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AN AMERICAN NATIONAL STANDARD

ASME B16.47a-1998

ADDENDA

to

ASME B16.47-1996
LARGE DIAMETER STEEL FLANGES
NPS 26 Through NPS 60

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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ASME B16.47a–1998

Following approval by the ASME B16 Committee and ASME, and after public review, ASME B16.47a-1998 was approved by the American National Standards Institute on February 20, 1998.

Addenda to the 1996 Edition of ASME B16.47 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 B16.47-1996.

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*
iii	Foreword	In the last paragraph, ASME address updated
vii	Committee Roster	Updated
2	2.4	First sentence corrected by Errata
8, 9	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) New material group 1.15 added (4) 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
11	Table 2-1.1	(1) A 350 Gr. LF6 Cl. 1 added (2) Note (4) added (3) Entries for last four class temperatures corrected by Errata
12	Table 2-1.2	(1) A 350 Gr. LF6 Cl. 2 added (2) Note (3) added (3) Working pressure for Class 75 at 500°F corrected by Errata to read *85*

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Page	*Location*	*Change*
20.1	Table 2-1.15	Added
27	Table 2-2.7	Working pressure for Class 400 at 850°F corrected by Errata to read *570*
28	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
42	Table 13	Depth of *C* in sketch corrected by Errata
43	Table 14	Depth of *C* in sketch corrected by Errata
44	Table 15	Depth of *C* in sketch corrected by Errata
59	Annex D	Addresses of ASME and ASTM updated
61	Interpretations	ASME address updated

SPECIAL NOTE:

The Interpretations to ASME B16.47 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.

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FOREWORD (a)

(This Foreword is not part of ASME B16.47-1996.)

In November, 1980, a task force was appointed within Subcommittee C of the American National Standards (ANSI) B16 Committee to develop a standard for pipe flanges in size NPS 26 through NPS 48. Every attempt was made to standardize those dimensions that existed within the industry for the materials covered by ANSI B16.5.

Prompted by suggestions received from committee members, the task force was authorized to increase the size range to NPS 60. The first draft was developed in December 1982 to include Class 75 through Class 1500 for the size range NPS 26 through NPS 60. Flange dimensions were based on the Manufacturers Standardization Society Standard Practice (MSS SP) 44 flanges except for Class 75 flanges which are ANSI/API 605 flanges.

At the request of the American Petroleum Institute (API), flange dimensions in accordance with the API Standard 605 were included in the subsequent drafts. Class 1500 flanges were deleted due to lack of interest in using large size flanges in that pressure–temperature rating.

The API-605 flanges for Classes 150 and 300 and for sizes NPS 36 and smaller for classes higher than Class 300 are not compatible with the MSS SP-44 flanges. Thus, the MSS SP-44 flanges are designated as Series A flanges and the API-605 flanges are designated as Series B flanges in this Standard. Materials covered in this Standard are as in ANSI B16.5 except nickel base alloys are excluded. Pressure–temperature ratings are in accordance with ANSI B16.5.

In 1982, American National Standards Committee B16 was reorganized as the American Society of Mechanical Engineers (ASME) B16 Committee operating under procedures accredited by ANSI. Following approval by the Standards Committee and ASME, approval as an American National Standard was given by ANSI on June 12, 1990.

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 permissible flange facing imperfections, adds blind flanges for Series B flanges, 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 B16.47-1996.

All requests for interpretations or suggestions for revisions should be sent to the Administrative Secretary B16, The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

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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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LARGE DIAMETER STEEL FLANGES

1 SCOPE

1.1 General

This Standard covers pressure–temperature ratings, materials, dimensions, tolerances, marking, and testing for pipe flanges in sizes NPS 26 through NPS 60 and in ratings Classes 75, 150, 300, 400, 600, and 900. Flanges may be cast, forged, or plate (for blind flanges only) materials, as listed in Table 1A.

Requirements and recommendations regarding bolting and gaskets are also included.

1.2 Flange Series

This Standard provides two series of flange dimensions. Series A specifies flange dimensions for general use flanges. Series B specifies flange dimensions for compact flanges which, in general, have smaller bolt circle diameters than Series A flanges. These two series of flanges are not interchangeable. The user should recognize that some flanged valves, equipment bolted between flanges, and flanged equipment may only be compatible with bolt circle diameter of one series of flanges.

1.3 References

1.3.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Annex E, 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 E. A flange 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.

1.3.2 Codes and Regulations. A flange used under the jurisdiction of the ASME Boiler and Pressure Vessel Code (ASME BPV 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, 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.

1.4 Applicable Ratings

The pressure–temperature ratings in this Standard are applicable upon its publication to all flanges within its scope which otherwise meet its requirements. For unused flanges maintained in inventory, the manufacturer of the flange 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. 1.3.2).

1.5 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.

1.6 Quality Systems

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

2 PRESSURE–TEMPERATURE RATINGS

2.1 Rating 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 A 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 in order to attain a joint which has

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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 sole 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. 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.

(a) 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 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, Classes 75 and 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.

2.4.2 Low Temperature Service. Some of the materials 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 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 carbon steel cylindrically bored welding neck flanges covered by this Standard are based upon their hubs at the welding end having a thickness at least equal to that calculated for pipe having 40.0 ksi specified minimum yield strength. The ratings also apply to such flanges used with components of unequal strength and unequal wall thickness when the attachment welds is made in accordance with the applicable code or regulation. See Figs. 5, 6, and 7.

2.7 Multiple Material Grades

Materials for flanges 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 the marking is in accordance with para. 4.1.2(d).

3 SIZE

3.1 Nominal Size

The size of a flange 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.

4 MARKING

4.1 General

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

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

7.6.3 Eccentricity between bolt circle diameter and machined facing diameters, 0.06 in.

8 TEST

8.1 Flange Testing

Flanges are not required to be hydrostatically tested.

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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 ¾Ni–1Mo–¾Cr	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

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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

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.

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TABLE 1B LIST OF BOLTING SPECIFICATIONS

Applicable ASTM Specifications[11]

Bolting Materials[1]					
High Strength (2)		Intermediate Strength (3)		Low Strength (4)	
Spec.-Gr.	Notes	Spec.-Gr.	Notes	Spec.-Gr.	Notes
A 193-B7	...	A 193-B5	...	A 193-B8 Cl. 1	(5)
A 193-B16	...	A 193-B6	...	A 193-B8C Cl. 1	(5)
		A 193-B6X	...	A 193-B8M Cl. 1	(5)
A 320-L7	(6)	A 193-B7M	...	A 193-B8T Cl. 1	(5)
A 320-L7A	(6)				
A 320-L7B	(6)	A 193-B8 Cl. 2	(7)	A 193-B8A	(5)
A 320-L7C	(6)	A 193-B8C Cl. 2	(7)	A 193-B8CA	...
A 320-L43	(6)	A 193-B8M Cl. 2	(7)	A 193-B8MA	...
		A 193-B8T Cl. 2	(7)	A 193-B8TA	(5)
A 354-BC	...				
A 354-BD	...	A 320-B8 Cl. 2	(7)	A 307-B	(8)
		A 320-B8C Cl. 2	(7)		
A 540-B21	...	A 320-B8F Cl. 2	(7)	A 320-B8 Cl. 1	(5)
A 540-B22	...	A 320-B8M Cl. 2	(7)	A 320-B8C Cl. 1	(5)
A 540-B23	...	A 320-B8T Cl. 2	(7)	A 320-B8M Cl. 1	(5)
A 540-B24	...			A 320-B8T Cl. 1	(5)
		A 449	(9)		
		A 453-651	(10)		
		A 453-660	(10)		

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 verified 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 Class 150 and Class 300 joints. See para. 5.4.1 for recommended gasket practices.
(5) This austenitic stainless material has been carbide solution treated but not strain hardened. Use A 194 nuts of corresponding material.
(6) This ferritic material is intended for low temperature service. Use A 194 Gr. 4 or Gr. 7 nuts.
(7) This austenitic stainless material has been carbide solution treated and strain hardened. Use A 194 nuts of corresponding material.
(8) 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.
(9) Acceptable nuts for use with quenched and tempered bolts are A 194 Gr. 2 and Gr. 2H. Mechanical property requirements for studs shall be the same as those for bolts.
(10) This special alloy is intended for high temperature service with austenitic stainless steel.
(11) ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the listed ASTM specifications, may also be used.

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TABLES 2 PRESSURE–TEMPERATURE RATINGS FOR GROUPS 1.1 THROUGH 2.8 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	75	150	300	400	600	900
–20 to 100	140	285	740	990	1480	2220
200	130	260	675	900	1350	2025
300	115	230	655	875	1315	1970
400	100	200	635	845	1270	1900
500	85	170	600	800	1200	1795
600	70	140	550	730	1095	1640
650	60	125	535	715	1075	1610
700	...	110	535	710	1065	1600
750	...	95	505	670	1010	1510
800	...	80	410	550	825	1235
850	...	65	270	355	535	805
900	...	50	170	230	345	515
950	...	35	105	140	205	310
1000	...	20	50	70	105	155

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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	75	150	300	400	600	900
–20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	730	970	1455	2185
400	100	200	705	940	1410	2115
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	505	670	1010	1510
800	...	80	410	550	825	1235
850	...	65	270	355	535	805
900	...	50	170	230	345	515
950	...	35	105	140	205	310
1000	...	20	50	70	105	155

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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	75	150	300	400	600	900
–20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	730	970	1455	2185
400	100	200	705	940	1410	2115
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	385	515	775	1160
1000	...	20	365	485	725	1090
1050	...	...	360	480	720	1080
1100	...	...	300	400	605	905
1150	...	...	225	295	445	670
1200	...	...	145	190	290	430

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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	75	150	300	400	600	900
–20 to 100	130	260	670	895	1345	2015
200	115	235	605	810	1215	1820
300	110	220	570	760	1140	1705
400	100	200	535	715	1070	1605
500	85	170	505	675	1015	1520
600	70	140	480	640	960	1440
650	60	125	470	625	935	1405
700	...	110	455	610	910	1370
750	...	95	450	600	900	1345
800	...	80	435	580	875	1310
850	...	65	425	570	855	1280
900	...	50	420	555	835	1255
950	...	35	385	515	775	1160
1000	...	20	345	460	685	1030
1050	...	...	335	450	670	1010
1100	...	...	260	345	520	780
1150	...	...	190	250	375	565
1200	...	...	135	185	275	410
1250	...	...	105	135	205	310
1300	...	...	75	100	150	225
1350	...	...	60	80	115	175
1400	...	...	45	60	90	135
1450	...	...	35	45	65	100
1500	...	...	25	35	50	75

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(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		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	75	150	300	400	600	900
–20 to 100	145	290	750	1000	1500	2250
200	130	260	720	960	1440	2160
300	115	230	665	885	1330	1995
400	100	200	615	820	1230	1845
500	85	170	575	770	1150	1730
600	70	140	555	740	1115	1670
650	60	125	550	735	1100	1650
700	...	110	540	725	1085	1625
750	...	95	530	710	1065	1595

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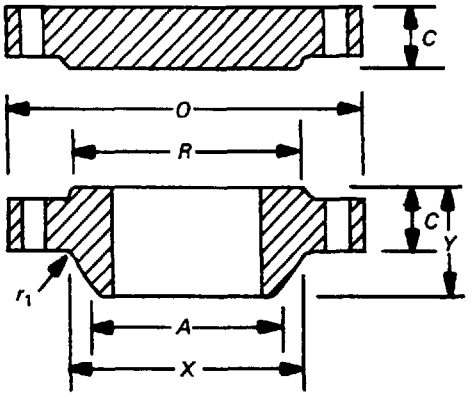

TABLE 12 DIMENSIONS OF CLASS 300 SERIES B FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	34.12	3.50	3.50	5.69	27.62	26.19	29.00	31.62	32	1.38	1¼	0.56
28	36.25	3.50	3.50	5.88	29.75	28.19	31.00	33.75	36	1.38	1¼	0.56
30	39.00	3.69	3.69	6.22	32.00	30.25	33.25	36.25	36	1.50	1⅜	0.56
32	41.50	4.06	4.06	6.62	34.00	32.25	35.50	38.50	32	1.62	1½	0.62
34	43.62	4.06	4.06	6.81	36.12	34.25	37.50	40.62	36	1.62	1½	0.62
36	46.12	4.06	4.06	7.12	38.00	36.25	39.75	42.88	32	1.75	1⅝	0.62
38	48.12	4.38	4.38	7.56	40.00	38.25	41.75	44.88	36	1.75	1⅝	0.62
40	50.12	4.56	4.56	7.81	42.00	40.25	43.88	46.88	40	1.75	1⅝	0.62
42	52.50	4.69	4.69	8.06	44.00	42.31	46.00	49.00	36	1.88	1¾	0.62
44	54.50	5.00	5.00	8.44	46.19	44.31	48.00	51.00	40	1.88	1¾	0.62
46	57.50	5.06	5.12	8.75	48.38	46.31	50.00	53.75	36	2.00	1⅞	0.62
48	59.50	5.06	5.31	8.81	50.31	48.31	52.25	55.75	40	2.00	1⅞	0.62
50	61.50	5.44	5.50	9.25	52.38	50.31	54.25	57.75	44	2.00	1⅞	0.62
52	63.50	5.62	5.68	9.56	54.44	52.31	56.25	59.75	48	2.00	1⅞	0.62
54	65.88	5.38	5.88	9.44	56.50	54.31	58.25	62.12	48	2.00	1⅞	0.62
56	69.50	6.06	6.18	10.56	58.81	56.31	60.50	65.00	36	2.38	2¼	0.69
58	71.94	6.06	6.38	10.81	60.94	58.31	62.75	67.44	40	2.38	2¼	0.69
60	73.94	5.94	6.56	10.69	62.94	60.31	65.00	69.44	40	2.38	2¼	0.69

(Notes follow Table 15)

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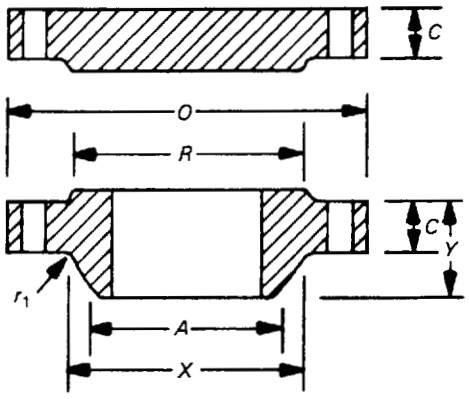

(a)

TABLE 13 DIMENSIONS OF CLASS 400 SERIES B FLANGES[1–6,10]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	33.50	3.50	3.50	5.88	27.12	26.00	28.00	30.75	28	1.50	1⅜	0.44
28	36.00	3.75	3.75	6.25	29.12	28.00	30.00	33.00	24	1.62	1½	0.50
30	38.25	4.00	4.00	6.69	31.25	30.00	32.25	35.25	28	1.62	1½	0.50
32	40.75	4.25	4.25	7.06	33.25	32.00	34.38	37.50	28	1.75	1⅝	0.50
34	42.75	4.38	4.38	7.38	35.38	34.00	36.50	39.50	32	1.75	1⅝	0.56
36	45.50	4.69	4.69	7.88	37.50	36.00	38.62	42.00	28	1.88	1¾	0.56
38	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	...	...	...	...	...
42	...	...	...	...	...	...	...	...	...	...	...	...
44	...	...	...	...	...	...	...	...	...	...	...	...
46	...	...	...	...	...	...	...	...	...	...	...	...
48	...	...	...	...	...	...	...	...	...	...	...	...
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

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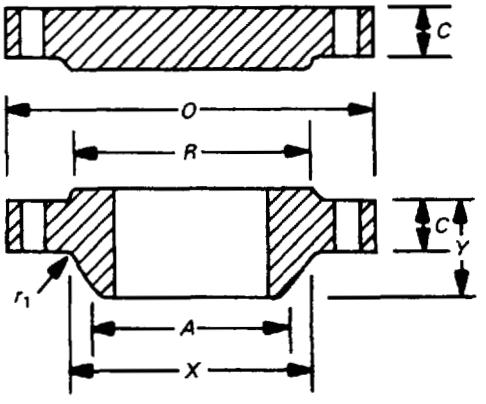

(a)

TABLE 14 DIMENSIONS OF CLASS 600 SERIES B FLANGES[1-6,10]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	35.00	4.38	4.38	7.12	27.50	26.00	28.62	31.75	28	1.75	1⅝	0.50
28	37.50	4.56	4.56	7.50	29.62	28.00	30.88	34.00	28	1.88	1¾	0.50
30	40.25	4.94	5.00	8.06	31.75	30.00	33.12	36.50	28	2.00	1⅞	0.50
32	42.75	5.12	5.31	8.50	33.88	32.00	35.25	38.75	28	2.12	2	0.50
34	45.75	5.56	5.68	9.19	36.00	34.00	37.50	41.50	24	2.38	2¼	0.56
36	47.75	5.75	5.94	9.56	38.12	36.00	39.75	43.50	28	2.38	2¼	0.56
38	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	...	...	...	...	...
42	...	...	...	...	...	...	...	...	...	...	...	...
44	...	...	...	...	...	...	...	...	...	...	...	...
46	...	...	...	...	...	...	...	...	...	...	...	...
48	...	...	...	...	...	...	...	...	...	...	...	...
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

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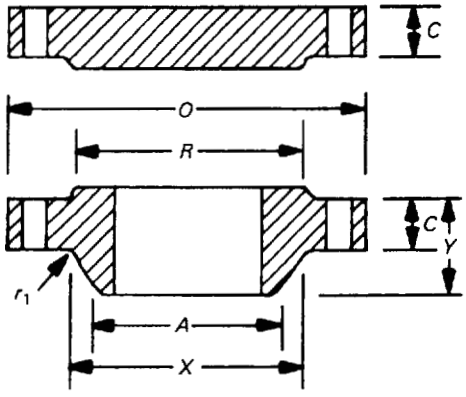

(a)

TABLE 15 DIMENSIONS OF CLASS 900 SERIES B FLANGES[1–6, 10]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	40.25	5.31	6.06	10.19	29.25	26.00	30.00	35.50	20	2.62	2½	0.44
28	43.50	5.81	6.56	10.88	31.38	28.00	32.25	38.25	20	2.88	2¾	0.50
30	46.50	6.12	6.93	11.38	33.50	30.00	34.50	40.75	20	3.12	3	0.50
32	48.75	6.31	7.31	11.94	35.75	32.00	36.50	43.00	20	3.12	3	0.50
34	51.75	6.75	7.68	12.56	37.88	34.00	39.00	45.50	20	3.38	3¼	0.56
36	53.00	6.81	7.94	12.81	40.00	36.00	40.50	47.25	24	3.12	3	0.56
38	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	...	...	...	...	...
42	...	...	...	...	...	...	...	...	...	...	...	...
44	...	...	...	...	...	...	...	...	...	...	...	...
46	...	...	...	...	...	...	...	...	...	...	...	...
48	...	...	...	...	...	...	...	...	...	...	...	...
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

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(a)	ASTM	American Society for Testing and Materials 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959
	MSS	Manufacturers Standardization Society of the Valve & Fittings Industry 127 Park Street, N.E., Vienna, Virginia 22180

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INTERPRETATIONS TO ASME B16.47 (a)

(These interpretations are not part of ASME B16.47-1996 and are included for information only. These interpretations apply to the 1988 and earlier editions and the requirements cited may be different in this Edition. Therefore, some replies may not be valid in regard to this Edition.)

INTRODUCTION

As a service to persons who use the B16 standards, the B16 Committee renders interpretations of the requirements upon request. The procedure for requesting an interpretation is described in the following paragraphs.

The interpretations include all replies which have been approved by the B16 Main Committee in response to inquiries concerning interpretation of this Standard.

An interpretation applies either to the Edition and Addenda in effect on the date of issuance of the interpretation or the Edition and Addenda stated in the interpretation. Subsequent revisions to this Standard may supersede the interpretation.

PROCEDURE FOR REQUESTING INTERPRETATIONS

On request, the B16 Committee will render an interpretation of any requirement of this Standard. Interpretations can only be rendered in response to a written request, which should be addressed to:

Secretary, B16 Main Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his request using the following format:

(a) Subject. Cite the applicable paragraph number(s) and/or give a concise description of the subject.

(b) Question. Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests which are not in this format may be rewritten in this format prior to being answered, which may inadvertently change the original intent of the request.

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INTERPRETATIONS NO. 2

Replies to Technical Inquiries Issued from January 1, 1996 Through December 31, 1997

Interpretation: 2-1

Subject: Series A Flanges

Date Issued: April 30, 1997

File: B16-96-013

Question: According to ASME B16.47-1990, may Series A flanges be manufactured and used for all materials listed in Table 1A?

Reply: Yes, within the restriction of General Note (b) of Table 1A.

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ASME B16.47-1996
(Revision of ASME B16.47-1990)

LARGE DIAMETER STEEL FLANGES

NPS 26 Through NPS 60

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers

AN AMERICAN NATIONAL STANDARD

LARGE DIAMETER STEEL FLANGES

NPS 26 Through NPS 60

ASME B16.47-1996
(Revision of ASME B16.47-1990)

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Date of Issuance: January 31, 1997

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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.

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FOREWORD

(This Foreword is not part of ASME B16.47-1996.)

In November, 1980, a task force was appointed within Subcommittee C of the American National Standards (ANSI) B16 Committee to develop a standard for pipe flanges in size NPS 26 through NPS 48. Every attempt was made to standardize those dimensions that existed within the industry for the materials covered by ANSI B16.5.

Prompted by suggestions received from committee members, the task force was authorized to increase the size range to NPS 60. The first draft was developed in December 1982 to include Class 75 through Class 1500 for the size range NPS 26 through NPS 60. Flange dimensions were based on the Manufacturers Standardization Society Standard Practice (MSS SP) 44 flanges except for Class 75 flanges which are ANSI/API 605 flanges.

At the request of the American Petroleum Institute (API), flange dimensions in accordance with the API Standard 605 were included in the subsequent drafts. Class 1500 flanges were deleted due to lack of interest in using large size flanges in that pressure–temperature rating.

The API-605 flanges for Classes 150 and 300 and for sizes NPS 36 and smaller for classes higher than Class 300 are not compatible with the MSS SP-44 flanges. Thus, the MSS SP-44 flanges are designated as Series A flanges and the API-605 flanges are designated as Series B flanges in this Standard. Materials covered in this Standard are as in ANSI B16.5 except nickel base alloys are excluded. Pressure–temperature ratings are in accordance with ANSI B16.5.

In 1982, American National Standards Committee B16 was reorganized as the American Society of Mechanical Engineers (ASME) B16 Committee operating under procedures accredited by ANSI. Following approval by the Standards Committee and ASME, approval as an American National Standard was given by ANSI on June 12, 1990.

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 permissible flange facing imperfections, adds blind flanges for Series B flanges, 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 B16.47-1996.

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

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

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LARGE DIAMETER STEEL FLANGES

1 SCOPE

1.1 General

This Standard covers pressure–temperature ratings, materials, dimensions, tolerances, marking, and testing for pipe flanges in sizes NPS 26 through NPS 60 and in ratings Classes 75, 150, 300, 400, 600, and 900. Flanges may be cast, forged, or plate (for blind flanges only) materials, as listed in Table 1A.

Requirements and recommendations regarding bolting and gaskets are also included.

1.2 Flange Series

This Standard provides two series of flange dimensions. Series A specifies flange dimensions for general use flanges. Series B specifies flange dimensions for compact flanges which, in general, have smaller bolt circle diameters than Series A flanges. These two series of flanges are not interchangeable. The user should recognize that some flanged valves, equipment bolted between flanges, and flanged equipment may only be compatible with bolt circle diameter of one series of flanges.

1.3 References

1.3.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Annex E, 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 E. A flange 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.

1.3.2 Codes and Regulations. A flange used under the jurisdiction of the ASME Boiler and Pressure Vessel Code (ASME BPV 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, 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.

1.4 Applicable Ratings

The pressure–temperature ratings in this Standard are applicable upon its publication to all flanges within its scope which otherwise meet its requirements. For unused flanges maintained in inventory, the manufacturer of the flange 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. 1.3.2).

1.5 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.

1.6 Quality Systems

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

2 PRESSURE–TEMPERATURE RATINGS

2.1 Rating 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 A, 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

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all these elements in order 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 sole 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. 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 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 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, Classes 75 and 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.

2.4.2 Low Temperature Service. Some of the materials 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 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 carbon steel cylindrically bored welding neck flanges covered by this Standard are based upon their hubs at the welding end having a thickness at least equal to that calculated for pipe having 40.0 ksi specified minimum yield strength. The ratings also apply to such flanges used with components of unequal strength and unequal wall thickness when the attachment welds is made in accordance with the applicable code or regulation. See Figs. 5, 6, and 7.

2.7 Multiple Material Grades

Materials for flanges 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 the marking is in accordance with para. 4.1.2(d).

3 SIZE

3.1 Nominal Size

The size of a flange 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.

4 MARKING

4.1 General

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

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

4.1.2 Materials

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

(b) Plate flanges and forged flanges shall be marked with the ASTM specification number 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 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: 75 (Series B only), 150, 300, 400, 600, or 900.

4.1.4 Designation. The designation of Series A B16/A for flange dimensions in accordance with Tables 5 through 9 and Series B B16/B for flange dimensions in accordance with Tables 10 through 15 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, 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.

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.

5 MATERIALS

5.1 General

Flanges 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.) The ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the specifications listed in Table 1, 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 or susceptibility to intergranular corrosion of austenitic materials are among those items requiring attention. A detailed discussion of precautionary considerations can be found in Appendix F of ASME 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 applications 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 user's 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.

5.3 Bolting

Bolting listed in Table 1B is recommended for use in flange joints covered by this Standard. Bolting of other material may be used if permitted by the applicable code or governmental 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 Gr. 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

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

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ability to seat the selected gasket and to 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 75, 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) Where Class 150 steel flanges are bolted to Class 125 cast iron flanges, the gaskets should be made of Group 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.

(b) Where Class 300 steel flanges are bolted to Class 250 cast iron flanges, the gaskets should be made of Group 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 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.

(c) 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 fluctuations may occur.

5.4 Gaskets

Ring-joint gasket materials shall conform to ASME B16.20. Materials for other gaskets are described in Annex B, 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 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 Annex B, Fig. B1, Group Ia, shall be used.

5.4.2 Gaskets for Class 150 Flanged Joints. It is recommended that only Fig. B1, Group Ia or Ib gaskets be used for Class 150 flanged joints.

5.4.3 Gaskets for Class 75 Flanged Joints. It is recommended that only Group Ia gaskets with a gasket factor $m = 2$ or less, and minimum design seating stress $y = 1600$ psi or less, be used. The m and y factors are those given in Table 2-5.1, Appendix 2 of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

6 DIMENSIONS

6.1 Facings

6.1.1 General. Classes 75, 150, and 300 flanges are regularly furnished with a 0.06 in. raised face, which is included in the minimum flange thickness C. Classes 400, 600, and 900 flanges are regularly furnished with 0.25 in. raised face, which is additional to the minimum flange thickness C. It is recommended that the Class 75 flanges be used only with a 0.06 in. raised face or flat face.

Dimensions for ring-joint facing are given in Table 3 for Series A flanges. Any other facing than the above, when required for any class, shall be furnished as follows.

6.1.1.1 In the case of the 0.25 in. raised face for Classes 150 and 300, the minimum flange thickness C shall first be provided and then the raised face shall be added thereto.

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

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6.1.2 Blind Flanges. 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 the mating flange. When the center part is depressed, its diameter shall not be greater than the inside diameter of the mating flange. Machining of the depressed center is not required.

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

6.1.3.1 The thickness of a Class 75, 150, or 300 flange from which the raised face has been removed shall be no less than the applicable *C* dimension of Tables 5, 6, 10, 11, and 12, minus 0.06 in.

6.1.3.2 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 *C* dimension of Tables 7 to 9 and 13 to 15.

6.1.3.3 A gasket of Group Ia material in Annex B, Fig. B1, is recommended for all joints having two flat faced flanges using a gasket which has a larger diameter than those of the raised face.

6.1.3.4 The flange facing shall conform with para. 6.1.4 for the full width of seating of the gasket.

6.1.4 Flange Facing Finish. The finish of contact faces of pipe flanges shall be judged by visual comparison with Ra Standards (see ANSI/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.

6.1.4.1 Ring-Joint. The side wall surface to gasket groove shall not exceed 63 μin. roughness.

6.1.4.2 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.

6.1.5 Flange Facing Finish Imperfections. Imperfections in the flange facing finish shall not exceed the dimensions shown in Table 16. 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.

6.2 Flange Bolt Holes

Bolt holes are in multiples of four. Bolt holes shall be equally spaced.

6.3 Spot Facing

All cast and forged steel flanges shall have bearing surfaces for bolting which shall be parallel to the flange face 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 5 through 15. Any spot facing or back facing shall be in accordance with MSS SP-9.

6.4 Welding End Preparation for Welding Neck Flanges

6.4.1 Welding ends are shown in Figs. 1 through 7.

6.4.2 The contours of the outside of the welding neck beyond the welding groove are shown in Figs. 1, 2, 5, and 7.

6.4.3 Straight through bores shown in Figs. 1 and 2 are standard unless otherwise specifically ordered to suit the special conditions illustrated in Figs. 3, 4, 6, and 7.

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

6.5 Flange Bolting Dimensions

6.5.1 Stud-bolts threaded at both ends or full length, or bolts with hexagonal heads may be used. Dimensional recommendations for bolts, stud-bolts, and nuts are shown in Table 4. See para. 5.3 for bolting material.

6.5.2 For the method of calculating bolt lengths, see Annex C. The method of calculating bolt length is established for the convenience of industry to simplify the assembly of these parts on construction work, but

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users may select combinations of these bolt lengths to suit their needs. Hence, Annex C is not considered part of this Standard.

6.6 Gaskets for Line Flanges

6.6.1 Ring-joint gasket dimensions shall conform to ASME B16.20.

6.6.2 Nonmetallic gasket dimensions for Series A flanges with raised face shall conform to ASME B16.21.

6.6.3 Solid flat metal gaskets shall have contact width not greater than for Group III gaskets.

6.6.4 Spiral wound and double-jacketed corrugated metal gasket shall conform to ASME B16.20.

6.6.5 Nonmetallic gasket dimensions for Series B flanges with raised face shall have outside diameter equal to the raised face diameter and inside diameter equal to the nominal pipe size. If self-centering ring gaskets are used, the outside diameter shall equal the bolt circle diameter less one bolt hole diameter.

7 TOLERANCES[2]

7.1 General

For the purposes 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 E29. 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 Facings

7.2.1 Outside diameter, 0.06 in. raised face, 0.08 in.

7.2.2 Outside diameter, 0.25 in. raised face, 0.04 in.

7.2.3 Ring-joint groove tolerances are shown in Table 3.

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

7.3 Flange Thickness

Thickness, in.	
To 1.0	+0.12 in. −0
1.0–2.0	+0.19 in. −0
2.0–3.0	+0.31 in. −0
Over 3.0	+0.38 in. −0

7.4 Hub Dimensions Including Welding Ends

7.4.1 Nominal outside diameter of welding end of welding neck flanges (dimension *A* of Figs. 1 and 2).

+0.21 in.
−0.06 in.

7.4.2 Nominal inside diameter of welding ends of welding neck flanges (dimension *B* in the referenced Figures).

Figs. 1 and 2	+0.12 in. −0.06 in.
Fig. 3	+0 −0.06 in.

7.4.3 Bore of backing ring of welding neck flanges (dimension *C* of Figs. 3 and 4).

+0.010 in.
−0

7.4.4 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 $87\frac{1}{2}\%$ of the nominal thickness of the pipe to which the flange is to be attached.

7.5 Overall Length Through Hub on Welding Neck Flanges

0.19 in.

7.6 Drilling and Facing

7.6.1 Bolt circle diameter, 0.06 in.

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

7.6.3 Eccentricity between bolt circle diameter and machined facing diameters, 0.06 in.

8 TEST

8.1 Flange Testing

Flanges are not required to be hydrostatically tested.

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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 ¾Ni–1Mo–¾Cr	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

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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

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.

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TABLE 1B LIST OF BOLTING SPECIFICATIONS

Applicable ASTM Specifications[11]

Bolting Materials[1]					
High Strength (2)		Intermediate Strength (3)		Low Strength (4)	
Spec.-Gr.	Notes	Spec.-Gr.	Notes	Spec.-Gr.	Notes
A 193-B7	...	A 193-B5	...	A 193-B8 Cl. 1	(5)
A 193-B16	...	A 193-B6	...	A 193-B8C Cl. 1	(5)
		A 193-B6X	...	A 193-B8M Cl. 1	(5)
A 320-L7	(6)	A 193-B7M	...	A 193-B8T Cl. 1	(5)
A 320-L7A	(6)				
A 320-L7B	(6)	A 193-B8 Cl. 2	(7)	A 193-B8A	(5)
A 320-L7C	(6)	A 193-B8C Cl. 2	(7)	A 193-B8CA	...
A 320-L43	(6)	A 193-B8M Cl. 2	(7)	A 193-B8MA	...
		A 193-B8T Cl. 2	(7)	A 193-B8TA	(5)
A 354-BC	...				
A 354-BD	...	A 320-B8 Cl. 2	(7)	A 307-B	(8)
		A 320-B8C Cl. 2	(7)		
A 540-B21	...	A 320-B8F Cl. 2	(7)	A 320-B8 Cl. 1	(5)
A 540-B22	...	A 320-B8M Cl. 2	(7)	A 320-B8C Cl. 1	(5)
A 540-B23	...	A 320-B8T Cl. 2	(7)	A 320-B8M Cl. 1	(5)
A 540-B24	...			A 320-B8T Cl. 1	(5)
		A 449	(9)		
		A 453-651	(10)		
		A 453-660	(10)		

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 verified 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 Class 150 and Class 300 joints. See para. 5.4.1 for recommended gasket practices.
(5) This austenitic stainless material has been carbide solution treated but not strain hardened. Use A 194 nuts of corresponding material.
(6) This ferritic material is intended for low temperature service. Use A 194 Gr. 4 or Gr. 7 nuts.
(7) This austenitic stainless material has been carbide solution treated and strain hardened. Use A 194 nuts of corresponding material.
(8) 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.
(9) Acceptable nuts for use with quenched and tempered bolts are A 194 Gr. 2 and Gr. 2H. Mechanical property requirements for studs shall be the same as those for bolts.
(10) This special alloy is intended for high temperature service with austenitic stainless steel.
(11) ASME Boiler and Pressure Vessel Code, Section II materials, which also meet the requirements of the listed ASTM specifications, may also be used.

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TABLES 2 PRESSURE–TEMPERATURE RATINGS FOR GROUPS 1.1 THROUGH 2.8 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	75	150	300	400	600	900
−20 to 100	140	285	740	990	1480	2220
200	130	260	675	900	1350	2025
300	115	230	655	875	1315	1970
400	100	200	635	845	1270	1900
500	85	170	600	800	1200	1795
600	70	140	550	730	1095	1640
650	60	125	535	715	1075	1610
700	...	110	535	710	1065	1600
750	...	95	505	670	1010	1510
800	...	80	410	550	825	1235
850	65	270	355	535	805	805
900	50	170	230	345	515	515
950	35	105	140	205	310	310
1000	20	50	70	105	155	155

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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	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	730	970	1455	2185
400	100	200	705	940	1410	2115
500	80	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	505	670	1010	1510
800	...	80	410	550	825	1235
850	...	65	270	355	535	805
900	...	50	170	230	345	515
950	...	35	105	140	205	310
1000	...	20	50	70	105	155

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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	75	150	300	400	600	900
−20 to 100	130	265	695	925	1390	2085
200	125	250	655	875	1315	1970
300	115	230	640	850	1275	1915
400	100	200	620	825	1235	1850
500	85	170	585	775	1165	1745
600	70	140	535	710	1065	1600
650	60	125	525	695	1045	1570
700	...	110	520	690	1035	1555
750	...	95	475	630	945	1420
800	...	80	390	520	780	1175
850	...	65	270	355	535	805
900	...	50	170	230	345	515
950	...	35	105	140	205	310
1000	...	20	50	70	105	155

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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	75	150	300	400	600	900
−20 to 100	115	235	620	825	1235	1850
200	105	215	560	750	1125	1685
300	105	210	550	730	1095	1640
400	100	200	530	705	1060	1585
500	85	170	500	665	995	1495
600	70	140	455	610	915	1370
650	60	125	450	600	895	1345
700	...	110	450	600	895	1345
750	...	95	445	590	885	1325
800	...	80	370	495	740	1110
850	...	65	270	355	535	805
900	...	50	170	230	345	515
950	...	35	105	140	205	310
1000	...	20	50	70	105	155

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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	75	150	300	400	600	900
−20 to 100	130	265	695	925	1390	2085
200	130	260	680	905	1360	2035
300	115	230	655	870	1305	1955
400	100	200	640	855	1280	1920
500	85	170	620	830	1245	1865
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	280	375	560	845
1000	...	20	165	220	330	495

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TABLE 2-1.7 RATINGS FOR GROUP 1.7 MATERIALS

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

NOTES:
(1) Use normalized and tempered material only.
(2) Not to be used over 850°F.
(3) Not to be used over 1000°F.

WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	720	965	1445	2165
400	100	200	695	925	1385	2080
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	315	420	630	945
1000	...	20	200	270	405	605
1050	...	...	160	210	315	475

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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	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	720	965	1445	2165
400	100	200	695	925	1385	2080
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	320	425	640	955
1000	...	20	215	290	430	650
1050	...	...	145	190	290	430
1100	...	...	95	130	190	290
1150	...	...	60	80	125	185
1200	...	...	40	50	75	115

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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	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	730	970	1455	2185
400	100	200	705	940	1410	2115
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	375	505	755	1130
1000	...	20	260	345	520	780
1050	...	...	175	235	350	525
1100	...	...	110	145	220	330
1150	...	...	70	90	135	205
1200	...	...	40	55	80	125

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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	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	745	995	1490	2235
300	115	230	715	955	1430	2150
400	100	200	705	940	1410	2115
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	705	1055	1585
800	...	80	510	675	1015	1525
850	...	65	485	645	965	1450
900	...	50	370	495	740	1110
950	...	35	275	365	550	825
1000	...	20	200	265	400	595
1050	...	...	145	190	290	430
1100	...	...	100	135	200	300
1150	...	...	60	80	125	185
1200	...	...	35	45	70	105

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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	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	730	970	1455	2185
400	100	200	705	940	1410	2115
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	375	505	755	1130
1000	...	20	255	340	505	760
1050	...	...	170	230	345	515
1100	...	...	115	150	225	340
1150	...	...	75	100	150	225
1200	...	...	50	70	105	155

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TABLE 2-2.1 RATINGS FOR GROUP 2.1 MATERIALS

Nominal Designation	Forgings	Castings	Plates
18Cr–8Ni	A 182 Gr. F304 (1) A 182 Gr. F304H	A 351 Gr. CF3 (2) A 351 Gr. CF8 (1)	A 240 Gr. 304 (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	75	150	300	400	600	900
−20 to 100	135	275	720	960	1440	2160
200	115	230	600	800	1200	1800
300	100	205	540	720	1080	1620
400	95	190	495	660	995	1490
500	85	170	465	620	930	1395
600	70	140	435	580	875	1310
650	60	125	430	575	860	1290
700	...	110	425	565	850	1275
750	...	95	415	555	830	1245
800	...	80	405	540	805	1210
850	...	65	395	530	790	1190
900	...	50	390	520	780	1165
950	...	35	380	510	765	1145
1000	...	20	320	430	640	965
1050	...	...	310	410	615	925
1100	...	...	255	345	515	770
1150	...	...	200	265	400	595
1200	...	...	155	205	310	465
1250	...	...	115	150	225	340
1300	...	...	85	115	170	255
1350	...	...	60	80	125	185
1400	...	...	50	65	95	145
1450	...	...	35	45	70	105
1500	...	...	25	35	55	80

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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	75	150	300	400	600	900
−20 to 100	135	275	720	960	1440	2160
200	115	235	620	825	1240	1860
300	105	215	560	745	1120	1680
400	95	195	515	685	1025	1540
500	85	170	480	635	955	1435
600	70	140	450	600	900	1355
650	60	125	445	590	890	1330
700	...	110	430	580	870	1305
750	...	95	425	570	855	1280
800	...	80	420	565	845	1265
850	...	65	420	555	835	1255
900	...	50	415	555	830	1245
950	...	35	385	515	775	1160
1000	...	20	350	465	700	1050
1050	...	...	345	460	685	1030
1100	...	...	305	405	610	915
1150	...	...	235	315	475	710
1200	...	...	185	245	370	555
1250	...	...	145	195	295	440
1300	...	...	115	155	235	350
1350	...	...	95	130	190	290
1400	...	...	75	100	150	225
1450	...	...	60	80	115	175
1500	...	...	40	55	85	125

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TABLE 2-2.3 RATINGS FOR GROUP 2.3 MATERIALS

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

NOTE:
(1) Not to be used over 800°F.

WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	75	150	300	400	600	900
−20 to 100	115	230	600	800	1200	1800
200	95	195	505	675	1015	1520
300	85	175	455	605	910	1360
400	80	160	415	550	825	1240
500	70	145	380	510	765	1145
600	70	140	360	480	720	1080
650	60	125	350	470	700	1050
700	...	110	345	460	685	1030
750	...	95	335	450	670	1010
800	...	80	330	440	660	985
850	...	65	320	430	645	965

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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	75	150	300	400	600	900
−20 to 100	135	275	720	960	1440	2160
200	120	245	645	860	1290	1935
300	115	230	595	795	1190	1785
400	100	200	550	735	1105	1655
500	85	170	515	685	1030	1545
600	70	140	485	650	975	1460
650	60	125	480	635	955	1435
700	...	110	465	620	930	1395
750	...	95	460	610	915	1375
800	...	80	450	600	900	1355
850	...	65	445	595	895	1340
900	...	50	440	590	885	1325
950	...	35	385	515	775	1160
1000	...	20	355	475	715	1070
1050	...	...	315	415	625	940
1100	...	...	270	360	545	815
1150	...	...	235	315	475	710
1200	...	...	185	245	370	555
1250	...	...	140	185	280	420
1300	...	...	110	145	220	330
1350		...	85	115	170	255
1400	...	...	65	85	130	195
1450	...	...	50	70	105	155
1500	...	...	40	50	75	115

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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	75	150	300	400	600	900
−20 to 100	135	275	720	960	1440	2160
200	125	255	660	880	1320	1980
300	115	230	615	820	1230	1845
400	100	200	575	765	1145	1720
500	85	170	540	720	1080	1620
600	70	140	515	685	1025	1540
650	60	125	505	670	1010	1510
700	...	110	495	660	990	1485
750	...	95	490	655	985	1475
800	...	80	485	650	975	1460
850	...	65	485	645	970	1455
900	...	50	450	600	900	1350
950	...	35	385	515	775	1160
1000	...	20	365	485	725	1090
1050	...	...	360	480	720	1080
1100	...	...	325	430	645	965
1150	...	...	275	365	550	825
1200	...	...	170	230	345	515
1250	...	...	125	165	245	370
1300	...	...	95	125	185	280
1350	...	...	70	90	135	205
1400	...	...	55	75	110	165
1450	...	...	40	55	80	125
1500	...	...	35	45	70	105

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TABLE 2-2.6 RATINGS FOR GROUP 2.6 MATERIALS

Nominal Designation	Forgings	Castings	Plates
25Cr–12Ni		A 351 Gr. CH8 (1) A 351 Gr. CH20 (1)(4)	
23Cr–12Ni			A 240 Gr. 309S (1)(2)(3) A 240 Gr. 309H

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) 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.
(4) For service temperatures above 850°F, it is recommended that killed steel containing not less than 0.10% residual silicon be used.

WORKING PRESSURES BY CLASSES, psig						
Class Temp., °F	75	150	300	400	600	900
−20 to 100	130	260	670	895	1345	2015
200	115	230	605	805	1210	1815
300	110	220	570	760	1140	1705
400	100	200	535	710	1065	1600
500	85	170	505	670	1010	1510
600	70	140	480	635	955	1435
650	60	125	465	620	930	1395
700	...	110	455	610	910	1370
750	...	95	445	595	895	1340
800	...	80	435	580	870	1305
850	...	65	425	565	850	1275
900	...	50	415	555	830	1245
950	...	35	385	515	775	1160
1000	...	20	335	450	670	1010
1050	...	...	290	390	585	875
1100	...	...	225	300	445	670
1150	...	...	170	230	345	515
1200	...	...	130	175	260	390
1250	...	...	100	135	200	300
1300	...	...	80	105	160	235
1350		...	60	80	115	175
1400	...	...	45	60	90	135
1450	...	...	30	40	60	95
1500	...	...	25	30	50	70

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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	75	150	300	400	600	900
−20 to 100	130	260	670	895	1345	2015
200	115	235	605	810	1215	1820
300	110	220	570	760	1140	1705
400	100	200	535	715	1070	1605
500	85	170	505	675	1015	1520
600	70	140	480	640	960	1440
650	60	125	470	625	935	1405
700	...	110	455	610	910	1370
750	...	95	450	600	900	1345
800	...	80	435	580	875	1310
850	...	65	425	575	855	1280
900	...	50	420	555	835	1255
950	...	35	385	515	775	1160
1000	...	20	345	460	685	1030
1050	...	...	335	450	670	1010
1100	...	...	260	345	520	780
1150	...	...	190	250	375	565
1200	...	...	135	185	275	410
1250	...	...	105	135	205	310
1300	...	...	75	100	150	225
1350	...	...	60	80	115	175
1400	...	...	45	60	90	135
1450	...	...	35	45	65	100
1500	...	...	25	35	50	75

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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	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	720	960	1440	2160
300	115	230	665	885	1330	1995
400	100	200	615	820	1230	1845
500	85	170	575	770	1150	1730
600	70	140	555	740	1115	1670
650	60	125	550	735	1100	1650
700	...	110	540	725	1085	1625
750	...	95	530	710	1065	1595

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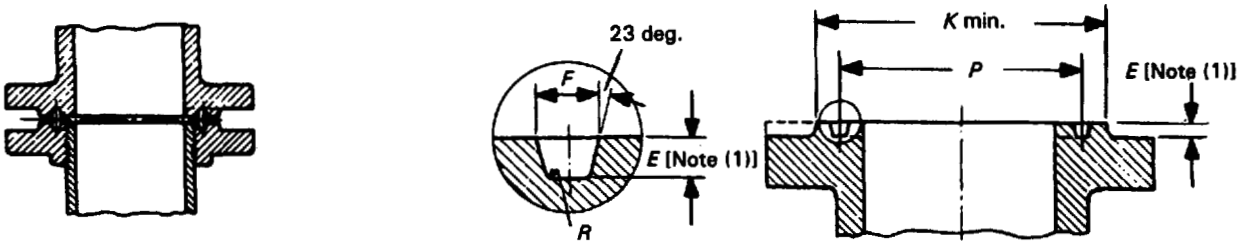

TABLE 3 DIMENSIONS OF RING-JOINT FACINGS[2,3]

Nominal Pipe Size				Groove Number	Groove Dimensions				Diameter of Raised Portion
					Pitch Diam.	Depth	Width	Radius at Bottom	
300	400	600	900		*P*	*E*	*F*	*R*	*K*
26	26	26	...	R93	29.500	0.500	0.781	0.06	31.88
28	28	28	...	R94	31.500	0.500	0.781	0.06	33.88
30	30	30	...	R95	33.750	0.500	0.781	0.06	36.12
32	32	32	...	R96	36.000	0.562	0.906	0.06	38.75
34	34	34	...	R97	38.000	0.562	0.906	0.06	40.75
36	36	36	...	R98	40.250	0.562	0.906	0.06	43.00
...	...	...	26	R100	29.500	0.688	1.188	0.09	32.75
...	...	...	28	R101	31.500	0.688	1.312	0.09	35.00
...	...	...	30	R102	33.750	0.688	1.312	0.09	37.25
...	...	...	32	R103	36.000	0.688	1.312	0.09	39.50
...	...	...	34	R104	38.000	0.812	1.438	0.09	42.00
...	...	...	36	R105	40.250	0.812	1.438	0.09	44.25

Tolerances	
E (depth)	+0.016 −0
F (width)	±0.008
P (pitch diameter)	±0.005
R (radius at bottom)	Max.
23 deg. (angle)	±½ deg.

GENERAL NOTES:
(a) Dimensions are in inches.
(b) Ring-joint gaskets are not contemplated for NPS 38 and larger flanges.

NOTES:
(1) Height of raised portion is equal to the depth of groove dimension *E*, but is not subjected to the tolerances for *E*. Full face contour may be used.
(2) For facing requirements for flanges, see para. 6.1.1.
(3) See para. 4.1.7 for marking requirements.

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TABLE 4 FLANGE BOLTING DIMENSIONAL RECOMMENDATIONS

	Carbon Steel	Other Materials
Stud-bolts	**ANSI B18.2.1**	
Bolts smaller than 3/4 in.	ANSI B18.2.1, square or heavy hex head	ANSI B18.2.1, heavy hex head
Bolts equal to or larger than 3/4 in.	ANSI B18.2.1, square or hex head	ANSI B18.2.1, heavy hex head
Nuts smaller than 3/4 in.	ASME/ANSI B18.2.2, heavy hex	
Nuts equal to or larger than 3/4 in.	ASME/ANSI B18.2.2, hex or heavy hex	ASME/ANSI B18.2.2, heavy hex
Male threads	ANSI B1.1, Cl. 2A, coarse series	ANSI B1.1., Cl. 2A; coarse series up through 1 in. bolts; 8 thread series for larger bolts
Female threads	ANSI B1.1, Cl. 2B, coarse series	ANSI B1.1, Cl. 2B; coarse series up through 1 in. bolts, 8 thread series for larger bolts

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WELDING ENDS
(Welding Neck Flanges, No Backing Rings)

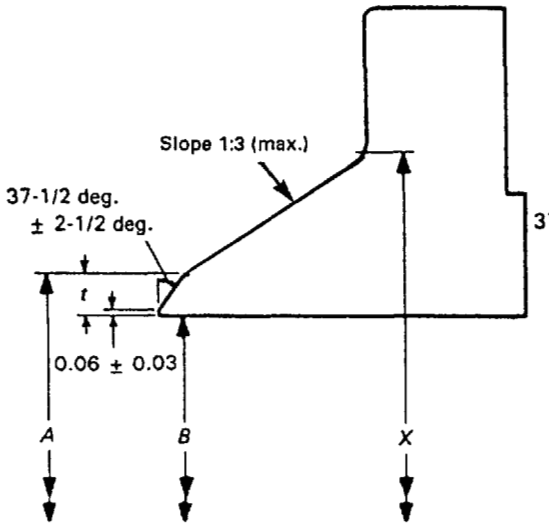

FIG. 1 BEVEL FOR WALL THICKNESSES t FROM 0.19 in. TO 0.88 in., INCLUSIVE[1-3]

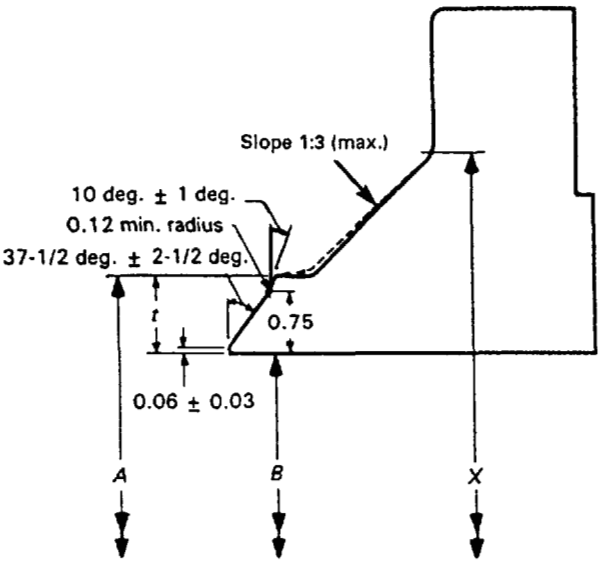

FIG. 2 BEVEL FOR WALL THICKNESSES t GREATER THAN 0.88 in.[1-3]

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. 6.4 and 7.4 for details and tolerances.

(2) See Figs. 3 and 4 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 O.D. 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 and 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. 5, 6, and 7.

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WELDING ENDS
(Welding Neck Flanges With Backing Rings)

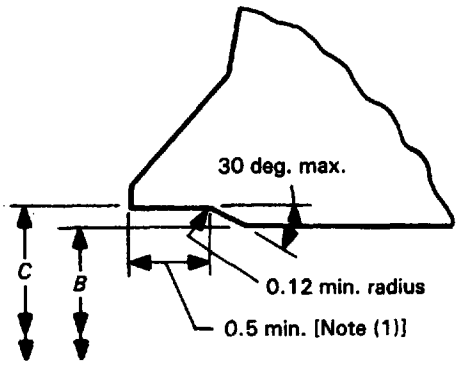

FIG. 3 INSIDE CONTOUR FOR USE WITH RECTANGULAR BACKING RING[1-3]

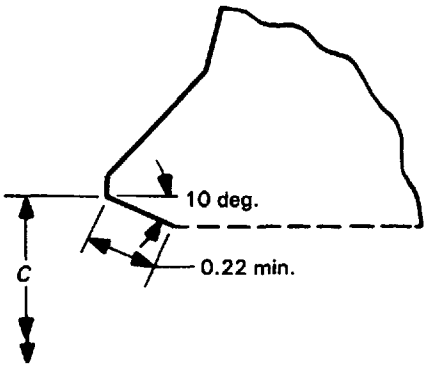

FIG. 4 INSIDE CONTOUR FOR USE WITH TAPER BACKING RING[1-3]

A = nominal outside diameter of welding end, in.
B = nominal inside diameter of pipe
= $A - 2t$, in.
C = $A - 0.031 - 1.75t - 0.010$ in.
t = nominal wall thickness of pipe, in.
0.031 = minus tolerance on O.D. of pipe, in.
$1.75t$ = 87½% of nominal wall multiplied by two to convert into terms of diameter
0.010 = plus tolerance on diameter C, in. (see para. 7.4.3.)

NOTES:
(1) 0.5 in. depth based on use of 0.75 in. wide backing ring.
(2) See paras. 6.4 and 7.4 for details and tolerances.
(3) See Figs. 1 and 2 for welding end details of welding neck flanges.

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

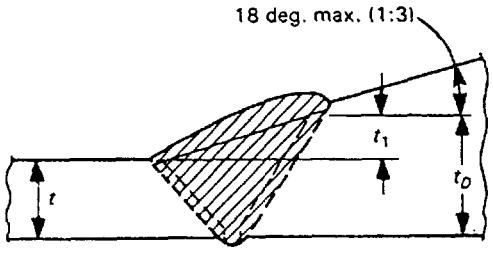

FIG. 5 BEVEL FOR OUTSIDE THICKNESS[1-3]

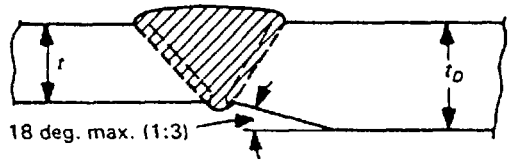

FIG. 6 BEVEL FOR INSIDE THICKNESS[1-3]

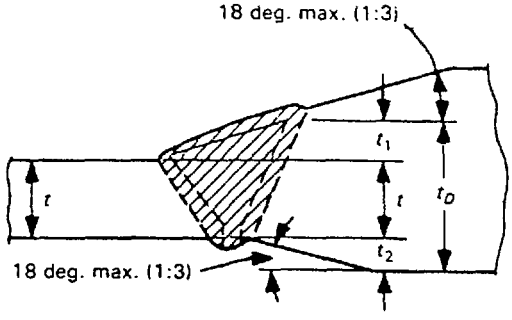

FIG. 7 BEVEL FOR COMBINED THICKNESS[1-3]

NOTES:

(1) Neither t_1, t_2, nor their sum ($t_1 + t_2$) shall exceed $0.5t$.

(2) When the minimum specified yield strengths of the sections to be joined are unequal, the value of t_D shall at least equal t times the ratio of minimum specified yield strength of the pipe to yield strength of the flange.

(3) Welding shall be in accordance with the applicable code.

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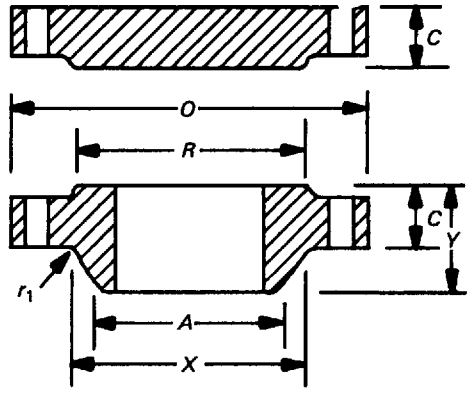

TABLE 5 DIMENSIONS OF CLASS 150 SERIES A FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	34.25	2.69	2.69	4.75	26.62	26.00	29.50	31.75	24	1.38	1¼	0.38
28	36.50	2.81	2.81	4.94	28.62	28.00	31.50	34.00	28	1.38	1¼	0.44
30	38.75	2.94	2.94	5.38	30.75	30.00	33.75	36.00	28	1.38	1¼	0.44
32	41.75	3.19	3.19	5.69	32.75	32.00	36.00	38.50	28	1.62	1½	0.44
34	43.75	3.25	3.25	5.88	34.75	34.00	38.00	40.50	32	1.62	1½	0.50
36	46.00	3.56	3.56	6.19	36.75	36.00	40.25	42.75	32	1.62	1½	0.50
38	48.75	3.44	3.44	6.19	39.00	38.00	42.25	45.25	32	1.62	1½	0.50
40	50.75	3.56	3.56	6.44	41.00	40.00	44.25	47.25	36	1.62	1½	0.50
42	53.00	3.81	3.81	6.75	43.00	42.00	47.00	49.50	36	1.62	1½	0.50
44	55.25	4.00	4.00	7.00	45.00	44.00	49.00	51.75	40	1.62	1½	0.50
46	57.25	4.06	4.06	7.31	47.12	46.00	51.00	53.75	40	1.62	1½	0.50
48	59.50	4.25	4.25	7.56	49.12	48.00	53.50	56.00	44	1.62	1½	0.50
50	61.75	4.38	4.38	8.00	51.25	50.00	55.50	58.25	44	1.88	1¾	0.50
52	64.00	4.56	4.56	8.25	53.25	52.00	57.50	60.50	44	1.88	1¾	0.50
54	66.25	4.75	4.75	8.50	55.25	54.00	59.50	62.75	44	1.88	1¾	0.50
56	68.75	4.88	4.88	9.00	57.38	56.00	62.00	65.00	48	1.88	1¾	0.50
58	71.00	5.06	5.06	9.25	59.38	58.00	64.00	67.25	48	1.88	1¾	0.50
60	73.00	5.19	5.19	9.44	61.38	60.00	66.00	69.25	52	1.88	1¾	0.50

(Notes follow Table 15)

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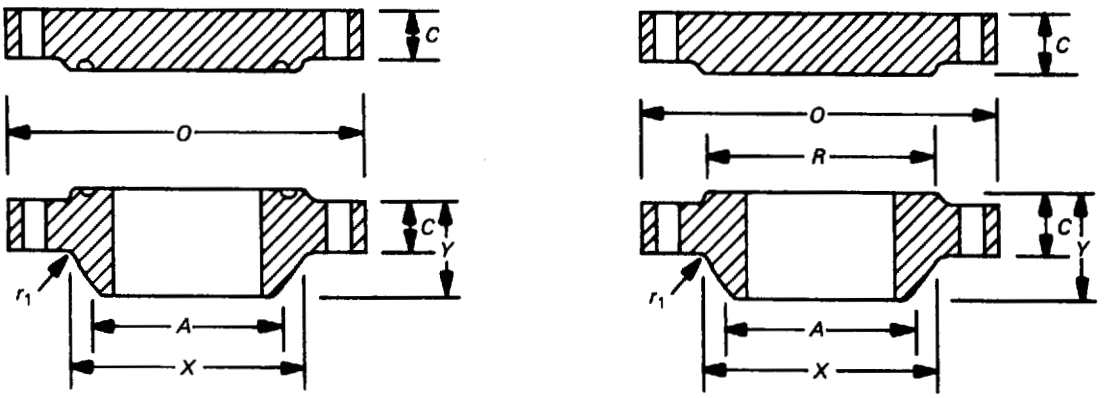

TABLE 6 DIMENSIONS OF CLASS 300 SERIES A FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	38.25	3.12	3.31	7.25	28.38	26.00	29.50	34.50	28	1.75	$1\frac{5}{8}$	0.38
28	40.75	3.38	3.56	7.75	30.50	28.00	31.50	37.00	28	1.75	$1\frac{5}{8}$	0.44
30	43.00	3.62	3.75	8.25	32.56	30.00	33.75	39.25	28	1.88	$1\frac{3}{4}$	0.44
32	45.25	3.88	3.94	8.75	34.69	32.00	36.00	41.50	28	2.00	$1\frac{7}{8}$	0.44
34	47.50	4.00	4.12	9.12	36.88	34.00	38.00	43.50	28	2.00	$1\frac{7}{8}$	0.50
36	50.00	4.12	4.38	9.50	39.00	36.00	40.25	46.00	32	2.12	2	0.50
38	46.00	4.25	4.25	7.12	39.12	38.00	40.50	43.00	32	1.62	$1\frac{1}{2}$	0.50
40	48.75	4.50	4.50	7.62	41.25	40.00	42.75	45.50	32	1.75	$1\frac{5}{8}$	0.50
42	50.75	4.69	4.69	7.88	43.25	42.00	44.75	47.50	32	1.75	$1\frac{5}{8}$	0.50
44	53.25	4.88	4.88	8.12	45.25	44.00	47.00	49.75	32	1.88	$1\frac{3}{4}$	0.50
46	55.75	5.06	5.06	8.50	47.38	46.00	49.00	52.00	28	2.00	$1\frac{7}{8}$	0.50
48	57.75	5.25	5.25	8.81	49.38	48.00	51.25	54.00	32	2.00	$1\frac{7}{8}$	0.50
50	60.25	5.50	5.50	9.12	51.38	50.00	53.50	56.25	32	2.12	2	0.50
52	62.25	5.69	5.69	9.38	53.38	52.00	55.50	58.25	32	2.12	2	0.50
54	65.25	6.00	6.00	9.94	55.50	54.00	57.75	61.00	28	2.38	$2\frac{1}{4}$	0.50
56	67.25	6.06	6.06	10.25	57.62	56.00	59.75	63.00	28	2.38	$2\frac{1}{4}$	0.50
58	69.25	6.25	6.25	10.50	59.62	58.00	62.00	65.00	32	2.38	$2\frac{1}{4}$	0.50
60	71.25	6.44	6.44	10.75	61.62	60.00	64.00	67.00	32	2.38	$2\frac{1}{4}$	0.50

(Notes follow Table 15)

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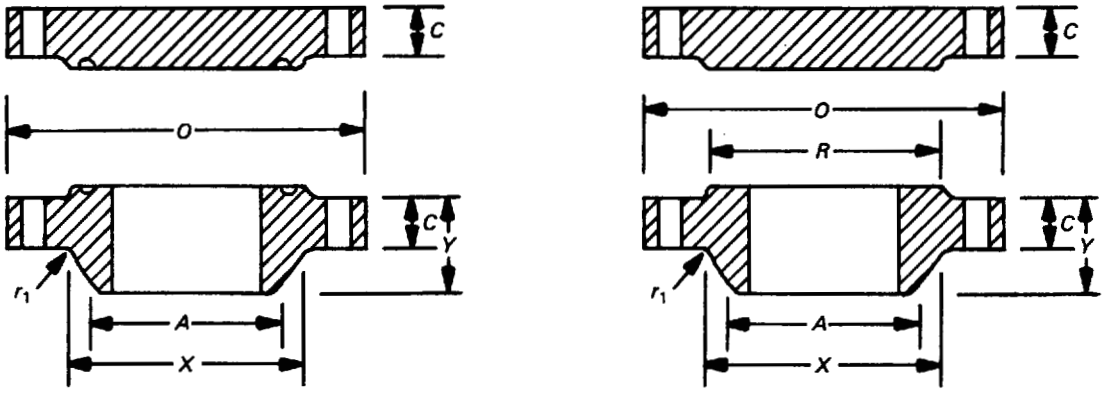

TABLE 7 DIMENSIONS OF CLASS 400 SERIES A FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	38.25	3.50	3.88	7.62	28.62	26.00	29.50	34.50	28	1.88	1¾	0.44
28	40.75	3.75	4.12	8.12	30.81	28.00	31.50	37.00	28	2.00	1⅞	0.50
30	43.00	4.00	4.38	8.62	32.94	30.00	33.75	39.25	28	2.12	2	0.50
32	45.25	4.25	4.56	9.12	35.00	32.00	36.00	41.50	28	2.12	2	0.50
34	47.50	4.38	4.81	9.50	37.19	34.00	38.00	43.50	28	2.12	2	0.56
36	50.00	4.50	5.06	9.88	39.38	36.00	40.25	46.00	32	2.12	2	0.56
38	47.50	4.88	4.88	8.12	39.50	38.00	40.75	44.00	32	1.88	1¾	0.56
40	50.00	5.12	5.12	8.50	41.50	40.00	43.00	46.25	32	2.00	1⅞	0.56
42	52.00	5.25	5.25	8.81	43.62	42.00	45.00	48.25	32	2.00	1⅞	0.56
44	54.50	5.50	5.50	9.18	45.62	44.00	47.25	50.50	32	2.12	2	0.56
46	56.75	5.75	5.75	9.62	47.75	46.00	49.50	52.75	36	2.12	2	0.56
48	59.50	6.00	6.00	10.12	49.88	48.00	51.50	55.25	28	2.38	2¼	0.56
50	61.75	6.19	6.25	10.56	52.00	50.00	53.62	57.50	32	2.38	2¼	0.56
52	63.75	6.38	6.44	10.88	54.00	52.00	55.62	59.50	32	2.38	2¼	0.56
54	67.00	6.69	6.75	11.38	56.12	54.00	57.88	62.25	28	2.62	2½	0.56
56	69.00	6.88	6.94	11.75	58.25	56.00	60.12	64.25	32	2.62	2½	0.56
58	71.00	7.00	7.12	12.06	60.25	58.00	62.12	66.25	32	2.62	2½	0.56
60	74.25	7.31	7.44	12.56	62.38	60.00	64.38	69.00	32	2.88	2¾	0.56

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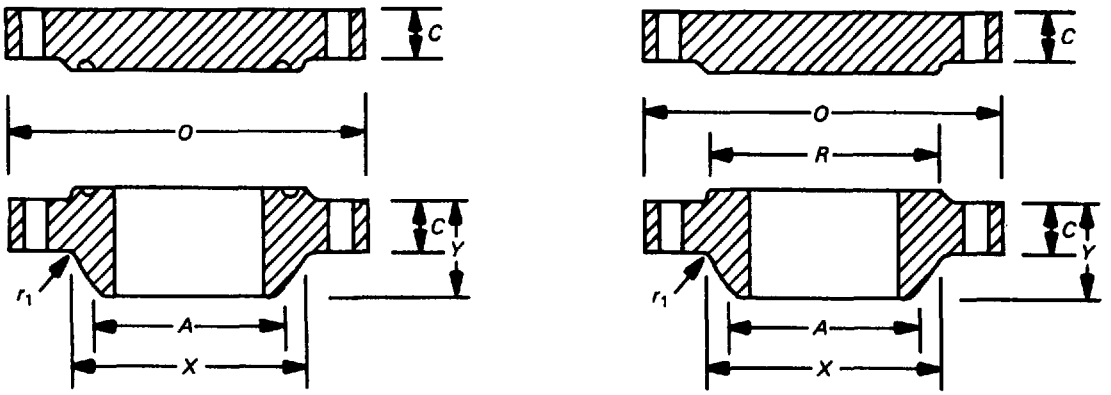

TABLE 8 DIMENSIONS OF CLASS 600 SERIES A FLANGES[1-6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	40.00	4.25	4.94	8.75	29.44	26.00	29.50	36.00	28	2.00	1⅞	0.50
28	42.25	4.38	5.19	9.25	31.62	28.00	31.50	38.00	28	2.12	2	0.50
30	44.50	4.50	5.50	9.75	33.94	30.00	33.75	40.25	28	2.12	2	0.50
32	47.00	4.62	5.81	10.25	36.12	32.00	36.00	42.50	28	2.38	2¼	0.50
34	49.00	4.75	6.06	10.62	38.31	34.00	38.00	44.50	28	2.38	2¼	0.56
36	51.75	4.88	6.38	11.12	40.62	36.00	40.25	47.00	28	2.62	2½	0.56
38	50.00	6.00	6.12	10.00	40.25	38.00	41.50	45.75	28	2.38	2¼	0.56
40	52.00	6.25	6.38	10.38	42.25	40.00	43.75	47.75	32	2.38	2¼	0.56
42	55.25	6.62	6.75	11.00	44.38	42.00	46.00	50.50	28	2.62	2½	0.56
44	57.25	6.81	7.00	11.38	46.50	44.00	48.25	52.50	32	2.62	2½	0.56
46	59.50	7.06	7.31	11.81	48.62	46.00	50.25	54.75	32	2.62	2½	0.56
48	62.75	7.44	7.69	12.44	50.75	48.00	52.50	57.50	32	2.88	2¾	0.56
50	65.75	7.75	8.00	12.94	52.88	50.00	54.50	60.00	28	3.12	3	0.56
52	67.75	8.00	8.25	13.25	54.88	52.00	56.50	62.00	32	3.12	3	0.56
54	70.00	8.25	8.56	13.75	57.00	54.00	58.75	64.25	32	3.12	3	0.56
56	73.00	8.56	8.88	14.25	59.12	56.00	60.75	66.75	32	3.38	3¼	0.62
58	75.00	8.75	9.12	14.56	61.12	58.00	63.00	68.75	32	3.38	3¼	0.62
60	78.50	9.19	9.56	15.31	63.38	60.00	65.25	71.75	28	3.62	3½	0.69

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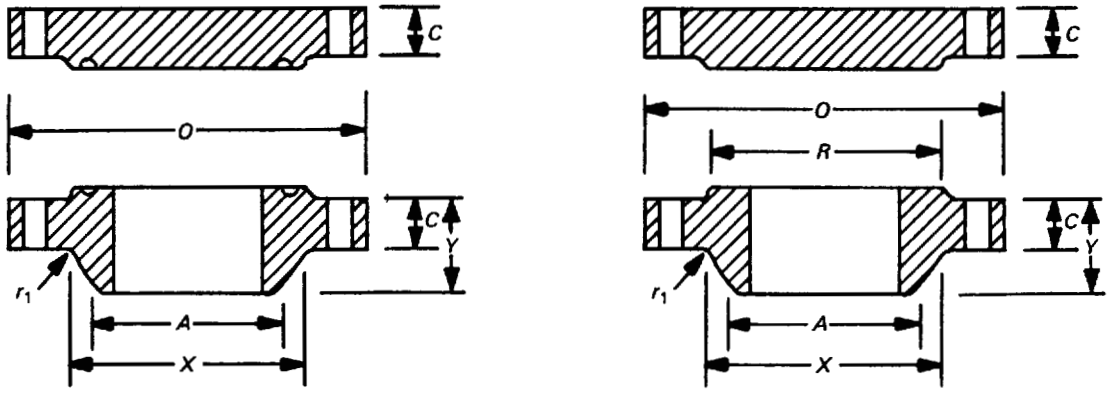

TABLE 9 DIMENSIONS OF CLASS 900 SERIES A FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	42.75	5.50	6.31	11.25	30.50	26.00	29.50	37.50	20	2.88	2¾	0.44
28	46.00	5.62	6.75	11.75	32.75	28.00	31.50	40.25	20	3.12	3	0.50
30	48.50	5.88	7.18	12.25	35.00	30.00	33.75	42.75	20	3.12	3	0.50
32	51.75	6.25	7.62	13.00	37.25	32.00	36.00	45.50	20	3.38	3¼	0.50
34	55.00	6.50	8.06	13.75	39.62	34.00	38.00	48.25	20	3.62	3½	0.56
36	57.50	6.75	8.44	14.25	41.88	36.00	40.25	50.75	20	3.62	3½	0.56
38	57.50	7.50	8.50	13.88	42.25	38.00	43.25	50.75	20	3.62	3½	0.75
40	59.50	7.75	8.81	14.31	44.38	40.00	45.75	52.75	24	3.62	3½	0.81
42	61.50	8.12	9.12	14.62	46.31	42.00	47.75	54.75	24	3.62	3½	0.81
44	64.88	8.44	9.56	15.38	48.62	44.00	50.00	57.62	24	3.88	3¾	0.88
46	68.25	8.88	10.06	16.18	50.88	46.00	52.50	60.50	24	4.12	4	0.88
48	70.25	9.19	10.38	16.50	52.88	48.00	54.50	62.50	24	4.12	4	0.94
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

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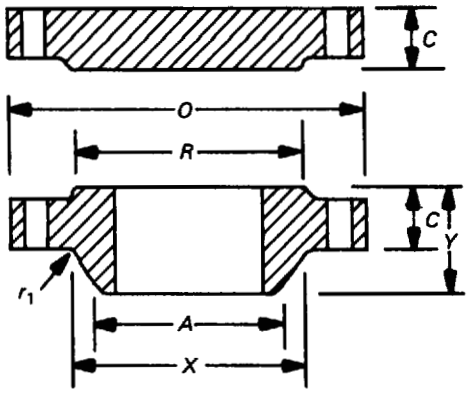

TABLE 10 DIMENSIONS OF CLASS 75 SERIES B FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	30.00	1.31	1.31	2.31	26.62	26.06	27.75	28.50	36	0.75	5/8	0.31
28	32.00	1.31	1.31	2.44	28.62	28.06	29.75	30.50	40	0.75	5/8	0.31
30	34.00	1.31	1.31	2.56	30.62	30.06	31.75	32.50	44	0.75	5/8	0.31
32	36.00	1.38	1.44	2.75	32.62	32.06	33.75	34.50	48	0.75	5/8	0.31
34	38.00	1.38	1.50	2.88	34.62	34.06	35.75	36.50	52	0.75	5/8	0.31
36	40.69	1.44	1.67	3.38	36.81	36.06	38.00	39.06	40	0.88	3/4	0.38
38	42.69	1.50	1.75	3.50	38.81	38.06	40.00	41.06	40	0.88	3/4	0.38
40	44.69	1.50	1.75	3.62	40.81	40.06	42.00	43.06	44	0.88	3/4	0.38
42	46.69	1.56	1.88	3.75	42.81	42.06	44.00	45.06	48	0.88	3/4	0.38
44	49.25	1.69	1.94	4.12	44.88	44.06	46.25	47.38	36	1.00	7/8	0.38
46	51.25	1.75	2.00	4.25	46.88	46.06	48.25	49.38	40	1.00	7/8	0.38
48	53.25	1.81	2.12	4.38	48.88	48.06	50.25	51.38	44	1.00	7/8	0.38
50	55.25	1.88	2.18	4.56	50.94	50.06	52.25	53.38	44	1.00	7/8	0.38
52	57.38	1.88	2.25	4.75	52.94	52.06	54.25	55.50	48	1.00	7/8	0.38
54	59.38	1.94	2.38	4.94	55.00	54.06	56.25	57.50	48	1.00	7/8	0.38
56	62.00	2.00	2.44	5.31	57.12	56.06	58.50	59.88	40	1.12	1	0.44
58	64.00	2.06	2.50	5.44	59.12	58.06	60.50	61.88	44	1.12	1	0.44
60	66.00	2.19	2.62	5.69	61.12	60.06	62.50	63.88	44	1.12	1	0.44

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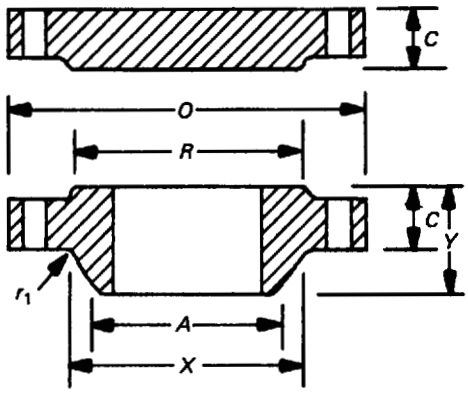

TABLE 11 DIMENSIONS OF CLASS 150 SERIES B FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	30.94	1.62	1.75	3.50	26.94	26.06	28.00	29.31	36	0.88	3/4	0.38
28	32.94	1.75	1.88	3.75	28.94	28.06	30.00	31.31	40	0.88	3/4	0.38
30	34.94	1.75	2.00	3.94	31.00	30.06	32.00	33.31	44	0.88	3/4	0.38
32	37.06	1.81	2.12	4.25	33.06	32.06	34.00	35.44	48	0.88	3/4	0.38
34	39.56	1.94	2.25	4.34	35.12	34.06	36.25	37.69	40	1.00	7/8	0.38
36	41.62	2.06	2.31	4.62	37.19	36.06	38.25	39.75	44	1.00	7/8	0.38
38	44.25	2.12	2.50	4.88	39.25	38.12	40.25	42.12	40	1.12	1	0.38
40	46.25	2.19	2.62	5.06	41.31	40.12	42.50	44.12	44	1.12	1	0.38
42	48.25	2.31	2.69	5.25	43.38	42.12	44.50	46.12	48	1.12	1	0.44
44	50.25	2.38	2.81	5.38	45.38	44.12	46.50	48.12	52	1.12	1	0.44
46	52.81	2.44	2.94	5.69	47.44	46.12	48.62	50.56	40	1.25	1 1/8	0.44
48	54.81	2.56	3.06	5.88	49.50	48.12	50.75	52.56	44	1.25	1 1/8	0.44
50	56.81	2.69	3.18	6.06	51.50	50.12	52.75	54.56	48	1.25	1 1/8	0.44
52	58.81	2.75	3.31	6.19	53.56	52.12	54.75	56.56	52	1.25	1 1/8	0.44
54	61.00	2.81	3.44	6.38	55.62	54.12	56.75	58.75	56	1.25	1 1/8	0.44
56	63.00	2.88	3.56	6.56	57.69	56.12	58.75	60.75	60	1.25	1 1/8	0.56
58	65.94	2.94	3.68	6.88	59.69	58.12	60.75	63.44	48	1.38	1 1/4	0.56
60	67.94	3.00	3.81	7.06	61.81	60.12	63.00	65.44	52	1.38	1 1/4	0.56

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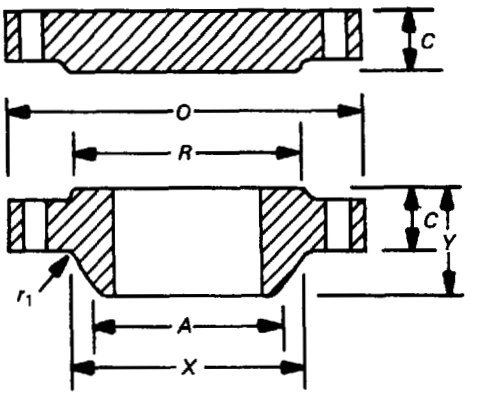

TABLE 12 DIMENSIONS OF CLASS 300 SERIES B FLANGES[1–6]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	34.12	3.50	3.50	5.69	27.62	26.19	29.00	31.62	32	1.38	1¼	0.56
28	36.25	3.50	3.50	5.88	29.75	28.19	31.00	33.75	36	1.38	1¼	0.56
30	39.00	3.69	3.69	6.22	32.00	30.25	33.25	36.25	36	1.50	1⅜	0.56
32	41.50	4.06	4.06	6.62	34.00	32.25	35.50	38.50	32	1.62	1½	0.62
34	43.62	4.06	4.06	6.81	36.12	34.25	37.50	40.62	36	1.62	1½	0.62
36	46.12	4.06	4.06	7.12	38.00	36.25	39.75	42.88	32	1.75	1⅝	0.62
38	48.12	4.38	4.38	7.56	40.00	38.25	41.75	44.88	36	1.75	1⅝	0.62
40	50.12	4.56	4.56	7.81	42.00	40.25	43.88	46.88	40	1.75	1⅝	0.62
42	52.50	4.69	4.69	8.06	44.00	42.31	46.00	49.00	36	1.88	1¾	0.62
44	54.50	5.00	5.00	8.44	46.19	44.31	48.00	51.00	40	1.88	1¾	0.62
46	57.50	5.06	5.12	8.75	48.38	46.31	50.00	53.75	36	2.00	1⅞	0.62
48	59.50	5.06	5.31	8.81	50.31	48.31	52.25	55.75	40	2.00	1⅞	0.62
50	61.50	5.44	5.50	9.25	52.38	50.31	54.25	57.75	44	2.00	1⅞	0.62
52	63.50	5.62	5.68	9.56	54.44	52.31	56.25	59.75	48	2.00	1⅞	0.62
54	65.88	5.38	5.88	9.44	56.50	54.31	58.25	62.12	48	2.00	1⅞	0.62
56	69.50	6.06	6.18	10.56	58.81	56.31	60.50	65.00	36	2.38	2¼	0.69
58	71.94	6.06	6.38	10.81	60.94	58.31	62.75	67.44	40	2.38	2¼	0.69
60	73.94	5.94	6.56	10.69	62.94	60.31	65.00	69.44	40	2.38	2¼	0.69

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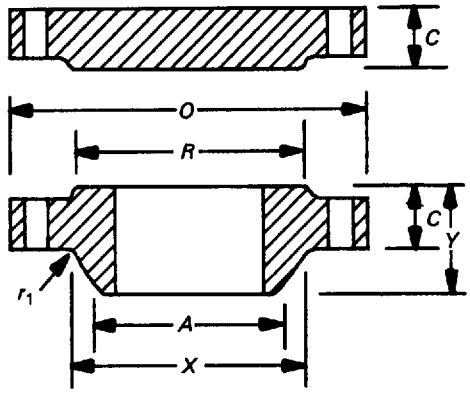

TABLE 13 DIMENSIONS OF CLASS 400 SERIES B FLANGES[1–6,10]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	33.50	3.50	3.50	5.88	27.12	26.00	28.00	30.75	28	1.50	$1\frac{3}{8}$	0.44
28	36.00	3.75	3.75	6.25	29.12	28.00	30.00	33.00	24	1.62	$1\frac{1}{2}$	0.50
30	38.25	4.00	4.00	6.69	31.25	30.00	32.25	35.25	28	1.62	$1\frac{1}{2}$	0.50
32	40.75	4.25	4.25	7.06	33.25	32.00	34.38	37.50	28	1.75	$1\frac{5}{8}$	0.50
34	42.75	4.38	4.38	7.38	35.38	34.00	36.50	39.50	32	1.75	$1\frac{5}{8}$	0.56
36	45.50	4.69	4.69	7.88	37.50	36.00	38.62	42.00	28	1.88	$1\frac{3}{4}$	0.56
38	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	...	...	...	...	...
42	...	...	...	...	...	...	...	...	...	...	...	...
44	...	...	...	...	...	...	...	...	...	...	...	...
46	...	...	...	...	...	...	...	...	...	...	...	...
48	...	...	...	...	...	...	...	...	...	...	...	...
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

(Notes follow Table 15)

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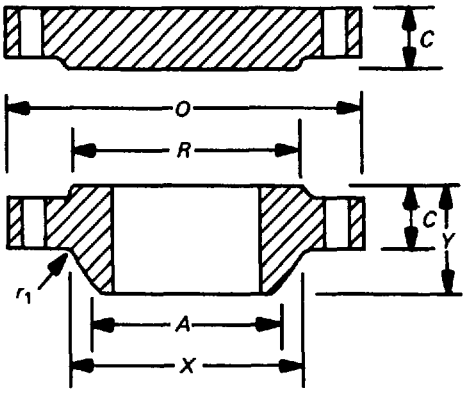

TABLE 14 DIMENSIONS OF CLASS 600 SERIES B FLANGES[1–6,10]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	35.00	4.38	4.38	7.12	27.50	26.00	28.62	31.75	28	1.75	$1\frac{5}{8}$	0.50
28	37.50	4.56	4.56	7.50	29.62	28.00	30.88	34.00	28	1.88	$1\frac{3}{4}$	0.50
30	40.25	4.94	5.00	8.06	31.75	30.00	33.12	36.50	28	2.00	$1\frac{7}{8}$	0.50
32	42.75	5.12	5.31	8.50	33.88	32.00	35.25	38.75	28	2.12	2	0.50
34	45.75	5.56	5.68	9.19	36.00	34.00	37.50	41.50	24	2.38	$2\frac{1}{4}$	0.56
36	47.75	5.75	5.94	9.56	38.12	36.00	39.75	43.50	28	2.38	$2\frac{1}{4}$	0.56
38	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	...	...	...	...	...
42	...	...	...	...	...	...	...	...	...	...	...	...
44	...	...	...	...	...	...	...	...	...	...	...	...
46	...	...	...	...	...	...	...	...	...	...	...	...
48	...	...	...	...	...	...	...	...	...	...	...	...
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

(Notes follow Table 15)

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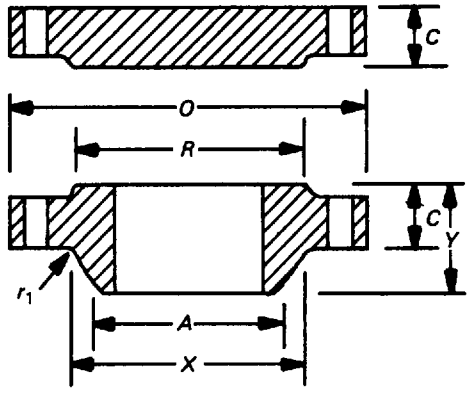

TABLE 15 DIMENSIONS OF CLASS 900 SERIES B FLANGES[1–6, 10]

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal Pipe Size	O. D. of Flange	Thickness of Flange, Min.[7]		Length Through Hub	Diam. of Hub[8]	Hub Diam.[9] Top	Raised Face Diam.	Drilling			Diam. of Bolt	Fillet Radius Min.
		WNF	Blind					Diam. of Bolt Circle	No. of Bolt Holes	Diam. of Bolt Hole		
	O	*C*	*C*	*Y*	*X*	*A*	*R*					r_1
26	40.25	5.31	6.06	10.19	29.25	26.00	30.00	35.50	20	2.62	$2\frac{1}{2}$	0.44
28	43.50	5.81	6.56	10.88	31.38	28.00	32.25	38.25	20	2.88	$2\frac{3}{4}$	0.50
30	46.50	6.12	6.93	11.38	33.50	30.00	34.50	40.75	20	3.12	3	0.50
32	48.75	6.31	7.31	11.94	35.75	32.00	36.50	43.00	20	3.12	3	0.50
34	51.75	6.75	7.68	12.56	37.88	34.00	39.00	45.50	20	3.38	$3\frac{1}{4}$	0.56
36	53.00	6.81	7.94	12.81	40.00	36.00	40.50	47.25	24	3.12	3	0.56
38	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	...	...	...	...	...
42	...	...	...	...	...	...	...	...	...	...	...	...
44	...	...	...	...	...	...	...	...	...	...	...	...
46	...	...	...	...	...	...	...	...	...	...	...	...
48	...	...	...	...	...	...	...	...	...	...	...	...
50	...	...	...	...	...	...	...	...	...	...	...	...
52	...	...	...	...	...	...	...	...	...	...	...	...
54	...	...	...	...	...	...	...	...	...	...	...	...
56	...	...	...	...	...	...	...	...	...	...	...	...
58	...	...	...	...	...	...	...	...	...	...	...	...
60	...	...	...	...	...	...	...	...	...	...	...	...

(Notes follow on next page)

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Notes to Tables 5–15

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) For tolerances, see Section 7.
(2) For facings, see para. 6.1.
(3) For flange bolt holes, see para. 6.2.
(4) For spot facing, see para. 6.3.
(5) The bore is to be specified by the purchaser. Tolerances in para. 7.4.2 apply.
(6) Blind flanges may be made with or without hubs at the manufacturer's option.
(7) 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 hub nonstandard.
(8) This dimension is for the large end of hub, which may be straight or tapered.
(9) For welding and bevel, see para. 6.4.
(10) Dimensions for Classes 400, 600, and 900 NPS 38 and larger for Series B flanges are the same as for the Series A flanges.

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TABLE 16 PERMISSIBLE IMPERFECTIONS IN FLANGE FACING FINISH (See Para. 6.1.5)

Nominal Pipe Size	Maximum Radial Projection of Imperfections Which Are No Deeper Than the Bottom of the Serration, in.	Maximum Depth and Radial Projection of Imperfections Which Are Deeper Than the Bottom of the Serration, in.
26–36	0.50	0.25
38–48	0.56	0.28
50–60	0.62	0.31

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ANNEX A
METHODS FOR ESTABLISHING PRESSURE–TEMPERATURE RATINGS

(This Annex is not part of ASME B16.47-1996 and is included for information only.)

A1 GENERAL

A1.1 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. Other considerations affecting or limiting the ratings include:

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

(b) distortion of flanges due to loadings transmitted through the pipeline; and

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

A1.2 Material Groups

Material groups in Table 1 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.

A1.3 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.

A2 RATINGS

A2.1 Rating Equation

Ratings given in Tables 2, psig at temperatures expressed in degrees Fahrenheit, for all materials and pressure classes, are established by Eq. (1):

$$P_T = P_r S_1/8750 \le P_c \qquad (1)$$

where

P_t = rated working pressure, psig, for the specified material at temperature T

P_r = pressure rating class index expressed in 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. A2.2, A2.3, and A2.4)

P_c = ceiling pressure, psig, as specified in A3 at temperature T

A2.2 Ratings for Group 1 Materials, Class 300 and Higher

The selected stress S_1 fore each material group among Group 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 alowable stress at temperature T as listed for ASME BPV Code, Section I, or, if not listed for Section I, as listed for Section VIII Division 1.

(b) At temperatures in the creep range (defined as those above 700°F for Group 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

[1]This definition of P_r does not apply to Class 75 and Class 150. See para. A2.4.

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for ASME BPV Code, Section I, or, if not listed for Section I, as listed for Section VIII, Division 1.

(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 BPV Code, Section II, Part D.

(e) Where more than one allowable stress value is listed for a material at any temperature, the lower value 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 the ASME BPV Code, Section III, Class 2 and Class 3 may be used only if the material is not listed for either Section I or Section VIII, Division 1.

A2.3 Ratings for Group 2 Materials, Class 300 and Higher

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

(a) At temperatures below the creep range, S_1 is determined in accordance with para. A2.2(a), except that 70% of yield strength shall be used, instead of 60%, in paras. A2.2(a)(1) and (a)(2).

(b) At temperatures in the creep range (defined as those above 950°F for Group 2 materials), S_1 is determined in accordance with para. A2.2(b).

(c) The limitations in paras. A2.2(c), (d), (e), and (f) apply.

A2.4 Ratings for Classes 75 and 150, All Material Groups

Pressure–temperature ratings for Classes 75 and 150 flanges are determined for each material group as set forth in paras. A2.1, A2.2, and A2.3 with the following exceptions.

(a) The value of P_r in Eq. (1) (para A2.1) shall be 57.5 psi for Class 75 and 115 psi for Class 150.

(b) The value for S_1 shall be in accordance with the requirements of paras. A2.1, A2.2, and A2.3.

(c) The value for P_T in Eq. (1) at temperature T (degrees Fahrenheit) shall not exceed that given by Eqs. (2) and (3).

For Class 75

$$P_T = 160 - 0.15T \quad (2)$$

For Class 150

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

The limits of T in equation (2) and (3) are 100°F min. and 1000°F max. For values of T less than 100°F, T equal to 100°F is used.

A3 MAXIMUM RATINGS

A3.1 Maximum Ratings

A set of maximum or ceiling pressure–temperature ratings, P_c, are shown in Table A1. They are imposed to limit deflections.

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TABLE A1 RATING CEILING VALUES

Temperature, °F	Working Pressure, psig, by Classes					
	75	150	300	400	600	900
−20 to 100	145	290	750	1000	1500	2250
200	130	260	750	1000	1500	2250
300	115	230	730	970	1455	2185
400	100	200	705	940	1410	2115
500	85	170	665	885	1330	1995
600	70	140	605	805	1210	1815
650	60	125	590	785	1175	1765
700	...	110	570	755	1135	1705
750	...	95	530	710	1065	1595
800	...	80	510	675	1015	1525
850	...	65	485	650	975	1460
900	...	50	450	600	900	1350
950	...	35	385	515	775	1160
1000	...	20	365	485	725	1090
1050	...	...	360	480	720	1080
1100	...	...	325	430	645	965
1150	...	...	275	365	550	825
1200	...	...	205	275	410	620
1250	...	...	180	245	365	545
1300	...	...	140	185	275	410
1350	...	...	105	140	205	310
1400	...	...	75	100	150	225
1450	...	...	60	80	115	175
1500	...	...	40	55	85	125

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ANNEX B

GASKETS
(Other Than Ring-Joint)

(This Annex is an integral part of ASME B16.47-1996 and is placed after the main text for convenience.)

B1 SCOPE

This Annex covers gasket characteristics.

B2 GASKET MATERIALS AND CONSTRUCTION

Classification of gasket materials and types is shown in Fig. B1. Other gaskets, which result in no increase in bolt 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.

B3 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 and ASME B16.20 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 I.D., its O.D., or both. Also to be considered is the question of allowing a "pocket" at the gasket I.D. (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) Gaskets are divided into three groups based on their gasket loading factors as shown in the ASME BPV Code, Section VIII, Division 1, Pressure Vessels.

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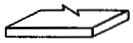
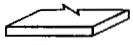
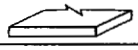
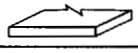
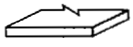
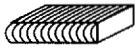
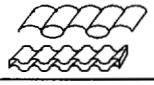
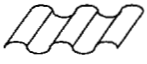
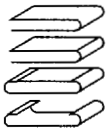
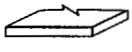
Gasket Group Number	Gasket Material	Sketches
Ia	Self-Energizing Types O-rings, metallic, elastomer, other gasket types considered as self-sealing	. . .
	Elastomer Without Fabric	
	Compressed Sheet Suitable for the Operating Conditions	
	Elastomer With Cotton Fabric Insertion	
	Elastomer With or Without Wire Reinforcement	
	Vegetable Fiber	
Ib	Spiral-Wound Metal, With Nonmetallic Fiber	
	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 Fiber	
	Corrugated Metal	
	Flat Metal Jacketed With Nonmetallic Fiber	
	Grooved Metal	
	Solid Flat Soft Aluminum	
IIIa and IIIb	Solid Flat Metal	
. . .	Ring-Joint	. . .

FIG. B1 GASKET GROUPS AND TYPICAL MATERIALS

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ANNEX C
METHOD FOR CALCULATING BOLT LENGTHS

(This Annex is not part of ASME B16.47-1996 and is included for information only. See para. 6.5.2.)

The following formulas [see Note (1)] may be used to establish bolt lengths.

$$L_{CSB} = A + n$$

where

A = $2(C + t + d) + G + F$ (i.e., stud-bolt length exclusive of negative length tolerance n)
C = minimum flange thickness [see Tables 5 through 15 and Note (2) below]
F = total height of facings of depth of ring-joint groove for both flanges (see Table C1)
G = 0.12 in. gasket thickness for raised face
L_{CSB} = calculated stud-bolt length (effective thread length, excluding end points)
L_{SSB} = specified stud-bolt length (effective thread length, excluding end points), which is L_{CSB} rounded off to the nearest practical increment (see Fig. C1)
d = heavy nut thickness (equals nominal bolt diameter, see ASME/ANSI B18.2.2)
n = negative tolerance on bolt length (see Table C2)
t = plus tolerance for flange thickness (see para. 7.2)

NOTES:

(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. 6.5.2)

(2) 0.06 in. raised face is included in minimum flange thickness for Classes 75, 150, and 300 flanges.

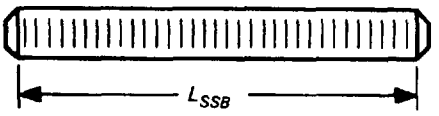

FIG. C1 SPECIFIED STUD-BOLT LENGTH

Data for Length Calculations
TABLE C1 *F* VALUES

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

NOTE:
(1) Raised face (0.06 in.) is included in minimum flange thickness for Classes 75, 150, and 300 flanges.

TABLE C2 *n* VALUES

Length		Negative Tolerance on Bolt Lengths, *n*
Stud-bolt	A	0.06 in. for lengths up to 12 in., incl. 0.12 in. for lengths over 12 in. to 18 in., incl. 0.25 in. for lengths over 18 in.

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ANNEX D
QUALITY SYSTEM PROGRAM

(This Annex is an integral part of ASME B16.47.1996 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 E.

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ANNEX E
REFERENCES

(This Annex is an integral part of ASME B16.47.1996 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.)

API Publications

API Standard 605-1988	Large-Diameter Carbon Steel Flanges

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
ANSI/ASME B46.1-1985	Surface Texture (Surface Roughness, Waviness, and Lay)

ASME Boiler and Pressure Vessel Code, 1995 Edition (Including Addenda Through 1995)

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

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

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ASTM Publications

A 105-93b	Forgings, Carbon Steel, for Piping Components
A 182-93b	Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service
A 193-93a	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
A 194-93a	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 216-89	Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
A 217-91	Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
A 240-93b	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
A 307-93a	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A 320-93	Alloy-Steel Bolting Materials for Low-Temperature Service
A 350-93	Forgings, Carbon and Low-Alloy Steel, Requiring Notch Toughness Testing for Piping Components
A 351-93	Steel Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts
A 352-92	Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
A 354-93	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 453-92	Bolting Materials, High-Temperature, 50 to 120 ksi [345 to 827 MPa] Yield Strength, With Expansion Coefficients Comparable to Austenitic Steels
A 515-92	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 540-92	Alloy-Steel Bolting Materials for Special Applications
E 29-93	Using Significant Digits in Test Data to Determine Conformance with Specifications

MSS Publications

MSS SP-9-1992	Spot-Facing for Bronze, Iron, and Steel Flanges
MSS SP-25-1978(R1983,R1988)	Standard Marking System for Valves, Fittings, Flanges, and Unions
MSS SP-44-1991	Steel Pipe Line Flanges
MSS SP-45-1992	Bypass and Drain Connection
MSS SP-61-1992	Pressure Testing of Steel Valves

Publications of the following organizations appear in the above list:

ASQC	American Society for Quality Control P.O. Box 3005 Milwaukee, WI 53201-3005
API	American Petroleum Institute 1220 L Street, N.W., Washington, D.C. 20005

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	ASME Order Department 22 Law Drive, Box 2300, Fairfield, New Jersey 07007-2300
ASTM	American Society for Testing and Materials 1916 Race Street, Philadelphia, Pennsylvania 19103
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.

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