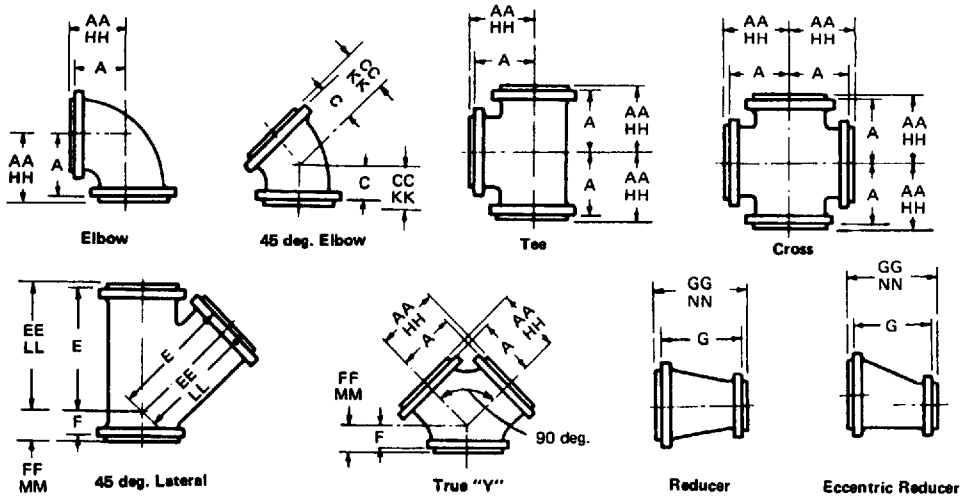


TABLE 25 DIMENSIONS OF CLASS 1500 FLANGED FITTINGS[1–8]

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Flange Edge					0.25 in. Raised Face (9)			
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting, d	Center-to-Flange Edge, Elbow, Tee, Cross, and True "Y" A	Center-to-Flange Edge 45 deg. Elbow C	Long Center-to-Flange Edge Lateral E	Short Center-to-Flange Edge Lateral and True "Y" F	Flange Edge-to-Flange Edge Reducer G	Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF
½	4.75	0.88	0.19	0.50	4.00	2.75	...	...	...	4.25	3.00	...	...
¾	5.12	1.00	0.23	0.69	4.25	3.00	...	...	...	4.50	3.25	...	...
1	5.88	1.12	0.26	0.88	4.75	3.25	8.75	2.25	4.50	5.00	3.50	9.00	2.50
1¼	6.25	1.12	0.31	1.12	5.25	3.75	9.75	2.75	5.25	5.50	4.00	10.00	3.00
1½	7.00	1.25	0.38	1.38	5.75	4.00	10.75	3.25	5.75	6.00	4.25	11.00	3.50
2	8.50	1.50	0.44	1.88	7.00	4.50	13.00	3.75	6.75	7.25	4.75	13.25	4.00
2½	9.62	1.62	0.50	2.25	8.00	5.00	15.00	4.25	7.75	8.25	5.25	15.25	4.50
3	10.50	1.88	0.62	2.75	9.00	5.50	17.00	4.75	8.75	9.25	5.75	17.25	5.00
4	12.25	2.12	0.75	3.62	10.50	7.00	19.00	5.75	10.25	10.75	7.25	19.25	6.00
5	14.75	2.88	0.91	4.38	13.00	8.50	23.00	7.25	13.25	13.25	8.75	23.25	7.50
6	15.50	3.25	1.09	5.38	13.62	9.12	24.62	7.88	14.00	13.88	9.38	24.88	8.12
8	19.00	3.62	1.41	7.00	16.12	10.62	29.62	8.88	16.50	16.38	10.88	29.88	9.12
10	23.00	4.25	1.72	8.75	19.25	11.75	35.75	10.00	19.75	19.50	12.00	36.00	10.25
12	26.50	4.88	2.00	10.38	22.00	13.00	40.50	11.75	22.50	22.25	13.25	40.75	12.00
14	29.50	5.25	2.19	11.38	24.50	14.00	43.75	12.25	25.25	24.75	14.25	44.00	12.50
16	32.50	5.75	2.50	13.00	27.00	16.00	48.00	14.50	27.75	27.25	16.25	48.25	14.75
18	36.00	6.38	2.81	14.62	30.00	17.50	53.00	16.25	31.00	30.25	17.75	53.25	16.50
20	38.75	7.00	3.12	16.38	32.50	18.50	57.50	17.50	33.50	32.75	18.75	57.75	17.75
24	46.00	8.00	3.72	19.62	38.00	20.50	67.00	20.25	39.25	38.75	20.75	67.25	20.50

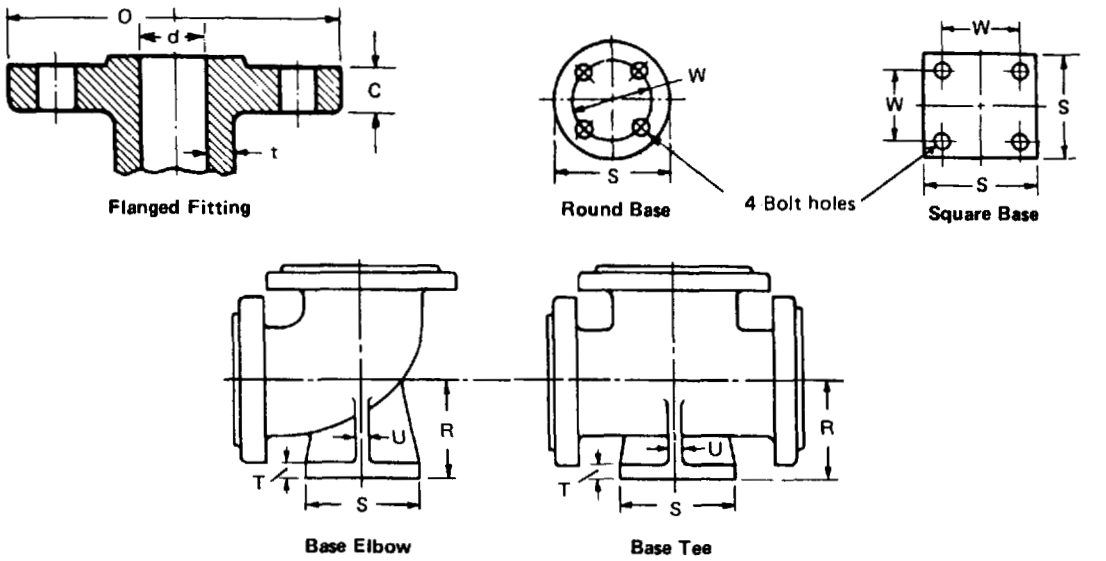


TABLE 25 DIMENSIONS OF CLASS 1500 FLANGED FITTINGS[1–8] (CONT'D)

15	16	17	18	19	20	21	22	23	24	25	26	1
0.25 in. Raised Face (9)	Ring Joint (9)									Base Drilling (16)		
Contact Surface-to-Contact Surface of Raised Face Reducer (10) GG	Center-to-End Elbow Tee Cross and True "Y" (11) HH	Center-to-End 45 deg. Elbow (11) KK	Long Center-to-End Lateral (11) LL	Short Center-to-End Lateral and True "Y" (11) MM	End-to-End Reducer NN	Center-to-Base [(12)–(14)] R	Diameter of Round Base or Width of Square Base (12) S	Thickness of Base [(12), (15)] T	Thickness of Ribs (12) U	Bolt Circle or Bolt Spacing W	Diameter of Drilled Holes	Nominal Pipe Size
...	4.25	3.00	...	...	See Notes (10) and (11)	...	...	...	...	...	...	½
...	4.50	3.25	...	...		...	...	...	...	...	...	¾
5.00	5.00	3.50	9.00	2.50		...	...	...	...	...	...	1
5.75	5.50	4.00	10.00	3.00		...	...	...	...	...	...	1¼
6.25	6.00	4.25	11.00	3.50		...	...	...	...	...	...	1½
7.25	7.31	4.81	13.31	4.06		5.50	6.50	0.88	0.75	5.00	0.75	2
8.25	8.31	5.31	15.31	4.56		6.00	6.50	0.88	0.75	5.00	0.75	2½
9.25	9.31	5.81	17.31	5.06		6.50	7.50	1.00	0.75	5.88	0.88	3
10.75	10.81	7.31	19.31	6.06		7.75	10.00	1.25	0.75	7.88	0.88	4
13.75	13.31	8.81	23.31	7.56		9.00	10.00	1.25	0.75	7.88	0.88	5
14.50	14.00	9.50	25.00	8.25		9.75	12.50	1.44	1.00	10.62	0.88	6
17.00	16.56	11.06	30.06	9.31		11.50	12.50	1.44	1.00	10.62	0.88	8
20.25	19.69	12.19	36.19	10.44		13.75	15.00	1.62	1.12	13.00	1.00	10
23.00	22.56	13.56	41.06	12.31		15.50	15.00	1.62	1.12	13.00	1.00	12
25.75	25.12	14.62	44.38	12.88		17.25	17.50	1.88	1.25	15.25	1.12	14
28.25	27.69	16.69	48.69	15.19		18.75	17.50	1.88	1.25	15.25	1.12	16
31.50	30.69	18.19	53.69	16.94		...	...	...	...	...	...	18
34.00	33.19	19.19	58.19	18.19		...	...	...	...	...	...	20
39.75	38.81	21.31	67.81	21.06		...	...	...	...	...	...	24

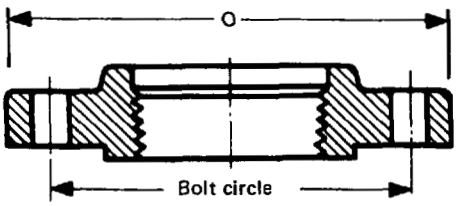
(Notes follow on next page)

TABLE 25 (CONT'D)

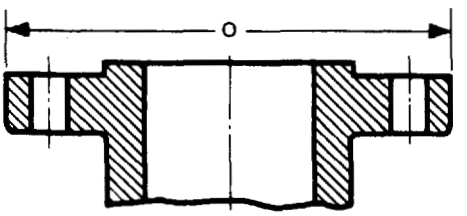
GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 23.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(10) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(11) These dimensions apply to straight sizes only. (See paras. 6.2.5 and 6.3.1.3.) For the center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-flange edge or flange edge-to-flange edge dimensions for largest opening, and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimension.
(12) The base dimensions apply to all straight and reducing sizes.
(13) For reducing fittings, the size and center-to-face dimensions of base are determined by the size of the largest opening of fitting. In the case of reducing base elbows, orders shall specify whether the base shall be opposite the larger or smaller opening.
(14) Bases shall be plain faced unless otherwise specified, and the center-to-base dimension R shall be the finished dimension.
(15) Bases may be cast integral or attached as weldments at the option of the manufacturer.
(16) The bolt hole template for round base is the same as for Class 300 flanges, Table 11, of corresponding outside diameter, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.

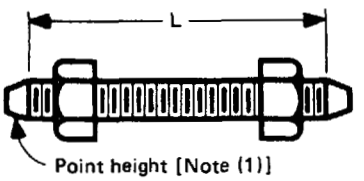
CLASS 2500 PIPE FLANGES, AND FLANGED FITTINGS



Flange



Flanged Fitting



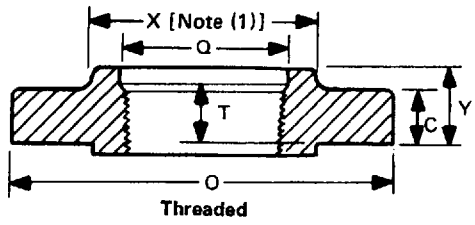
Stud Bolt With Nuts

TABLE 26 TEMPLATES FOR DRILLING CLASS 2500 FLANGES[2]

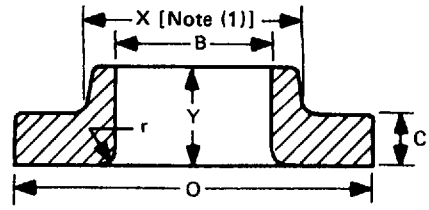
1	2	3	4	5	6	7	8	9
		Drilling [(3), (4)]				Length of Bolts [(1), (5)] L		
Nominal Pipe Size	Outside Diameter of Flange O	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts	0.25 in. Raised Face	Male and Female; also Tongue and Groove	Ring Joint
½	5.25	3.50	0.88	4	¾	4.75	4.50	4.75
¾	5.50	3.75	0.88	4	¾	5.00	4.75	5.00
1	6.25	4.25	1.00	4	⅞	5.50	5.25	5.50
1¼	7.25	5.12	1.12	4	1	6.00	5.75	6.00
1½	8.00	5.75	1.25	4	1⅛	6.75	6.50	6.75
2	9.25	6.75	1.12	8	1	7.00	6.75	7.00
2½	10.50	7.75	1.25	8	1⅛	7.75	7.50	8.00
3	12.00	9.00	1.38	8	1¼	8.75	8.50	9.00
4	14.00	10.75	1.62	8	1½	10.00	9.75	10.25
5	16.50	12.75	1.88	8	1¾	11.75	11.50	12.25
6	19.00	14.50	2.12	8	2	13.50	13.25	14.00
8	21.75	17.25	2.12	12	2	15.00	14.75	15.50
10	26.50	21.25	2.62	12	2½	19.25	19.00	20.00
12	30.00	24.38	2.88	12	2¾	21.25	21.00	22.00

GENERAL NOTE: Dimensions are in inches.

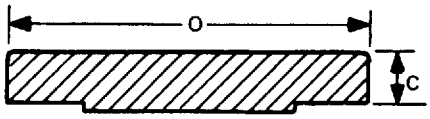
NOTES:
(1) Length of stud bolt does not include the height of the points. See para. 6.10.2.
(2) For other dimensions, see Tables 27 and 28.
(3) For flange bolt holes, see para. 6.5.
(4) For spot facing, see para. 6.6.
(5) Bolt lengths not shown in Table are determined in accordance with Annex F. See para. 6.10.2.



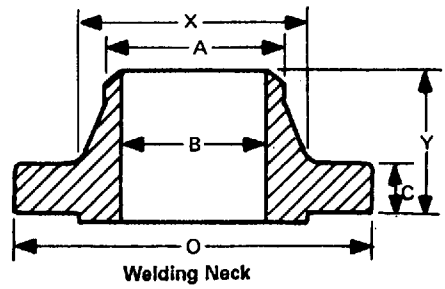
Threaded
(1/2 to 2-1/2 only)



Lapped



Blind



Welding Neck

TABLE 27 DIMENSIONS OF CLASS 2500 FLANGES[2-8]

1	2	3	4	5	6	7	8	9	10	11	12	13
					Length Through Hub				Bore			
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C	Diameter of Hub X	Hub Diameter Beginning of Chamfer Welding Neck (9) A	Threaded Y	Lapped Y	Welding Neck Y	Thread Length Threaded Flange (10), Min. T	Lapped, Min. B	Welding, Neck B	Corner Radius of Bore of Lapped Flange and Pipe r	Counterbore Threaded Flange, Min. Q
½	5.25	1.19	1.69	0.84	1.56	1.56	2.88	1.12	0.90		0.12	0.93
¾	5.50	1.25	2.00	1.05	1.69	1.69	3.12	1.25	1.11		0.12	1.14
1	6.25	1.38	2.25	1.32	1.88	1.88	3.50	1.38	1.38		0.12	1.41
1¼	7.25	1.50	2.88	1.66	2.06	2.06	3.75	1.50	1.72		0.19	1.75
1½	8.00	1.75	3.12	1.90	2.38	2.38	4.38	1.75	1.97		0.25	1.99
2	9.25	2.00	3.75	2.38	2.75	2.75	5.00	2.00	2.46		0.31	2.50
2½	10.50	2.25	4.50	2.88	3.12	3.12	5.62	2.25	2.97		0.31	3.00
3	12.00	2.62	5.25	3.50	...	3.62	6.62	...	3.60		0.38	...
4	14.00	3.00	6.50	4.50	...	4.25	7.50	...	4.60		0.44	...
5	16.50	3.62	8.00	5.56	...	5.12	9.00	...	5.69		0.44	...
6	19.00	4.25	9.25	6.63	...	6.00	10.75	...	6.75		0.50	...
8	21 75	5.00	12.00	8.63	...	7.00	12.50	...	8.75		0.50	...
10	26.50	6.50	14.75	10.75	...	9.00	16.50	...	10.92		0.50	...
12	30.00	7.25	17.38	12.75	...	10.00	18.25	...	12.92		0.50	...

To be specified by purchaser.

(Notes follow on next page)

TABLE 27 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) This dimension is for large end of hub, which may be straight or tapered. Taper shall not exceed 7 deg. on threaded, slip-on, socket welding, and lapped flanges.
(2) For tolerances, see Section 7.
(3) For facings, see para. 6.4.
(4) For flange bolt holes, see para. 6.5 and Table 26.
(5) For spot facing, see para. 6.6.
(6) For reducing threaded and slip-on flanges, see Table 7.
(7) Blind flanges may be made with or without hubs at the manufacturer's option.
(8) For reducing welding neck flanges, see para. 6.8.
(9) For welding end bevel, see para. 6.7.
(10) For threads in threaded flanges, see para. 6.9.

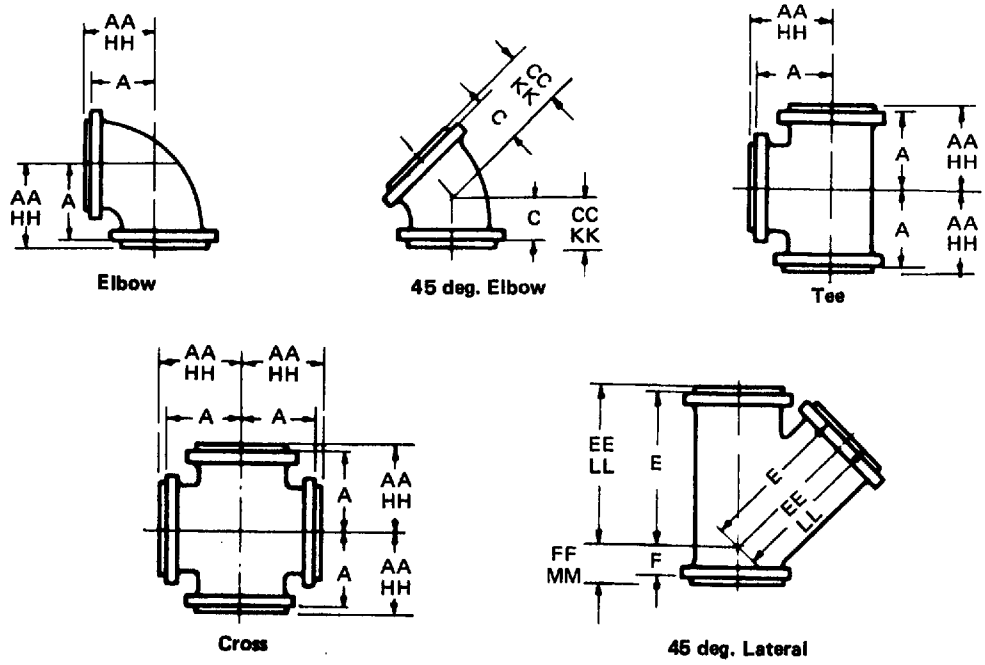
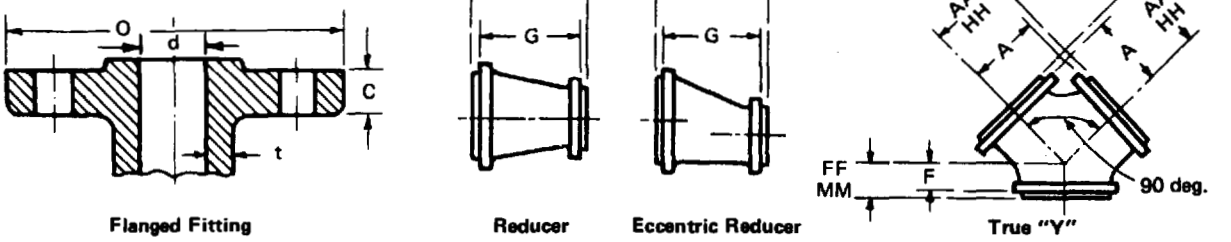


TABLE 28 DIMENSIONS OF CLASS 2500 FLANGED FITTINGS[1-8]

1	2	3	4	5	6	7	8	9	10
					Flange Edge				
Nominal Pipe Size	Outside Diameter of Flange O	Thickness of Flange, Min. C	Wall Thickness of Fitting, Min. t_m	Inside Diameter of Fitting, d	Center-to-Flange Edge, Elbow, Tee, Cross, and True "Y" A	Center-to-Flange Edge 45 deg. Elbow C	Long Center-to-Flange Edge Lateral E	Short Center-to-Flange Edge Lateral and True "Y" F	Flange Edge-to-Flange Edge Reducer G
½	5.25	1.19	0.25	0.44	4.94	...	...	...	...
¾	5.50	1.25	0.28	0.56	5.12	...	...	...	...
1	6.25	1.38	0.34	0.75	5.81	3.75	...	...	...
1¼	7.25	1.50	0.44	1.00	6.62	4.00	...	...	...
1½	8.00	1.75	0.50	1.12	7.31	4.50	...	...	...
2	9.25	2.00	0.62	1.50	8.62	5.50	15.00	5.00	9.00
2½	10.50	2.25	0.75	1.88	9.75	6.00	17.00	5.50	10.00
3	12.00	2.62	0.88	2.25	11.12	7.00	19.50	6.50	11.25
4	14.00	3.00	1.09	2.88	13.00	8.25	22.75	7.50	13.00
5	16.50	3.62	1.34	3.62	15.38	9.75	27.00	9.00	15.25
6	19.00	4.25	1.59	4.38	17.75	11.25	31.00	10.25	17.50
8	21.75	5.00	2.06	5.75	19.88	12.50	35.00	11.50	20.00
10	26.50	6.50	2.59	7.25	24.75	15.75	43.00	14.50	25.00
12	30.00	7.25	3.03	8.62	27.75	17.50	49.00	16.00	28.50



Flanged Fitting | Reducer | Eccentric Reducer | True "Y"

TABLE 28 DIMENSIONS OF CLASS 2500 FLANGED FITTINGS[1-8] (CONT'D)

11	12	13	14	15	16	17	18	19	20	1
0.25 in. Raised Face (9)					Ring Joint (9)					
Center-to-Contact Surface of Raised Face Elbow, Tee, Cross, and True "Y" AA	Center-to-Contact Surface of Raised Face 45 deg. Elbow CC	Long Center-to-Contact Surface of Raised Face Lateral EE	Short Center-to-Contact Surface of Raised Face Lateral and True "Y" FF	Contact Surface-to-Contact Surface of Raised Face Reducer (10) GG	Center-to-End Elbow, Tee Cross, and True "Y" (11) HH	Center-to-End 45 deg. Elbow (11) KK	Long Center-to-End Lateral (11) LL	Short Center-to-End Lateral and True "Y" (11) MM	End-to-End Reducer NN	Nominal Pipe Size
5.19	...	...	...	...	5.19	...	...	...	See Notes (10) and (11)	½
5.37	...	...	...	...	5.19	...	...	...		¾
6.06	4.00	...	...	...	6.06	4.00	...	...		1
6.87	4.25	...	...	...	6.94	4.31	...	...		1¼
7.56	4.75	...	...	...	7.62	4.81	...	...		1½
8.87	5.75	15.25	5.25	9.50	8.94	5.81	15.31	5.31		2
10.00	6.25	17.25	5.75	10.50	10.12	6.38	17.38	5.88		2½
11.37	7.25	19.75	6.75	11.75	11.50	7.38	19.88	6.88		3
13.25	8.50	23.00	7.75	13.50	13.44	8.69	23.19	7.94		4
15.62	10.00	27.25	9.25	15.75	15.88	10.25	27.50	9.50		5
18.00	11.50	31.25	10.50	18.00	18.25	11.75	31.50	10.75		6
20.12	12.75	35.25	11.75	20.50	20.44	13.06	35.56	12.06		8
25.00	16.00	43.25	14.75	25.50	25.44	16.44	43.69	15.19		10
28.00	17.75	49.25	16.25	29.00	28.44	18.19	49.69	16.62		12

(Notes follow on next page)

TABLE 28 (CONT'D)

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) For tolerances, see Section 7.
(2) For facings, see para. 6.4.
(3) For flange bolt holes, see para. 6.5 and Table 26.
(4) For spot facing, see para. 6.6.
(5) For intersecting center lines, center-to-contact surface, and center-to-end dimensions of side outlet fittings, see para. 6.2.4.
(6) For center-to-contact surface and center-to-end dimensions of special degree elbows, see para. 6.2.5.
(7) For reinforcement of certain fittings, see para. 6.1.
(8) For drains, see para. 6.12.
(9) For center-to-contact surface and center-to-end dimensions of reducing fittings, see para. 6.2.3.
(10) For contact surface-to-contact surface and end-to-end dimensions of reducers and eccentric reducers, see para. 6.2.3.
(11) These dimensions apply to straight sizes only. (See paras. 6.2.3 and 6.4.1.3.) For the center-to-end dimensions of reducing fittings or end-to-end dimensions of reducers, use center-to-flange edge or flange edge-to-flange edge dimensions for largest opening, and add the proper height to provide for ring joint groove applying to each flange. See Table 5 for ring joint facing dimensions.

ANNEX A

THREADING OF PIPE FOR AMERICAN NATIONAL STANDARD THREADED FLANGES

(This Annex is an integral part of ASME B16.5-1996 and is placed after the main text for convenience.)

The length of external taper threads in ASME B1.20.1 is sufficient to provide a satisfactory joint when assembled with corresponding internal taper threads in couplings and fittings. In this Standard, the length of internal thread in Class 150, Class 300, and Class 400 flanges also conforms to ASME B1.20.1.

In Class 600 and higher rated flanges, the length through the hub may exceed the length for internal threads in ASME B1.20.1. Where this occurs, the extended length of internal threads follows the taper of the standard taper threads. Therefore, the diameters of the extra threads are smaller than those shown in ASME B1.20.1.

When threaded flanges conforming to this Standard are assembled with threaded-end pipe, it is intended that the end of the pipe be reasonably close to the mating surface of the flange. To meet this intent, the following requirements are imposed on the mating pipe and external thread.

(1) Pipe to be threaded into flanges of Class 600 or higher rating shall be Schedule 80 or heavier in wall thickness.

(2) The length of external effective thread on the pipe end shall be greater than specified in ASME B1.20.1. When tested with the standard ring gage, the pipe end shall project beyond the gage by the distance specified in Table A1, subject to a tolerance of one thread pitch as provided in ASME B1.20.1.

(3) The extra threads shall continue the taper specified in ASME B1.20.1, so that the pitch diameter of the thread at the pipe end is less than specified therein.

(4) It is recommended that power equipment be used to assemble threaded joints having longer than standard taper threads, in order to bring the pipe end close to the flange face.

TABLE A1 PROJECTION OF THREADED PIPE END THROUGH RING GAGE BY FLANGE PRESSURE RATING CLASSES

Nominal Pipe Size	150, 300, 400	600		900		1500		2500	
	Number of Turns	Number of Turns	in.	Number of Turns	in.	Number of Turns	in.	Number of Turns	in.
½	...	Use taper pipe thread per ASME B1.20.1 in these sizes.		...	...	3½	0.25	7	0.50
¾	...			...		5	0.35	7	0.50
1	...			...	...	5	0.44	7½	0.65
1¼	...			...	...	5	0.44	7½	0.65
1½	...			...	...	5	0.44	7½	0.65
2	...			...	...	5	0.44	7½	0.65
2½	...			...	...	5	0.62	8	1.00
3	...	1	0.12	3	0.38	6	0.75	10	1.25
3½	...	1	0.12	...	...	...	...	...	...
4	...	1½	0.19	3½	0.44	6½	0.81	10½	1.31
5		1½	0.19	3½	0.44	6½	0.81	10½	1.31
6		1½	0.19	3½	0.44	7½	0.94	11½	1.44
8		2	0.25	4	0.50	8	1.00	14	1.75
10	Use taper pipe thread per ASME B1.20.1.	3	0.38	5	0.62	9	1.12	15	2.00
12		3	0.38	5	0.62	10	1.25	19	2.38
14		3	0.38	6	0.75	...	...	...	...
16		3	0.38	6	0.75	...	...	...	...
18		3	0.38	6	0.75	...	...	...	...
20		3	0.38	6	0.75	...	...	...	...
24		3	0.38	6	0.75	...	...	...	...

ANNEX B
DIMENSIONS OF STEEL PIPE (TABLE BY WEIGHT CLASS)

(This Annex is not part of ASME B16.5-1996 and is included for information only.)

TABLE B1 DIMENSIONS OF WELDED AND SEAMLESS STEEL PIPE (ASME B36.10M)
Listed as Standard Wall, Extra Strong, and Double Extra Strong Wall

Nominal Pipe Size	Outside Diameter, in.	Wall Thickness, in.		
		Standard Wall	Extra Strong Wall	Double Extra Strong Wall
1/8	0.405	**0.068**	**0.095**	. . .
1/4	0.540	**0.088**	**0.119**	. . .
3/8	0.675	**0.091**	**0.126**	. . .
1/2	0.840	**0.109**	**0.147**	0.294
3/4	1.050	**0.113**	**0.154**	0.308
1	1.315	**0.133**	**0.179**	0.358
1 1/4	1.660	**0.140**	**0.191**	0.362
1 1/2	1.900	**0.145**	**0.200**	0.400
2	2.375	**0.154**	**0.218**	0.436
2 1/2	2.875	**0.203**	**0.276**	0.522
3	3.500	**0.216**	**0.300**	0.600
3 1/2	4.000	**0.226**	**0.318**	. . .
4	4.500	**0.237**	**0.337**	0.674
5	5.563	**0.258**	**0.375**	0.750
6	6.625	**0.280**	**0.432**	0.864
8	8.625	**0.322**	**0.500**	0.875
10	10.750	**0.365**	**0.500**	1.000
12	12.750	0.375	0.500	1.000
14	14.000	**0.375**	0.500	. . .
16	16.000	**0.375**	**0.500**	. . .
18	18.000	0.375	0.500	. . .
20	20.000	**0.375**	**0.500**	. . .
24	24.000	**0.375**	0.500	. . .

GENERAL NOTES:

(a) The decimal thicknesses listed for the respective sizes represent their nominal dimensions as given in ASME B36.10M. For tolerances on wall thicknesses, see appropriate material specifications.

(b) Thicknesses shown in bold face type for Standard Wall are identical with corresponding thicknesses shown in bold face type for Schedules 20, 30, and 40 in Annex C. Those shown in bold face type for Extra Strong Wall are identical with corresponding thicknesses shown in bold face type in Schedules 60 and 80 in Annex C. Double Extra Strong Wall has no corresponding schedule numbers.

ANNEX C
DIMENSIONS OF STEEL PIPE (TABLE BY SCHEDULES)

(This Annex is not part of ASME B16.5-1996 and is included for information only.)

TABLE C1 DIMENSIONS OF WELDED AND SEAMLESS STEEL PIPE (ASME B36.10M)
Listed by Schedule Numbers

Nominal Pipe Size	Outside Diameter, in.	Schedule 10	Schedule 20	Schedule 30	Schedule 40	Schedule 60	Schedule 80	Schedule 100	Schedule 120	Schedule 140	Schedule 160
		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1/8	0.405	...	...	...	**0.068**	...	**0.095**	...	...	...	...
1/4	0.540	...	...	...	**0.088**	...	**0.119**	...	...	...	...
3/8	0.675	...	...	...	**0.091**	...	**0.126**	...	...	...	...
1/2	0.840	...	...	...	**0.109**	...	**0.147**	...	...	...	0.188
3/4	1.050	...	...	...	**0.113**	...	**0.154**	...	...	...	0.219
1	1.315	...	...	...	**0.133**	...	**0.179**	...	...	...	0.250
1 1/4	1.660	...	...	...	**0.140**	...	**0.191**	...	...	...	0.250
1 1/2	1.900	...	...	...	**0.145**	...	**0.200**	...	...	...	0.281
2	2.375	...	...	...	**0.154**	...	**0.218**	...	...	...	0.344
2 1/2	2.875	...	...	...	**0.203**	...	**0.276**	...	...	...	0.375
3	3.500	...	...	...	**0.216**	...	**0.300**	...	...	...	0.438
3 1/2	4.000	...	...	...	**0.226**	...	**0.318**	...	...	...	...
4	4.500	...	...	...	**0.237**	...	**0.337**	...	0.438	...	0.531
5	5.563	...	...	...	**0.258**	...	**0.375**	...	0.500	...	0.625
6	6.625	...	...	...	**0.280**	...	**0.432**	...	0.562	...	0.719
8	8.625	...	0.250	0.277	**0.322**	0.406	**0.500**	0.594	0.719	0.812	0.906
10	10.750	...	0.250	0.307	**0.365**	**0.500**	0.594	0.719	0.844	1.000	1.125
12	12.750	...	0.250	0.330	0.406	0.562	0.688	0.844	1.000	1.125	1.312
14	14.000	0.250	0.312	**0.375**	0.438	0.594	0.750	0.938	1.094	1.250	1.406
16	16.000	0.250	0.312	**0.375**	**0.500**	0.656	0.844	1.031	1.219	1.438	1.594
18	18.000	0.250	0.312	0.438	0.562	0.750	0.938	1.156	1.375	1.562	1.781
20	20.000	0.250	**0.375**	**0.500**	0.594	0.812	1.031	1.281	1.500	1.750	1.969
24	24.000	0.250	**0.375**	0.562	0.688	0.969	1.219	1.531	1.812	2.062	2.344
30	30.000	0.312	0.500	0.625	...	...	...	...	...	...	...

GENERAL NOTES:

(a) The decimal thicknesses listed for the respective pipe sizes represent their nominal dimensions as given in ASME B36.10M. For tolerances on wall thicknesses, see appropriate material specifications.

(b) Thicknesses shown in bold face type for Schedules 20, 30, and 40 are identical with thicknesses shown in bold face type for Standard Wall pipe in Annex B. Those in bold face type Schedules 60 and 80 are identical with thicknesses in bold face type for Extra Strong Wall in Annex B.

(c) Some of the larger heavier wall sections are beyond the capabilities of seamless mill production and must be obtained from turned-and-bored billets or other sources.

ANNEX D
METHODS FOR ESTABLISHING PRESSURE–TEMPERATURE RATINGS

(This Annex is not part of ASME B16.5-1996 and is included for information only.)

D1 GENERAL

D1.1 Introduction

Pressure–temperature ratings in this Standard have been determined by the procedures in this Annex.

The primary consideration in establishing ratings is adequate wall thickness to sustain stresses due to pressure and other loadings. See para. D1.2. Other considerations affecting or limiting the ratings include:

(1) stresses in flanges resulting from bolt-up necessary to maintain gasket seal;

(2) distortion of flanges and flanged fittings due to loadings transmitted through the pipeline; and

(3) limitations applying primarily to valves but imposed also on flanges in order to maintain compatible ratings.

D1.2 Wall Thickness

Wall thickness requirements for flanged fittings are set forth in para. 6.1, and minimum thicknesses t_m are listed in the tables designated in para. 6.1. These values are all greater than those determined by Eq. (1):

$$t = 1.5\ P_c d/(2S - 1.2\ P_c) \qquad (1)$$

where

t = calculated thickness, in.
P_c = pressure rating class designation, psi (e.g., P_c = 150 psi for Class 150)
d = inside diameter of the fitting, in.
S = stress factor of 7000 psi

Equation (1) gives a thickness 50% greater than for a simple cylinder designed for a stress of 7000 psi when subjected to an internal pressure equal to the pressure rating class designation in pounds per square inch. Actual values in the dimension tables listed in para. 6.1 are approximately 0.1 in. to 0.2 in. heavier than those given by the equation.

D1.3 Material Groups

Material groups in Tables 1A are based on identical or closely matched allowable stress and yield strength values. Where they are not identical, the lower value has been applied.

Note that material groups are not numbered consecutively. Some groups are intended for use only in valves. See ASME B16.34.

D1.4 Material Properties

The allowable stress and yield strength values used to calculate the pressure–temperature ratings were taken from the ASME Boiler and Pressure Vessel Code, Section II, Part D. In addition, data has been provided directly by the ASME Boiler and Pressure Vessel Subcommittee on Materials.

D2 RATINGS IN CUSTOMARY UNITS

D2.1 Rating Equation

Ratings given in Table 2 in pounds per square inch (gage) at temperatures expressed in degrees Fahrenheit, for all materials and pressure classes, are established by Eq. (2):

$$P_T = P_r S_1/8750 \le P_c \qquad (2)$$

P_c = ceiling pressure, psig, as specified in D3 at temperature T
P_T = rated working pressure, psig, for the specified material at temperature T
P_r = pressure rating class index, psi[1] (e.g., P_r = 300 psi for Class 300)
S_1 = selected stress, psi, for the specified material at temperature T. See paras. D2.2, D2.3, and D2.4.

[1] This definition of P_r does not apply to Class 150. See para. D2.4.

D2.2 Ratings for Group No. 1 Materials, Class 300 and Higher

The selected stress S_1 for each Material Group among Group No. 1 materials in Table 1A is determined as follows:

(a) At temperatures below the creep range, S_1 shall be lowest of the following values:

(1) 60% of specified minimum yield strength at 100°F;

(2) 60% of the yield strength at temperature *T;*

(3) 1.25 times the allowable stress at temperature *T* as listed for ASME Boiler and Pressure Vessel Code, Section I;

(b) At temperatures in the creep range (defined as those above 700°F for Group No. 1 materials), S_1 shall be the lowest of the following values:

(1) 60% of the yield strength at temperature *T;*

(2) the allowable stress at Temperature *T* as listed for ASME Boiler and Pressure Vessel Code, Section I;

(c) In no case shall the value of S_1 increase with increasing temperature.

(d) Yield strength values for determination of values of S_1 shall be obtained from ASME Boiler and Pressure Vessel Code, Section II, Part D.

(e) Where more than one allowable stress value is listed for a material at any temperature, the lower values shall be used. If lower allowable stress values do not appear, and it is noted in the allowable stress table that the allowable stress values exceed two-thirds of the yield strength at temperature, then the allowable stress values shall be determined as two-thirds of the tabulated yield strength at temperature.

(f) Allowable stress values listed for ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, may be used only if the material is not listed for Section I. Allowable stress values listed for ASME Boiler and Pressure Vessel Code, Section III, Classes 2 and 3, may be used only if the material is not listed for either Section I or Section VIII, Division 1.

D2.3 Ratings for Group Nos. 2 and 3 Materials, Class 300 and Higher

The selected stress S_1 for each material group among Group Nos. 2 and 3 materials in Table 1A is determined as follows.

(a) At temperatures below the creep range, S_1 is determined in accordance with para. D2.2(a), except that 70% of yield strength shall be used, instead of 60%, in paras. D2.2(a)(1) and (2).

(b) At temperatures in the creep range (defined as those above 950°F for Group No. 2 materials), S_1 is determined in accordance with para. D2.2(b). For Group No. 3 materials, the creep range temperature limits shall be determined on an individual material basis.

(c) The limitations in paras. D2.2(c), (d), (e), and (f) apply.

D2.4 Ratings for Class 150, All Material Groups

Pressure–temperature ratings for Class 150 flanges and flanged fittings are determined for each Material Group as set forth in paras. D2.1, D2.2, and D2.3, with the following exceptions.

(a) The value of P_r in Eq. (2) (see para. D2.1) shall be 115 psi rather than 150 psi.

(b) The value for S_1 shall be in accordance with the requirements of paras. D2.1, D2.2, and D2.3.

(c) The value for P_T in Eq. (2) at temperature T (degrees Fahrenheit) shall not exceed that given by Eq. (3):

$$P_T = 320 - 0.3T \quad (3)$$

The limits of T in equation (3) are 100°F min. and 1000°F max. For values of T less than 100°F, T equal to 100°F is used.

D3 MAXIMUM RATINGS

D3.1 Maximum Ratings

A set of maximum or ceiling pressure–temperature ratings, P_c, are shown in Table D1. They are imposed to limit deflections.

TABLE D1 RATING CEILING VALUES

Temperature, °F	Working Pressure, psig. by Classes						
	150	300	400	600	900	1500	2500
−20 to 100	290	750	1000	1500	2250	3750	6250
200	260	750	1000	1500	2250	3750	6250
300	230	730	970	1455	2185	3640	6070
400	200	705	940	1410	2115	3530	5880
500	170	665	885	1330	1995	3325	5540
600	140	605	805	1210	1815	3025	5040
650	125	590	785	1175	1765	2940	4905
700	110	570	755	1135	1705	2840	4730
750	95	530	710	1065	1595	2660	4430
800	80	510	675	1015	1525	2540	4230
850	65	485	650	975	1460	2435	4060
900	50	450	600	900	1350	2245	3745
950	35	385	515	775	1160	1930	3220
1000	20	365	485	725	1090	1820	3030
1050	...	360	480	720	1080	1800	3000
1100	...	325	430	645	965	1610	2685
1150	...	275	365	550	825	1370	2285
1200	...	205	275	410	620	1030	1715
1250	...	180	245	365	545	910	1515
1300	...	140	185	275	410	685	1145
1350	...	105	140	205	310	515	860
1400	...	75	100	150	225	380	630
1450	...	60	80	115	175	290	485
1500	...	40	55	85	125	205	345

ANNEX E

LIMITING DIMENSIONS OF GASKETS
Other than Ring Joint

(This Annex is an integral part of ASME B16.5-1996 and is placed after the main text for convenience.)

E1 SCOPE

This Annex covers gasket characteristics.

E2 GASKET MATERIALS AND CONSTRUCTION

Classification of gasket materials and types is shown in Fig. E1. Other gaskets, which result in no increase in both loads or flange moment over those resulting from the gaskets included in the respective groups in this Appendix, may be used and warrant the ratings of this Standard with the limiting dimensions of the applicable group. See also para. 5.4 for application of gaskets.

E3 GASKET DIMENSIONS

(a) The actual dimensions of a gasket must be established by the user. Reference to a dimensional standard for gaskets, such as ASME B16.21, is recommended. In any case, selected dimensions should be based on the type of gasket and its characteristics. These characteristics include its density, flexibility, resistance to the fluid and its temperature, and the necessity for satisfactorily compressing the gasket on its inside diameter, its outside diameter, or both. Also to be considered is the question of allowing a "pocket" at the gasket inside diameter (between the flange facings), or of allowing any intrusion of the gasket into the flange bore. Consideration should be given to the service fluid as well as to the possibility of damage which might result from partially disintegrated gaskets.

(b) Limiting gasket dimensions are given in Tables E1, E2, and E3. These dimensions represent approximately the maximum combinations of widths and diameters of the different types of gaskets covered which meet rating requirements. Variations which tend to reduce bolt loads and flange moments (e.g., reducing the gasket width) may be made; however, in departing from the tabulated dimensions, consideration should be given to the stability of the gasket under high bolt loads. As a general rule, the area of unconfined nonmetallic gaskets should not be less that the total bolt area.

(c) Gaskets are divided into three groups based on their gasket loading factors as shown in the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Pressure Vessels.

(d) Gasket contact widths for the three groups are as follows:

Group No. I	Slip-on flange raised face width
Group No. II	Large tongue width
Group No. III	Small tongue width minus 0.03 in., but not less than 0.18 in.

(e) Gaskets of Group No. Ia have inside diameters equal to the outside diameter of the corresponding pipe, which follows the principle established in ASME B16.21. In order to avoid pocketing of fluid handled, Group No. I gaskets may be extended to the inside diameter of valves, pipe, or the bore of integral, welding neck, or socket weld type flanges. Group No. Ia gaskets have outside contact diameters equal to the outside diameter of the raised face.

(f) Gaskets of Groups Nos. IIa and IIIa also have inside diameters equal to the outside diameter of the corresponding pipe. It may be desirable under some conditions to make the inside diameter of these gaskets equal to the inside diameter of valves, pipe, or the bore of integral, welding neck, or socket weld type flanges, and this is permissible provided the gasket contact width does not exceed that shown. This provision affects gaskets shown in Figs. E4, E5, E8, and E9 and requires a reduction in gasket outside diameters as well as inside diameters.

Additional provisions for varying gasket widths in contact with raised face are covered in para. E3(b). Group Nos. IIb and IIIb have outside contact diameters equal to the outside diameter of the raised face.

(g) The outside diameter of gaskets or centering

rings extending beyond the raised face is equal to the bolt circle minus one bolt diameter. This type gasket is designed to be aligned by the flange bolts.

(h) Group Nos. IIa and IIIa gaskets are designed for those users who prefer that narrow gaskets be located close to the bore, thereby keeping the pressure area to a minimum and giving maximum flexibility to the flanged joint. See para. E3(f). Group Nos. IIb and IIIb gaskets are to be located at the outside of the raised face for ease in aligning the gaskets without a centering ring.

(i) Group No. Ia gaskets with edges extending to the bolts (see Fig. E3) are dimensionally the same as the corresponding flat ring gaskets given in ASME B16.21. See para. E3(c).

E4 TOLERANCES

Gasket contact widths for Group Nos. II and III shall not exceed specified contact width by more than 10%.

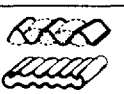
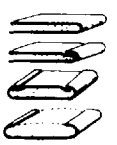
Gasket Group Number	Gasket Material	Sketches
Ia	Self-energizing types: O rings, metallic, elastomer, other gasket types considered as self-sealing	—
	Elastomer without fabric	
	Compressed sheet suitable for the operating conditions	
	Elastomer with cotton fabric insertion	
	Elastomer with or without wire reinforcement	
	Vegetable fiber	
Ib	Spiral-wound metal, with nonmetallic filler	
	Corrugated aluminum, copper or copper alloy or corrugated aluminum, copper or copper alloy double jacketed with nonmetallic filler	
	Corrugated aluminum, copper, or brass	
IIa and IIb	Corrugated metal or corrugated metal double jacketed with nonmetallic filler	
	Corrugated metal	
	Flat metal jacketed with nonmetallic filler	
	Grooved metal	
	Solid flat soft aluminum	
IIa and IIIb	Solid flat metal	
	Ring joint	

FIG. E1 GASKET GROUPS AND TYPICAL MATERIALS

TABLE E1 GROUP NOS. Ia and Ib GASKETS

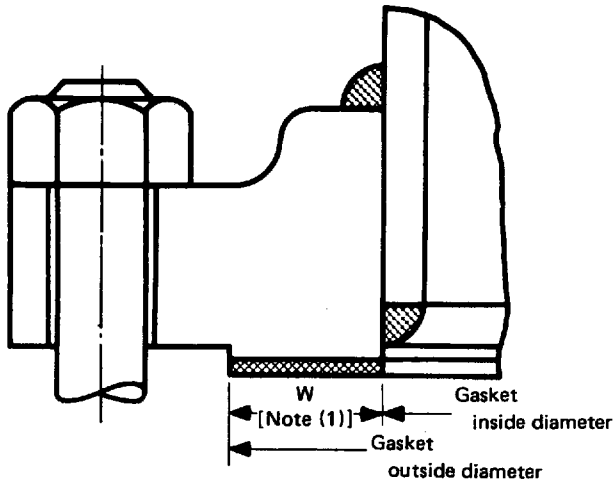


FIG. E2[3] SLIP-ON RAISED FACE WIDTH GASKET

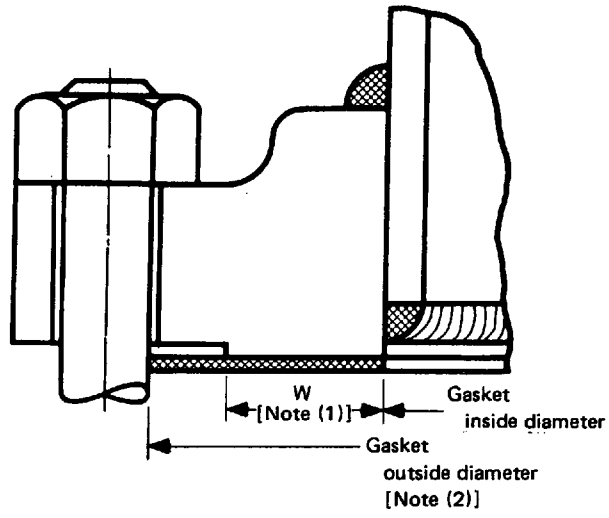


FIG. E3[3] SLIP-ON RAISED FACE WIDTH GASKET WITH EDGES EXTENDING TO THE BOLT

Nominal Size	Gasket Contact Width (1) W	Fig. E2		Fig. E3						
		Inside Diameter	Outside Diameter	Inside Diameter	Outside Diameter (2)					
					150	300	400	600	900	1500	2500
½	0.27	0.84	1.38	0.84	1.88	2.12	2.12	2.12	2.50	2.50	2.75
¾	0.31	1.06	1.69	1.06	2.25	2.62	2.62	2.62	2.75	2.75	3.00
1	0.34	1.31	2.00	1.31	2.62	2.88	2.88	2.88	3.12	3.12	3.38
¼	0.42	1.66	2.50	1.66	3.00	3.25	3.25	3.25	3.50	3.50	4.12
1½	0.48	1.91	2.88	1.91	3.38	3.75	3.75	3.75	3.88	3.88	4.62
2	0.62	2.38	3.62	2.38	4.12	4.38	4.38	4.38	5.62	5.62	5.75
2½	0.62	2.88	4.12	2.88	4.88	5.12	5.12	5.12	6.50	6.50	6.62
3	0.75	3.50	5.00	3.50	5.38	5.88	5.88	5.88	6.62	6.88	7.75
3½	0.75	4.00	5.50	4.00	6.38	6.50	6.38	6.38	. . .	. . .	. . .
4	0.84	4.50	6.19	4.50	6.88	7.12	7.00	7.62	8.12	8.25	9.25
5	0.88	5.56	7.31	5.56	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	0.94	6.62	8.50	6.62	8.75	9.88	9.75	10.50	11.38	11.12	12.50
8	1.00	8.62	10.62	8.62	11.00	12.12	12.00	12.62	14.12	13.88	15.25
10	1.00	10.75	12.75	10.75	13.38	14.25	14.12	15.75	17.12	17.12	18.75
12	1.12	12.75	15.00	12.75	16.12	16.62	16.50	18.00	19.62	20.50	21.62
14	1.12	14.00	16.25	14.00	17.75	19.12	19.00	19.38	20.50	22.75	. . .
16	1.25	16.00	18.50	16.00	20.25	21.25	21.12	22.25	22.62	25.25	. . .
18	1.50	18.00	21.00	18.00	21.62	23.50	23.38	24.12	25.12	27.75	. . .
20	1.50	20.00	23.00	20.00	23.88	25.75	25.50	26.88	27.50	29.75	. . .
24	1.62	24.00	27.25	24.00	28.25	30.50	30.25	31.12	33.00	35.50	. . .

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Applies to both Figs. E2 and E3. Gasket diameters may be varied. See para. E3(b).
(2) Gasket outside diameter may be extended, or an attached centering service may be used. The outside diameter of extended metallic gaskets or of any centering ring may be 0.12 in. less than specified.
(3) Slip-on type flange is shown for illustration purposes only. Gaskets may be used with other types of flange. See para. E3(e).

TABLE E2A GROUP NO. IIa GASKETS

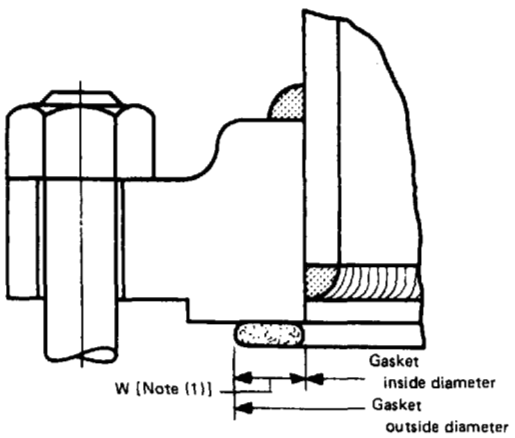


FIG. E4[3] LARGE TONGUE WIDTH GASKET WITH GASKET I.D. EQUAL TO PIPE I.D.

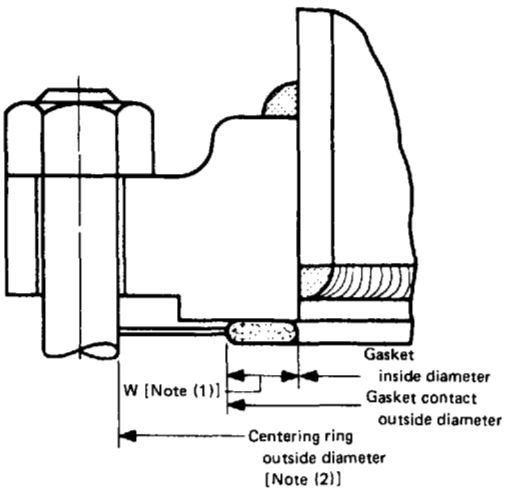


FIG. E5[3] LARGE TONGUE WIDTH GASKET WITH GASKET I.D. EQUAL TO PIPE I.D., WITH CENTERING RING

Nominal Size	Gasket Contact Width (1) W	Fig. E4		Fig. E3								
		Inside Diameter	Outside Diameter	Inside Diameter	Gasket Contact Outside Diameter	Centering Ring Outside Diameter (2)						
						150	300	400	600	900	1500	2500
½	0.19	0.84	1.22	0.84	1.22	1.88	2.12	2.12	2.12	2.50	2.50	2.75
¾	0.19	1.06	1.44	1.06	1.44	2.25	2.62	2.62	2.62	2.75	2.75	3.00
1	0.25	1.31	1.81	1.31	1.81	2.62	2.88	2.88	2.88	3.12	3.12	3.38
1¼	0.31	1.66	2.28	1.66	2.28	3.00	3.25	3.25	3.25	3.50	3.50	4.12
1½	0.38	1.91	2.66	1.91	2.66	3.38	3.75	3.75	3.75	3.88	3.88	4.62
2	0.38	2.38	3.12	2.38	3.12	4.12	4.38	4.38	4.38	5.62	5.62	5.75
2½	0.38	2.88	3.62	2.83	3.62	4.88	5.12	5.12	5.12	6.50	6.50	6.62
3	0.38	3.50	4.25	3.50	4.25	5.38	5.88	5.88	5.83	6.62	6.88	7.75
3½	0.38	4.00	4.75	4.00	4.75	6.38	6.50	6.38	6.38	. . .	. . .	. . .
4	0.50	4.50	5.50	4.50	5.50	6.88	7.12	7.00	7.62	8.12	8.25	9.25
5	0.50	5.56	6.56	5.56	6.56	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	0.50	6.62	7.62	6.62	7.62	8.75	9.88	9.75	10.50	11.38	11.12	12.50
8	0.62	8.62	9.88	8.62	9.88	11.00	12.12	12.00	12.62	14.12	13.88	15.25
10	0.75	10.75	12.25	10.75	12.25	13.38	14.25	14.12	15.75	17.12	17.12	18.75
12	0.75	12.75	14.25	12.75	14.25	16.12	16.62	16.50	18.00	19.62	20.50	21.62
14	0.75	14.00	15.50	14.00	15.50	17.75	19.12	19.00	19.38	20.50	22.75	. . .
16	0.88	16.00	17.75	16.00	17.75	20.25	21.25	21.12	22.25	22.62	25.25	. . .
18	0.88	18.00	19.75	18.00	19.75	21.62	23.50	23.38	24.12	25.12	27.75	. . .
20	1.00	20.00	22.00	20.00	22.00	23.88	25.75	25.50	26.88	27.50	29.75	. . .
24	1.00	24.00	26.00	24.00	26.00	28.25	30.50	30.25	31.12	33.00	35.50	. . .

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) Applies to both Figs. E4 and E5. Gasket diameters may be varied, provided the gasket contact width does not exceed that shown, subject to tolerances in para. E4. See para. E3(d).

(2) Metallic gaskets may have attached centering device. The outside diameter of any centering ring may be 0.12 in. less than specified.

(3) Slip-on type flange is shown for illustration purposes only. Gaskets may be used with other types of flange. See para. E3(f).

TABLE E2B GROUP NO. IIb GASKETS

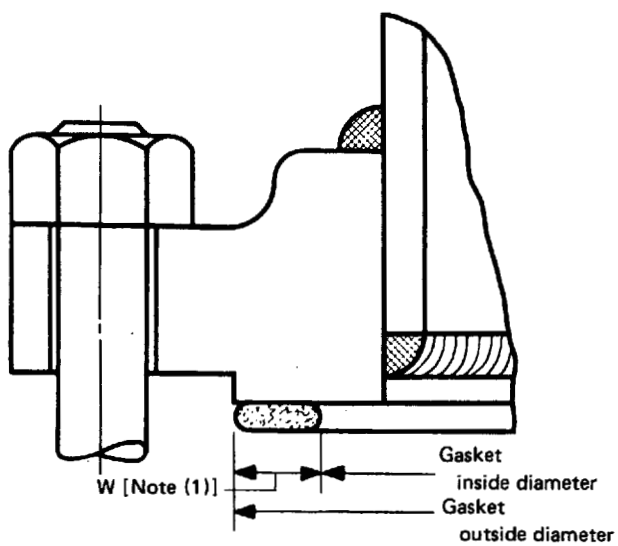


FIG. E6[3] LARGE TONGUE WIDTH GASKET WITH GASKET OUTSIDE DIMENSION EQUAL TO O.D. OF RAISED FACE

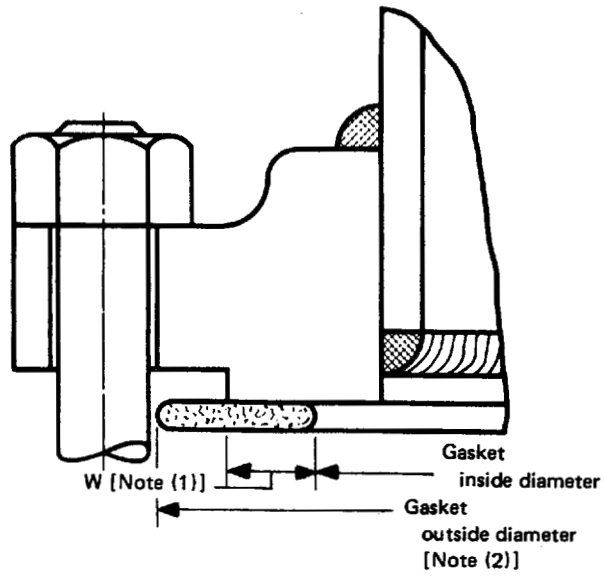


FIG. E7[3] LARGE TONGUE WIDTH GASKET WITH EDGES EXTENDING TO THE BOLT

Nominal Size	Gasket Contact Width (1) W	Fig. E6		Fig. E7							
		Inside Diameter	Outside Diameter	Inside Diameter	Outside Diameter (2)						
					150	300	400	600	900	1500	2500
½	0.19	1.00	1.38	1.00	1.88	2.12	2.12	2.12	2.50	2.50	2.75
¾	0.19	1.31	1.69	1.31	2.25	2.62	2.62	2.62	2.75	2.75	3.00
1	0.25	1.50	2.00	1.50	2.62	2.88	2.88	2.88	3.12	3.12	3.38
1¼	0.31	1.88	2.50	1.88	3.00	3.25	3.25	3.25	3.50	3.50	4.12
1½	0.38	2.12	2.88	2.12	3.38	3.75	3.75	3.75	3.88	3.88	4.62
2	0.38	2.88	3.62	2.88	4.12	4.38	4.38	4.38	5.62	5.62	5.75
2½	0.38	3.38	4.12	3.38	4.88	5.12	5.12	5.12	6.50	6.50	6.62
3	0.38	4.25	5.00	4.25	5.38	5.88	5.88	5.88	6.62	6.88	7.75
3½	0.38	4.75	5.50	4.75	6.38	6.50	6.38	6.38	...	...	...
4	0.50	5.19	6.19	5.19	6.88	7.12	7.00	7.62	8.12	8.25	9.25
5	0.50	6.31	7.31	6.31	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	0.50	7.50	8.50	7.50	8.75	9.88	9.75	10.50	11.38	11.12	12.50
8	0.62	9.38	10.62	9.38	11.00	12.12	12.00	12.62	14.12	13.88	15.25
10	0.75	11.25	12.75	11.25	13.38	14.25	14.12	15.75	17.12	17.12	18.75
12	0.75	13.50	15.00	13.50	16.12	16.62	16.50	18.00	19.62	20.50	21.62
14	0.75	14.75	16.25	14.75	17.75	19.12	19.00	19.38	20.50	22.75	...
16	0.88	16.75	18.50	16.75	20.25	21.25	21.12	22.25	22.62	25.25	...
18	0.88	19.25	21.00	19.25	21.62	23.50	23.38	24.12	25.12	27.75	...
20	1.00	21.00	23.00	21.00	23.88	25.75	25.50	26.88	27.50	29.75	...
24	1.00	25.25	27.25	25.25	28.25	30.50	30.25	31.12	33.00	35.50	...

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) Applies to both Figs. E6 and E7. Gasket diameters may be varied, provided the gasket contact width does not exceed that shown, subject to tolerances in para. E4. See para. E3(d).

(2) Gasket outside diameter may be extended, or an attached centering device may be used. The outside diameter of extended metallic gasket or of any centering ring may be 0.12 in. less than specified.

(3) Slip-on type flanges are shown for illustration purposes only. Gaskets may be used with other types of flange. See para. E3(f).

TABLE E3A GROUP NO. IIIa GASKETS

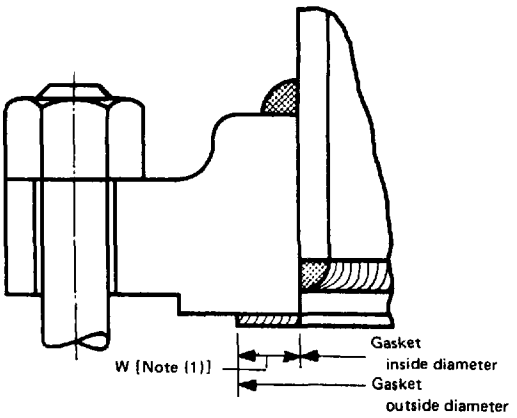


FIG. E8[3] SMALL TONGUE WIDTH GASKET WITH GASKET I.D. EQUAL TO PIPE O.D.

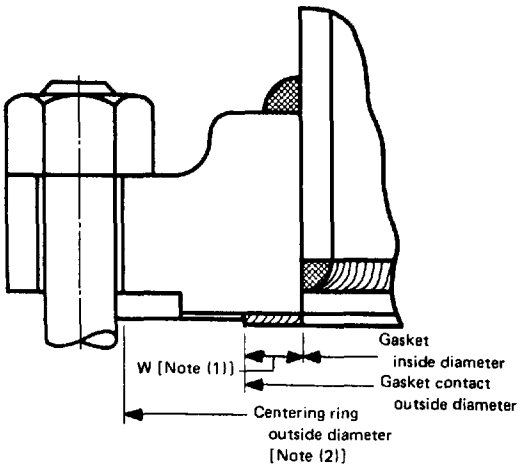


FIG. E9[3] SMALL TONGUE WIDTH GASKET WITH GASKET I.D. EQUAL TO PIPE O.D., WITH CENTERING RING

Nominal Size	Gasket Contact Width (1) W	Fig. E8		Fig. E9								
		Inside Diameter	Outside Diameter	Inside Diameter	Gasket Contact Outside Diameter	Centering Ring Outside Diameter (2)						
						150	300	400	600	900	1500	2500
½	0.19	0.84	1.22	0.84	1.22	1.88	2.12	2.12	2.12	2.50	2.50	2.75
¾	0.19	1.06	1.44	1.06	1.44	2.25	2.62	2.62	2.62	2.75	2.75	3.00
1	0.19	1.31	1.69	1.31	1.69	2.62	2.88	2.88	2.88	3.12	3.12	3.38
1¼	0.19	1.66	2.03	1.66	2.03	3.00	3.25	3.25	3.25	3.50	3.50	4.12
1½	0.19	1.91	2.28	1.91	2.28	3.38	3.75	3.75	3.75	3.88	3.88	4.62
2	0.19	2.38	2.75	2.38	2.75	4.12	4.38	4.38	4.38	5.62	5.62	5.75
2½	0.19	2.88	3.25	2.88	3.25	4.88	5.12	5.12	5.12	6.50	6.50	6.62
3	0.19	3.50	3.88	3.50	3.88	5.38	5.88	5.88	5.88	6.62	6.88	7.75
3½	0.19	4.00	4.38	4.00	4.38	6.38	6.50	6.38	6.38	. . .	. . .	. . .
4	0.22	4.50	4.94	4.50	4.94	6.88	7.12	7.00	7.62	8.12	8.25	9.25
5	0.22	5.56	6.00	5.56	6.00	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	0.22	6.62	7.06	6.62	7.06	8.75	9.88	9.75	10.50	11.38	11.12	12.50
8	0.28	8.62	9.19	8.62	9.19	11.00	12.12	12.00	12.62	14.12	13.88	15.25
10	0.34	10.75	11.44	10.75	11.44	13.38	14.25	14.12	15.75	17.12	17.12	18.75
12	0.34	12.75	13.44	12.75	13.44	16.12	16.62	16.50	18.00	19.62	20.50	21.62
14	0.34	14.00	14.69	14.00	14.69	17.75	19.12	19.00	19.38	20.50	22.75	. . .
16	0.41	16.00	16.81	16.00	16.81	20.25	21.25	21.12	22.25	22.62	25.25	. . .
18	0.41	18.00	18.81	18.00	18.81	21.62	23.50	23.38	24.12	25.12	27.75	. . .
20	0.47	20.00	20.94	20.00	20.94	23.88	25.75	25.50	26.88	27.50	29.75	. . .
24	0.47	24.00	24.94	24.00	24.94	28.25	30.50	30.25	31.12	33.00	35.50	. . .

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) Applies to both Figs. E8 and E9. Gasket diameters may be varied, provided the gasket contact width does not exceed that shown, subject to tolerances in para. E4. See para. E3(d).

(2) Metallic gaskets may have attached centering device. The outside diameter of any centering ring may be 0.12 in. less than specified.

(3) Slip-on type flanges are shown for illustration purposes only. Gaskets may be used with other types of flange. See para. E3(f).

TABLE E3B GROUP NO. IIIb GASKETS

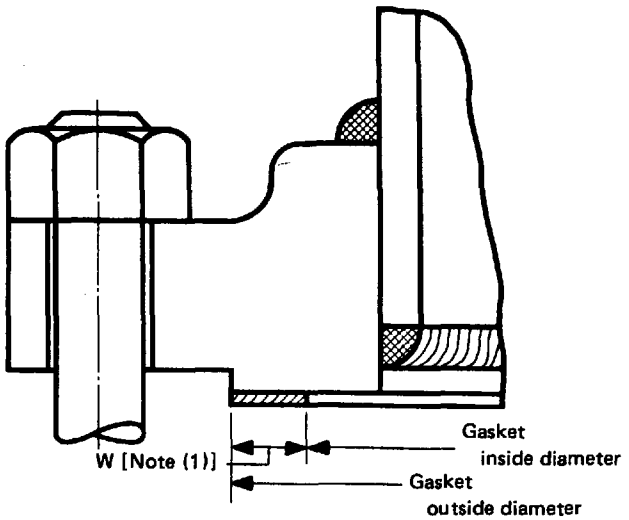


FIG. E10[3] SMALL TONGUE WIDTH GASKET WITH GASKET O.D. EQUAL TO O.D. OF RAISED FACE

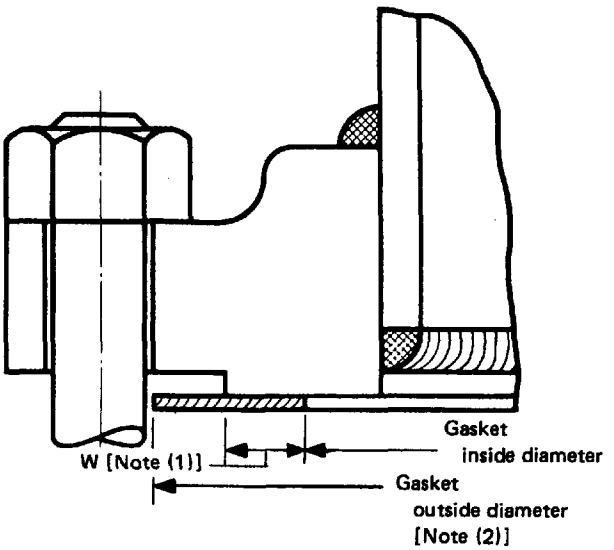


FIG. E11[3] SMALL TONGUE WIDTH GASKET WITH EDGES EXTENDING TO THE BOLT

Nominal Size	Gasket Contact Width (1) W	Fig. E10		Fig. E11						
		Inside Diameter	Outside Diameter	Inside Diameter	Outside Diameter (2)					
					150	300	400	600	900	1500	2500
½	0.19	1.00	1.38	1.00	1.88	2.12	2.12	2.12	2.50	2.50	2.75
¾	0.19	1.31	1.69	1.31	2.25	2.62	2.62	2.62	2.75	2.75	3.00
1	0.19	1.62	2.00	1.62	2.62	2.88	2.88	2.88	3.12	3.12	3.38
1¼	0.19	2.12	2.50	2.12	3.00	3.25	3.25	3.25	3.50	3.50	4.12
1½	0.19	2.50	2.88	2.50	3.38	3.75	3.75	3.75	3.88	3.88	4.62
2	0.19	3.25	3.62	3.25	4.12	4.38	4.38	4.38	5.62	5.62	5.75
2½	0.19	3.75	4.12	3.75	4.88	5.12	5.12	5.12	6.50	6.50	6.62
3	0.19	4.62	5.00	4.62	5.38	5.88	5.88	5.88	6.62	6.88	7.75
3½	0.19	5.12	5.50	5.12	6.38	6.50	6.38	6.38	...	...	...
4	0.22	5.75	6.19	5.75	6.88	7.12	7.00	7.62	8.12	8.25	9.25
5	0.22	6.88	7.31	6.88	7.75	8.50	8.38	9.50	9.75	10.00	11.00
6	0.22	8.06	8.50	8.06	8.75	9.88	9.75	10.50	11.38	11.12	12.50
8	0.28	10.06	10.62	10.06	11.00	12.12	12.00	12.62	14.12	13.88	15.25
10	0.34	12.06	12.75	12.06	13.38	14.25	14.12	15.75	17.12	17.12	18.75
12	0.34	14.31	15.00	14.31	16.12	16.62	16.50	18.00	19.62	20.50	21.62
14	0.34	15.56	16.25	15.56	17.75	19.12	19.00	19.38	20.50	22.75	...
16	0.41	17.69	18.50	17.69	20.25	21.25	21.12	22.25	22.62	25.25	...
18	0.41	20.19	21.00	20.19	21.62	23.50	23.38	24.12	25.12	27.75	...
20	0.47	22.06	23.00	22.06	23.88	25.75	25.50	26.88	27.50	29.75	...
24	0.47	26.31	27.25	26.31	28.25	30.50	30.25	31.12	33.00	35.50	...

GENERAL NOTE: Dimensions are in inches.

NOTES:

(1) Applies to both Figs. E10 and E11. Gasket diameters may be varied, provided the gasket contact width does not exceed that shown, subject to tolerances in para. E4. See para. E3(d).

(2) Gasket outside diameter may be extended, or an attached centering device may be used. The outside diameter of extended metallic gasket or of any centering ring may be 0.12 in. less than specified.

(3) Slip-on type flanges are shown for illustration purposes only. Gaskets may be used with other types of flange. See para. E3(f).

ANNEX F
METHOD FOR CALCULATING BOLT LENGTHS[1]

(This Annex is not part of ASME B16.5-1996 and is included for information only. See para. 6.10.2.)

The following formulas were used in establishing dimension L in Tables 8, 11, 14, 17, 20, 23, and 26. They are given for convenience in determining lengths not given in the tables.

$$L_{CSB} \text{ [See footnote (2)]} = A + n$$

$$L_{CMB} \text{ [See footnote (2)]} = B + n$$

where

A = $2(C + t + d) + G + F - a$, i.e., stud bolt length exclusive of negative length tolerance n

B = $2(C + t) + d + G + F + p - a$, i.e., machine bolt length exclusive of negative tolerance n

C = minimum flange thickness[3] (see Tables 9, 12, 15, 18, 21, 24, and 27)

F = total height of facings or depth of ring joint groove for both flanges (see Table F1)

G = 0.12 in. gasket thickness for raised face, male and female and tongue and groove flanges; also approximate distance between ring joint flanges listed in Table 5

L_{CMB} = calculated machine bolt length as measured from underside of head to end of point

L_{CSB} = calculated stud bolt length (effective thread length, excluding end points)

L_{SMB} = specified machine bolt length (from underhead to end, including end point) which is L_{CMB} rounded off to the nearest 0.25 in. increment (see Fig. F2)

L_{SSB} = specified stud bolt length (effective thread length, excluding end points) which is L_{CSB} rounded off to the nearest 0.25 in. increment (see Fig. F1)

a = zero, except where the small female face is on the end of pipe, a = 0.19 in.

d = heavy nut thickness (equals nominal bolt diameter, see ASME B18.2.2)

n = negative tolerance on bolt length (see Table F2)

p = allowance for height of point of machine bolt (= 1.5 times thread pitch)

t = plus tolerance for flange thickness (see para. 7.3)

[1] The equations used in this Annex are for calculated bolt lengths established to assure full thread engagement of heavy hexagon nuts when worst case tolerances occur on all relevant dimensions of the flanged joint. The use of shorter bolt lengths is acceptable provided that full thread engagement is obtained at assembly (see para. 6.10.2).

[2] For lapped joints calculate stud bolt and machine bolt lengths as follows.

For ring joint groove facing:

$$L_{CSB} = A + \text{(pipe thickness for each lap)} + n$$

$$L_{CMB} = B + \text{(pipe thickness for each lap)} + n$$

For other than ring joint facing:

$$L_{CSB} = A - F + \text{(Table F3 thicknesses)} + n$$

$$L_{CMB} = B - F + \text{(Table F3 thicknesses)} + n$$

[3] 0.06 in. raised face is included in minimum flange thickness for Classes 150 and 300 flanges.

TABLE F1 *F* VALUES

Flanged Joint Class	Total Height of Facings or Depth of Ring Joint Groove for Both Flanges *F*, in.			
	Type of Flange Facing (1)			
	0.06 in. Raised	0.25 in. Raised	Male and Female or Tongue and Groove	Ring Joint
150 and 300	Zero (2)	0.50	0.25	2 × groove depth
400 to 2500	0.12	0.50	0.25	2 × groove depth

NOTES:
(1) See Fig. 8 and Tables 4 and 5.
(2) Raised face (0.06 in.) is included in minimum flange thickess for Classes 150 and 300 flanges.

TABLE F2 *n* VALUES

Dimension	Negative Tolerance on Bolt Lengths *n*, in.	Length, in.
Stud Bolt		
A		
or	0.06	
[*A* + (pipe thickness for each lap)]	0.12	≤12
or	0.25	>12, ≤18
[*A* − *F* + (Table F3 thicknesses)]		>18
Machine Bolt		
B		
or	For *n* values, use negative length tolerances per ANSI B18.2.1.	. . .
[*B* + (pipe thickness for each lap)]		
or		
[*B* − *F* + (Table F3 thicknesses)]		

TABLE F3 THICKNESSES FOR LAPPED JOINTS

Lap Combination	Classes 150 and 300 Flanges	Classes 400 to 2500 Flanges, inclusive
For lapped to 0.06 in. raised face	One lap	. . .
For lapped to lapped	Both laps	Both laps
For lapped to 0.25 in. male face on flange	. . .	One lap and 0.25 in.
For lapped to female face on flange	. . .	One lap not less than 0.25 in.
For male in lap to female in lap	. . .	2 × pipe wall with lap for male not less than 0.25 in.

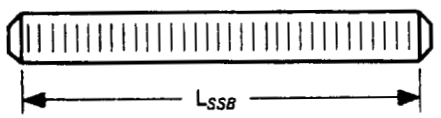


FIG. F1 SPECIFIED STUD BOLT LENGTH

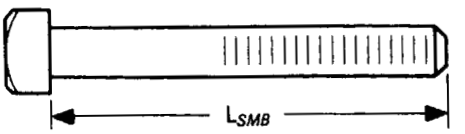


FIG. F2 SPECIFIED MACHINE BOLT LENGTH

ANNEX G
QUALITY SYSTEM PROGRAM

(This Annex is an integral part of ASME B16.5.1996 and is placed after the main text for convenience.)

The products manufactured in accordance with this Standard shall be produced under a quality system program following the principles of an appropriate standard from the ISO 9000 series.[1] A determination of the need for registration and/or certification of the product manufacturer's quality system program by an independent organization shall be the responsibility of the manufacturer. The detailed documentation demonstrating program compliance shall be available to the purchaser at the manufacturer's facility. A written summary description of the program utilized by the product manufacturer shall be available to the purchaser upon request. The product manufacturer is defined as the entity whose name or trademark appears on the product in accordance with the marking or identification requirements of this Standard.

[1] The series is also available from the American National Standards Institute (ANSI) and the American Society for Quality Control (ASQC) as American National Standards that are identified by a prefix "Q" replacing the prefix "ISO". Each standard of the series is listed under Annex H.

ANNEX H
REFERENCES

(This Annex is an integral part of ASME B16.5-1996 and is placed after the main text for convenience.)

The following is a list of standards and specifications referenced in this Standard, showing the year of approval. Products covered by each ASTM specification are listed for convenience. (See specifications for exact titles and detailed contents.)

ASME Publications

ASME B1.1-1989	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1-1983(R1992)	Pipe Threads, General Purpose (Inch)
ASME B16.20-1993	Metallic Gaskets for Pipe Flanges — Ring Joint, Spiral-Wound and Jacketed
ASME B16.21-1992	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34-1996	Valves — Flanged, Threaded, and Welding End
ASME B18.2.1-1981(R1992)	Square and Hex Bolts and Screws — Inch Series
ASME B18.2.2-1987(R1993)	Square and Hex Nuts (Inch Series)
ASME B31.3-1992	Chemical Plant and Petroleum Refinery Piping
ASME B36.10M-1985	Welded and Seamless Wrought Steel Pipe
ASME B46.1-1985	Surface Texture (Surface Roughness, Waviness, and Lay)

ASME Boiler and Pressure Vessel Code, 1992 Edition (Including Addenda through 1994)

Section I	Power Boilers
Section II	Materials
Section III	Nuclear Power Plant Components
Section VIII, Div. 1 & 2	Pressure Vessels

ASTM Publications

A 105-95b	Forgings, Carbon Steel, for Piping Components
A 106-95	Seamless Carbon Steel Pipe for High Temperature Service
A 182-95c	Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service
A 193-95a	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

A 194-95a	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
A 203-93	Pressure Vessel Plates, Alloy Steel, Nickel
A 204-93	Pressure Vessel Plates, Alloy Steel, Molybdenum
A 216-93	Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
A 217-93	Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
A 240-95b	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
A 307-94	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A 320-95$^{\epsilon 1}$	Alloy-Steel Bolting Materials for Low-Temperature Service
A 350-96	Forgings, Carbon and Low-Alloy Steel, Requiring Notch Toughness Testing for Piping Components
A 351-94a	Steel Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts
A 352-93	Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
A 354-95	Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
A 387-92$^{\epsilon 1}$	Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum
A 449-93	Quenched and Tempered Steel Bolts and Studs
A 453-95	Bolting Materials, High-Temperature, 50 to 120 ksi [345 to 827 Mpa] Yield Strength, With Expansion Coefficients Comparable to Austenitic Steels
A 515-94	Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
A 516-90	Pressure Vessel Plates, Carbon Steel, For Moderate- and Lower-Temperature Service
A 537-91	Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel
A 540-95	Alloy-Steel Bolting Materials for Special Applications
B 127-94a$^{\epsilon 1}$	Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
B 160-93	Nickel Rod and Bar
B 162-93a$^{\epsilon 1}$	Nickel Plate, Sheet and Strip
B 164-93	Nickel-Copper Alloy Rod, Bar and Wire
B 166-95	Nickel-Chromium-Iron Alloys (UNS N06600, N06601 and N06690) and Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617) Rod, Bar and Wire
B 168-95	Nickel-Chromium-Iron Alloys (UNS N06600, N06601, and N06690) and Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617) Plate, Sheet and Strip

B 333-95	Nickel-Molybdenum Alloy Plate, Sheet and Strip
B 335-95	Nickel-Molybdenum Alloy Rod
B 408-95	Nickel-Iron-Chromium Alloy Plate, Sheet and Strip
B 409-95	Nickel-Iron-Chromium Alloy Plate, Sheet, and Strip
B 424-93	Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and N08821) Plate, Sheet and Strip
B 425-93	Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221) Rod and Bar
B 434-95	Nickel-Molybdenum-Chromium-Iron Alloy (UNS N10003) Plate, Sheet and Strip
B 435-94	UNS N06002, UNS N06230, and UNS R30556 Plate, Sheet, and Strip
B 443-93	Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Plate, Sheet, and Strip
B 446-93	Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Rod and Bar
B 462-95	Forged or Rolled UNS N08020, UNS N00824, UNS N08026, and UNS N08367 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service
B 463-93	UNS N08020, UNS N08024 and UNS N08026 Alloy Plate Sheet and Strip
B 473-95	UNS N08020, UNS N08026, and UNS N08024 Nickel Alloy Bar and Wire
B 511-93	Nickel-Iron-Chromium-Silicon Alloy Bars and Shapes
B 536-95	Nickel-Iron Chromium-Silicon Alloys (UNS N08830 and N08332) Plate, Sheet, and Strip
B 564-95a$^{\epsilon 1}$	Nickel Alloy Forgings
B 572-94	UNS N06002, UNS N06230, and UNS R30556 Rod
B 573-95	Nickel-Molybdenum-Chromium-Iron Alloy (UNS N10003) Rod
B 574-94$^{\epsilon 1}$	Low-Carbon Nickel-Molybdenum-Chromium and Low-Carbon Nickel-Chromium Molybdenum Alloy Rod
B 575-94	Low-Carbon Nickel-Molybdenum-Chromium and Low-Carbon Nickel-Chromium Molybdenum Alloy Plate, Sheet, and Strip
B 581-94$^{\epsilon 1}$	Nickel-Chromium-Iron-Molybdenum-Copper Alloy Rod
B 582-93	Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip
B 599-93b	Nickel-Iron-Chromium-Molybdenum-Columbium Stabilized Alloy (UNS N08700) Plate, Sheet and Strip
B 620-93	Nickel-Iron-Chromium-Molybdenum Alloy (UNS N08320) Plate, Sheet, and Strip
B 621-95	Nickel-Iron-Chromium-Molybdenum Alloy (UNS N08320) Rod
B 625-93a	UNS N08904, UNS N08925, UNS N08031, UNS N08932, and UNS N08925 Plate, Sheet and Strip

B 649-93	Ni-Fe-Cr-Mo-Cu Low Carbon Alloy (UNS N08904) and Ni-Fe-Cr-Mo-Cu-N Low Carbon Alloys (UNS N08925, UNS N08031, and UNS N08926) Bar and Wire
B 672-95	Nickel-Iron-Chromium-Molybdenum Columbium Stabilized Alloy (UNS N08700) Bar and Wire
E 29-93	Using Significant Digits in Test Data to Determine Conformance with Specifications

International Standards Organization (ISO)

ISO 9000-1: 1994	Quality management and quality assurance standards — Part 1: Guidelines for selection and use
ISO 9000-2: 1993	Quality management and quality assurance standard — Part 2: Generic guidelines for the application of ISO 9001, ISO 9002, and ISO 9003
ISO 9000-3: 1991	Quality management and quality assurance standards — Part 3: Guidelines for the application of ISO 9001 to the development, supply and maintenance of software
ISO 9001: 1994	Quality systems — Model for quality assurance in design, development, production, installation, and servicing
ISO 9002: 1994	Quality systems — Model for quality assurance in production and servicing
ISO 9003: 1994	Quality systems — Model for quality assurance in final inspection and test

MSS Publications

MSS SP-9-1992	Spot Facing for Bronze, Iron, and Steel Flanges
MSS SP-25-1978(R1985)	Standard Marking System for Valves, Fittings, Flanges, and Unions
MSS SP-44-1991	Steel Pipe Line Flanges
MSS SP-45-1992	Bypass and Drain Connections
MSS SP-61-1992	Pressure Testing of Steel Valves

Publications of the following organizations appear in the above list:

ASME	The American Society of Mechanical Engineers 345 East 47th Street, New York, New York 10017-2392
	ASME Order Department 22 Law Drive, Box 2300, Fairfield, New Jersey 07007-2300

ASQC	American Society for Quality Control P.O. Box 3005, Milwaukee, Wisconsin 53201-3005
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959
ISO	International Organization for Standardization 1, rue de Varembé, Case postale 56, CH–1121 Genéve 20, Switzerland/Suisse
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry 127 Park Street, N.E., Vienna, Virginia 22180

ISO documents are available from ANSI. Publications appearing above which have been approved as American National Standards may also be obtained from ANSI.

ANSI	American National Standards Institute, Inc. 11 West 42nd Street, New York, New York, 10036