

ASME B16.24-2016

(Revision of ASME B16.24-2011)

Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves

**Classes 150, 300, 600, 900,
1500, and 2500**

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AN AMERICAN NATIONAL STANDARD



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FOREWORD

The development of the first Bronze Flanged Standard began in 1910 to eliminate the confusion prevailing in the trade with respect to bronze flange dimensions and service ratings. The work culminated and was published in 1914 under the title "1914 Brass Standard Flange Dimensions" for 150-lb and 250-lb (now Class 150 and Class 250) steam pressures.

This was superseded in 1928 by the Manufacturers Standardization Society of Valves and Fittings Industry (MSS) "Standard Practice" SP-2, which contained changes to provide interchangeability with the American Cast-Iron Flange Standards for 125-lb (now Class 125) and Class 250 stream pressures. Subsequent revisions were issued in 1930 and 1936. In the latter, a new column of thickness for 300-lb (now Class 300) flanges was added.

In the 1937 edition, illustrations and dimensions of bronze-flanged fittings were added. This was edited and reprinted in 1943 to conform to the U.S. Department of Commerce, National Bureau of Standards, Simplified Practice Recommendation R-183-42, and to the War Production Board Limitation Order L-252, dated January 23, 1943.

In the 1946 edition, the pressure-temperature ratings were added for the Class 150 and Class 300 standards and the dimensions for that reference to the Class 250 standard were omitted. Limitation Order L-252 was canceled on April 28, 1945. The period of government prohibition of manufacture and civilian use of the Class 250 standard (during the life of Order L-252) caused no hardship on the part of either the manufacturer or the consumer, indicating that this pressure class in bronze products did not warrant being recognized as a standard.

This Standard was reviewed and reaffirmed in 1949. In October 1951, MSS ceded it to Sectional Committee B16 on Pipe Flanges and Flanged Fittings for review and possible approval as an American Standard.

Following approval of the sectional committee and sponsor organizations, it was sent to the American Standards Association (ASA), now the American National Standards Institute (ANSI), for approval and designation as an American Standard. This was granted on February 27, 1953.

In 1961, following the organization of Subcommittee No. 11 (now Subcommittee J), the 1953 edition was revised. Chief among the changes recommended was the deletion of reference to brass. This resulted from an action of ASTM redefining the alloys that could properly be called bronze. Several other changes that brought the Standard up to date were also approved by the B16 Committee, with approval designation as an American Standard being granted on July 20, 1962.

Subcommittee J, in keeping with regulations of ANSI, reviewed the Standard in 1969. Only minor changes were made. Among these were the presentation of pressure-temperature ratings in tabular form, and the gasket-retaining grooves being made permissible rather than recommended. Final approval of the changes was granted by ANSI on January 27, 1971.

A revision was undertaken in 1977, and several changes were proposed. Foremost among these was the addition of metric equivalents and the elimination of the optional gasket-retaining grooves. In addition, the Standard was extensively revised editorially. Following approvals by Subcommittee J and the Standards Committee, ANSI granted its approval on June 26, 1979.

In 1982, the American National Standard Committee B16 was reorganized as an ASME Committee, operating under procedures accredited by ANSI.

In 1991, the scope of the Standard was changed from bronze pipe flanges and fittings to cast copper alloy flanges and flanged fittings, and it was expanded to include class designations 150, 300, 600, 900, 1500, and 2500. The 1991 edition also established U.S. Customary units as the standard, and editorial revisions were made to improve the text. Following approval by the Standards Committee and ASME, the 1991 edition of the Standard was approved as an American National Standard by ANSI on February 1, 1991, with the new designation ASME B16.24-1991 and the new title "Cast Copper Alloy Pipe Flanges and Flanged Fittings."

In 2001, the Standard was revised to include Nonmandatory Appendix A, Quality System Program. Editorial revisions were made for clarification. Following approval by the B16 Standards

Committee and the ASME Supervisory Board, the Standard was approved as an American National Standard by ANSI on October 24, 2001.

In the 2006 edition, metric units became the primary reference units while maintaining U.S. Customary units in either parenthetical or separate forms. Requirements for Class 400 flanges were omitted from the Standard. In addition, several editorial revisions were made for clarity. Following approval by the Standards Committee and the ASME Board, ASME B16.24-2006, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500 was approved as an American National Standard by ANSI on November 9, 2006.

In the 2011 edition, references to ASME Standards were revised to no longer list specific edition years; the latest edition of ASME publications applies unless stated otherwise. Materials manufactured to other editions of the referenced ASTM standards have been permitted to be used to manufacture fittings meeting the requirements of this Standard as long as the fitting manufacturer verifies the material meets the requirements of the referenced edition. Following approval by the Standards Committee and the ASME Board on PTCS, the 2011 revision was approved as an American National Standard by ANSI on August 9, 2011, with the designation ASME B16.24-2011.

In this 2016 edition, provisions have been made to revise the scope and table readings, and a new Mandatory Appendix and a new Nonmandatory Appendix have been added. Following the approval by the ASME B16 Standards Committee, approval as an American National Standard was given by ANSI on September 23, 2016, with the new designation ASME B16.24-2016 and the new title "Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500."

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Standardization of Valves, Flanges, Fittings, and Gaskets

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

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The American Society of Mechanical Engineers
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New York, NY 10016-5990
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The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

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Interpretations. Upon request, the B16 Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B16 Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at <http://go.asme.org/InterpretationRequest>. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may e-mail the request to the Secretary of the B16 Standards Committee at SecretaryB16@asme.org, or mail it to the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
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. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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ASME B16.24-2016

SUMMARY OF CHANGES

Following approval by the ASME B16 Committee and ASME, and after public review, ASME B16.24-2016 was approved by the American National Standards Institute on September 23, 2016.

ASME B16.24-2016 includes the following changes identified by a margin note, **(16)**. In addition, the title of the Standard was updated to include valves. The Record Numbers listed below are explained in more detail in the "List of Changes in Record Number Order" following this Summary of Changes.

<i>Page</i>	<i>Location</i>	<i>Change (Record Number)</i>
1	1	Revised in its entirety (15-1068)
	2.2	Reference to Mandatory Appendix III updated
	2.5	Revised to include valves (15-2830)
	2.6	Revised to include valves (15-2830)
2	3.1	(1) Subparagraphs (b) and (c) revised in their entirety (15-863) (2) Subparagraph (d) deleted (15-863)
	3.3	References to paras. 6.5 and 6.6 updated (15-863)
	3.4	Revised to include valves (15-863)
	3.5	Revised (15-863)
	3.6	Revised to include valves (15-863)
8	Table 6	Revised in its entirety (15-863)
	Table 7	Added (15-863)
	4.1	Revised to include valves (15-2830)
	5.1	Revised to include valves (15-863)
	5.1.2	Revised (15-863)
	5.1.3	Revised to include valves (15-2830)
10	5.1.4	Revised to include valves (15-2830)
	5.1.5	Revised to include valves (15-2830)
	6.2.3	Revised (15-863)
	6.2.3.4	Revised (15-2830)
	6.4	Added, and following paragraphs redesignated (15-2830)
	6.5	(1) Revised to include valves (15-2830) (2) References to paras. 6.5.1 and 6.5.2 updated (15-2830)
	6.5.1	Revised to include valves (15-2830)
	6.5.2	Revised to include valves (15-2830)

<i>Page</i>	<i>Location</i>	<i>Change (Record Number)</i>
11	7	Title revised (15-863)
	7.1.1	Revised (15-863)
	7.1.2	Revised (15-863)
	7.1.3	Added (15-2830)
	7.2	Metric equivalent revised (15-2830)
	7.6	Revised in its entirety (11-560)
	7.9	Revised to include valves (15-2830)
	8	Title revised (15-2830)
12	8.1.6	Added, and following paragraph redesignated (15-2830)
	8.1.7	Revised to include valves (15-2830)
	8.2	(1) First paragraph redesignated 8.2.1 (15-2830) (2) Paragraph 8.2.2 added (15-2830)
13	11.3	Added (15-2830)
15	Mandatory Appendix I	In second sentence, table numbers updated (15-2830)
20	Table I-6	Revised in its entirety (15-863)
	Table I-7	Added (15-863)
21–23	Mandatory Appendix II	Added (15-2830)
24	Mandatory Appendix III	(1) Redesignated from Mandatory Appendix II (15-2830) (2) ASME B16.10, ASME B16.34, ASME B16.47, and ASME B31T references added (15-2830) (3) ASTM and MSS references updated to latest editions (15-2830)
25	Nonmandatory Appendix A	In footnote 1, reference to Mandatory Appendix III updated
26	Nonmandatory Appendix B	Added (15-863)

LIST OF CHANGES IN RECORD NUMBER ORDER

Record Number	Change
11-560	Changed para. 7.6 to match the wording of other ASME B16 documents regarding thread gauging
15-863	Added a method for determining pressure–temperature ratings for flanges that conform to ASME B16.5 dimensions, revised pressure–temperature rating tables for ASTM B148 alloy C95200, and added pressure–temperature rating tables for ASTM B148 alloy C95400
15-1068	Changed the Scope of the Standard
15-2830	Revised the Standard to include construction details for ASTM B148 valves and updated references

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CAST COPPER ALLOY PIPE FLANGES, FLANGED FITTINGS, AND VALVES

CLASSES 150, 300, 600, 900, 1500, AND 2500

(16) 1 SCOPE

1.1 Inclusions

This Standard covers the following cast copper alloy:

- (a) threaded pipe flanges and blind flanges having class designations 150, 300, 600, 900, 1500, and 2500
- (b) flanged fittings having rating class designations 150 and 300
- (c) threaded and flanged valves having rating class designations 150, 300, 600, 1500, and 2500

1.2 Dimensional Requirements

This Standard establishes requirements for

- (a) pressure-temperature ratings
- (b) size and method of designating openings for reduced fittings
- (c) markings
- (d) materials
- (e) dimensions
- (f) bolting and gaskets
- (g) tolerances
- (h) nondestructive examination for valves
- (i) tests

1.3 MSS SP-80 Requirements

This Standard also provides dimensional requirements for flanged ends of valves conforming to MSS SP-80.

1.4 ASTM B148 Requirements

ASME B16.24 requirements and the supplemental requirements of Mandatory Appendix II shall apply for the construction of valves under this Standard that are made from ASTM B148 materials.

2 GENERAL

2.1 Relevant Units

This Standard states values in both SI (Metric) and U.S. Customary units. As an exception, diameters of bolts and flange bolt holes are expressed in U.S. Customary units only. These systems of units are to be regarded separately as standard. Within the text,

the U.S. Customary units are shown in parentheses or in separate tables that appear in Mandatory Appendix I. The values stated in each system are not exact equivalents; therefore, it is required that each system of units be used independently of the other. Except for the diameter of bolts and flange bolt holes, combining values from the two systems constitutes nonconformance with the Standard.

2.2 References

Codes, standards, and specifications containing provisions to the extent referenced herein constitute requirements of this Standard. These references are listed in Mandatory Appendix III.

2.3 Quality Systems

Guidelines relating to the product manufacturer's quality system program are described in Nonmandatory Appendix A.

2.4 Service Conditions

Criteria for selection of material suitable for particular fluid service are not within the scope of this Standard.

2.5 User Accountability

This Standard cites duties and responsibilities that are to be assumed by the flange or flange fitting and valve user in the following areas:

- (a) application
- (b) installation
- (c) system hydrostatic testing
- (d) operation
- (e) material selection

2.6 Time of Purchase, Manufacture, or Installation

The pressure-temperature ratings in this Standard are applicable upon its publication to all flanges, flanged fittings, and valves within its scope that otherwise meet its requirements. For unused flanges, flanged fittings, and valves maintained in inventory, the manufacturer of the flanges, flanged fittings, and valves may certify conformance to this edition, provided that it can be demonstrated 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 pressure-temperature ratings are applicable except as may be governed by the applicable code or regulation.

2.7 Denotation

2.7.1 Pressure-Temperature Rating Designation.

Class, followed by a dimensionless number, is the designation for pressure-temperature ratings as follows: Class 150, Class 300, Class 600, Class 900, Class 1500, and Class 2500.

2.7.2 Size. NPS, followed by a dimensionless number, is the designation for nominal fittings size. NPS is related to the reference nominal diameter (DN) used in international standards. The relationship is typically as follows:

NPS	DN
$\frac{1}{2}$	15
$\frac{3}{4}$	20
1	25
$1\frac{1}{4}$	32
$1\frac{1}{2}$	40
2	50
$2\frac{1}{2}$	65
3	80
4	100

GENERAL NOTE: For $NPS \geq 4$, the related $DN = 25 \times NPS$.

3 PRESSURE-TEMPERATURE RATINGS

(16) 3.1 General

(a) For flanges and flanged fittings, the tabulated pressure-temperature ratings of Table 1 (Table I-1) shall apply for the materials listed in paras. 6.2.1 and 6.2.2, provided that the dimensional requirements of Tables 2 through 5 (Tables I-2 through I-5) are met.

(b) Requirements for valves made from ASTM B61 alloy C92200 and ASTM B62 alloy C83600 are covered by MSS SP-80.

(c) For ASTM B148 alloys C95200 and C95400 flanges, and flanged and threaded end valves only, the tabulated pressure-temperature ratings of Table 6 (Table I-6) and Table 7 (Table I-7) shall apply, provided that the dimensional requirements of ASME B16.5 are met for flanges and applicable dimensional requirements of ASME B16.5 or ASME B16.47 are met for flanged valves. Threaded end valves shall have taper pipe threads (NPT) meeting the dimensional requirements of ASME B1.20.1.

3.2 Flanged Joints

A flanged joint is composed of separate and independent, although interrelated, components. The flanges, the gasket, and the bolting are assembled by another

influence — the assembler. Proper controls must be exercised in the selection and application for all these elements to attain a joint that has acceptable leak tightness. Special techniques (e.g., controlled bolt tightening) are described in ASME PCC-1.

3.3 Pressure-Temperature Ratings of Flanged Joints (16)

Pressure-temperature ratings in this Standard apply to flanged joints that conform to the requirements on bolting in paras. 6.5 and 9.1, on gaskets in paras. 6.6 and 9.2, and to flanged joints that are made up in accordance with good practice for alignment and assembly. Use of the pressure-temperature ratings for flanged joints not conforming to these requirements is the sole responsibility of the user. Requirements for alignment and assembly of joints and consideration of leakage due to forces and moments developed in the connected piping or equipment are not covered in this Standard. If the two flanges in a flanged joint do not have the same pressure-temperature ratings, the pressure-temperature rating of the joint at any temperature is the lower of the two flange pressure-temperature ratings at that temperature.

3.4 Rating Temperature (16)

The temperature shown for a corresponding pressure-temperature rating is the temperature of the pressure-containing shell of the flange, flanged fitting, or valve. In general, this temperature is the same as that of the contained fluid. Use of a pressure-temperature rating corresponding to a temperature other than that of the contained fluid is the responsibility of the user, subject to the applicable code or regulation. For any temperature below -29°C (-20°F), the pressure-temperature rating shall be no greater than the pressure-temperature rating for -29°C (-20°F). See para. 6.5.1 for temperature limitations on use of ASTM A307 bolting.

3.5 Low-Temperature Service (16)

It is the responsibility of the user to verify that all of the component materials (i.e., flange, bolting, and gasket, etc.) selected are acceptable for use in temperature applications below -29°C (-20°F). When permitted, copper alloy flanges, flanged fittings, and valves manufactured in accordance with this Standard, assembled with suitable bolting and gaskets, and subject to the applicable code or regulations shall not be used at temperatures below -198°C (-325°F) except for ASTM B148 alloy C95200, which can be used to -269°C (-452°F). For guidance on low-temperature service, refer to ASME B31T.

3.6 System Hydrostatic Test (16)

Flanged joints, flanged fittings, and flanged or threaded end valves may be subjected to system hydrostatic tests at pressures not to exceed 1.5 times the tabulated pressure at 38°C (100°F). System testing at higher

**Table 1 Pressure–Temperature Ratings for ASTM B61 Alloy C92200 and
ASTM B62 Alloy C83600**

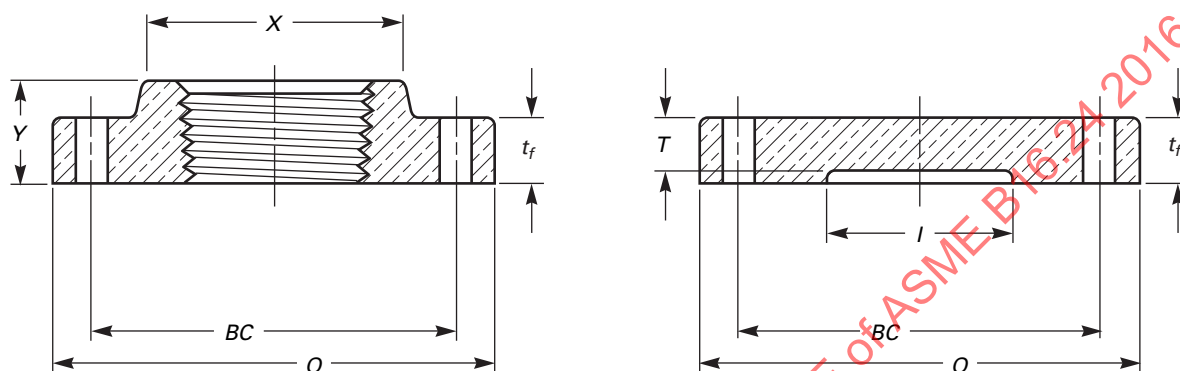
Service Temperature, °C	Pressure, bar			
	Class 150		Class 300	
	ASTM B62 C83600	ASTM B61 C92200	ASTM B62 C83600	ASTM B61 C92200
–29 to 66	15.5	15.5	34.5	34.5
100	14.3	14.6	31.4	32.4
125	13.4	14.1	29.1	30.9
150	12.4	13.4	26.8	29.3
175	11.4	12.4	24.3	27.6
200	...	11.9	...	26.1
208 [Note (1)]	10.3	...	21.4	...
225	...	11.5	...	24.6
232	9.3	...	19.3	...
250	...	10.5	...	23.0
275	...	10.0	...	21.6
289	...	9.7	...	20.7
Test pressure	24.1	24.1	51.7	51.7

GENERAL NOTE: 1 bar = 100 kPa.

NOTE:

(1) Some codes (e.g., ASME Boiler and Pressure Vessel Code, Section I; ASME B31.1; and ASME B31.5) limit the rating temperature of the indicated material to 208°C (406°F).

Table 2 Dimensions of Class 150 Threaded Companion and Blind Flanges for Alloys C83600 and C92200



NPS	Diameter of Flange, O	Minimum Thickness of Flange, t_f [Note (1)]	Bolt Circle, BC	Number of Bolts [Note (2)]	Nominal Bolt Size, in.	Nominal Diameter of Bolt Hole, in.	Minimum Diameter of Hub, X	Minimum Length Overall, Y	Maximum Diameter of Counter-bore, l	Minimum Thickness at Recess, T
1/2	90	7.9	60.3	4	1/2	5/8	30	15	13	6.4
3/4	100	8.6	69.9	4	1/2	5/8	38	16	19	7.1
1	110	9.7	79.4	4	1/2	5/8	49	17	25	7.9
1 1/4	115	10.4	88.9	4	1/2	5/8	59	21	32	8.6
1 1/2	125	11.2	98.4	4	1/2	5/8	65	22	38	9.6
2	150	12.7	120.7	4	5/8	3/4	78	25	51	11.2
2 1/2	180	14.2	139.7	4	5/8	3/4	90	29	64	12.7
3	190	15.7	152.4	4	5/8	3/4	108	30	76	14.2
3 1/2	215	17.5	177.8	8	5/8	3/4	122	32	89	15.7
4	230	17.5	190.5	8	5/8	3/4	135	33	102	15.7
5	255	19.1	215.9	8	3/4	7/8	164	37	127	17.5
6	280	20.6	241.3	8	3/4	7/8	192	40	152	19.1
8	345	23.9	298.5	8	3/4	7/8	246	44	203	22.4
10	405	25.4	362.0	12	7/8	1	305	49	254	23.9
12	485	26.9	431.8	12	7/8	1	365	56	305	25.4

GENERAL NOTES:

(a) Dimensions are in millimeters.

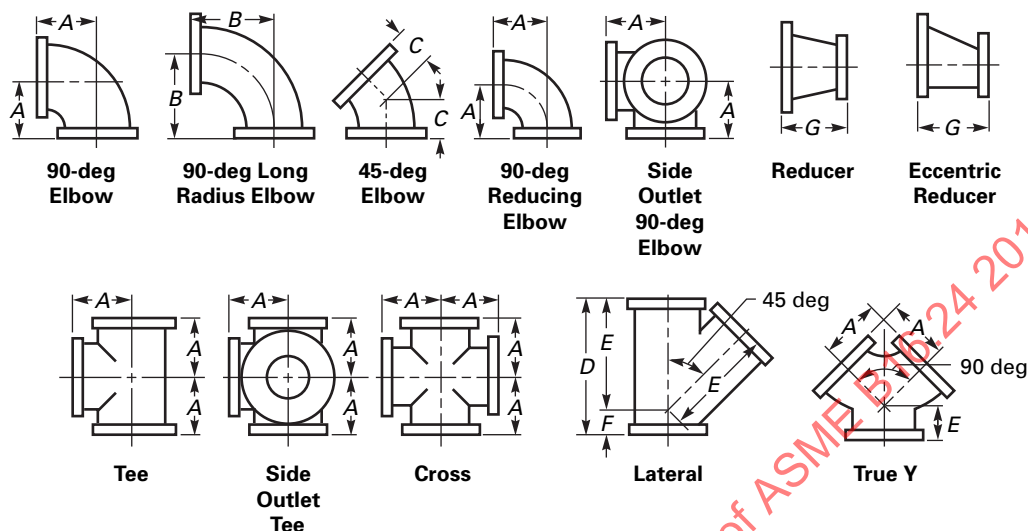
(b) For flange facing, see para. 7.2.

(c) Flange diameters and drilling templates correspond to those prescribed in ASME B16.1, ASME B16.5, and ASME B16.42.

NOTES:

(1) For flange spot facing and thickness, see para. 7.9.

(2) For flanges integral with fittings or valves, see para. 7.8.

Table 3 Dimensions of Class 150 Elbows, Tees, Crosses, Laterals, True Ys (Straight Sizes), and Reducers

NPS	Center-to-Face, A [Notes (1)–(7)]	Face-to-Face, A+A	Center-to-Face, B [Note (1)]	Center-to-Face, C [Note (1)]	Face-to-Face, D [Notes (4), (5)]	Center-to-Face, E [Notes (4), (5)]	Center-to-Face, F [Notes (4), (5)]	Face-to-Face, G [Note (8)]	Wall Thickness, t [Note (9)]	Minimum Port Diameter, l
1/2	76	152	...	41	...	...	...	...	2.3	13
3/4	83	166	...	45	...	...	...	...	2.8	19
1	89	178	127	45	191	146	45	...	3.0	25
1 1/4	95	190	140	51	204	159	45	...	3.6	32
1 1/2	102	204	152	57	229	178	51	...	4.1	38
2	114	228	165	64	267	203	64	127	4.8	51
2 1/2	127	254	178	76	305	241	64	140	5.1	64
3	140	280	197	76	330	254	76	152	5.6	76
3 1/2	152	304	216	89	368	292	76	165	6.4	89
4	165	330	229	102	381	305	76	178	6.8	102
5	191	380	260	114	432	343	89	203	7.6	127
6	203	406	292	127	457	368	89	229	8.4	152
8	229	458	356	140	559	445	114	279	10.4	203
10	279	558	419	165	648	521	127	305	12.2	254
12	305	610	483	191	762	622	140	356	14.2	305

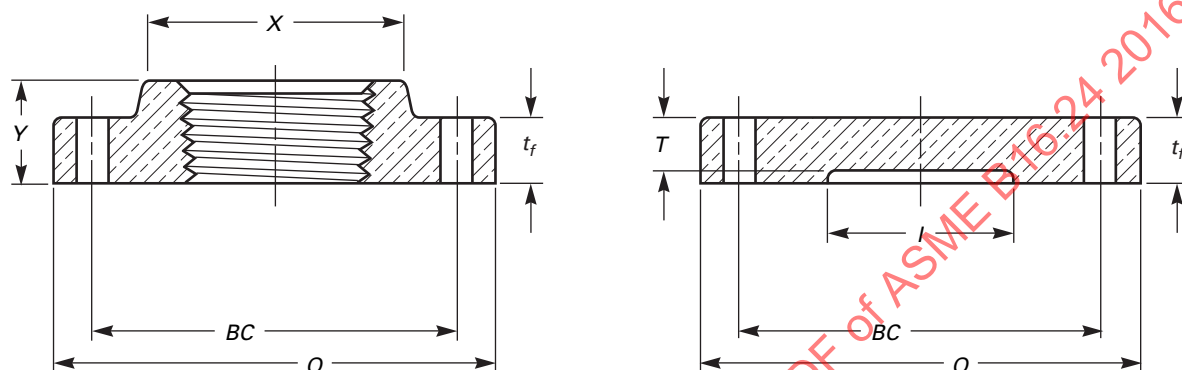
GENERAL NOTES:

- (a) Dimensions are in millimeters.
 (b) For flange and bolt hole dimensions, see Table 2 and para. 7.8.
 (c) For center-to-face tolerance, see para. 10.3.

NOTES:

- (1) For intersecting centerlines of side outlet fittings, see para. 8.1.1.
 (2) For center-to-face dimensions of reducing elbows, see para. 8.1.2(b).
 (3) For center-to-face dimensions of special degree elbows, see para. 8.1.2(c).
 (4) For reinforcements of crosses and laterals, see para. 8.2.
 (5) For center-to-face dimensions of reducing tees, crosses, and laterals, see para 8.1.3(a).
 (6) For center-to-face dimensions of tees reducing on both runs, see para 8.1.3(c).
 (7) For center-to-face dimensions of reducing side outlet tees having two different size reductions on the outlets, see para. 8.1.3(b).
 (8) For face-to-face dimensions of reducers and eccentric reducers, see para. 8.1.5.
 (9) For wall thickness tolerance, see para. 10.2.

Table 4 Dimensions of Class 300 Threaded Companion and Blind Flanges for Alloys C83600 and C92200



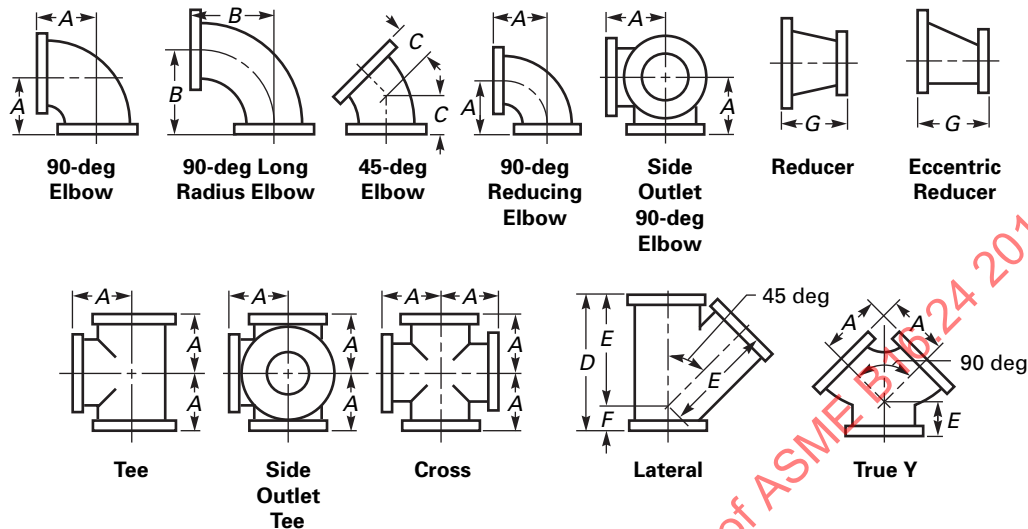
NPS	Diameter of Flange, O	Minimum Thickness of Flange, t_f [Note (1)]	Bolt Circle, BC	Number of Bolts [Note (2)]	Nominal Bolt Size, in.	Nominal Diameter of Bolt Hole, in.	Minimum Diameter of Hub, X	Minimum Length Overall, Y	Maximum Diameter of Counter-bore, I	Minimum Thickness at Recess, T
1/2	95	12.7	66.7	4	1/2	5/8	30	15	13	11.2
3/4	115	13.5	82.6	4	5/8	3/4	38	16	19	11.9
1	125	15.0	88.9	4	5/8	3/4	49	18	25	13.5
1 1/4	135	15.7	98.4	4	5/8	3/4	59	21	32	14.2
1 1/2	155	17.5	114.3	4	3/4	7/8	65	22	38	15.7
2	165	19.1	127.0	8	5/8	3/4	78	25	51	17.5
2 1/2	190	20.6	149.2	8	3/4	7/8	90	28	64	19.1
3	210	23.1	168.3	8	3/4	7/8	108	30	76	21.3
3 1/2	230	24.6	184.2	8	3/4	7/8	122	32	89	23.1
4	255	26.9	200.0	8	3/4	7/8	135	33	102	25.4
5	280	28.4	235.0	8	3/4	7/8	164	37	127	26.9
6	320	30.2	269.9	12	3/4	7/8	192	40	152	28.4
8	380	35.1	330.2	12	7/8	1	246	44	203	33.3

GENERAL NOTES:

- (a) Dimensions are in millimeters.
 (b) For flange facing, see para. 7.2.
 (c) Flange diameters and drilling templates correspond to those prescribed in ASME B16.1, ASME B16.5, and ASME B16.42.

NOTES:

- (1) For flange spot facing and thickness, see para. 7.9.
 (2) For flanges integral with fittings or valves, see para. 7.8.

Table 5 Dimensions of Class 300 Elbows, Tees, Crosses, Laterals, True Ys (Straight Sizes), and Reducers

NPS	Center-to-Face, A [Notes (1)–(7)]	Face-to-Face, A+A	Center-to-Face, B [Note (1)]	Center-to-Face, C [Note (1)]	Face-to-Face, D [Notes (4), (5)]	Center-to-Face, E [Notes (4), (5)]	Center-to-Face, F [Notes (4), (5)]	Face-to-Face, G [Note (8)]	Wall Thickness, t [Note (9)]	Minimum Port Diameter, l
1/2	76	152	...	44	...	...	...	...	3.0	13
3/4	89	178	...	57	...	...	...	...	4.1	19
1	102	204	127	57	216	165	51	...	4.3	25
1 1/4	108	216	140	64	241	184	57	...	4.8	32
1 1/2	114	228	152	70	280	216	64	...	5.1	38
2	127	254	165	76	293	229	64	127	6.4	51
2 1/2	140	280	178	89	331	267	64	140	7.1	64
3	152	304	197	89	355	279	76	152	8.4	76
3 1/2	165	330	216	102	394	318	76	165	9.1	89
4	178	356	229	114	419	343	76	178	10.4	102
5	203	406	260	127	470	381	89	203	12.2	127
6	216	432	292	104	547	445	102	229	14.2	152
8	254	508	356	152	648	521	127	279	18.3	203

GENERAL NOTES:

- (a) Dimensions are in millimeters.
 (b) For flange and bolt hole dimensions, see Table 4 and para. 7.8.
 (c) For center-to-face tolerance, see para. 10.3.

NOTES:

- (1) For intersecting centerlines of side outlet fittings, see para 8.1.1.
 (2) For center-to-face dimensions of reducing elbows, see para. 8.1.2(b).
 (3) For center-to-face dimensions of special degree elbows, see para. 8.1.2(c).
 (4) For reinforcement of crosses and laterals, see para. 8.2.
 (5) For center-to-face dimensions of reducing tees, crosses, and laterals, see para. 8.1.3(a).
 (6) For center-to-face dimensions of tees reducing on both runs, see para. 8.1.3(c).
 (7) For center-to-face dimensions on reducing side outlet tees having two different size reductions on the outlets, see para. 8.1.3(b).
 (8) For face-to-face dimensions of reducers and eccentric reducers, see para. 8.1.5.
 (9) For wall thickness tolerance, see para. 10.2.

(16) **Table 6 Pressure–Temperature Ratings for ASTM B148 Alloy C95200 Flanges**

Service Temperature, °C	Pressure, bar					
	Class 150	Class 300	Class 600	Class 900	Class 1500	Class 2500
–29 to 38	13.6	35.4	70.8	106.1	176.9	294.9
65	12.5	33.5	66.7	100.0	166.6	277.7
100	12.3	32.1	64.2	96.3	160.5	267.4
125	12.1	31.5	62.9	94.4	157.4	262.3
150	11.8	30.9	67.7	92.6	154.3	257.1
175	11.7	30.4	60.9	91.3	152.2	253.7
200	11.6	30.2	60.5	90.7	151.2	252.0
225	11.5	30.0	60.1	90.1	150.2	250.3
250	11.5	30.0	60.1	90.1	150.2	250.3
275	11.5	30.0	60.1	90.1	150.2	250.3
300	9.0	23.3	46.7	70.0	116.7	194.6
325	5.4	14.0	28.0	42.0	69.9	116.6

(16) **Table 7 Pressure–Temperature Ratings for ASTM B148 Alloy C95400 Flanges**

Service Temperature, °C	Pressure, bar					
	Class 150	Class 300	Class 600	Class 900	Class 1500	Class 2500
–29 to 38	16.3	42.6	85.2	127.7	212.9	354.9
65	15.5	40.5	81.1	121.6	202.6	337.7
100	15.2	39.7	79.4	119.1	198.5	330.9
125	15.1	39.5	79.0	118.5	197.5	329.1
150	15.1	39.5	79.0	118.5	197.5	329.1
175	15.1	39.5	79.0	118.5	197.5	329.1
200	13.8	39.5	79.0	118.5	197.5	329.1
225	13.0	39.5	79.0	118.5	197.5	329.1
250	12.1	34.5	69.3	103.9	173.1	288.6
275	11.2	29.3	58.6	87.8	146.4	244.0
300	8.9	23.2	46.5	69.7	116.2	193.7
325	7.0	19.1	36.3	54.4	90.7	151.1

pressures is the responsibility of the user, subject to the requirements of the applicable code or regulations.

4 SIZE AND METHOD OF DESIGNATING OPENINGS

(16) 4.1 Flanges, Fittings, and Valves

The size of a flange, fitting, or valve is identified by the corresponding NPS.

4.2 Reducing Fittings

Reducing fittings shall be designated by the size of the openings in their proper sequence as indicated in Fig. 1.

5 MARKING

(16) 5.1 General

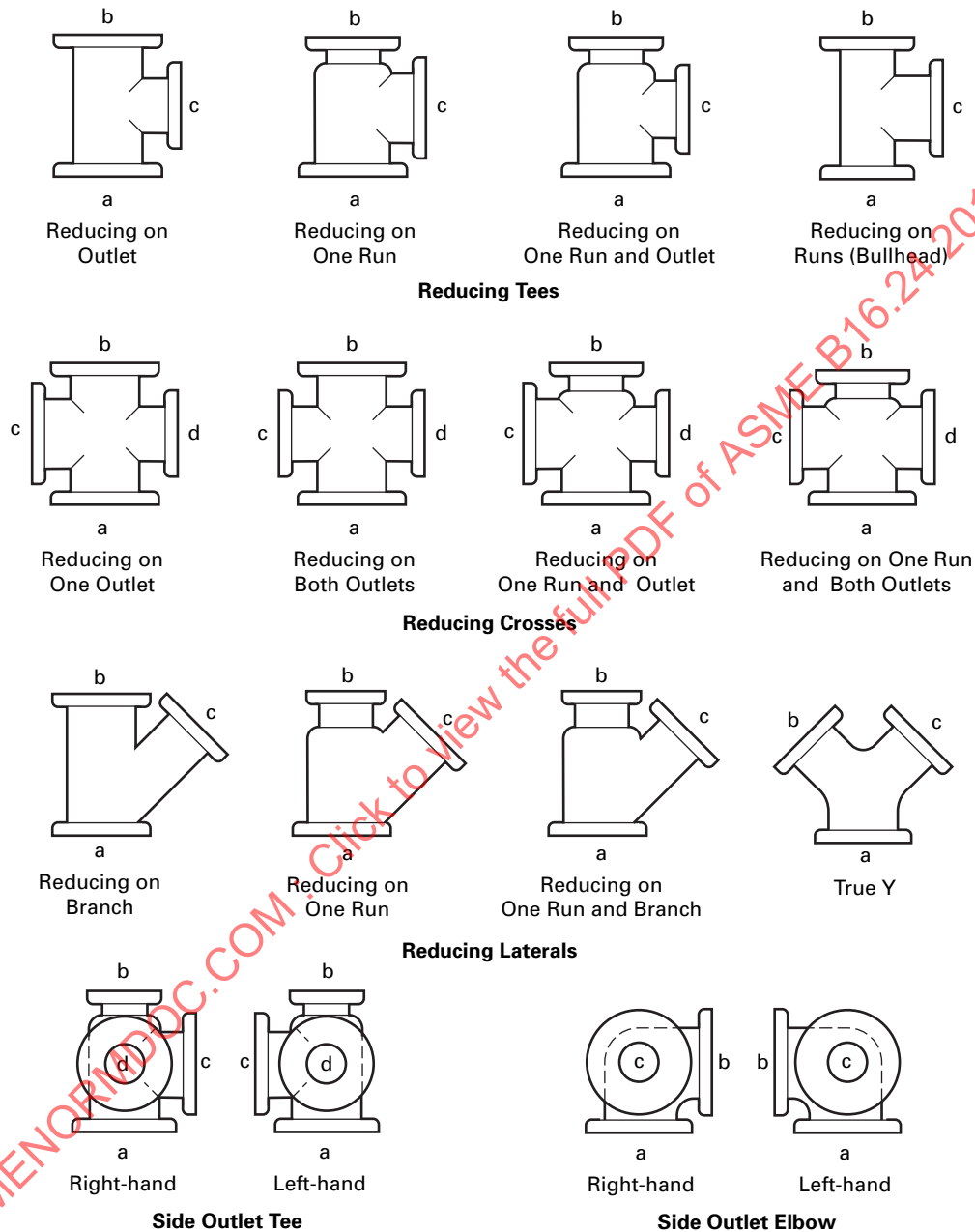
Except as modified herein, flanges, flanged fittings, and valves shall be marked as required in MSS SP-25.

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

5.1.2 Material. All flanges, flanged fittings, and valves shall be marked with the material's applicable ASTM designation (e.g., B61, B62, and B148). In addition, the applicable grade identification symbol "952" or "954" is required for flanges cast to ASTM B148.¹ (16)

5.1.3 Pressure–Temperature Rating Designation. (16)
The flange, flanged fitting, or valve shall be marked with the number that corresponds to its pressure–temperature rating class designation (i.e., 150, 300, 600, 900, 1500, or 2500).

¹ An ASME Boiler and Pressure Vessel Code, Section II specification number may be substituted for an ASTM Specification number, provided the requirements of the ASME Specification are identical to or more stringent than the ASTM Specification for the grade, class, or type of material.

Fig. 1 Method of Designating Outlets of Reducing Fittings**GENERAL NOTES:**

- In designating the openings of reducing fittings, they should be read in the order indicated by the sequence of the letters "a," "b," "c," and "d." In designating the outlets of side outlet reducing fittings, the side outlet is named last and in the case of the cross, which is not shown, the side outlet is designated by the letter "e."
- The largest opening establishes the basic size of a reducing fitting. The largest opening is named first, except for bullhead tees, which are reducing on both runs, and for double branch elbows where both branches are reducing, the outlet is the largest opening and named last in both cases. (Double branch elbows are not included in this Standard.)

(16) **5.1.4 Conformance.** The designation B16 or B16.24 shall be applied to the flange, flanged fitting, and valve, preferably located adjacent to the class designation, to indicate conformance to this Standard. The use of the prefix "ASME" is optional.

(16) **5.1.5 Size.** The NPS designation shall be marked on flanges, flanged fittings, and valves. Reducing flanges and reducing flanged fittings shall be marked with the applicable NPS designations as required by paras. 4.1 and 4.2.

6 MATERIALS

6.1 General

Products covered by this Standard shall be made of castings produced to the requirements of para. 6.2 or 6.3.

6.2 Flanges

Flanges shall be in accordance with the material requirements specified in para. 6.2.1, 6.2.2, or 6.2.3.

6.2.1 ASTM B61. Castings shall meet the requirements of ASTM B61 alloy C92200.

6.2.2 ASTM B62. Castings shall meet the requirements of ASTM B62 alloy C83600.

(16) **6.2.3 ASTM B148.** Castings shall meet the requirements of ASTM B148 alloy C95200 or alloy C95400, and the additional requirements specified in paras. 6.2.3.1 through 6.2.3.5.

6.2.3.1 Ordering Information. Ordering information for ASTM B148 castings shall include tests on each lot and the form of the test bar.

6.2.3.2 Test Bars. For ASTM B148 castings, a minimum of three test bars shall be poured from each lot of cast metal. Chemical composition and mechanical property tests shall be performed using the test bars from each lot.

6.2.3.3 Sampling. For ASTM B148 castings, the sample for chemical analysis shall be taken from the test bar casting or other casting sample in such a manner as to be representative of each casting lot.

(16) **6.2.3.4 Weld Repair Approval.** ASTM B148 castings shall not be repaired, plugged, welded, or burned-in unless permission from the user of the cast product has been previously secured. This will be requested of the user upon the manufacturer's determination that casting defects are such that after the approved repair, the usefulness and the strength of the casting will not be impaired.

6.2.3.5 Weld Repair. For ASTM B148 castings, preparation for repair welding shall include inspection to ensure complete removal of the defect. Repairs shall

be made using welding procedures qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Repair welding shall be done by welders or welding operators meeting the qualification requirements of that Code.

6.3 Flanged Fittings

Material for flanged fittings shall be in accordance with either para. 6.2.1 or 6.2.2.

6.4 Valves — Flanged and Threaded

(16)

Material for flanged and threaded valves shall be in accordance with para. 6.2.3.

6.5 Bolting

(16)

Bolting materials recommended for use with copper alloy flanges and flanged fittings are described in paras. 6.5.1 and 6.5.2.

6.5.1 Steel Bolting. Carbon steel bolting conforming to ASTM A307 is not recommended to be used below -29°C (-20°F) nor above 204°C (400°F) and is limited to use with Classes 150 and 300 flanges, flanged fittings, and flanged valve end connections. (16)

6.5.2 Nonferrous Boltings. The following nonferrous bolting materials are recommended for Classes 150 and 300 flanges, flanged fittings, and valves within the temperature limitation stated. Other bolting materials that have a specified minimum yield strength of at least 206 MPa (30 ksi) may be used when permitted by the applicable code or regulation. (16)

ASTM Specification	Alloy No.	Condition	Notes
B98	C65100	Half hard	(1)
	C65500	Half hard	(1)
	C66100	Half hard	(1)
B150	C61400	...	(2)
	C63000	...	(2)
	C64200	...	(2)
B164	N04400	Hot finish	...
	N04400	Cold drawn	(2)
	N04400	Cold drawn, stress relieved	(2)
	N04400	Cold drawn, stress equalized	(2)
	N04405	Hot finish	...
	N04405	Cold drawn	(2)

NOTES:

(1) Maximum operating temperature is 177°C (350°F).

(2) Maximum operating temperature is 288°C (550°F).

6.6 Gaskets

Materials for gaskets are described in ASME B16.5. The user is responsible for selection of gasket materials that will withstand the expected bolt loading without injurious crushing and that are suitable for the service

conditions. Particular attention needs to be given to gasket selection if a hydrostatic test approaches or exceeds the test pressure specified in para. 3.6.

6.7 Materials Selection

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. A discussion of precautionary considerations can be found in Appendix F of ASME B31.3.

(16) 7 FLANGE AND VALVE BODY DIMENSIONS

7.1 General

Flange dimensions are dependent on the flange casting material.

- (16) **7.1.1 ASTM B61 and ASTM B62.** For flange castings made of ASTM B61 alloy C92200 or ASTM B62 alloy C83600, the flange dimensions shall be in accordance with Tables 2 and 4 (Tables I-2 and I-4) with alternative facings as permitted in para. 7.2.

- (16) **7.1.2 ASTM B148 Alloys.** For flange castings made of ASTM B148 alloys C95200 and C95400, the flange dimensions shall be in accordance with the applicable dimensional requirements of ASME B16.5.

- (16) **7.1.3 ASTM B148 End Flanges.** For valve flanged body castings, the end flange dimensions shall be in accordance with the applicable dimensional requirements of ASME B16.5 or ASME B16.47.

(16) 7.2 End-Flange Facings

Unless otherwise specified by the purchaser, Classes 150 and 300 blind and companion flanges shall be furnished with a flat face. Unless otherwise specified by the purchaser, Class 600 and higher companion flanges shall be furnished with a 6.4-mm (0.25-in.) raised face, with the exception of the small male face (on end of pipe) and the small female face (on end of pipe). When using straight pipe threads, any of the flange pipe threads shown in ASME B16.5 may be used with copper alloy flanges. When flanges of ASTM B61 or ASTM B62 are furnished with one of the alternative ASME B16.5 facings, any required raised-face dimension shall be in addition to the basic flange thickness, t_f , of Tables 2 and 4 (Tables I-2 and I-4).

7.3 Threaded Flanges

Threaded flanges shall have a taper pipe thread in accordance with ASME B1.20.1. Variations in alignment of the thread with the axis of the flange shall not exceed 5 mm/m (0.06 in./ft) (0.5%).

7.4 Thread Chamfer

All flanges of ASTM B61 and ASTM B62 materials shall be made without a counterbore. The threads shall

be chamfered approximately to the major diameter of the thread at the pipe end of the flange at an angle approximately 45 deg with the axis of the thread. The chamfer shall be concentric with the thread and shall be included in the measurement of the thread length.

7.5 Thread Length

The length of the thread shall include the chamfer.

7.6 Thread Gauging

(16)

The reference point for gauging is the starting end of the flange, provided the chamfer does not exceed the major diameter of the internal thread. When a chamfer on the internal thread exceeds this limit, the reference point becomes the last thread scratch on the chamfer cone.

7.7 Threaded Flange Assembly

External pipe threads used with higher-pressure flanges shall be longer than normal to bring the end of the pipe close to the face of the flange when parts are assembled by power equipment. The additional length and number of turns are shown in Mandatory Appendix I of ASME B16.5 for ASME B1.20.1 threads.

7.8 Flanged Bolt Holes

Bolt holes are in multiples of four. Bolt holes shall be equally spaced, and pairs of bolt holes shall straddle fitting or valve centerlines.

7.9 Spot and Back Facing

(16)

Flanges, flanged fittings, and flanged valves covered by this Standard shall have bearing surfaces for bolting that shall be parallel to the flange face within 1 deg. Any spot or back facing shall not reduce the flange thickness, t_f , below the dimension required by para. 7.1. The spot facing diameter shall be in accordance with MSS SP-9. When cutting into the hub of flanges, flanged fittings, and flanged valve bodies with back facing tools, the intersection shall have a radius not less than 1.5 mm (0.06 in.).

8 FITTING AND VALVE DIMENSIONS

(16)

8.1 Center-to-Face Dimensions

8.1.1 Side Outlet Fittings. Side outlet elbows and side outlet tees shall have all openings on intersecting centerlines.

8.1.2 Elbows

(a) The center-to-face dimensions for straight size 90-deg elbows, 90-deg long radius elbows, 45-deg elbows, and side outlet 90-deg elbows are shown in Tables 3 and 5 (Tables I-3 and I-5).

(b) Reducing 90-deg elbows and reducing side outlet 90-deg elbows shall have the same center-to-face dimensions as straight size fittings shown in Tables 3 and 5

(Tables I-3 and I-5), corresponding to the size of the largest opening.

(c) Special degree elbows ranging from 1 deg to 45 deg, inclusively, shall have the same center-to-face dimensions given for 45-deg elbows, and those over 45 deg and up to 90 deg, inclusively, shall have the same center-to-face dimensions given for 90-deg elbows. The angle designation of an elbow is its deflection from straight line flow and is the angle between the flange faces.

8.1.3 Tees, Crosses, and Laterals

(a) The center-to-face dimensions for straight size tees, with or without side outlet, crosses, and laterals are shown in Tables 3 and 5 (Tables I-3 and I-5).

(b) Reducing tees, with or without side outlet, reducing crosses, and reducing laterals shall have the same center-to-face dimensions as straight size fittings shown in Tables 3 and 5 (Tables I-3 and I-5), corresponding to the size of the largest opening. Tees, crosses, and laterals, reducing on the run only, shall have the same center-to-face dimensions as straight size fittings shown in Tables 3 and 5 (Tables I-3 and I-5), corresponding to the size of the largest opening.

(c) Tees reducing on both runs are generally known as bullhead tees and have the same center-to-face dimensions as straight size fittings corresponding to the size of the outlet.

8.1.4 True Ys. Center-to-face dimensions for straight size true Ys are shown in Tables 3 and 5 (Tables I-3 and I-5). Reducing sizes are considered special and should be made to suit conditions.

8.1.5 Reducers and Eccentric Reducers. The face-to-face dimensions for all combinations of reducers and eccentric reducers shall be the same as given in Tables 3 and 5 (Tables I-3 and I-5) for the larger opening.

(16) **8.1.6 Valves.** Flanged valves shall have face-to-face dimensions in accordance with ASME B16.10. Threaded valves face-to-face shall be manufacturer's standard.

(16) **8.1.7 Interchangeability.** Class 150 flanged fittings and valves in NPS 1 and larger sizes have a bolting pattern that is dimensionally interchangeable with ASME B16.1, Class 125 Cast Iron Flanged Fittings; ASME B16.5, Class 150 Steel Flanged Fittings; and ASME B16.42, Class 150 Ductile Iron Flanged Fittings. Class 300 flanged fittings in NPS 1 and larger have a bolting pattern that is dimensionally interchangeable with ASME B16.1, Class 250 Cast Iron Flanged Fittings; ASME B16.5, Class 300 Steel Flanged Fittings; and ASME B16.42, Class 300 Ductile Iron Flanged Fittings.

(16) 8.2 Wall Thickness

8.2.1 Fittings. For inspection purposes, the minimum wall thickness, t , of flanged fittings at the time of manufacture shall be as shown in Tables 3 and 5

(Tables I-3 and I-5), except as provided in para. 10.2. Additional metal thickness needed to withstand assembly stresses, shapes other than circular, and stress concentrations shall be determined by the manufacturer. In particular, 45-deg laterals, true Ys, and crosses may require additional reinforcement to compensate for inherent weaknesses in these shapes.

8.2.2 Valves. ASME B16.34 wall thickness shall apply for ASTM B148 valves.

9 BOLTING AND GASKETS

9.1 Bolting

For carbon steel and nonferrous bolts smaller than $\frac{3}{4}$ in., ASME B18.2.1, Square Heads; ASME B18.2.1, Heavy Hex Heads; and ASME B18.2.2, Heavy Hex Nuts are recommended. For carbon steel and nonferrous bolts $\frac{3}{4}$ in. and larger, ASME B18.2.1, Standard Heads; ASME B18.2.1, Hex Heads; ASME B18.2.2, Hex Nuts; and ASME B18.2.2, Heavy Hex Nuts are recommended.

It is recommended that all bolting be threaded in accordance with ASME B1.1, Unified Screw Threads, Coarse Thread Series, Class 2A and Class 2B.

9.2 Gaskets

Full-faced gaskets extending to the flange edge as given in ASME B16.21 are recommended for flat-faced surfaces such as shown in Tables 2 and 4 (Tables I-2 and I-4). Metallic gaskets are not recommended to be used with flat-faced flanges.

10 TOLERANCES²

10.1 Convention

For determining conformance with this Standard, the convention for fixing significant digits where limits (maximum and minimum values) are specified shall be as defined in ASTM E29. This requires that an observed or calculated value be rounded off to the nearest unit in the last right-hand digit used for expressing the limit. Decimal values and tolerances do not imply a particular method of measurement.

10.2 Wall Thickness

Fittings with local areas having a less than minimum wall thickness will be acceptable, provided that

(a) the area of minimum thickness can be enclosed by a circle whose diameter is no greater than $0.35\sqrt{dt}$ where d is the inside diameter, and t is the minimum wall thickness, as shown in Tables 3 and 5 (Tables I-3 and I-5)

(b) measured thickness is not less than $0.9t$

(c) enclosure circles are separated from each other by an edge-to-edge distance not less than $1.75\sqrt{dt}$

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

10.3 Center-to-Face

The following tolerances shall be permitted on all center-to-contact surface dimensions of fittings:

NPS	Tolerance, mm (in.)
≤10	±0.8 (±0.03)
≥12	±1.5 (±0.06)

Tolerances for contact surface-to-contact surface (face-to-face) dimensions shall be twice those given above. The largest opening in the fitting governs the tolerance to be applied to all openings.

10.4 Facings

Outside diameter, 6.4 mm (0.25 in.) raised face, 0.5 mm (0.02 in.).

10.5 Flange Thickness

NPS	Tolerance, mm (in.)
≤12	+3.0 (+0.12) −0.0 (−zero)

10.6 Counterbore, Threaded Flanges

NPS	Tolerance, mm (in.)
≤10	+0.8 (+0.03) −0.0 (−zero)
≥12	+1.5 (+0.06) −0.0 (−zero)

10.7 Drilling and Facing

- (a) Bolt circle diameter, ±1.5 mm (±0.06 in.)
- (b) Center-to-center of adjacent bolt holes, ±0.8 mm (±0.03 in.)

11 PRESSURE TESTING

11.1 Flange Test

Flanges are not required to be pressure-tested.

11.2 Flanged Fitting Test

11.2.1 Shell Pressure Test. Each flanged fitting shall be given a shell pressure test.

11.2.2 Test Conditions. The shell pressure test for flanged fittings shall be at a pressure not less than 1.5 times the 38°C (100°F) pressure-temperature rating rounded off to the next higher 0.5-bar (10-psi) increment.

11.2.3 Test Fluid. The pressure test shall be made using water, which may contain a corrosion inhibitor or kerosene, as the test fluid. Other suitable test fluids may be used, provided their viscosity is not greater than that of water. The test-fluid temperature shall not exceed 50°C (125°F).

11.2.4 Test Duration. The minimum test duration shall be as follows:

Fitting Size	Duration, s
NPS ≤ 2	60
2½ ≤ NPS ≤ 8	120
NPS ≥ 10	180

11.2.5 Acceptance. No visible leakage is permitted through the pressure boundary wall.

11.3 Valve Pressure Test

(16)

Each valve shall be given a shell and closure test that meets the requirements of ASME B16.34, section 7.

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MANDATORY APPENDIX I

DIMENSIONS OF FITTINGS IN U.S. CUSTOMARY UNITS

(16)

This Appendix provides tables for standard inch dimensions. (See Tables I-1 through I-7.)

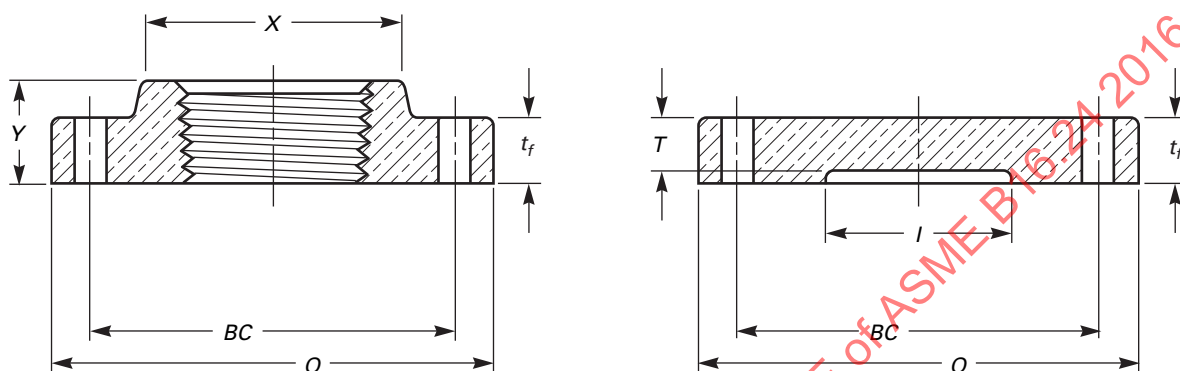
Table I-1 Pressure–Temperature Ratings for ASTM B61 Alloy C92200 and ASTM B62 Alloy C83600

Service Temperature, °F	Pressure, psig			
	Class 150		Class 300	
	ASTM B62 C83600	ASTM B61 C92200	ASTM B62 C83600	ASTM B61 C92200
–20 to 150	225	225	500	500
175	220	220	480	490
200	210	215	465	475
225	205	210	445	465
250	195	205	425	450
275	190	200	410	440
300	180	195	390	425
350	165	180	350	400
400	...	170	...	375
406	150	...	...	...
450	135 [Note (1)]	160	280 [Note (1)]	350
500	...	150	...	325
550	...	140	...	300
Test pressure	350	350	750	750

NOTE:

- (1) Some codes (e.g., ASME Boiler and Pressure Vessel Code, Section I; ASME B31.1; and ASME B31.5) limit the rating temperature of the indicated material to 406°F.

Table I-2 Dimensions of Class 150 Threaded Companion and Blind Flanges for Alloys C83600 and C92200



NPS	Diameter of Flange, O	Minimum Thickness of Flange, t_f [Note (1)]	Bolt Circle, BC	Number of Bolts [Note (2)]	Diameter of Bolts	Diameter of Bolt Hole	Minimum Diameter of Hub, X	Minimum Length Overall, Y	Maximum Diameter of Counter-bore, l	Minimum Thickness at Recess, T
$\frac{1}{2}$	3.50	0.31	2.38	4	$\frac{1}{2}$	$\frac{5}{8}$	1.19	0.59	0.50	0.25
$\frac{3}{4}$	3.88	0.34	2.75	4	$\frac{1}{2}$	$\frac{5}{8}$	1.25	0.62	0.75	0.28
1	4.25	0.38	3.12	4	$\frac{1}{2}$	$\frac{5}{8}$	1.94	0.69	1.00	0.31
$1\frac{1}{4}$	4.62	0.41	3.50	4	$\frac{1}{2}$	$\frac{5}{8}$	2.31	0.81	1.25	0.34
$1\frac{1}{2}$	5.00	0.44	3.88	4	$\frac{1}{2}$	$\frac{5}{8}$	2.56	0.88	1.50	0.38
2	6.00	0.50	4.75	4	$\frac{5}{8}$	$\frac{3}{4}$	3.06	1.00	2.00	0.44
$2\frac{1}{2}$	7.00	0.56	5.50	4	$\frac{5}{8}$	$\frac{3}{4}$	3.56	1.12	2.50	0.50
3	7.50	0.62	6.00	4	$\frac{5}{8}$	$\frac{3}{4}$	4.25	1.19	3.00	0.56
$3\frac{1}{2}$	8.50	0.69	7.00	8	$\frac{5}{8}$	$\frac{3}{4}$	4.81	1.25	3.50	0.62
4	9.00	0.69	7.50	8	$\frac{5}{8}$	$\frac{3}{4}$	5.31	1.31	4.00	0.62
5	10.00	0.75	8.50	8	$\frac{3}{4}$	$\frac{7}{8}$	6.44	1.44	5.00	0.69
6	11.00	0.81	9.50	8	$\frac{3}{4}$	$\frac{7}{8}$	7.56	1.56	6.00	0.75
8	13.50	0.94	11.75	8	$\frac{3}{4}$	$\frac{7}{8}$	9.69	1.75	8.00	0.88
10	16.00	1.00	14.25	12	$\frac{7}{8}$	1	12.00	1.94	10.00	0.94
12	19.00	1.06	17.00	12	$\frac{7}{8}$	1	14.38	2.19	12.00	1.00

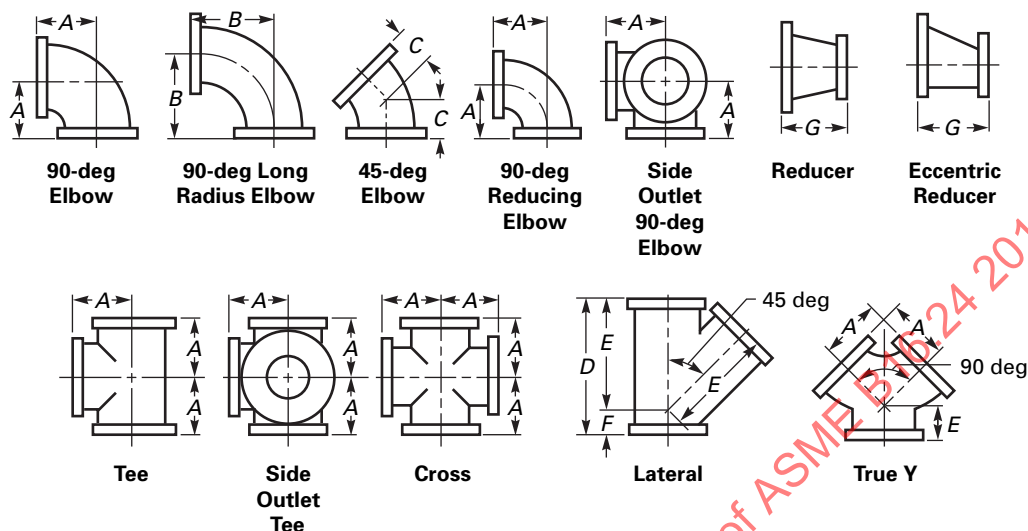
GENERAL NOTES:

- Dimensions are in inches.
- For flange facing, see para. 7.2.
- Flange diameters and drilling templates correspond to those prescribed in ASME B16.1, ASME B16.5, and ASME B16.42.

NOTES:

- For flange spot facing and thickness, see para. 7.9.
- For flanges integral with fittings or valves, see para. 7.8.

Table I-3 Dimensions of Class 150 Elbows, Tees, Crosses, Laterals, True Ys (Straight Sizes), and Reducers



NPS	Center-to-Face, A [Notes (1)–(7)]	Face-to-Face, A+A	Center-to-Face, B [Note (1)]	Center-to-Face, C [Note (1)]	Face-to-Face, D [Notes (4), (5)]	Center-to-Face, E [Notes (4), (5)]	Center-to-Face, F [Notes (4), (5)]	Face-to-Face, G [Note (8)]	Wall Thickness, t [Note (9)]	Minimum Port Diameter, l
1/2	3.00	6.00	...	1.62	...	...	...	...	0.09	0.50
3/4	3.25	6.50	...	1.75	...	...	...	...	0.11	0.75
1	3.50	7.00	5.00	1.75	7.50	5.75	1.75	...	0.12	1.00
1 1/4	3.75	7.50	5.50	2.00	8.00	6.25	1.75	...	0.14	1.25
1 1/2	4.00	8.00	6.00	2.25	9.00	7.00	2.00	...	0.16	1.50
2	4.50	9.00	6.50	2.50	10.50	8.00	2.50	5.00	0.19	2.00
2 1/2	5.00	10.00	7.00	3.00	12.00	9.50	2.50	5.50	0.20	2.50
3	5.50	11.00	7.75	3.00	13.00	10.00	3.00	6.00	0.22	3.00
3 1/2	6.00	12.00	8.50	3.50	14.50	11.50	3.00	6.50	0.25	3.50
4	6.50	13.00	9.00	4.00	15.00	12.00	3.00	7.00	0.27	4.00
5	7.50	15.00	10.25	4.50	17.00	13.50	3.50	8.00	0.30	5.00
6	8.00	16.00	11.50	5.00	18.00	14.50	3.50	9.00	0.33	6.00
8	9.00	18.00	14.00	5.50	22.00	17.50	4.50	11.00	0.41	8.00
10	11.00	22.00	16.50	6.50	25.50	20.50	5.00	12.00	0.48	10.00
12	12.00	24.00	19.00	7.50	30.00	24.50	5.50	14.00	0.56	12.00

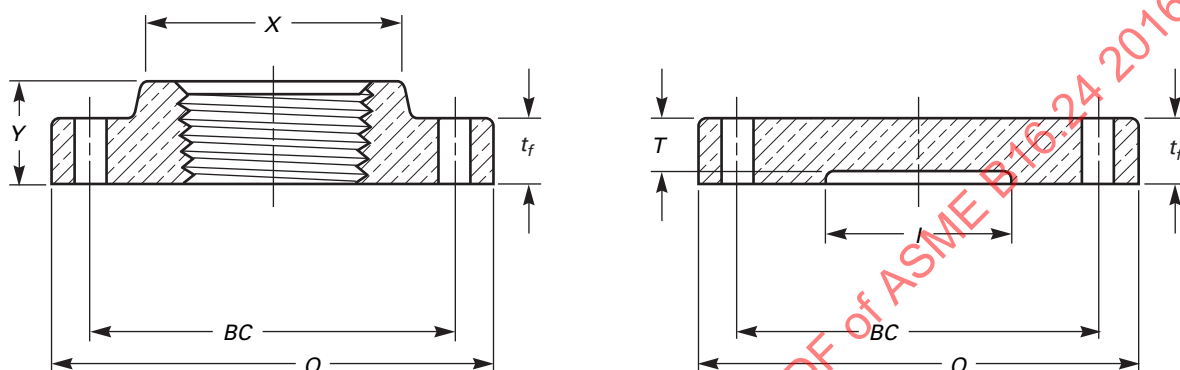
GENERAL NOTES:

- Dimensions are in inches.
- For flange and bolt hole dimensions, see Table I-2 and para. 7.8.
- For center-to-face tolerance, see para. 10.3.

NOTES:

- For intersecting centerlines of side outlet fittings, see para. 8.1.1.
- For center-to-face dimensions of reducing elbows, see para. 8.1.2(b).
- For center-to-face dimensions of special degree elbows, see para. 8.1.2(c).
- For reinforcements of crosses and laterals, see para. 8.2.
- For center-to-face dimensions of reducing tees, crosses, and laterals, see para 8.1.3(a).
- For center-to-face dimensions of tees reducing on both runs, see para 8.1.3(c).
- For center-to-face dimensions of reducing side outlet tees having two different size reductions on the outlets, see para. 8.1.3(b).
- For face-to-face dimensions of reducers and eccentric reducers, see para. 8.1.5.
- For wall thickness tolerance, see para. 10.2.

Table I-4 Dimensions of Class 300 Threaded Companion and Blind Flanges for Alloys C83600 and C92200



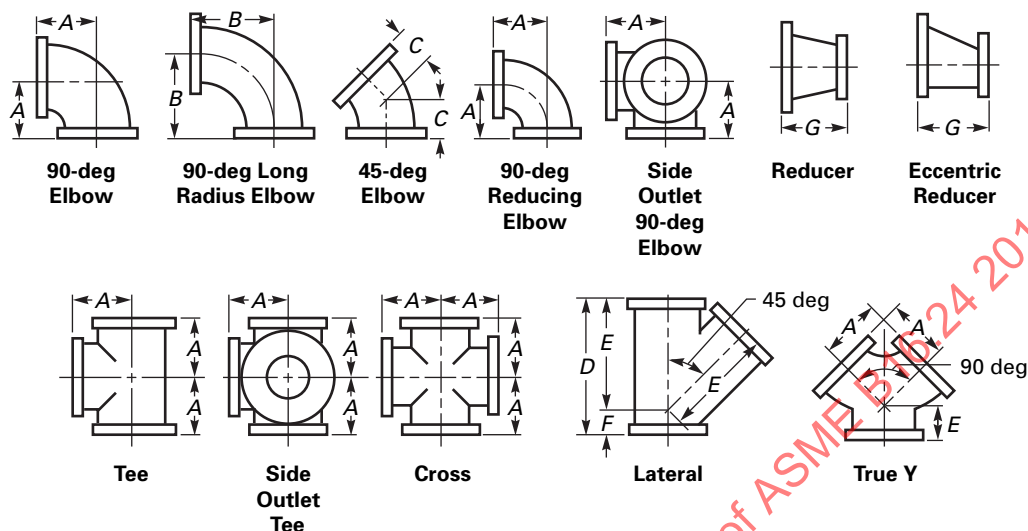
NPS	Diameter of Flange, O	Minimum Thickness of Flange, t_f [Note (1)]	Bolt Circle, BC	Number of Bolts [Note (2)]	Diameter of Bolts	Diameter of Bolt Hole	Minimum Diameter of Hub, X	Minimum Length Overall, Y	Maximum Diameter of Counter-bore, I	Minimum Thickness at Recess, T
$\frac{1}{2}$	3.75	0.50	2.62	4	$\frac{1}{2}$	$\frac{5}{8}$	1.19	0.59	0.50	0.44
$\frac{3}{4}$	4.62	0.53	3.25	4	$\frac{3}{8}$	$\frac{3}{4}$	1.50	0.62	0.75	0.47
1	4.88	0.59	3.50	4	$\frac{5}{8}$	$\frac{3}{4}$	1.94	0.69	1.00	0.53
$1\frac{1}{4}$	5.25	0.62	3.88	4	$\frac{5}{8}$	$\frac{3}{4}$	2.31	0.81	1.25	0.56
$1\frac{1}{2}$	6.12	0.69	4.50	4	$\frac{3}{4}$	$\frac{7}{8}$	2.56	0.88	1.50	0.62
2	6.50	0.75	5.00	8	$\frac{5}{8}$	$\frac{3}{4}$	3.06	1.00	2.00	0.69
$2\frac{1}{2}$	7.50	0.81	5.88	8	$\frac{3}{4}$	$\frac{7}{8}$	3.56	1.12	2.50	0.75
3	8.25	0.91	6.62	8	$\frac{3}{4}$	$\frac{7}{8}$	4.25	1.19	3.00	0.84
$3\frac{1}{2}$	9.00	0.97	7.25	8	$\frac{3}{4}$	$\frac{7}{8}$	4.81	1.25	3.50	0.91
4	10.00	1.06	7.88	8	$\frac{3}{4}$	$\frac{7}{8}$	5.31	1.31	4.00	1.00
5	11.00	1.12	9.25	8	$\frac{3}{4}$	$\frac{7}{8}$	6.44	1.44	5.00	1.06
6	12.50	1.19	10.62	12	$\frac{3}{4}$	$\frac{7}{8}$	7.56	1.56	6.00	1.12
8	15.00	1.38	13.00	12	$\frac{7}{8}$	1	9.69	1.75	8.00	1.31

GENERAL NOTES:

- (a) Dimensions are in inches.
 (b) For flange facing, see para. 7.2.
 (c) Flange diameters and drilling templates correspond to those prescribed in ASME B16.1, ASME B16.5, and ASME B16.42.

NOTES:

- (1) For flange spot facing and thickness, see para. 7.9.
 (2) For flanges integral with fittings or valves, see para. 7.8.

Table I-5 Dimensions of Class 300 Elbows, Tees, Crosses, Laterals, True Ys (Straight Sizes), and Reducers

NPS	Center-to-Face, A [Notes (1)–(7)]	Face-to-Face, A+A	Center-to-Face, B [Note (1)]	Center-to-Face, C [Note (1)]	Face-to-Face, D [Notes (4), (5)]	Center-to-Face, E [Notes (4), (5)]	Center-to-Face, F [Notes (4), (5)]	Face-to-Face, G [Note (8)]	Wall Thickness, t [Note (9)]	Minimum Port Diameter, l
1/2	3.00	6.00	...	1.75	...	...	...	...	0.12	0.50
3/4	3.50	7.00	...	2.25	...	...	...	...	0.16	0.75
1	4.00	8.00	5.00	2.25	8.50	6.50	2.00	...	0.17	1.00
1 1/4	4.25	8.50	5.50	2.50	9.50	7.25	2.25	...	0.19	1.25
1 1/2	4.50	9.00	6.00	2.75	11.00	8.50	2.50	...	0.20	1.50
2	5.00	10.00	6.50	3.00	11.50	9.00	2.50	5.00	0.25	2.00
2 1/2	5.50	11.00	7.00	3.50	13.00	10.50	2.50	5.50	0.28	2.50
3	6.00	12.00	7.75	3.50	14.00	11.00	3.00	6.00	0.33	3.00
3 1/2	6.50	13.00	8.50	4.00	15.50	12.50	3.00	6.50	0.36	3.50
4	7.00	14.00	9.00	4.50	16.50	13.50	3.00	7.00	0.41	4.00
5	8.00	16.00	10.25	5.00	18.50	15.00	3.50	8.00	0.48	5.00
6	8.50	17.00	11.50	5.50	21.50	17.50	4.00	9.00	0.56	6.00
8	10.00	20.00	14.00	6.00	25.50	20.50	5.00	11.00	0.72	8.00

GENERAL NOTES:

- (a) Dimensions are in inches.
 (b) For flange and bolt hole dimensions, see Table I-4 and para. 7.8.
 (c) For center-to-face tolerance, see para. 10.3.

NOTES:

- (1) For intersecting centerlines of side outlet fittings, see para 8.1.1.
 (2) For center-to-face dimensions of reducing elbows, see para. 8.1.2(b).
 (3) For center-to-face dimensions of special degree elbows, see para. 8.1.2(c).
 (4) For reinforcement of crosses and laterals, see para. 8.2.
 (5) For center-to-face dimensions of reducing tees, crosses, and laterals, see para. 8.1.3(a).
 (6) For center-to-face dimensions of tees reducing on both runs, see para. 8.1.3(c).
 (7) For center-to-face dimensions on reducing side outlet tees having two different size reductions on the outlets, see para. 8.1.3(b).
 (8) For face-to-face dimensions of reducers and eccentric reducers, see para. 8.1.5.
 (9) For wall thickness tolerance, see para. 10.2.

(16) **Table I-6 Pressure–Temperature Ratings for ASTM B148 Alloy C95200 Flanges**

Service Temperature, °F	Pressure, psi					
	Class 150	Class 300	Class 600	Class 900	Class 1500	Class 2500
–20 to 100	195	515	1,030	1,555	2,570	4,285
150	185	480	965	1,450	2,415	4,030
200	180	470	940	1,405	2,345	3,910
250	175	455	915	1,370	2,285	3,805
300	170	445	895	1,340	2,230	3,720
350	170	440	880	1,320	2,200	3,670
400	170	440	875	1,315	2,190	3,650
450	165	435	870	1,310	2,180	3,635
500	165	435	870	1,310	2,180	3,635
550	155	400	800	1,205	2,005	3,345
600	95	255	505	760	1,270	2,115

(16) **Table I-7 Pressure–Temperature Ratings for ASTM B148 Alloy C95400 Flanges**

Service Temperature, °F	Pressure, psi					
	Class 150	Class 300	Class 600	Class 900	Class 1500	Class 2500
–20 to 100	235	615	1,235	1,850	3,085	5,145
150	225	585	1,175	1,760	2,930	4,885
200	220	575	1,150	1,730	2,880	4,800
250	220	570	1,145	1,715	2,860	4,765
300	220	570	1,145	1,715	2,860	4,765
350	220	570	1,145	1,715	2,860	4,765
400	200	570	1,145	1,715	2,860	4,765
450	185	570	1,145	1,715	2,860	4,765
500	170	475	955	1,430	2,380	3,970
550	145	375	755	1,130	1,885	3,145
600	110	290	585	875	1,455	2,430