AN AMERICAN NATIONAL STANDARD

Factory-Made Wrought Steel Buttwelding Fittings

ASME B16.9-1993

(REVISION OF ASME/ANSI B16.9-1986)

The American Society of
Mechanical Engineers

345 East 47th Street, New York, N.Y. 10017

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The 1993 edition of this Standard is being issued with an automatic addenda subscription service. The use of an addenda allows revisions made in response to public review comments or committee actions to be published as necessary; revisions published in addenda will become effective 6 months after the Date of Issuance of the addenda. The next edition of this Standard is scheduled for publication in 1998.

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.

FOREWORD

(This Foreword is not part of ASME B16.9-1993.)

In 1921, the American Engineering Standards Committee, later American Standards Association (ASA), organized Sectional Committee B16 to unify and further develop national standards for pipe flanges and fittings (and, later, for valves, gaskets, and valve actuators). Cosponsors of the B16 Committee were the American Society of Mechanical Engineers (ASME), the Heating and Piping Contractors National Association [now the Mechanical Contractors Association of America (MCAA)], and the Manufacturers Standardization Society of the Valve and Fittings Industry (MSS). Cosponsors were later designated as cosecretariat organizations.

Standardization of welding fittings was initiated in 1937 by a subgroup (designated Subgroup 6) of Subcommittee No. 3. After consideration of several drafts, a standard was approved by the Committee, cosponsors, and ASA, and published with the designation ASA B16.9-1940.

Revisions were made in 1950 and 1955 to add sizes up to NPS 24 and to complete coverage of fittings in some sizes. These revisions were approved and published as ASA B16.9-1951 and ASA B16.9-1958. With the subgroup now designated Subcommittee No. 6 (later Subcommittee F), further revisions were begun to clarify the intent of the standard, to add angularity tolerances, and to include fittings of different types (long radius reducing elbows and crosses) and smaller sizes (NPS ¼ and ½). This revision was published as ASA B16.9-1964 after ASA approval.

After reorganization of ASA, first as the United States of America Standards Institute (USASI), then as the American National Standards Institute (ANSI), with the Sectional Committee being redesignated as an American National Standards Committee, another revision increasing the size range to NPS 48 and revising the text for clarity was approved and published as ANSI B16.9-1971.

In 1975, Subcommittee F began a major revision to bring the standard up to date with current practice and usage. Common fractions were expressed as decimals (but without intending higher precision) and metric dimensional equivalents were added. Provisions for step-wise change of radius for NPS ¾ long radius elbows and 180 deg. returns were introduced. Following Standards Committee, cosecretariat, and ANSI approval, the revision was published as ANSI B16.9-1978. It was updated by a corrective addendum, B16.9a-1981, issued in February 1982.

In 1982, American National Standards Committee B16 was reorganized as an ASME Committee operating under procedures accredited by ANSI. In this edition, the text has been revised and inch dimensions are established as the standard. Following approval by the Standards Committee and ASME, approval as an American National Standard was given by ANSI on November 12, 1986 with the new designation ASME/ANSI B16.9-1986.

In 1991 the Subcommittee reviewed the document and made a number of revisions. Dimensions for short pattern lap joints were also added to this 1993 Edition of the Standard.

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

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CONTENTS

FACTORY-MADE WROUGHT STEEL BUTTWELDING FITTINGS

1 SCOPE

1.1 General

This Standard covers overall dimensions, tolerances, ratings, testing, and markings for wrought carbon and alloy steel factory-made buttwelding fittings of NPS ½ through 48. It covers fittings of any producible wall thickness.

1.2 Exclusions

This Standard does not cover low pressure corrosion resistant buttwelding fittings. See MSS SP-43, Wrought Stainless Steel Butt-Welding Fittings.

1.3 Partial Compliance Fittings

Fittings may be made to special dimensions, sizes, shapes, tolerances, or of wrought materials other than those covered by this Standard by agreement between the manufacturer and the purchaser. When such fittings meet all other stipulations of this Standard, they shall be considered as being in partial compliance therewith, provided they are appropriately marked. (See para. 4.4.)

1.4 Fabricated Fittings

Fabricated laterals and other fittings employing circumferential or intersection welds are considered pipe fabrication, and shall be manufactured in accordance with the applicable section of ASME B31, Code for Pressure Piping.

1.5 Standard Units

The inch is the standard unit for linear dimensions. Values in millimeters are for information and reference only. See Annex A.

NOTES:

(1) Tolerance values shown in Table 1 in decimal inches are common fractions rounded as follows:

0.03 = 1/32	0.12 = 1/8
0.06 = 1/16	0.16 = 5/32
0.09 = 3/32	0.19 = 3/16
0.22 = 7/32	0.38 = 3/8
0.25 = 1/4	

(2) Dimensions in Tables 2 through 9 are common fractions or dimensions from ANSI/ASME B36.10M, rounded to two-place decimal fractions.

1.6 References

1.6.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Annex B, 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 B. A product made in conformance with a prior edition of reference standards and in all other respects conforming to this Standard will be considered to be in conformance.

1.6.2 Codes and Regulations. A fitting used under the jurisdiction of the ASME Boiler and Pressure Vessel Code, the ASME Code for Pressure Piping, or a governmental regulation is subject to any limitation of that code or regulation. This includes any maximum temperature limitation, or rule governing the use of a material at low temperature.

1.7 Service Conditions

Criteria for selection of fitting types and materials suitable for particular fluid service are not within the scope of this Standard.

1.8 Welding

Installation welding requirements are outside the scope of this Standard. Installation welding shall be done in accordance with the applicable piping code or regulation covering the piping system into which the fittings are installed.

2 PRESSURE RATINGS

2.1 Basis of Ratings

The allowable pressure ratings for fittings designed in accordance with this Standard may be calculated as for straight seamless pipe of equivalent material (as shown by comparison of composition and mechanical properties in the respective material specifications) in accordance with the rules established in the applicable sections of ASME B31, Code for Pressure Piping. For the calculation, applicable data for the NPS, wall thickness (or schedule number), and material equivalent to that of the fitting material shall be used. NPS, wall thickness (or schedule number), and material identity on the fittings are in lieu of pressure rating markings.

2.2 Design of Fittings

The design of fittings shall be established by mathematical analyses contained in nationally recognized pressure vessel or piping codes or at the manufacturer's option by proof testing in accordance with Section 9 of this Standard. In order to meet design or manufacturing requirements it is expected that some portion of formed fittings may have to be thicker than the pipe wall with which the fitting is intended to be used. The mathematical analyses, if used, may take into account such thicker sections. Records of mathematical analysis and/or successful proof test data shall be available at the manufacturer's facility for inspection by the purchaser.

3 SIZE

The size of fittings in Tables 1 through 9 is identified by the corresponding nominal pipe size (NPS) as defined in ANSI/ASME B36.10M.

4 MARKING

4.1 Standard Marking

Each fitting shall be permanently marked to show the following:

(*a*) manufacturer's name or trademark;

(*b*) material and product identification (ASTM or ASME grade symbol). Conformance to this standard is indicated by the prefix "WP" in the grade symbol;

(*c*) schedule number or nominal wall thickness designation;

(*d*) NPS.

4.2 Exceptions

Where the size of the fitting does not permit complete marking, the identification marks may be omitted in reverse of the order presented above.

4.3 Depth of Stamping

Where steel stamps are used, care shall be taken so that the marking is not deep enough or sharp enough to cause cracks or to reduce the wall thickness of the fitting below the minimum allowed.

4.4 Partial Compliance Fittings

Fittings meeting all requirements of ASTM A 234, A 403, or A 420 except for dimensions, sizes, shapes, or tolerances shall be identified by the marking symbol of the specification followed by the applicable Supplementary Requirement number thereof. Fittings in partial compliance with the requirements of the specification shall not use the marking prefix "WP," and shall be identified as agreed upon between manufacturer and purchaser.

5 MATERIAL

Wrought fittings covered by this Standard shall be in accordance with ASTM A 234, A 403, A 420, or the corresponding ASME standard except as provided in para. 1.3. The term *wrought* denotes fittings made of pipe, tubing, plate, or forgings. Fittings made from block forgings may only be supplied subject to agreement between manufacturer and purchaser. Such fittings need not meet the requirements of Section 7, Surface Contours.

6 FITTINGS DIMENSIONS

6.1 General

This Standard provides for a fixed position for the welding ends with reference to either the center line of the fittings or the overall dimensions. Dimensional standards for these fittings will be found in Tables 2 through 9 and Tables A2 through A9 of Annex A.

6.2 Special Dimensions

For applications where fatigue loading is a concern, required minimum dimensions shall be furnished by the purchaser.

7 SURFACE CONTOURS

Where adjacent openings in fittings are not in parallel planes, they shall be joined by a circular arc on the external surfaces. The arc may be terminated in tangents.

8 END PREPARATION

The standard welding bevels and root face are shown in Fig. 1. Transitions from the welding bevel to outside surface of the fitting and from the root face to the inside surface of the fitting lying within the maximum envelope shown in Fig. 2 are at the manufacturer's option except as covered in Note (5) of Fig. 2 or unless otherwise specifically ordered.

9 DESIGN PROOF TEST

9.1 Required Tests

Proof tests shall be made as set forth herein when the manufacturer chooses proof testing to qualify the fitting design. Unless otherwise agreed upon between manufacturer and purchaser, the only required type of proof test is a bursting strength test.

9.2 Test Assembly

9.2.1 Representative Components. Fittings that are representative of production and selected for test shall be identified as to material, grade, and lot, including heat treatment. They shall be inspected for dimensional compliance to this Standard.

9.2.2 Other Components. Straight seamless or welded pipe sections whose calculated bursting strength is at least as great as the proof test pressure as calculated in para. 9.3 shall be welded to each end of the fitting to be tested. Any internal misalignment greater than 0.06 in. (1.6 mm) shall be reduced by taper boring at a slope not over 1:3. Length of pipe sections for closures shall be as follows.

(*a*) Minimum length of pipe shall be one pipe O.D. for NPS 14 and smaller.

(*b*) Minimum length of pipe shall be one-half pipe O.D. for NPS greater than 14 in.

9.3 Test Procedure

Test fluid shall be water or other liquid used for hydrostatic testing. Hydrostatic pressure shall be applied to the assembly. The test is successful if the assembly withstands, without rupture, 105% of the computed proof test pressure defined below.

$$P = \frac{2St}{D}$$

where

P = computed proof of test pressure
S = actual tensile strength of the test fitting, determined on a specimen representative of the test fitting, which shall meet the tensile strength requirements of the applicable material of para. 5.0
t = nominal pipe wall thickness of the pipe that the fitting marking identifies
D = specified outside diameter of pipe

9.4 Applicability of Test Results

It is not necessary to conduct an individual test of fittings with all combinations of sizes, wall thicknesses, and materials. A successful proof test on one representative fitting may represent others to the extent described herein.

9.4.1 Size Range. One test fitting may be used to qualify similarly proportioned fittings with an NPS range from one-half to twice that for the tested fitting. The test of a non-reducing fitting qualifies reducing fittings of the same pattern. The test of a reducing fitting qualifies reductions to smaller sizes.

9.4.2 Thickness Range. One test fitting may be used to qualify similarly proportioned fittings with t/D ranges from one-half to three times that for the tested fitting.

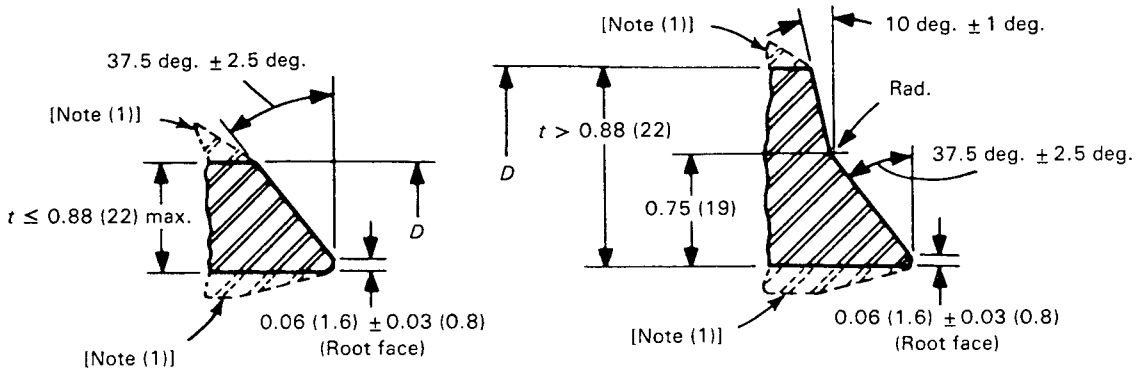
9.4.3 Material Grades. The pressure retaining capacity of a geometrically identical fitting made of various grades of steel will be directly proportional to the tensile properties of the various grades. Therefore, it is necessary to test only a single material grade in a representative fitting to prove the design of the fitting.

10 PRODUCTION TESTS

Hydrostatic testing of wrought fittings is not required by this Standard. All fittings shall be capable of withstanding, without leakage or impairment of serviceability, a hydrostatic test pressure required by the applicable piping code for seamless pipe of material equivalent to the fitting material and of the NPS and wall thickness the fitting marking identifies.

11 TOLERANCES

Tolerances for fittings are shown in Tables 1 and A1, and apply to the nominal dimensions given in Tables 2 through 9 and A2 through A9. Where given in the tables, the minimum and maximum dimensions are based on these tolerances. The listings with decimals do not imply precision measurement such as use of vernier, micrometer, electronic readout equipment, etc.



(a) Plain Bevel

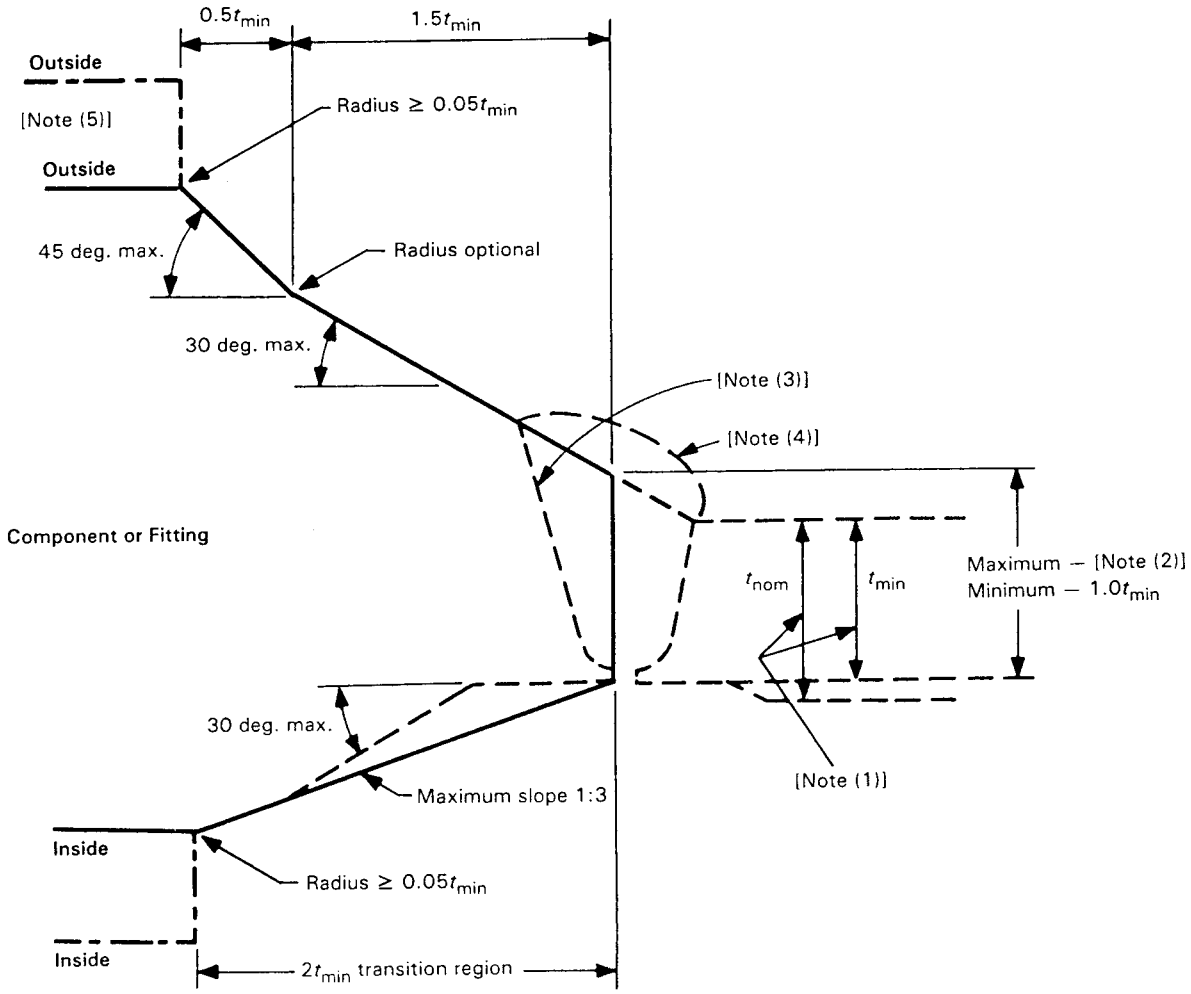
(b) Compound Bevel

Nominal Wall Thickness t	End Preparation
Less than x [Note (2)]	Cut square or slightly chamfer, at manufacturer's option.
x to 0.88 incl. (22) [Note (2)]	Plain bevel as in sketch (a) above.
More than 0.88 (22)	Compound bevel as in sketch (b) above.

GENERAL NOTES:
(1) Dimensions in parentheses are in millimeters.
(2) Other dimensions are in inches.

NOTES:
(1) See Section 8 and Fig. 2 for transition contours.
(2) x = 0.19 (5) for carbon steel or ferritic alloy steel and 0.12 (4) for austenitic alloy steel.

FIG. 1 WELDING BEVELS AND ROOT FACE



NOTES:
(1) The value of t_{min} is whichever of the following is applicable:
  (a) the minimum ordered wall thickness of the pipe;
  (b) 0.875 times the nominal wall thickness of pipe ordered to a pipe schedule wall thickness that has an undertolerance of 12.5%.
(2) The maximum thickness at the end of the component is:
  (a) the greater of (t_{min} + 0.16 in.) or 1.15t_{min} when ordered on a minimum wall basis;
  (b) the greater of (t_{min} + 0.16 in.) or 1.10t_{nom} when ordered on a nominal wall basis.
(3) Weld bevel shown is for illustration only.
(4) The weld reinforcement permitted by applicable code may lie outside the maximum envelope.
(5) Where transitions using maximum slope do not intersect outside surface within the transition region, as shown by phantom outline, maximum slopes shown shall be used. Alternately, radii lying within the envelope may be used.

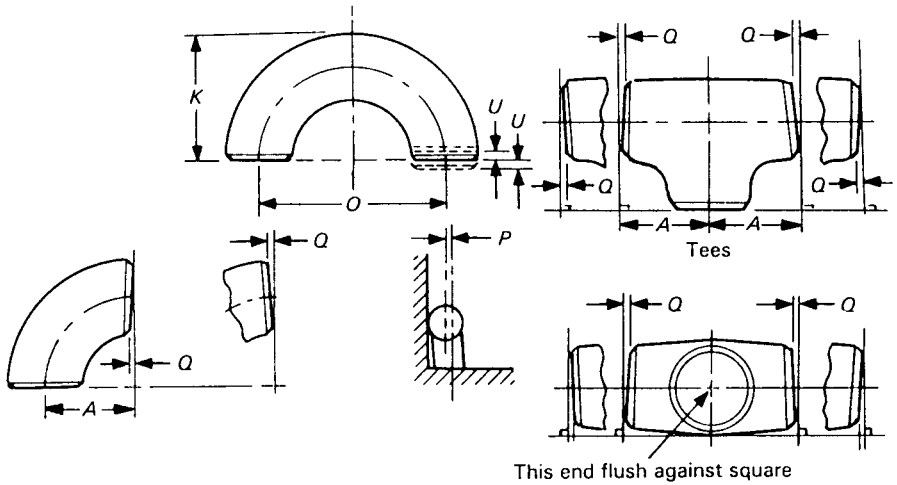
FIG. 2 MAXIMUM ENVELOPE FOR WELDING END TRANSITIONS

TABLE 1 TOLERANCES

All Fittings				90 deg. and 45 deg. Elbows and Tees	Reducers and Lap Joint Stub Ends	Caps	180 deg. Returns			Lap Joint Stub Ends		
Nominal Pipe Size (NPS)	Outside Diameter at Bevel (1),(2) *D*	Inside Diameter at End (1),(3),(4)	Wall Thickness (3) *t*	Center-to-End Dimension *A,B,C,M*	Overall Length *F,H*	Overall Length *E*	Center-to-Center Dimension *O*	Back-to-Face Dimension *K*	Alignment of Ends *U*	Outside Diameter of Lap *G*	Fillet Radius of Lap *R*	Outside Diameter of Barrel
1/2 to 2 1/2	+0.06 −0.03	0.03	Not less than 87.5% of nominal thickness	0.06	0.06	0.12	0.25	0.25	0.03	+0 −0.03	+0 −0.03	See Table 7 for limiting dimensions
3 to 3 1/2	0.06	0.06		0.06	0.06	0.12	0.25	0.25	0.03	+0 −0.03	+0 −0.03	
4	0.06	0.06		0.06	0.06	0.12	0.25	0.25	0.03	+0 −0.03	+0 −0.06	
5 to 8	+0.09 −0.06	0.06		0.06	0.06	0.25	0.25	0.25	0.03	+0 −0.03	+0 −0.06	
10 to 18	+0.16 −0.12	0.12		0.09	0.09	0.25	0.38	0.25	0.06	+0 −0.06	+0 −0.06	
20 to 24	+0.25 −0.19	0.19		0.09	0.09	0.25	0.38	0.25	0.06	+0 −0.06	+0 −0.06	
26 to 30	+0.25 0.19	0.19		0.12	0.19	0.38	. . .	. . .	. . .	. . .	. . .	
32 to 48	+0.25 0.19	0.19		0.19	0.19	0.38	. . .	. . .	. . .	. . .	. . .	

TABLE 1 TOLERANCES (CONT'D)

Nominal Pipe Size (NPS)	Angularity Tol.	
	Off Angle *Q*	Off Plane *P*
1/2 to 4	0.03	0.06
5 to 8	0.06	0.12
10 to 12	0.09	0.19
14 to 16	0.09	0.25
18 to 24	0.12	0.38
26 to 30	0.19	0.38
32 to 42	0.19	0.50
44 to 48	0.19	0.75



GENERAL NOTE: Dimensions are in inches. Tolerances are equal plus and minus except as noted.

NOTES:
(1) Out-of-round is the sum of absolute values of plus and minus tolerance.
(2) This tolerance may be exceeded in localized areas of formed fittings where increased wall thickness is required to meet design requirements of para. 2.2.
(3) The inside diameter and the nominal wall thicknesses at ends are to be specified by the purchaser.
(4) Unless otherwise specified by the purchaser, these tolerances apply to the nominal inside diameter, which equals the difference between the nominal outside diameter and twice the nominal wall thickness.

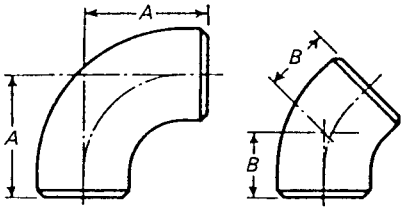


TABLE 2 DIMENSIONS OF LONG RADIUS ELBOWS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*	Center-to-End	
		90 deg. Elbows *A*	45 deg. Elbows *B*
1/2	0.84	1.50	0.62
3/4 (1)	1.05	1.50	0.75
1	1.32	1.50	0.88
1 1/4	1.66	1.88	1.00
1 1/2	1.90	2.25	1.12
2	2.38	3.00	1.38
2 1/2	2.88	3.75	1.75
3	3.50	4.50	2.00
3 1/2	4.00	5.25	2.25
4	4.50	6.00	2.50
5	5.56	7.50	3.12
6	6.62	9.00	3.75
8	8.62	12.00	5.00
10	10.75	15.00	6.25
12	12.75	18.00	7.50
14	14.00	21.00	8.75
16	16.00	24.00	10.00
18	18.00	27.00	11.25
20	20.00	30.00	12.50
22	22.00	33.00	13.50
24	24.00	36.00	15.00
26	26.00	39.00	16.00
28	28.00	42.00	17.25
30	30.00	45.00	18.50
32	32.00	48.00	19.75
34	34.00	51.00	21.00
36	36.00	54.00	22.25
38	38.00	57.00	23.62
40	40.00	60.00	24.88
42	42.00	63.00	26.00
44	44.00	66.00	27.38
46	46.00	69.00	28.62
48	48.00	72.00	29.88

GENERAL NOTE: Dimensions are in inches.

NOTE:
(1) *A* and *B* dimensions of 1.12 in. and 0.44 in. respectively may be furnished for NPS 3/4 at the manufacturer's option.

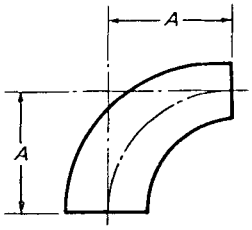


TABLE 3 DIMENSIONS OF LONG RADIUS REDUCING ELBOWS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End A	Nominal Pipe Size (NPS)	Outside Diameter at Bevel D		Center-to-End A
	Large End	Small End			Large End	Small End	
2 × 1 1/2	2.38	1.90	3.00	10 × 8	10.75	8.62	15.00
2 × 1 1/4	2.38	1.66	3.00	10 × 6	10.75	6.62	15.00
2 × 1	2.38	1.32	3.00	10 × 5	10.75	5.56	15.00
2 1/2 × 2	2.88	2.38	3.75	12 × 10	12.75	10.75	18.00
2 1/2 × 1 1/2	2.88	1.90	3.75	12 × 8	12.75	8.62	18.00
2 1/2 × 1 1/4	2.88	1.66	3.75	12 × 6	12.75	6.62	18.00
3 × 2 1/2	3.50	2.88	4.50	14 × 12	14.00	12.75	21.00
3 × 2	3.50	2.38	4.50	14 × 10	14.00	10.75	21.00
3 × 1 1/2	3.50	1.90	4.50	14 × 8	14.00	8.62	21.00
3 1/2 × 3	4.00	3.50	5.25	16 × 14	16.00	14.00	24.00
3 1/2 × 2 1/2	4.00	2.88	5.25	16 × 12	16.00	12.75	24.00
3 1/2 × 2	4.00	2.38	5.25	16 × 10	16.00	10.75	24.00
4 × 3 1/2	4.50	4.00	6.00	18 × 16	18.00	16.00	27.00
4 × 3	4.50	3.50	6.00	18 × 14	18.00	14.00	27.00
4 × 2 1/2	4.50	2.88	6.00	18 × 12	18.00	12.75	27.00
4 × 2	4.50	2.38	6.00	18 × 10	18.00	10.75	27.00
5 × 4	5.56	4.50	7.50	20 × 18	20.00	18.00	30.00
5 × 3 1/2	5.56	4.00	7.50	20 × 16	20.00	16.00	30.00
5 × 3	5.56	3.50	7.50	20 × 14	20.00	14.00	30.00
5 × 2 1/2	5.56	2.88	7.50	20 × 12	20.00	12.75	30.00
6 × 5	6.62	5.56	9.00	20 × 10	20.00	10.75	30.00
6 × 4	6.62	4.50	9.00	24 × 22	24.00	22.00	36.00
6 × 3 1/2	6.62	4.00	9.00	24 × 20	24.00	20.00	36.00
6 × 3	6.62	3.50	9.00	24 × 18	24.00	18.00	36.00
8 × 6	8.62	6.62	12.00	24 × 16	24.00	16.00	36.00
8 × 5	8.62	5.56	12.00	24 × 14	24.00	14.00	36.00
8 × 4	8.62	4.50	12.00	24 × 12	24.00	12.75	36.00

GENERAL NOTE: Dimensions are in inches.

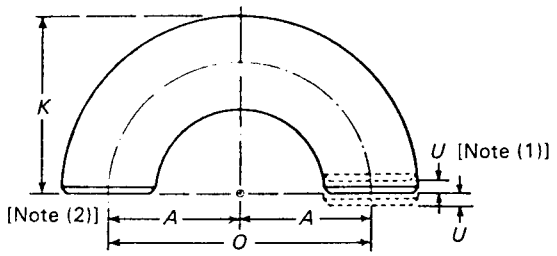


TABLE 4 DIMENSIONS OF LONG RADIUS RETURNS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*	Center-to-Center *O*	Back-to-Face *K*
1/2	0.84	3.00	1.88
3/4 (3)	1.05	3.00	2.00
1	1.32	3.00	2.19
1 1/4	1.66	3.75	2.75
1 1/2	1.90	4.50	3.25
2	2.38	6.00	4.19
2 1/2	2.88	7.50	5.19
3	3.50	9.00	6.25
3 1/2	4.00	10.50	7.25
4	4.50	12.00	8.25
5	5.56	15.00	10.31
6	6.62	18.00	12.31
8	8.62	24.00	16.31
10	10.75	30.00	20.38
12	12.75	36.00	24.38
14	14.00	42.00	28.00
16	16.00	48.00	32.00
18	18.00	54.00	36.00
20	20.00	60.00	40.00
22	22.00	66.00	44.00
24	24.00	72.00	48.00

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) See Table 1 for tolerance for alignment of ends, *U*.
(2) Dimension *A* is equal to one-half of dimension *O*.
(3) *O* and *K* dimensions of 2.25 in. and 1.69 in. respectively may be furnished for NPS 3/4 at the manufacturer's option.

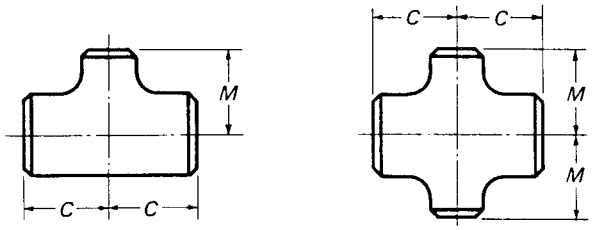


TABLE 5 DIMENSIONS OF STRAIGHT TEES AND CROSSES

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*	Center-to-End	
		Run *C*	Outlet (1),(2) *M*
1/2	0.84	1.00	1.00
3/4	1.05	1.12	1.12
1	1.32	1.50	1.50
1 1/4	1.66	1.88	1.88
1 1/2	1.90	2.25	2.25
2	2.38	2.50	2.50
2 1/2	2.88	3.00	3.00
3	3.50	3.38	3.38
3 1/2	4.00	3.75	3.75
4	4.50	4.12	4.12
5	5.56	4.88	4.88
6	6.62	5.62	5.62
8	8.62	7.00	7.00
10	10.75	8.50	8.50
12	12.75	10.00	10.00
14	14.00	11.00	11.00
16	16.00	12.00	12.00
18	18.00	13.50	13.50
20	20.00	15.00	15.00
22	22.00	16.50	16.50
24	24.00	17.00	17.00
26	26.00	19.50	19.50
28	28.00	20.50	20.50
30	30.00	22.00	22.00
32	32.00	23.50	23.50
34	34.00	25.00	25.00
36	36.00	26.50	26.50
38	38.00	28.00	28.00
40	40.00	29.50	29.50
42	42.00	30.00	28.00
44	44.00	32.00	30.00
46	46.00	33.50	31.50
48	48.00	35.00	33.00

GENERAL NOTE: Dimensions are in inches.

NOTES:
(1) Outlet dimension *M* for NPS 26 and larger is recommended but not required.
(2) Dimensions applicable to crosses NPS 24 and smaller.

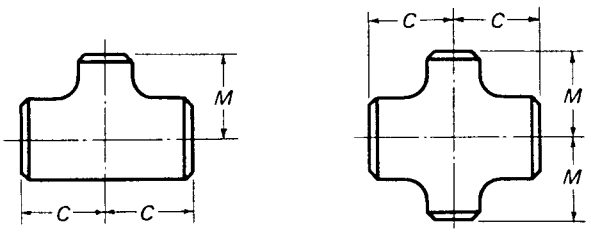


TABLE 6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		Center-to-End	
	Run	Outlet	Run *C*	Outlet (1) *M*		Run	Outlet	Run *C*	Outlet (1) *M*
1/2 × 1/2 × 3/8	0.84	0.68	1.00	1.00	6 × 6 × 5	6.62	5.56	5.62	5.38
1/2 × 1/2 × 1/4	0.84	0.54	1.00	1.00	6 × 6 × 4	6.62	4.50	5.62	5.12
3/4 × 3/4 × 1/2	1.05	0.84	1.12	1.12	6 × 6 × 3 1/2	6.62	4.00	5.62	5.00
3/4 × 3/4 × 3/8	1.05	0.68	1.12	1.12	6 × 6 × 3	6.62	3.50	5.62	4.88
1 × 1 × 3/4	1.32	1.05	1.50	1.50	6 × 6 × 2 1/2	6.62	2.88	5.62	4.75
1 × 1 × 1/2	1.32	0.84	1.50	1.50	8 × 8 × 6	8.62	6.62	7.00	6.62
1 1/4 × 1 1/4 × 1	1.66	1.32	1.88	1.88	8 × 8 × 5	8.62	5.56	7.00	6.38
1 1/4 × 1 1/4 × 3/4	1.66	1.05	1.88	1.88	8 × 8 × 4	8.62	4.50	7.00	6.12
1 1/4 × 1 1/4 × 1/2	1.66	0.84	1.88	1.88	8 × 8 × 3 1/2	8.62	4.00	7.00	6.00
1 1/2 × 1 1/2 × 1 1/4	1.90	1.66	2.25	2.25	10 × 10 × 8	10.75	8.62	8.50	8.00
1 1/2 × 1 1/2 × 1	1.90	1.32	2.25	2.25	10 × 10 × 6	10.75	6.62	8.50	7.62
1 1/2 × 1 1/2 × 3/4	1.90	1.05	2.25	2.25	10 × 10 × 5	10.75	5.56	8.50	7.50
1 1/2 × 1 1/2 × 1/2	1.90	0.84	2.25	2.25	10 × 10 × 4	10.75	4.50	8.50	7.25
2 × 2 × 1 1/2	2.38	1.90	2.50	2.38	12 × 12 × 10	12.75	10.75	10.00	9.50
2 × 2 × 1 1/4	2.38	1.66	2.50	2.25	12 × 12 × 8	12.75	8.62	10.00	9.00
2 × 2 × 1	2.38	1.32	2.50	2.00	12 × 12 × 6	12.75	6.62	10.00	8.62
2 × 2 × 3/4	2.38	1.05	2.50	1.75	12 × 12 × 5	12.75	5.56	10.00	8.50
2 1/2 × 2 1/2 × 2	2.88	2.38	3.00	2.75	14 × 14 × 12	14.00	12.75	11.00	10.62
2 1/2 × 2 1/2 × 1 1/2	2.88	1.90	3.00	2.62	14 × 14 × 10	14.00	10.75	11.00	10.12
2 1/2 × 2 1/2 × 1 1/4	2.88	1.66	3.00	2.50	14 × 14 × 8	14.00	8.62	11.00	9.75
2 1/2 × 2 1/2 × 1	2.88	1.32	3.00	2.25	14 × 14 × 6	14.00	6.62	11.00	9.38
3 × 3 × 2 1/2	3.50	2.88	3.38	3.25	16 × 16 × 14	16.00	14.00	12.00	12.00
3 × 3 × 2	3.50	2.38	3.38	3.00	16 × 16 × 12	16.00	12.75	12.00	11.62
3 × 3 × 1 1/2	3.50	1.90	3.38	2.88	16 × 16 × 10	16.00	10.75	12.00	11.12
3 × 3 × 1 1/4	3.50	1.66	3.38	2.75	16 × 16 × 8	16.00	8.62	12.00	10.75
3 1/2 × 3 1/2 × 3	4.00	3.50	3.75	3.62	16 × 16 × 6	16.00	6.62	12.00	10.38
3 1/2 × 3 1/2 × 2 1/2	4.00	2.88	3.75	3.50	18 × 18 × 16	18.00	16.00	13.50	13.00
3 1/2 × 3 1/2 × 2	4.00	2.38	3.75	3.25	18 × 18 × 14	18.00	14.00	13.50	13.00
3 1/2 × 3 1/2 × 1 1/2	4.00	1.90	3.75	3.12	18 × 18 × 12	18.00	12.75	13.50	12.62
4 × 4 × 3 1/2	4.50	4.00	4.12	4.00	18 × 18 × 10	18.00	10.75	13.50	12.12
4 × 4 × 3	4.50	3.50	4.12	3.88	18 × 18 × 8	18.00	8.62	13.50	11.75
4 × 4 × 2 1/2	4.50	2.88	4.12	3.75	20 × 20 × 18	20.00	18.00	15.00	14.50
4 × 4 × 2	4.50	2.38	4.12	3.50	20 × 20 × 16	20.00	16.00	15.00	14.00
4 × 4 × 1 1/2	4.50	1.90	4.12	3.38	20 × 20 × 14	20.00	14.00	15.00	14.00
5 × 5 × 4	5.56	4.50	4.88	4.62	20 × 20 × 12	20.00	12.75	15.00	13.62
5 × 5 × 3 1/2	5.56	4.00	4.88	4.50	20 × 20 × 10	20.00	10.75	15.00	13.12
5 × 5 × 3	5.56	3.50	4.88	4.38	20 × 20 × 8	20.00	8.62	15.00	12.75
5 × 5 × 2 1/2	5.56	2.88	4.88	4.25	22 × 22 × 20	22.00	20.00	16.50	16.00
5 × 5 × 2	5.56	2.38	4.88	4.12	22 × 22 × 18	22.00	18.00	16.50	15.50

(Notes follow at end of table)

TABLE 6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		Center-to-End	
	Run	Outlet	Run *C*	Outlet (1) *M*		Run	Outlet	Run *C*	Outlet (1) *M*
22 x 22 x 16	22.00	16.00	16.50	15.00	34 x 34 x 24	34.00	24.00	25.00	23.00
22 x 22 x 14	22.00	14.00	16.50	15.00	34 x 34 x 22	34.00	22.00	25.00	22.50
22 x 22 x 12	22.00	12.75	16.50	14.62	34 x 34 x 20	34.00	20.00	25.00	22.00
22 x 22 x 10	22.00	10.75	16.50	14.12	34 x 34 x 18	34.00	18.00	25.00	21.50
					34 x 34 x 16	34.00	16.00	25.00	21.00
24 x 24 x 22	24.00	22.00	17.00	17.00					
24 x 24 x 20	24.00	20.00	17.00	17.00	36 x 36 x 34	36.00	34.00	26.50	26.00
24 x 24 x 18	24.00	18.00	17.00	16.50	36 x 36 x 32	36.00	32.00	26.50	25.50
24 x 24 x 16	24.00	16.00	17.00	16.00	36 x 36 x 30	36.00	30.00	26.50	25.00
24 x 24 x 14	24.00	14.00	17.00	16.00	36 x 36 x 28	36.00	28.00	26.50	24.50
24 x 24 x 12	24.00	12.75	17.00	15.62	36 x 36 x 26	36.00	26.00	26.50	24.50
24 x 24 x 10	24.00	10.75	17.00	15.12	36 x 36 x 24	36.00	24.00	26.50	24.00
					36 x 36 x 22	36.00	22.00	26.50	23.50
26 x 26 x 24	26.00	24.00	19.50	19.00	36 x 36 x 20	36.00	20.00	26.50	23.00
26 x 26 x 22	26.00	22.00	19.50	18.50	36 x 36 x 18	36.00	18.00	26.50	22.50
26 x 26 x 20	26.00	20.00	19.50	18.00	36 x 36 x 16	36.00	16.00	26.50	22.00
26 x 26 x 18	26.00	18.00	19.50	17.50					
26 x 26 x 16	26.00	16.00	19.50	17.00	38 x 38 x 36	38.00	36.00	28.00	28.00
26 x 26 x 14	26.00	14.00	19.50	17.00	38 x 38 x 34	38.00	34.00	28.00	27.50
26 x 26 x 12	26.00	12.75	19.50	16.62	38 x 38 x 32	38.00	32.00	28.00	27.00
					38 x 38 x 30	38.00	30.00	28.00	26.50
28 x 28 x 26	28.00	26.00	20.50	20.50	38 x 38 x 28	38.00	28.00	28.00	25.50
28 x 28 x 24	28.00	24.00	20.50	20.00	38 x 38 x 26	38.00	26.00	28.00	25.50
28 x 28 x 22	28.00	22.00	20.50	19.50	38 x 38 x 24	38.00	24.00	28.00	25.00
28 x 28 x 20	28.00	20.00	20.50	19.00	38 x 38 x 22	38.00	22.00	28.00	24.50
28 x 28 x 18	28.00	18.00	20.50	18.50	38 x 38 x 20	38.00	20.00	28.00	24.00
28 x 28 x 16	28.00	16.00	20.50	18.00	38 x 38 x 18	38.00	18.00	28.00	23.50
28 x 28 x 14	28.00	14.00	20.50	18.00					
28 x 28 x 12	28.00	12.75	20.50	17.62	40 x 40 x 38	40.00	38.00	29.50	29.50
					40 x 40 x 36	40.00	36.00	29.50	29.00
30 x 30 x 28	30.00	28.00	22.00	21.50	40 x 40 x 34	40.00	34.00	29.50	28.50
30 x 30 x 26	30.00	26.00	22.00	21.50	40 x 40 x 32	40.00	32.00	29.50	28.00
30 x 30 x 24	30.00	24.00	22.00	21.00	40 x 40 x 30	40.00	30.00	29.50	27.50
30 x 30 x 22	30.00	22.00	22.00	20.50	40 x 40 x 28	40.00	28.00	29.50	26.50
30 x 30 x 20	30.00	20.00	22.00	20.00	40 x 40 x 26	40.00	26.00	29.50	26.50
30 x 30 x 18	30.00	18.00	22.00	19.50	40 x 40 x 24	40.00	24.00	29.50	26.00
30 x 30 x 16	30.00	16.00	22.00	19.00	40 x 40 x 22	40.00	22.00	29.50	25.50
30 x 30 x 14	30.00	14.00	22.00	19.00	40 x 40 x 20	40.00	20.00	29.50	25.00
30 x 30 x 12	30.00	12.75	22.00	18.62	40 x 40 x 18	40.00	18.00	29.50	24.50
30 x 30 x 10	30.00	10.75	22.00	18.12					
					42 x 42 x 40	42.00	40.00	30.00	28.00
32 x 32 x 30	32.00	30.00	23.50	23.00	42 x 42 x 38	42.00	38.00	30.00	28.00
32 x 32 x 28	32.00	28.00	23.50	22.50	42 x 42 x 36	42.00	36.00	30.00	28.00
32 x 32 x 26	32.00	26.00	23.50	22.50	42 x 42 x 34	42.00	34.00	30.00	28.00
32 x 32 x 24	32.00	24.00	23.50	22.00	42 x 42 x 32	42.00	32.00	30.00	28.00
32 x 32 x 22	32.00	22.00	23.50	21.50	42 x 42 x 30	42.00	30.00	30.00	28.00
32 x 32 x 20	32.00	20.00	23.50	21.00	42 x 42 x 28	42.00	28.00	30.00	27.50
32 x 32 x 18	32.00	18.00	23.50	20.50	42 x 42 x 26	42.00	26.00	30.00	27.50
32 x 32 x 16	32.00	16.00	23.50	20.00	42 x 42 x 24	42.00	24.00	30.00	26.00
32 x 32 x 14	32.00	14.00	23.50	20.00	42 x 42 x 22	42.00	22.00	30.00	26.00
34 x 34 x 32	34.00	32.00	25.00	24.50	42 x 42 x 20	42.00	20.00	30.00	26.00
34 x 34 x 30	34.00	30.00	25.00	24.00	42 x 42 x 18	42.00	18.00	30.00	25.50
34 x 34 x 28	34.00	28.00	25.00	23.50	42 x 42 x 16	42.00	16.00	30.00	25.00
34 x 34 x 26	34.00	26.00	25.00	23.50					

(Table 6 continues on next page)

TABLE 6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		Center-to-End	
	Run	Outlet	Run *C*	Outlet (1) *M*
44 x 44 x 42	44.00	42.00	32.00	30.00
44 x 44 x 40	44.00	40.00	32.00	29.50
44 x 44 x 38	44.00	38.00	32.00	29.00
44 x 44 x 36	44.00	36.00	32.00	28.50
44 x 44 x 34	44.00	34.00	32.00	28.50
44 x 44 x 32	44.00	32.00	32.00	28.00
44 x 44 x 30	44.00	30.00	32.00	28.00
44 x 44 x 28	44.00	28.00	32.00	27.50
44 x 44 x 26	44.00	26.00	32.00	27.50
44 x 44 x 24	44.00	24.00	32.00	27.50
44 x 44 x 22	44.00	22.00	32.00	27.00
44 x 44 x 20	44.00	20.00	32.00	27.00
46 x 46 x 44	46.00	44.00	33.50	31.50
46 x 46 x 42	46.00	42.00	33.50	31.00
46 x 46 x 40	46.00	40.00	33.50	30.50
46 x 46 x 38	46.00	38.00	33.50	30.00
46 x 46 x 36	46.00	36.00	33.50	30.00
46 x 46 x 34	46.00	34.00	33.50	29.50
46 x 46 x 32	46.00	32.00	33.50	29.50
46 x 46 x 30	46.00	30.00	33.50	29.00
46 x 46 x 28	46.00	28.00	33.50	29.00
46 x 46 x 26	46.00	26.00	33.50	29.00
46 x 46 x 24	46.00	24.00	33.50	28.50
46 x 46 x 22	46.00	22.00	33.50	28.50
48 x 48 x 46	48.00	46.00	35.00	33.00
48 x 48 x 44	48.00	44.00	35.00	33.00
48 x 48 x 42	48.00	42.00	35.00	32.00
48 x 48 x 40	48.00	40.00	35.00	32.00
48 x 48 x 38	48.00	38.00	35.00	32.00
48 x 48 x 36	48.00	36.00	35.00	31.00
48 x 48 x 34	48.00	34.00	35.00	31.00
48 x 48 x 32	48.00	32.00	35.00	31.00
48 x 48 x 30	48.00	30.00	35.00	30.00
48 x 48 x 28	48.00	28.00	35.00	30.00
48 x 48 x 26	48.00	26.00	35.00	30.00
48 x 48 x 24	48.00	24.00	35.00	29.00
48 x 48 x 22	48.00	22.00	35.00	29.00

GENERAL NOTE: Dimensions are in inches.

NOTE:
(1) Outlet dimension *M* for run sizes 14 and larger is recommended but not required.

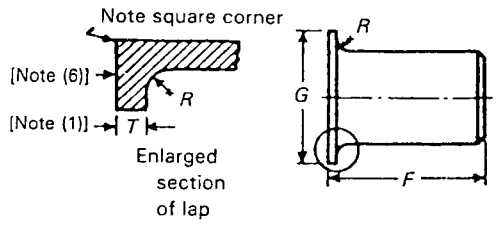


TABLE 7 DIMENSIONS OF LAP JOINT STUB ENDS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*	Long Pattern Length (2),(3),(7) *F*	Short Pattern Length (2),(3),(7) *F*	Radius of Fillet (4) *R*	Diameter of Lap (5) *G*	Outside Diameter of Barrel	
						Max.	Min.
1/2	0.84	3.00	2.00	0.12	1.38	0.896	0.809
3/4	1.05	3.00	2.00	0.12	1.69	1.106	1.019
1	1.32	4.00	2.00	0.12	2.00	1.376	1.284
1 1/4	1.66	4.00	2.00	0.19	2.50	1.716	1.629
1 1/2	1.90	4.00	2.00	0.25	2.88	1.965	1.869
2	2.38	6.00	2.50	0.31	3.62	2.456	2.344
2 1/2	2.88	6.00	2.50	0.31	4.12	2.966	2.844
3	3.50	6.00	2.50	0.38	5.00	3.596	3.469
3 1/2	4.00	6.00	3.00	0.38	5.50	4.096	3.969
4	4.50	6.00	3.00	0.44	6.19	4.593	4.469
5	5.56	8.00	3.00	0.44	7.31	5.683	5.532
6	6.62	8.00	3.50	0.50	8.50	6.743	6.594
8	8.62	8.00	4.00	0.50	10.62	8.743	8.594
10	10.75	10.00	5.00	0.50	12.75	10.913	10.719
12	12.75	10.00	6.00	0.50	15.00	12.913	12.719
14	14.00	12.00	6.00	0.50	16.25	14.170	13.969
16	16.00	12.00	6.00	0.50	18.50	16.180	15.969
18	18.00	12.00	6.00	0.50	21.00	18.190	17.969
20	20.00	12.00	6.00	0.50	23.00	20.240	19.969
22	22.00	12.00	6.00	0.50	25.25	22.240	21.969
24	24.00	12.00	6.00	0.50	27.25	24.240	23.969

GENERAL NOTES:
(a) Dimensions are in inches.
(b) See Table 1 for tolerances.

NOTES:
(1) The lap thickness *T* shall not be less than nominal pipe wall thickness.
(2) When short pattern stub ends are used with larger flanges in Classes 300 and 600, and with most sizes in Classes 900 and higher, and when long pattern stub ends are used with larger flanges in Classes 1500 and 2500, it may be necessary to increase the length of the stub ends in order to avoid covering the weld with the flange. Such increases in length shall be a matter of agreement between the manufacturer and the purchaser.
(3) When special facings such as tongue and groove, male and female, etc., are employed, additional lap thickness must be provided and such additional thickness shall be in addition to (not included in) the basic length *F*.
(4) These dimensions conform to the radius established for lap joint flanges in ASME/ANSI B16.5, Pipe Flanges and Flanged Fittings.
(5) This dimension conforms to standard machine facings shown in ASME/ANSI B16.5. The back face of the lap shall be machined to conform to the surface on which it seats. Where ring joint facings are to be applied use dimension *K* as given in ASME/ANSI B16.5.
(6) Gasket face finish shall be in accordance with ASME/ANSI B16.5 for raised face flanges.
(7) The long pattern shall be the standard when not specified by the purchaser. The short pattern shall be specified by the purchaser.

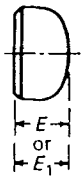
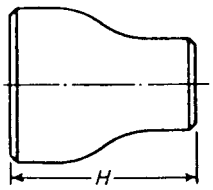


TABLE 8 DIMENSIONS OF CAPS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*	Length (1) *E*	Limiting Wall Thickness for Length *E*	Length (2) E_1
1/2	0.84	1.00	0.18	1.00
3/4	1.05	1.00	0.15	1.00
1	1.32	1.50	0.18	1.50
1 1/4	1.66	1.50	0.19	1.50
1 1/2	1.90	1.50	0.20	1.50
2	2.38	1.50	0.22	1.75
2 1/2	2.88	1.50	0.28	2.00
3	3.50	2.00	0.30	2.50
3 1/2	4.00	2.50	0.32	3.00
4	4.50	2.50	0.34	3.00
5	5.56	3.00	0.38	3.50
6	6.62	3.50	0.43	4.00
8	8.62	4.00	0.50	5.00
10	10.75	5.00	0.50	6.00
12	12.75	6.00	0.50	7.00
14	14.00	6.50	0.50	7.50
16	16.00	7.00	0.50	8.00
18	18.00	8.00	0.50	9.00
20	20.00	9.00	0.50	10.00
22	22.00	10.00	0.50	10.00
24	24.00	10.50	0.50	12.00
26	26.00	10.50	. . .	. . .
28	28.00	10.50	. . .	. . .
30	30.00	10.50	. . .	. . .
32	32.00	10.50	. . .	. . .
34	34.00	10.50	. . .	. . .
36	36.00	10.50	. . .	. . .
38	38.00	12.00	. . .	. . .
40	40.00	12.00	. . .	. . .
42	42.00	12.00	. . .	. . .
44	44.00	13.50	. . .	. . .
46	46.00	13.50	. . .	. . .
48	48.00	13.50	. . .	. . .

GENERAL NOTES:
(a) Dimensions are in inches.
(b) The shape of these caps shall be ellipsoidal and shall conform to the shape requirements as given in the ASME Boiler and Pressure Vessel Code.

NOTES:
(1) Length *E* applies for thickness not exceeding that given in column "Limiting Wall Thickness for Length *E*."
(2) Length E_1 applies for thickness greater than that given in column "Limiting Wall Thickness" for NPS 24 and smaller. For NPS 26 and larger, length E_1 shall be by agreement between manufacturer and purchaser.



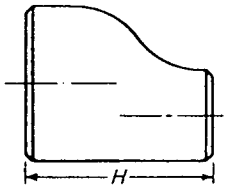


TABLE 9 DIMENSIONS OF REDUCERS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		End-to-End *H*	Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		End-to-End *H*
	Large End	Small End			Large End	Small End	
3/4 x 1/2	1.05	0.84	1.50	6 x 5	6.62	5.56	5.50
3/4 x 3/8	1.05	0.68	1.50	6 x 4	6.62	4.50	5.50
1 x 3/4	1.32	1.05	2.00	6 x 3 1/2	6.62	4.00	5.50
1 x 1/2	1.32	0.84	2.00	6 x 3	6.62	3.50	5.50
				6 x 2 1/2	6.62	2.88	5.50
1 1/4 x 1	1.66	1.32	2.00				
1 1/4 x 3/4	1.66	1.05	2.00	8 x 6	8.62	6.62	6.00
1 1/4 x 1/2	1.66	0.84	2.00	8 x 5	8.62	5.56	6.00
				8 x 4	8.62	4.50	6.00
1 1/2 x 1 1/4	1.90	1.66	2.50	8 x 3 1/2	8.62	4.00	6.00
1 1/2 x 1	1.90	1.32	2.50				
1 1/2 x 3/4	1.90	1.05	2.50	10 x 8	10.75	8.62	7.00
1 1/2 x 1/2	1.90	0.84	2.50	10 x 6	10.75	6.62	7.00
				10 x 5	10.75	5.56	7.00
2 x 1 1/2	2.38	1.90	3.00	10 x 4	10.75	4.50	7.00
2 x 1 1/4	2.38	1.66	3.00				
2 x 1	2.38	1.32	3.00	12 x 10	12.75	10.75	8.00
2 x 3/4	2.38	1.05	3.00	12 x 8	12.75	8.62	8.00
				12 x 6	12.75	6.62	8.00
2 1/2 x 2	2.88	2.38	3.50	12 x 5	12.75	5.56	8.00
2 1/2 x 1 1/2	2.88	1.90	3.50				
2 1/2 x 1 1/4	2.88	1.66	3.50	14 x 12	14.00	12.75	13.00
2 1/2 x 1	2.88	1.32	3.50	14 x 10	14.00	10.75	13.00
				14 x 8	14.00	8.62	13.00
3 x 2 1/2	3.50	2.88	3.50	14 x 6	14.00	6.62	13.00
3 x 2	3.50	2.38	3.50				
3 x 1 1/2	3.50	1.90	3.50	16 x 14	16.00	14.00	14.00
3 x 1 1/4	3.50	1.66	3.50	16 x 12	16.00	12.75	14.00
				16 x 10	16.00	10.75	14.00
3 1/2 x 3	4.00	3.50	4.00	16 x 8	16.00	8.62	14.00
3 1/2 x 2 1/2	4.00	2.88	4.00				
3 1/2 x 2	4.00	2.38	4.00	18 x 16	18.00	16.00	15.00
3 1/2 x 1 1/2	4.00	1.90	4.00	18 x 14	18.00	14.00	15.00
3 1/2 x 1 1/4	4.00	1.66	4.00	18 x 12	18.00	12.75	15.00
				18 x 10	18.00	10.75	15.00
4 x 3 1/2	4.50	4.00	4.00				
4 x 3	4.50	3.50	4.00	20 x 18	20.00	18.00	20.00
4 x 2 1/2	4.50	2.88	4.00	20 x 16	20.00	16.00	20.00
4 x 2	4.50	2.38	4.00	20 x 14	20.00	14.00	20.00
4 x 1 1/2	4.50	1.90	4.00	20 x 12	20.00	12.75	20.00
5 x 4	5.56	4.50	5.00				
5 x 3 1/2	5.56	4.00	5.00	22 x 20	22.00	20.00	20.00
5 x 3	5.56	3.50	5.00	22 x 18	22.00	18.00	20.00
5 x 2 1/2	5.56	2.88	5.00	22 x 16	22.00	16.00	20.00
5 x 2	5.56	2.38	5.00	22 x 14	22.00	14.00	20.00

TABLE 9 DIMENSIONS OF REDUCERS (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		End-to-End *H*	Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*		End-to-End *H*
	Large End	Small End			Large End	Small End	
24 x 22	24.00	22.00	20.00	38 x 36	38.00	36.00	24.00
24 x 20	24.00	20.00	20.00	38 x 34	38.00	34.00	24.00
24 x 18	24.00	18.00	20.00	38 x 32	38.00	32.00	24.00
24 x 16	24.00	16.00	20.00	38 x 30	38.00	30.00	24.00
				38 x 28	38.00	28.00	24.00
26 x 24	26.00	24.00	24.00	38 x 26	38.00	26.00	24.00
26 x 22	26.00	22.00	24.00				
26 x 20	26.00	20.00	24.00	40 x 38	40.00	38.00	24.00
26 x 18	26.00	18.00	24.00	40 x 36	40.00	36.00	24.00
				40 x 34	40.00	34.00	24.00
28 x 26	28.00	26.00	24.00	40 x 32	40.00	32.00	24.00
28 x 24	28.00	24.00	24.00	40 x 30	40.00	30.00	24.00
28 x 20	28.00	20.00	24.00				
28 x 18	28.00	18.00	24.00	42 x 40	42.00	40.00	24.00
				42 x 38	42.00	38.00	24.00
30 x 28	30.00	28.00	24.00	42 x 36	42.00	36.00	24.00
30 x 26	30.00	26.00	24.00	42 x 34	42.00	34.00	24.00
30 x 24	30.00	24.00	24.00	42 x 32	42.00	32.00	24.00
30 x 20	30.00	20.00	24.00	42 x 30	42.00	30.00	24.00
32 x 30	32.00	30.00	24.00				
32 x 28	32.00	28.00	24.00	44 x 42	44.00	42.00	24.00
32 x 26	32.00	26.00	24.00	44 x 40	44.00	40.00	24.00
32 x 24	32.00	24.00	24.00	44 x 38	44.00	38.00	24.00
				44 x 36	44.00	36.00	24.00
34 x 32	34.00	32.00	24.00				
34 x 30	34.00	30.00	24.00	46 x 44	46.00	44.00	28.00
34 x 26	34.00	26.00	24.00	46 x 42	46.00	42.00	28.00
34 x 24	34.00	24.00	24.00	46 x 40	46.00	40.00	28.00
				46 x 38	46.00	38.00	28.00
36 x 34	36.00	34.00	24.00				
36 x 32	36.00	32.00	24.00	48 x 46	48.00	46.00	28.00
36 x 30	36.00	30.00	24.00	48 x 44	48.00	44.00	28.00
36 x 26	36.00	26.00	24.00	48 x 42	48.00	42.00	28.00
36 x 24	36.00	24.00	24.00	48 x 40	48.00	40.00	28.00

GENERAL NOTE: Dimensions are in inches.

ANNEX A
METRIC (SI) TABLES

(This Annex is an integral part of ASME B16.9-1993 and is placed after the main text for convenience.)

The technique of rounding the metric conversions of the inch dimensions recognized two basic categories of dimensions occurring in this Standard, based upon the function or safety significance of variations in the dimensions.

Where some slight shift of the absolute value of the minimum and maximum dimensions permitted by the inch dimensions and those provided by the converted metric dimensions do not unacceptably affect the functional or safety characteristics of the fitting, the metric conversions have been rounded to whole millimeter values in order to facilitate ease of measurement by ordinary measuring tapes or rulers with nonmagnified vision. Furthermore, the rounding has not always been made to the nearest whole millimeter. In some cases it has been made to the whole millimeter, which would facilitate tables manifesting logical increments in both the dimensions and their tolerances. It is recognized that the introduction of such variances will create a conflict in the acceptance dimensions or gaging between the inch and metric data. Experience indicates a probability that no serious difficulties will result from this conflict. Hence it is the intent of this Standard that any dimension that is within tolerance by either metric or inch measurement is considered to be in conformance with this Standard.

Where it was considered advisable to limit the variance between the minimum and maximum dimensions permitted by the existing tolerances and those permitted by the converted metric dimensions, closer rounding was utilized.

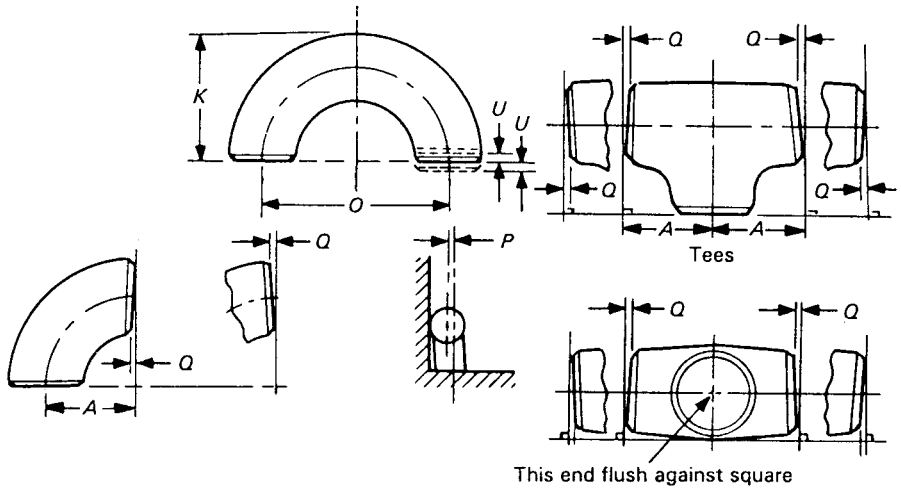
The metric dimensions shown in Tables A1 through A9 are for information and reference. They are not exact equivalents of the dimensions in Tables 1 through 9. If used by agreement between manufacturer and purchaser, complete dimensional interchangeability with standard components cannot be assured. Use of a combination of standard and metric values is contrary to the intent of this Standard.

TABLE A1 TOLERANCES

All Fittings				90 deg. and 45 deg. Elbows and Tees	Reducers and Lap Joint Stub Ends	Caps	180 deg. Returns			Lap Joint Stub Ends		
Nominal Pipe Size (NPS)	Outside Diameter at Bevel (1),(2) *D*	Inside Diameter at End (1),(3),(4)	Wall Thickness (3) *t*	Center-to-End Dimension *A,B,C,M*	Overall Length *F,H*	Overall Length *E*	Center-to-Center Dimension *O*	Back-to-Face Dimension *K*	Alignment of Ends *U*	Outside Diameter of Lap *G*	Fillet Radius of Lap *R*	Outside Diameter of Barrel
1/2 to 2 1/2	1	0.8	Not less than 87.5% of nominal thickness	2	2	4	7	7	1	+0 −1	+0 −1	See Table A7 for limiting dimensions
3 to 3 1/2	1	1.6		2	2	4	7	7	1	+0 −1	+0 −1	
4	+2 −1	1.6		2	2	4	7	7	1	+0 −1	+0 −2	
5 to 6	+3 −1	1.6		2	2	7	7	7	1	+0 −1	+0 −2	
8	2	1.6		2	2	7	7	7	1	+0 −1	+0 −2	
10	+4 −3	3.2		2	2	7	10	7	2	+0 −2	+0 −2	
12 to 18	+4 −3	3.2		3	3	7	10	7	2	+0 −2	+0 −2	
20 to 24	+6 −5	4.8		3	3	7	10	7	2	+0 −2	+0 −2	
26 to 30	+7 −5	4.8		3	3	10	...	...	...	...	...	
32 to 48	+7 −5	4.8		5	5	10	...	...	...	...	...	

TABLE A1 TOLERANCES (CONT'D)

Nominal Pipe Size (NPS)	Angularity Tol.	
	Off Angle *Q*	Off Plane *P*
½ to 4	1	2
5 to 8	2	4
10 to 12	3	5
14 to 16	3	7
18 to 24	4	10
26 to 30	5	10
32 to 42	5	13
44 to 48	5	20



GENERAL NOTE: Dimensions are in millimeters (except NPS). Tolerances are equal plus and minus except as noted.

NOTES:
(1) Out-of-round is the sum of absolute values of plus and minus tolerance.
(2) This tolerance may be exceeded in localized areas of formed fittings where increased wall thickness is required to meet design requirements of para. 2.2
(3) The inside diameter and the nominal wall thicknesses at ends are to be specified by the purchaser.
(4) Unless otherwise specified by the purchaser, these tolerances apply to the nominal inside diameter, which equals the difference between the nominal outside diameter and twice the nominal wall thickness.

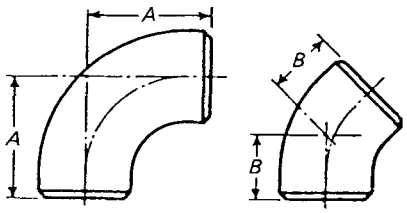


TABLE A2 DIMENSIONS OF LONG RADIUS ELBOWS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*			Center-to-End					
				90 deg. Elbows *A*			45 deg. Elbows *B*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
1/2	20	21	22	36	38	40	14	16	18
3/4 (1)	26	27	28	36	38	40	17	19	21
1	32	33	34	36	38	40	20	22	24
1 1/4	41	42	43	46	48	50	23	25	27
1 1/2	47	48	49	55	57	59	27	29	31
2	59	60	61	74	76	78	33	35	37
2 1/2	72	73	74	93	95	97	42	44	46
3	88	89	90	112	114	116	49	51	53
3 1/2	101	102	103	131	133	135	55	57	59
4	113	114	116	150	152	154	62	64	66
5	140	141	144	188	190	192	77	79	81
6	167	168	171	227	229	231	93	95	97
8	217	219	221	303	305	307	125	127	129
10	270	273	277	379	381	383	157	159	161
12	321	324	328	454	457	460	187	190	193
14	353	356	360	530	533	536	219	222	225
16	403	406	410	607	610	613	251	254	257
18	454	457	461	683	686	689	283	286	289
20	503	508	514	759	762	765	315	318	321
22	554	559	565	835	838	841	340	343	346
24	605	610	616	911	914	917	378	381	384
26	655	660	667	988	991	994	403	406	409
28	706	711	718	1064	1067	1070	435	438	441
30	757	762	769	1140	1143	1146	467	470	473
32	808	813	820	1214	1219	1224	497	502	507
34	859	864	871	1290	1295	1300	528	533	538
36	909	914	921	1367	1372	1377	560	565	570
38	960	965	972	1443	1448	1453	595	600	605
40	1011	1016	1023	1519	1524	1529	627	632	637
42	1062	1067	1074	1595	1600	1605	655	660	665
44	1113	1118	1125	1671	1676	1681	690	695	700
46	1163	1168	1175	1748	1753	1758	722	727	732
48	1214	1219	1226	1824	1829	1834	754	759	764

NOTES TO TABLE A2

GENERAL NOTE: Dimensions are in millimeters.

NOTE:
(1) *A* and *B* dimensions for NPS 3/4 may be as shown below at the manufacturer's option.

Center-to-End					
90 deg. Elbows *A*			45 deg. Elbows *B*		
Min.	Nom.	Max.	Min.	Nom.	Max.
27	29	31	9	11	13

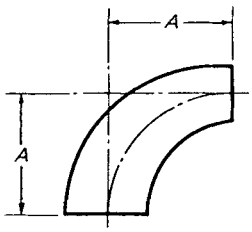


TABLE A3 DIMENSIONS OF LONG RADIUS REDUCING ELBOWS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*			Nominal Pipe Size (NPS)	Center-to-End *A*			Nominal Pipe Size (NPS)	Center-to-End *A*		
	Min.	Nom.	Max.		Min.	Nom.	Max.		Min.	Nom.	Max.
1	32	33	34	2 × 1 1/2	74	76	78	10 × 8	379	381	383
1 1/4	41	42	43	2 × 1 1/4	74	76	78	10 × 6	379	381	383
1 1/2	47	48	49	2 × 1	74	76	78	10 × 5	379	381	383
2	59	60	61								
2 1/2	72	73	74	2 1/2 × 2	93	95	97	12 × 10	454	457	460
				2 1/2 × 1 1/2	93	95	97	12 × 8	454	457	460
3	88	89	90	2 1/2 × 1 1/4	93	95	97	12 × 6	454	457	460
3 1/2	101	102	103								
4	113	114	116	3 × 2 1/2	112	114	116	14 × 12	530	533	536
5	140	141	144	3 × 2	112	114	116	14 × 10	530	533	536
6	167	168	171	3 × 1 1/2	112	114	116	14 × 8	530	533	536
8	217	219	221	3 1/2 × 3	131	133	135	16 × 14	607	610	613
10	270	273	277	3 1/2 × 2 1/2	131	133	135	16 × 12	607	610	613
12	321	324	328	3 1/2 × 2	131	133	135	16 × 10	607	610	613
14	353	356	360								
16	403	406	410	4 × 3 1/2	150	152	154	18 × 16	683	686	689
				4 × 3	150	152	154	18 × 14	683	686	689
18	454	457	461	4 × 2 1/2	150	152	154	18 × 12	683	686	689
20	503	508	514	4 × 2	150	152	154	18 × 10	683	686	689
22	554	559	565								
24	605	610	616	5 × 4	188	190	192	20 × 18	759	762	765
				5 × 3 1/2	188	190	192	20 × 16	759	762	765
				5 × 3	188	190	192	20 × 14	759	762	765
				5 × 2 1/2	188	190	192	20 × 12	759	762	765
								20 × 10	759	762	765
				6 × 5	227	229	231				
				6 × 4	227	229	231	24 × 22	911	914	917
				6 × 3 1/2	227	229	231	24 × 20	911	914	917
				6 × 3	227	229	231	24 × 18	911	914	917
								24 × 16	911	914	917
				8 × 6	303	305	307	24 × 14	911	914	917
				8 × 5	303	305	307	24 × 12	911	914	917
				8 × 4	303	305	307				

GENERAL NOTE: Dimensions are in millimeters.

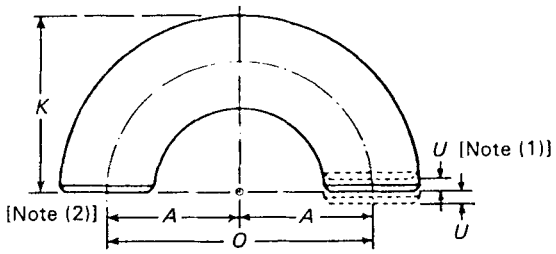


TABLE A4 DIMENSIONS OF LONG RADIUS RETURNS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*			Center-to-Center *O*			Back-to-Face *K*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
1/2	20	21	22	69	76	83	41	48	55
3/4 (3)	26	27	28	69	76	83	44	51	58
1	32	33	34	69	76	83	49	56	63
1 1/4	41	42	43	88	95	102	63	70	77
1 1/2	47	48	49	107	114	121	76	83	90
2	59	60	61	145	152	159	99	106	113
2 1/2	72	73	74	184	191	198	125	132	139
3	88	89	90	222	229	236	152	159	166
3 1/2	101	102	103	260	267	274	177	184	191
4	113	114	116	298	305	312	203	210	217
5	140	141	144	374	381	388	255	262	269
6	167	168	171	450	457	464	306	313	320
8	217	219	221	603	610	617	407	414	421
10	270	273	277	752	762	772	511	518	525
12	321	324	328	904	914	924	612	619	626
14	353	356	360	1057	1067	1077	704	711	718
16	403	406	410	1209	1219	1229	806	813	820
18	454	457	461	1362	1372	1382	907	914	921
20	503	508	514	1514	1524	1534	1009	1016	1023
22	554	559	565	1666	1676	1686	1111	1118	1125
24	605	610	616	1819	1829	1839	1212	1219	1226

GENERAL NOTE: Dimensions are in millimeters.

NOTES:
(1) See Table A1 for tolerance for alignment of ends *U*.
(2) Dimension *A* is equal to one-half of dimension *O*.
(3) *O* and *K* dimensions for size NPS 3/4 may be as shown below at the manufacturer's option.

Center-to-Center *O*			Back-to-Face *K*		
Min.	Nom.	Max.	Min.	Nom.	Max.
50	57	64	36	43	50

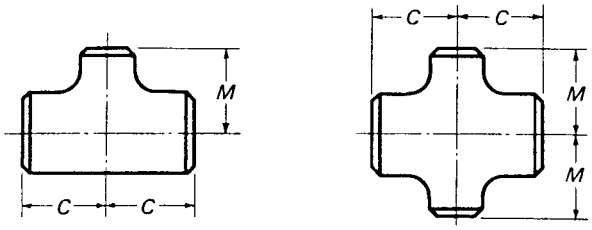


TABLE A5 DIMENSIONS OF STRAIGHT TEES AND CROSSES

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*			Center-to-End					
				Run *C*			Outlet (1), (2) *M*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
1/2	20	21	22	23	25	27	23	25	27
3/4	26	27	28	27	29	31	27	29	31
1	32	33	34	36	38	40	36	38	40
1 1/4	41	42	43	46	48	50	46	48	50
1 1/2	47	48	49	55	57	59	55	57	59
2	59	60	61	62	64	66	62	64	66
2 1/2	72	73	74	74	76	78	74	76	78
3	88	89	90	84	86	88	84	86	88
3 1/2	101	102	103	93	95	97	93	95	97
4	113	114	116	103	105	107	103	105	107
5	140	141	144	122	124	126	122	124	126
6	167	168	171	141	143	145	141	143	145
8	217	219	221	176	178	180	176	178	180
10	270	273	277	214	216	218	214	216	218
12	321	324	328	251	254	257	251	254	257
14	353	356	360	276	279	282	276	279	282
16	403	406	410	302	305	308	302	305	308
18	454	457	461	340	343	346	340	343	346
20	503	508	514	378	381	384	378	381	384
22	554	559	565	416	419	422	416	419	422
24	605	610	616	429	432	435	429	432	435
26	655	660	667	492	495	498	492	495	498
28	706	711	718	518	521	524	518	521	524
30	757	762	769	556	559	562	556	559	562
32	808	813	820	592	597	602	592	597	602
34	859	864	871	630	635	640	630	635	640
36	909	914	921	668	673	678	668	673	678
38	960	965	972	706	711	716	706	711	716
40	1011	1016	1023	744	749	754	744	749	754
42	1062	1067	1074	757	762	767	706	711	716
44	1113	1118	1125	808	813	818	757	762	767
46	1163	1168	1175	846	851	856	795	800	805
48	1214	1219	1226	884	889	894	833	838	843

GENERAL NOTE: Dimensions are in millimeters.

NOTES:
(1) Outlet dimension *M* for NPS 26 and larger is recommended but not required.
(2) Dimensions applicable to crosses NPS 24 and smaller.

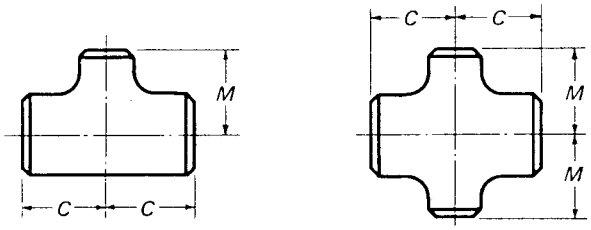


TABLE A6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES

Nominal Pipe Size (NPS)	Outside Diameter of Reducing Tees and Crosses						Center-to-End Lengths of Tees and Crosses					
	Run *D*			Outlet *D*			Run *C*			Outlet (1) *M*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
1/2 × 1/2 × 3/8	20	21	22	16	17	18	23	25	27	23	25	27
1/2 × 1/2 × 1/4	20	21	22	13	14	15	23	25	27	23	25	27
3/4 × 3/4 × 1/2	26	27	28	20	21	22	27	29	31	27	29	31
3/4 × 3/4 × 3/8	26	27	28	16	17	18	27	29	31	27	29	31
1 × 1 × 3/4	32	33	34	26	27	28	36	38	40	36	38	40
1 × 1 × 1/2	32	33	34	20	21	22	36	38	40	36	38	40
1 1/4 × 1 1/4 × 1	41	42	43	32	33	34	46	48	50	46	48	50
1 1/4 × 1 1/4 × 3/4	41	42	43	26	27	28	46	48	50	46	48	50
1 1/4 × 1 1/4 × 1/2	41	42	43	20	21	22	46	48	50	46	48	50
1 1/2 × 1 1/2 × 1 1/4	47	48	49	41	42	43	55	57	59	55	57	59
1 1/2 × 1 1/2 × 1	47	48	49	32	33	34	55	57	59	55	57	59
1 1/2 × 1 1/2 × 3/4	47	48	49	26	27	28	55	57	59	55	57	59
1 1/2 × 1 1/2 × 1/2	47	48	49	20	21	22	55	57	59	55	57	59
2 × 2 × 1 1/2	59	60	61	47	48	49	62	64	66	58	60	62
2 × 2 × 1 1/4	59	60	61	41	42	43	62	64	66	55	57	59
2 × 2 × 1	59	60	61	32	33	34	62	64	66	49	51	53
2 × 2 × 3/4	59	60	61	26	27	28	62	64	66	42	44	46
2 1/2 × 2 1/2 × 2	72	73	74	59	60	61	74	76	78	68	70	72
2 1/2 × 2 1/2 × 1 1/2	72	73	74	47	48	49	74	76	78	65	67	69
2 1/2 × 2 1/2 × 1 1/4	72	73	74	41	42	43	74	76	78	62	64	66
2 1/2 × 2 1/2 × 1	72	73	74	32	33	34	74	76	78	55	57	59
3 × 3 × 2 1/2	88	89	90	72	73	74	84	86	88	81	83	85
3 × 3 × 2	88	89	90	59	60	61	84	86	88	74	76	78
3 × 3 × 1 1/2	88	89	90	47	48	49	84	86	88	71	73	75
3 × 3 × 1 1/4	88	89	90	41	42	43	84	86	88	68	70	72
3 1/2 × 3 1/2 × 3	101	102	103	88	89	90	93	95	97	90	92	94
3 1/2 × 3 1/2 × 2 1/2	101	102	103	72	73	74	93	95	97	87	89	91
3 1/2 × 3 1/2 × 2	101	102	103	59	60	61	93	95	97	81	83	85
3 1/2 × 3 1/2 × 1 1/2	101	102	103	47	48	49	93	95	97	77	79	81
4 × 4 × 3 1/2	113	114	116	101	102	103	103	105	107	100	102	104
4 × 4 × 3	113	114	116	88	89	90	103	105	107	96	98	100
4 × 4 × 2 1/2	113	113	116	72	73	74	103	105	107	93	95	97
4 × 4 × 2	113	114	116	59	60	61	103	105	107	87	89	91
4 × 4 × 1 1/2	113	114	116	47	48	49	103	105	107	84	86	88

(Notes follow at end of table)

(Table A6 continues on next page)

TABLE A6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter of Reducing Tees and Crosses						Center-to-End Lengths of Tees and Crosses					
	Run *D*			Outlet *D*			Run *C*			Outlet (1) *M*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
5 × 5 × 4	140	141	144	113	114	116	122	124	126	115	117	119
5 × 5 × 3½	140	141	144	101	102	103	122	124	126	112	114	116
5 × 5 × 3	140	141	144	88	89	90	122	124	126	109	111	113
5 × 5 × 2½	140	141	144	72	73	74	122	124	126	106	108	110
5 × 5 × 2	140	141	144	59	60	61	122	124	126	103	105	107
6 × 6 × 5	167	168	171	140	141	144	141	143	145	135	137	139
6 × 6 × 4	167	168	171	113	114	116	141	143	145	128	130	132
6 × 6 × 3½	167	168	171	101	102	103	141	143	145	125	127	129
6 × 6 × 3	167	168	171	88	89	90	141	143	145	122	124	126
6 × 6 × 2½	167	168	171	72	73	74	141	143	145	119	121	123
8 × 8 × 6	217	219	221	167	168	171	176	178	180	166	168	170
8 × 8 × 5	217	219	221	140	141	144	176	178	180	160	162	164
8 × 8 × 4	217	219	221	113	114	116	176	178	180	154	156	158
8 × 8 × 3½	217	219	221	101	102	103	176	178	180	150	152	154
10 × 10 × 8	270	273	277	217	219	221	214	216	218	201	203	205
10 × 10 × 6	270	273	277	167	168	171	214	216	218	192	194	196
10 × 10 × 5	270	273	277	140	141	144	214	216	218	189	191	193
10 × 10 × 4	270	273	277	113	114	116	214	216	218	182	184	186
12 × 12 × 10	321	324	328	270	273	277	251	254	257	238	241	244
12 × 12 × 8	321	324	328	217	219	221	251	254	257	226	229	232
12 × 12 × 6	321	324	328	167	168	171	251	254	257	216	219	222
12 × 12 × 5	321	324	328	140	140	144	251	254	257	213	216	219
14 × 14 × 12	353	356	360	321	324	328	276	279	282	267	270	273
14 × 14 × 10	353	356	360	270	273	277	276	279	282	254	257	260
14 × 14 × 8	353	356	360	217	219	221	276	279	282	245	248	251
14 × 14 × 6	353	356	360	167	168	171	276	279	282	235	238	241
16 × 16 × 14	403	406	410	353	356	360	302	305	308	302	305	308
16 × 16 × 12	403	406	410	321	324	328	302	305	308	292	295	298
16 × 16 × 10	403	406	410	270	273	277	302	305	308	280	283	286
16 × 16 × 8	403	406	410	217	219	221	302	305	308	270	273	276
16 × 16 × 6	403	406	410	167	168	171	302	305	308	261	264	267
18 × 18 × 16	454	457	461	403	406	410	340	343	346	327	330	333
18 × 18 × 14	454	457	461	353	356	360	340	343	346	327	330	333
18 × 18 × 12	454	457	461	321	324	328	340	343	346	318	321	324
18 × 18 × 10	454	457	461	270	273	277	340	343	346	305	308	311
18 × 18 × 8	454	457	461	217	219	221	340	343	346	295	298	301
20 × 20 × 18	503	508	514	454	457	461	378	381	384	365	368	371
20 × 20 × 16	503	508	514	403	406	410	378	381	384	353	356	359
20 × 20 × 14	503	508	514	353	356	360	378	381	384	353	356	359
20 × 20 × 12	503	508	514	321	324	328	378	381	384	343	346	349
20 × 20 × 10	503	508	514	270	273	277	378	381	384	330	333	336
20 × 20 × 8	503	508	514	217	219	221	378	381	384	321	324	327
22 × 22 × 20	554	559	565	503	508	514	416	419	422	403	406	409
22 × 22 × 18	554	559	565	454	457	461	416	419	422	391	394	397
22 × 22 × 16	554	559	565	403	406	410	416	419	422	378	381	384
22 × 22 × 14	554	559	565	353	356	360	416	419	422	378	381	384
22 × 22 × 12	554	559	565	321	324	328	416	419	422	368	371	374
22 × 22 × 10	554	559	565	270	273	277	416	419	422	356	359	362

(Notes follow at end of table)

TABLE A6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter of Reducing Tees and Crosses						Center-to-End Lengths of Tees and Crosses					
	Run *D*			Outlet *D*			Run *C*			Outlet (1) *M*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
24 × 24 × 22	605	610	616	554	559	565	429	432	435	429	432	435
24 × 24 × 20	605	610	616	503	508	514	429	432	435	429	432	435
24 × 24 × 18	605	610	616	454	457	461	429	432	435	416	419	422
24 × 24 × 16	605	610	616	403	406	410	429	432	435	403	406	409
24 × 24 × 14	605	610	616	353	356	360	429	432	435	403	406	409
24 × 24 × 12	605	610	616	321	324	328	429	432	435	394	397	400
24 × 24 × 10	605	610	616	270	273	277	429	432	435	381	384	387
26 × 26 × 24	655	660	667	605	610	616	492	495	498	480	483	486
26 × 26 × 22	655	660	667	554	559	565	492	495	498	467	470	473
26 × 26 × 20	655	660	667	503	508	514	492	495	498	454	457	460
26 × 26 × 18	655	660	667	454	457	461	492	495	498	441	444	447
26 × 26 × 16	655	660	667	403	406	410	492	495	498	429	432	435
26 × 26 × 14	655	660	667	353	356	360	492	495	498	429	432	435
26 × 26 × 12	655	660	667	321	324	328	492	495	498	419	422	425
28 × 28 × 26	706	711	718	655	660	667	518	521	524	518	521	524
28 × 28 × 24	706	711	718	605	610	616	518	521	524	505	508	511
28 × 28 × 22	706	711	718	554	559	565	518	521	524	492	495	498
28 × 28 × 20	706	711	718	503	508	514	518	521	524	480	483	486
28 × 28 × 18	706	711	718	454	457	461	518	521	524	467	470	473
28 × 28 × 16	706	711	718	403	406	410	518	521	524	454	457	460
28 × 28 × 14	706	711	718	353	356	360	518	521	524	454	457	460
28 × 28 × 12	706	711	718	321	324	328	518	521	524	445	448	451
30 × 30 × 28	757	762	769	706	711	718	556	559	562	543	546	549
30 × 30 × 26	757	762	769	655	660	667	556	559	562	543	546	549
30 × 30 × 24	757	762	769	605	610	616	556	559	562	530	533	536
30 × 30 × 22	757	762	769	554	559	565	556	559	562	518	521	524
30 × 30 × 20	757	762	769	503	508	514	556	559	562	505	508	511
30 × 30 × 18	757	762	769	454	457	461	556	559	562	492	495	498
30 × 30 × 16	757	762	769	403	406	410	556	559	562	480	483	486
30 × 30 × 14	757	762	769	353	356	360	556	559	562	480	483	486
30 × 30 × 12	757	762	769	321	324	328	556	559	562	470	473	476
30 × 30 × 10	757	762	769	270	273	277	556	559	562	457	460	463
32 × 32 × 30	808	813	820	757	762	769	592	597	602	579	584	589
32 × 32 × 28	808	813	820	706	711	718	592	597	602	567	572	577
32 × 32 × 26	808	813	820	655	660	667	592	597	602	567	572	577
32 × 32 × 24	808	813	820	605	610	616	592	597	602	554	559	564
32 × 32 × 22	808	813	820	554	559	565	592	597	602	541	546	551
32 × 32 × 20	808	813	820	503	508	514	592	597	602	528	533	538
32 × 32 × 18	808	813	820	454	457	461	592	597	602	516	521	526
32 × 32 × 16	808	813	820	403	406	410	592	597	602	503	508	513
32 × 32 × 14	808	813	820	353	356	360	592	597	602	503	508	513
34 × 34 × 32	859	864	871	808	813	820	630	635	640	617	622	627
34 × 34 × 30	859	864	871	757	762	769	630	635	640	605	610	615
34 × 34 × 28	859	864	871	706	711	718	630	635	640	592	597	602
34 × 34 × 26	859	864	871	655	660	667	630	635	640	592	597	602
34 × 34 × 24	859	864	871	605	610	616	630	635	640	579	584	589
34 × 34 × 22	859	864	871	554	559	565	630	635	640	567	572	577
34 × 34 × 20	859	864	871	503	508	514	630	635	640	554	559	564
34 × 34 × 18	859	864	871	454	457	461	630	635	640	541	546	551
34 × 34 × 16	859	864	871	403	406	410	630	635	640	528	533	538

(Table A6 continues on next page)

TABLE A6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter of Reducing Tees and Crosses						Center-to-End Lengths of Tees and Crosses					
	Run *D*			Outlet *D*			Run *C*			Outlet (1) *M*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
36 × 36 × 34	909	914	921	859	864	871	668	673	678	655	660	665
36 × 36 × 32	909	914	921	808	813	820	668	673	678	643	648	653
36 × 36 × 30	909	914	921	757	762	769	668	673	678	630	635	640
36 × 36 × 28	909	914	921	706	711	718	668	673	678	617	622	627
36 × 36 × 26	909	914	921	655	660	667	668	673	678	617	622	627
36 × 36 × 24	909	914	921	605	610	616	668	673	678	605	610	615
36 × 36 × 22	909	914	921	554	559	565	668	673	678	592	597	602
36 × 36 × 20	909	914	921	503	508	514	668	673	678	579	584	589
36 × 36 × 18	909	914	921	454	457	461	668	673	678	567	572	577
36 × 36 × 16	909	914	921	403	406	410	668	673	678	554	559	564
38 × 38 × 36	960	965	972	909	914	921	706	711	716	706	711	716
38 × 38 × 34	960	965	972	859	864	871	706	711	716	693	698	703
38 × 38 × 32	960	965	972	808	813	820	706	711	716	681	686	691
38 × 38 × 30	960	965	972	757	762	769	706	711	716	668	673	678
38 × 38 × 28	960	965	972	706	711	718	706	711	716	643	648	653
38 × 38 × 26	960	965	972	655	660	667	706	711	716	643	648	653
38 × 38 × 24	960	965	972	605	610	616	706	711	716	630	635	640
38 × 38 × 22	960	965	972	554	559	565	706	711	716	617	622	627
38 × 38 × 20	960	965	972	503	508	514	706	711	716	605	610	615
38 × 38 × 18	960	965	972	454	457	461	706	711	716	592	597	602
40 × 40 × 38	1011	1016	1023	960	965	972	744	749	754	744	749	754
40 × 40 × 36	1011	1016	1023	909	914	921	744	749	754	732	737	742
40 × 40 × 34	1011	1016	1023	859	864	871	744	749	754	719	724	729
40 × 40 × 32	1011	1016	1023	808	813	820	744	749	754	706	711	716
40 × 40 × 30	1011	1016	1023	757	762	769	744	749	754	693	698	703
40 × 40 × 28	1011	1016	1023	706	711	718	744	749	754	668	673	678
40 × 40 × 26	1011	1016	1023	655	660	667	744	749	754	668	673	678
40 × 40 × 24	1011	1016	1023	605	610	616	744	749	754	655	660	665
40 × 40 × 22	1011	1016	1023	554	559	565	744	749	754	643	648	653
40 × 40 × 20	1011	1016	1023	503	508	514	744	749	754	630	635	640
40 × 40 × 18	1011	1016	1023	454	457	461	744	749	754	617	622	627
42 × 42 × 40	1062	1067	1074	1011	1016	1023	757	762	767	706	711	716
42 × 42 × 38	1062	1067	1074	960	968	972	757	762	767	706	711	716
42 × 42 × 36	1062	1067	1074	909	914	921	757	762	767	706	711	716
42 × 42 × 34	1062	1067	1074	859	864	871	757	762	767	706	711	716
42 × 42 × 32	1062	1067	1074	808	813	820	757	762	767	706	711	716
42 × 42 × 30	1062	1067	1074	757	762	769	757	762	767	706	711	716
42 × 42 × 28	1062	1067	1074	706	711	718	757	762	767	693	698	703
42 × 42 × 26	1062	1067	1074	655	660	667	757	762	767	693	698	703
42 × 42 × 24	1062	1067	1074	605	610	616	757	762	767	655	660	665
42 × 42 × 22	1062	1067	1074	554	559	565	757	762	767	655	660	665
42 × 42 × 20	1062	1067	1074	503	508	514	757	762	767	655	660	665
42 × 42 × 18	1062	1067	1074	454	457	461	757	762	767	643	648	653
42 × 42 × 16	1062	1067	1074	403	406	410	757	762	767	630	635	640
44 × 44 × 42	1113	1118	1125	1062	1067	1074	808	813	818	757	762	767
44 × 44 × 40	1113	1118	1125	1011	1016	1023	808	813	818	744	749	754
44 × 44 × 38	1113	1118	1125	960	965	972	808	813	818	732	737	742
44 × 44 × 36	1113	1118	1125	909	914	921	808	813	818	719	724	729
44 × 44 × 34	1113	1118	1125	859	864	871	808	813	818	719	724	729
44 × 44 × 32	1113	1118	1125	808	813	820	808	813	818	706	711	716

TABLE A6 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES (CONT'D)

Nominal Pipe Size (NPS)	Outside Diameter of Reducing Tees and Crosses						Center-to-End Lengths of Tees and Crosses					
	Run *D*			Outlet *D*			Run *C*			Outlet (1) *M*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
44 x 44 x 30	1113	1118	1125	757	762	764	808	813	818	706	711	716
44 x 44 x 28	1113	1118	1125	706	711	718	808	813	818	693	698	703
44 x 44 x 26	1113	1118	1125	655	660	667	808	813	818	693	698	703
44 x 44 x 24	1113	1118	1125	605	610	616	808	813	818	693	698	703
44 x 44 x 22	1113	1118	1125	554	559	565	808	813	818	681	686	691
44 x 44 x 20	1113	1118	1125	503	508	514	808	813	818	681	686	691
46 x 46 x 44	1163	1168	1175	1113	1118	1125	846	851	856	795	800	805
46 x 46 x 42	1163	1168	1175	1062	1067	1074	846	851	856	782	787	792
46 x 46 x 40	1163	1168	1175	1011	1016	1023	846	851	856	770	775	780
46 x 46 x 38	1163	1168	1175	960	965	972	846	851	856	757	762	767
46 x 46 x 36	1163	1168	1175	909	914	921	846	851	856	757	762	767
46 x 46 x 34	1163	1168	1175	859	864	871	846	851	856	744	749	754
46 x 46 x 32	1163	1168	1175	808	813	820	846	851	856	744	749	754
46 x 46 x 30	1163	1168	1175	757	762	764	846	851	856	732	737	742
46 x 46 x 28	1163	1168	1175	706	711	718	846	851	856	732	737	742
46 x 46 x 26	1163	1168	1175	655	660	667	846	851	856	732	737	742
46 x 46 x 24	1163	1168	1175	605	610	616	846	851	856	719	724	729
46 x 46 x 22	1163	1168	1175	554	559	565	846	851	856	719	724	729
48 x 48 x 46	1214	1219	1226	1163	1168	1175	884	889	894	833	838	843
48 x 48 x 44	1214	1219	1226	1113	1118	1125	884	889	894	833	838	843
48 x 48 x 42	1214	1219	1226	1062	1067	1074	884	889	894	808	813	818
48 x 48 x 40	1214	1219	1226	1011	1016	1023	884	889	894	808	813	818
48 x 48 x 38	1214	1219	1226	960	965	972	884	889	894	808	813	818
48 x 48 x 36	1214	1219	1226	909	914	921	884	889	894	782	787	792
48 x 48 x 34	1214	1219	1226	859	864	871	884	889	894	782	787	792
48 x 48 x 32	1214	1219	1226	808	813	820	884	889	894	782	787	792
48 x 48 x 30	1214	1219	1226	757	762	769	884	889	894	757	762	767
48 x 48 x 28	1214	1219	1226	706	711	718	884	889	894	757	762	767
48 x 48 x 26	1214	1219	1226	655	660	667	884	889	894	757	762	767
48 x 48 x 24	1214	1219	1226	605	610	616	884	889	894	732	737	742
48 x 48 x 22	1214	1219	1226	554	559	565	884	889	894	732	737	742

GENERAL NOTE: Dimensions are in millimeters.

NOTE:
(1) Outlet dimension *M* for run sizes 14 and larger is recommended but not required.

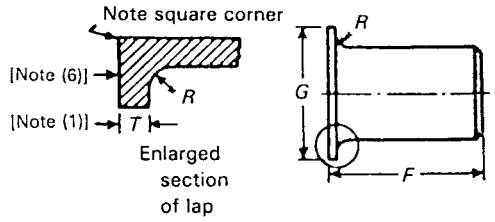


TABLE A7 DIMENSIONS OF LAP JOINT STUB ENDS

Nominal Pipe Size (NPS)	Outside Diameter at Bevel *D*			Long Pattern Length (2), (3), (7) *F*			Short Pattern Length (2), (3), (7) *F*			Radius of Fillet (3) *R*		Diameter of Lap (4) *G*		Outside Diameter of Barrel	
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom. and Max.	Min.	Nom. and Max.	Min.	Max.
1/2	20	21	22	74	76	78	49	51	53	2	3	34	35	20.55	22.76
3/4	26	27	28	74	76	78	49	51	53	2	3	42	43	25.88	28.09
1	32	33	34	100	102	104	49	51	53	2	3	50	51	32.61	34.95
1 1/4	41	42	43	100	102	104	49	51	53	4	5	63	64	41.38	43.59
1 1/2	47	48	49	100	102	104	49	51	53	5	6	72	73	47.47	49.94
2	59	60	61	150	152	154	62	64	66	7	8	91	92	59.54	62.38
2 1/2	72	73	74	150	152	154	62	64	66	7	8	104	105	72.24	75.34
3	88	89	90	150	152	62	62	64	66	9	10	126	127	88.11	91.34
3 1/2	101	102	103	150	152	154	74	76	78	9	10	139	140	100.81	104.04
4	113	114	116	150	152	154	74	76	78	9	11	156	157	113.51	116.66
5	140	141	144	201	203	205	74	76	78	9	11	185	186	140.51	144.35
6	167	168	171	201	203	205	87	89	91	11	13	215	216	167.49	171.27
8	217	219	221	201	203	205	100	102	104	11	13	269	270	218.29	222.07
10	270	273	277	252	254	256	125	127	129	11	13	322	324	272.26	277.19
12	321	324	328	251	254	257	149	152	155	11	13	379	381	323.06	327.99
14	353	356	360	302	305	308	149	152	155	11	13	411	413	354.81	359.92
16	403	406	410	302	305	308	149	152	155	11	13	468	470	405.61	410.97
18	454	457	461	302	305	308	149	152	155	11	13	531	533	456.41	462.03
20	503	508	514	302	305	308	149	152	155	11	13	582	584	507.21	514.10
22	554	559	565	302	305	308	149	152	155	11	13	639	641	558.01	564.90
24	605	610	616	302	305	308	149	152	155	11	13	690	692	608.81	615.70

NOTES TO TABLE A7

GENERAL NOTES:
(a) Dimensions are in millimeters.
(b) See Table A1 for tolerances.

NOTES:
(1) The lap thickness *T* shall not be less than nominal pipe wall thickness.
(2) When short pattern stub ends are used with larger flanges in Classes 300 and 600, and with most sizes in Classes 900 and higher, and when long pattern stub ends are used with larger flanges in Classes 1500 and 2500, it may be necessary to increase the length of the stub ends in order to avoid covering the weld with the flange. Such increases in length shall be a matter of agreement between the manufacturer and purchaser.
(3) When special facings such as tongue and groove, male and female, etc., are employed, additional lap thickness must be provided and such additional thickness shall be in addition to (not included in) the basic length *F*.
(4) These dimensions conform to the radius established for lap joint flanges in ASME/ANSI B16.5, Pipe Flanges and Flanged Fittings.
(5) This dimension conforms to standard machined facings shown in ASME/ANSI B16.5. The back face of the lap shall be machined to conform to the surface on which it seats. Where ring joint facings are to be applied, use dimension *K* as given in ASME/ANSI B16.5.
(6) Gasket face finish shall be in accordance with ASME/ANSI B16.5 for raised face flanges.
(7) The long pattern shall be the standard when not specified by the purchaser. The short pattern shall be specified by the purchaser.

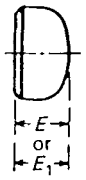
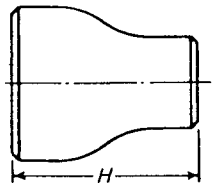


TABLE A8 DIMENSIONS OF CAPS

Nominal Pipe Size (NSP)	Outside Diameter at Bevel D			Length (1) E			Limiting Wall Thickness For Length E	Length (2) E_1		
	Min.	Nom.	Max.	Min.	Nom.	Max.		Min.	Nom.	Max.
1/2	20	21	22	21	25	29	3.73	21	25	29
3/4	26	27	28	21	25	29	3.91	21	25	29
1	32	33	34	34	38	42	4.55	34	38	42
1 1/4	41	42	43	34	38	42	4.85	34	38	42
1 1/2	47	48	49	34	38	42	5.08	34	38	42
2	59	60	61	34	38	42	5.54	40	44	48
2 1/2	72	73	74	34	38	42	7.01	47	51	55
3	88	89	90	47	51	55	7.62	60	64	68
3 1/2	101	102	103	60	64	68	8.08	72	76	80
4	113	114	116	60	64	68	8.56	72	76	80
5	140	141	144	69	76	83	9.53	82	89	96
6	167	168	171	82	89	96	10.97	95	102	109
8	217	219	221	95	102	109	12.70	120	127	134
10	270	273	277	120	127	134	12.70	145	152	159
12	321	324	328	145	152	159	12.70	171	178	185
14	353	356	360	158	165	172	12.70	184	191	198
16	403	406	410	171	178	185	12.70	196	203	210
18	454	457	461	196	203	210	12.70	222	229	236
20	503	508	514	222	229	236	12.70	247	254	261
22	554	559	565	247	254	261	12.70	247	254	261
24	605	610	616	260	267	274	12.70	298	305	312
26	655	660	667	257	267	277	...	...	...	...
28	706	711	718	257	267	277	...	...	...	...
30	757	762	769	257	267	277	...	...	...	...
32	808	813	820	257	267	277	...	...	...	...
34	859	864	871	257	267	277	...	...	...	...
36	909	914	921	257	267	277	...	...	...	...
38	960	965	972	295	305	315	...	...	...	...
40	1011	1016	1023	295	305	315	...	...	...	...
42	1062	1067	1074	295	305	315	...	...	...	...
44	1113	1118	1125	333	343	353	...	...	...	...
46	1163	1168	1175	333	343	353	...	...	...	...
48	1214	1219	1226	333	343	353	...	...	...	...

GENERAL NOTES:
(a) Dimensions are in millimeters.
(b) The shape of these caps shall be ellipsoidal and shall conform to the shape requirements as given in the ASME Boiler and Pressure Vessel Code.

NOTES:
(1) Length E applies for thickness not exceeding that given in column "Limiting Wall Thickness for Length E."
(2) Length E_1 applies for thickness greater than that given in column "Limiting Wall Thickness" for NPS 24 and smaller. For NPS 26 and larger, length E_1 shall be by agreement between manufacturer and purchaser.



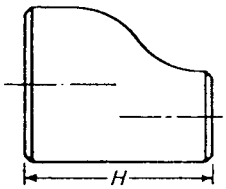


TABLE A9 DIMENSIONS OF REDUCERS

Nominal Pipe Size (NPS)	O.D. of Large End *D*			O.D. of Small End *D*			End-to-End Length of Reducers *H*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
3/4 × 1/2	26	27	28	20	21	23	36	38	40
3/4 × 3/8	26	27	28	16	17	18	36	38	40
1 × 3/4	32	33	34	26	27	28	49	51	53
1 × 1/2	32	33	34	20	21	22	49	51	53
1 1/4 × 1	41	42	43	32	33	34	49	51	53
1 1/4 × 3/4	41	42	43	26	27	28	49	51	53
1 1/4 × 1/2	41	42	43	20	21	22	49	51	53
1 1/2 × 1 1/4	47	48	49	41	42	43	62	64	66
1 1/2 × 1	47	48	49	32	33	34	62	64	66
1 1/2 × 3/4	47	48	49	26	27	28	62	64	66
1 1/2 × 1/2	47	48	49	20	21	22	62	64	66
2 × 1 1/2	59	60	61	47	48	49	74	76	78
2 × 1 1/4	59	60	61	41	42	43	74	76	78
2 × 1	59	60	61	32	33	34	74	76	78
2 × 3/4	59	60	61	26	27	28	74	76	78
2 1/2 × 2	72	73	74	59	60	61	87	89	91
2 1/2 × 1 1/2	72	73	74	47	48	49	87	89	91
2 1/2 × 1 1/4	72	73	74	41	42	43	87	89	91
2 1/2 × 1	72	73	74	32	33	34	87	89	91
3 × 2 1/2	88	89	90	72	73	74	87	89	91
3 × 2	88	89	90	59	60	61	87	89	91
3 × 1 1/2	88	89	90	47	48	49	87	89	91
3 × 1 1/4	88	89	90	41	42	43	87	89	91
3 1/2 × 3	100	102	103	88	89	90	100	102	104
3 1/2 × 2 1/2	100	102	103	72	73	74	100	102	104
3 1/2 × 2	100	102	103	59	60	61	100	102	104
3 1/2 × 1 1/2	100	102	103	47	48	49	100	102	104
3 1/2 × 1 1/4	100	102	103	41	42	43	100	102	104
4 × 3 1/2	113	114	116	101	102	103	100	102	104
4 × 3	113	114	116	88	89	90	100	102	104
4 × 2 1/2	113	114	116	72	73	74	100	102	104
4 × 2	113	114	116	59	60	61	100	102	104
4 × 1 1/2	113	114	116	47	48	49	100	102	104
5 × 4	140	141	144	113	114	116	125	127	129
5 × 3 1/2	140	141	144	101	102	103	125	127	129
5 × 3	140	141	144	88	89	90	125	127	129
5 × 2 1/2	140	141	144	72	73	74	125	127	129
5 × 2	140	141	144	59	60	61	125	127	129

(Note follows at end of table)

(Table A9 continues on next page)

TABLE A9 DIMENSIONS OF REDUCERS (CONT'D)

Nominal Pipe Size (NPS)	O.D. of Large End *D*			O.D. of Small End *D*			End-to-End Length of Reducers *H*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
6 × 5	167	168	171	140	141	142	138	140	142
6 × 4	167	168	171	113	114	116	138	140	142
6 × 3½	167	168	171	101	102	103	138	140	142
6 × 3	167	168	171	88	89	90	138	140	142
6 × 2½	167	168	171	72	73	74	138	140	142
8 × 6	217	219	221	167	168	171	150	152	154
8 × 5	217	219	221	140	141	144	150	152	154
8 × 4	217	219	221	113	114	116	150	152	154
8 × 3½	217	219	221	101	102	103	150	152	154
10 × 8	270	273	277	217	219	221	176	178	180
10 × 6	270	273	277	167	168	171	176	178	180
10 × 5	270	273	277	140	141	144	176	178	180
10 × 4	270	273	277	113	114	116	176	178	180
12 × 10	321	324	328	270	273	277	200	203	206
12 × 8	321	324	328	217	219	221	200	203	206
12 × 6	321	324	328	167	168	171	200	203	206
12 × 5	321	324	328	140	141	144	200	203	206
14 × 12	353	356	360	321	324	328	327	330	333
14 × 10	353	356	360	270	273	277	327	330	333
14 × 8	353	356	360	217	219	221	327	330	333
14 × 6	353	356	360	167	168	171	327	330	333
16 × 14	403	406	410	353	356	360	353	356	359
16 × 12	403	406	410	321	324	328	353	356	359
16 × 10	403	406	410	270	273	277	353	356	359
16 × 8	403	406	410	217	219	221	353	356	359
18 × 16	454	457	461	403	406	410	378	381	384
18 × 14	454	457	461	353	356	360	378	381	384
18 × 12	454	457	461	321	324	328	378	381	384
18 × 10	454	457	461	270	273	277	378	381	384
20 × 18	503	508	514	454	457	461	505	508	511
20 × 16	503	508	514	403	406	410	505	508	511
20 × 14	503	508	514	353	356	360	505	508	511
20 × 12	503	508	514	321	324	328	505	508	511
22 × 20	554	559	565	503	508	514	505	508	511
22 × 18	554	559	565	454	457	461	505	508	511
22 × 16	554	559	565	403	406	410	505	508	511
22 × 14	554	559	565	353	356	360	505	508	511
24 × 22	605	610	616	554	559	565	505	508	511
24 × 20	605	610	616	503	508	514	505	508	511
24 × 18	605	610	616	454	457	461	505	508	511
24 × 16	605	610	616	403	406	410	505	508	511
26 × 24	655	660	667	605	610	616	607	610	613
26 × 22	655	660	667	554	559	565	607	610	613
26 × 20	655	660	667	503	508	514	607	610	613
26 × 18	655	660	667	454	457	461	607	610	613

TABLE A9 DIMENSIONS OF REDUCERS (CONT'D)

Nominal Pipe Size (NPS)	O.D. of Large End *D*			O.D. of Small End *D*			End-to-End Length of Reducers *H*		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
28 x 26	706	711	718	655	660	667	607	610	613
28 x 24	706	711	718	605	610	616	607	610	613
28 x 20	706	711	718	503	508	514	607	610	613
28 x 18	706	711	718	454	457	461	607	610	613
30 x 28	757	762	769	706	711	718	607	610	613
30 x 26	757	762	769	655	660	667	607	610	613
30 x 24	757	762	769	605	610	616	607	610	613
30 x 20	757	762	769	503	508	514	607	610	613
32 x 30	808	813	820	757	762	769	605	610	615
32 x 28	808	813	820	706	711	718	605	610	615
32 x 26	808	813	820	655	660	667	605	610	615
32 x 24	808	813	820	605	610	616	605	610	615
34 x 32	859	864	871	808	813	820	605	610	615
34 x 30	859	864	871	757	762	769	605	610	615
34 x 26	859	864	871	655	660	667	605	610	615
34 x 24	859	864	871	605	610	616	605	610	615
36 x 34	909	914	921	859	864	871	605	610	615
36 x 32	909	914	921	808	813	820	605	610	615
36 x 30	909	914	921	757	762	769	605	610	615
36 x 26	909	914	921	655	660	667	605	610	615
36 x 24	909	914	921	605	610	616	605	610	615
38 x 36	960	965	972	909	914	921	605	610	615
38 x 34	960	965	972	859	864	871	605	610	615
38 x 32	960	965	972	808	813	820	605	610	615
38 x 30	960	965	972	757	762	769	605	610	615
38 x 28	960	965	972	706	711	718	605	610	615
38 x 26	960	965	972	655	660	667	605	610	615
40 x 38	1011	1016	1023	960	965	972	605	610	615
40 x 36	1011	1016	1023	909	914	921	605	610	615
40 x 34	1011	1016	1023	859	864	871	605	610	615
40 x 32	1011	1016	1023	808	813	820	605	610	615
40 x 30	1011	1016	1023	757	762	769	605	610	615
42 x 40	1062	1067	1074	1011	1016	1023	605	610	615
42 x 38	1062	1067	1074	960	965	972	605	610	615
42 x 36	1062	1067	1074	909	914	921	605	610	615
42 x 34	1062	1067	1074	859	864	871	605	610	615
42 x 32	1062	1067	1074	808	813	820	605	610	615
42 x 30	1062	1067	1074	757	762	769	605	610	615
44 x 42	1113	1118	1125	1062	1067	1074	605	610	615
44 x 40	1113	1118	1125	1011	1016	1023	605	610	615
44 x 38	1113	1118	1125	960	965	972	605	610	615
44 x 36	1113	1118	1125	909	914	921	605	610	615
46 x 44	1163	1168	1175	1113	1118	1125	706	711	716
46 x 42	1163	1168	1175	1062	1067	1074	706	711	716
46 x 40	1163	1168	1175	1011	1016	1023	706	711	716
46 x 38	1163	1168	1175	960	965	972	706	711	716
48 x 46	1214	1219	1226	1163	1168	1175	706	711	716
48 x 44	1214	1219	1226	1113	1118	1125	706	711	716
48 x 42	1214	1219	1226	1062	1067	1074	706	711	716
48 x 40	1214	1219	1226	1011	1016	1023	706	711	716

GENERAL NOTE: Dimensions are in millimeters.

ANNEX B
REFERENCES

(This Annex is an integral part of ASME B16.9-1993 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.

ASME Publications (Approved as American National Standards)

ASME/ANSI B16.5-1988	Pipe Flanges and Flanged Fittings
ASME B16.25-1992	Buttwelding Ends
ASME B31	Code for Pressure Piping
ANSI/ASME B36.10M-1985	Welded and Seamless Wrought Steel Pipes
ASME BPV-1992	ASME Boiler and Pressure Vessel Code

ASTM Publications

ASTM A 234-91c	Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 403-91	Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 420-91	Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service

MSS Publications

MSS SP-43-1991	Wrought Stainless Steel Butt-Welding Fittings

Publications of the following organizations appear on the above list:

ASME	The American Society of Mechanical Engineers 345 East 47th Street, New York, New York 10017 ASME Order Department 22 Law Drive, Box 2300 Fairfield, New Jersey 07007-2300
ASTM	American Society of Testing and Materials 1916 Race Street, Philadelphia, Pennsylvania 19103

MSS	Manufacturers Standardization Society of the Valve and Fittings Industry 127 Park Street NE, Vienna, VA 22180

Publications appearing above which have been approved as American National Standards may also be obtained from

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

INTERPRETATIONS TO ASME B16.9

(These interpretations are not part of ASME B16.9-1993 and are included for information only.)

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
United Engineering Center
345 East 47th Street
New York, NY 10017

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.

ASME procedures provide for reconsideration of an interpretation when or if additional information is available which the inquirer believes might affect the interpretation. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

INTERPRETATIONS NO. 1

Replies to Technical Inquiries Issued From January 1, 1986 Through October 31, 1992

Interpretation: 1-1

Subject: Paragraph 1.2, Scope

Date Issued: February 19, 1986

File: B16-85-019

Question: Are straight cone taper and step reducers included in the scope of ANSI B16.9-1978?

Reply: Yes. See para. 1.2 of the Standard.

Interpretation: 1-2

Subject: Paragraph 1.3, Scope

Date Issued: April 8, 1987

File: B16-86-005

Question: Do fabricated fittings employing intersection welds fall within the scope of ASME/ ANSI B16.9-1986?

Reply: No. See para. 1.3.

Interpretation: 1-3

Subject: Paragraph 1.1, "Factory-Made"

Date Issued: June 10, 1987

File: B16-87-002

Question (1): What is the definition or intended meaning of the term "factory-made" as used in ANSI B16.9-1978, Section 1, Scope, para. 1.1?

Reply (1): "Factory-made" means production facilities, manufacturing methods (using tools, dies, jigs, and fixtures), and inspection procedures to a quality control system of a standard line of butt-welding fittings.

Question (2): Section 1, Scope, para. 1.3 considers fabricated laterals, or other fittings employing intersection welds, as pipe fabrications to be designed in accordance with ANSI B31. Is the intent of this provision to exclude fabricated fittings from the provisions of ANSI B16.9?

Reply (2): Yes.

Question (3): Do elbows with miter joints meet the provisions of Section 7, Surface Contours, para. 7.1?

Reply (3): No.

Interpretation: 1-4

Subject: Inside Diameter of Fittings

Date Issued: February 27, 1990

File: B16-88-002

Question: Does ANSI B16.9-1978 place any minimum dimensional requirements on the inside diameter of fittings at a position other than the welding ends?

Reply: No.

Interpretation: 1-5

Subject: Paragraph 9, Design Proof Test

Date Issued: February 27, 1990

File: B16-88-003

Question (1): Does para. 9 of ASME/ANSI B16.9-1986 require you to use the nominal wall thickness of the pipe that the test fitting marking identifies when calculating the burst pressure "P"?

Reply (1): Yes.

Question (2): Is the actual wall thickness of the pipe used in the test required to be greater than the nominal wall thickness of the pipe that the fitting marking identifies?

Reply (2): ASME/ANSI B16.9-1986 does not address the requirements for the wall thickness of the pipe used in the test.

Interpretation: 1-6

Subject: Table A1, Tolerances

Date Issued: February 27, 1990

File: B16-88-004

Question: Does a NPS 30 buttweld long radius elbow that has an out-of-roundness value of 10 mm (major outside diameter 814 mm and a minor outside diameter of 804 mm) meet the dimensional tolerance requirements of ASME/ANSI B16.9-1986, Table A1?

Reply: No. The O.D. of a NPS 32 long radius elbow has a nominal outside diameter at the weld bevel of 813 mm with a +7 mm, −5 mm tolerance and an out-of-roundness tolerance of 12 mm. The minor outside diameter of the fitting is out of tolerance.

Interpretation: 1-7

Subject: Table 2 Dimensions of 45° Elbows

Date Issued: February 27, 1990

File: B16-88-006

Question: Does ASME/ANSI B16.9-1986 require dimensions on 45° elbows that would permit two (2) to be welded in series and meet the dimensional requirements of the corresponding size 90° elbow?

Reply: No.

Interpretation: 1-8

Subject: Paragraph 9.3.5, Proof Tests

Date Issued: February 27, 1990

File: B16-88-008

Question: Are fittings made to ASME/ANSI B16.9-1986, that were designed by successful proof tests which fulfilled the requirements of earlier editions of B16.9, considered as fulfilling the requirements of the 1986 edition?

Reply: Yes, provided the test data has been reviewed and meets the B16.9-1986 requirements.

Interpretation: 1-9

Subject: Tolerances in Parallelism

Date Issued: May 10, 1990

File: B16-90-003

Question: Do Table 7 and/or Table 1 of ASME/ANSI B16.9-1986 have a tolerance on parallelism between face and backface of the lap of a Lap Joint Stub End?

Reply: No.

Interpretation: 1-10

Subject: Paragraph 11.2, Dimensions

Date Issued: May 10, 1990

File: B16-90-004

Question: Do the provisions of para. 11.2, ANSI B16.9-1978, prohibit the use of vernier, micrometer, electronic read-out equipment, etc. for the determination of actual dimensions of B16.9 fittings?

Reply: No.

Interpretation: 1-11

Subject: Design Proof Test

Date Issued: August 8, 1990

File: B16-90-008

Question: Does ASME/ANSI B16.9-1986 cover Design Proof Test requirements for branch fittings (other than tees or crosses covered in Tables 5 and 6) in which reinforcement considerations must be analyzed?

Reply: No.

Interpretation: 1-12

Subject: Paragraph 9.2.3, Design Proof Test

Date Issued: June 27, 1990

File: B16-90-014

Question: What value of "S" shall be used in the formulae for P (Adj) (adjusted proof test pressure, psig) and P (computed bursting pressure of pipe which the fitting's marking identifies, psig) presented in para. 9.2.3, ANSI B16.9-1978?

Reply: The value of "S" is the same for both equations as follows: S = Minimum specified tensile strength of the pipe which the fittings marking identifies, psi.

Interpretation: 1-13

Subject: Tolerances

Date Issued: January 23, 1991

File: B16-90-028

Question (1): According to ASME/ANSI B16.9-1986, must all inside diameter, outside diameter, and wall thickness tolerances (see Tables 1 and A1) be met for each fitting?

Reply (1): Yes.

Question (2): Is there any precedence under which the tolerance must be applied?

Reply (2): No.

Question (3): In ASME/ANSI B16.9-1986, is there a maximum tolerance on wall thickness?

Reply (3): No.

Interpretation: 1-14

Subject: Taper Boring

Date Issued: January 23, 1991

File: B16-90-029

Question (1): According to ASME/ANSI B16.9-1986, when a B16.9 fitting dimension is shortened due to taper boring, what tolerances apply?

Reply (1): Those in Table 1, Tolerances. See also para. 1.3.

Question (2): According to ASME/ANSI B16.28-1986, when a B16.28 fitting dimension is shortened due to taper boring, what tolerances apply?

Reply (2): Those in Table 1, Tolerances.

Interpretation: 1-15

Subject: Table A1, Tolerances

Date Issued: January 24, 1991

File: B16-90-019

Question: Does Table A1, ASME/ANSI B16.9-1986, specify tolerances for inside diameter out-of-roundness?

Reply: No.

Interpretation: 1-16

Subject: Clarification of Long Radius Elbow

Date Issued: January 25, 1991

File: B16-90-027

Question: Does ASME/ANSI B16.9-1986, for 90° long radius elbows, require the openings to be joined by circular arcs on the external surfaces?

Reply: Yes, but the circular arcs may be terminated in tangents. See ASME/ANSI B16.9-1986, Section 7, Surface Contours.

Interpretation: 1-17

Subject: Paragraph 9.2.2, Other Components

Date Issued: February 19, 1991

File: B16-90-031

Question: Is the actual wall thickness or the pipe material used in the Design Proof Test Assembly described in ASME/ANSI B16.9-1986 in para. 9.2.2 limited to the nominal wall thickness or compatible pipe material that the fitting marking identifies?

Reply: No.

Interpretation: 1-18

Subject: Proof Testing of Fittings

Date Issued: September 19, 1991

File: B16-90-011

Question: Can successful proof pressure test data of an ASME/ANSI B16.9-1986 fitting such as a tee be applied to qualify a non-similar B16.9 fitting such as an elbow?

Reply: No. Test data may only be applied to qualify fittings similar to the test fittings as outlined in Section 9.4, ASME/ANSI B16.9-1986.

Interpretation: 1-19

Subject: Wall Thickness Limitations for Fittings

Date Issued: September 19, 1991

File: B16-91-012

Question: Does ASME/ANSI B16.9-1986 have any restrictions on the maximum wall thickness used for B16.9 fitting construction?

Reply: No, provided the ends are prepared to match the customer's pipe within the tolerances specified in Table 1.

Interpretation: 1-20

Subject: Table 9, Straight Cone Taper Reducers

Date Issued: April 2, 1992

File: B16-91-013

Question: Are straight cone taper reducers included in the scope of ASME/ANSI B16.9-1986?

Reply: Yes, however the welding end preparations described in ASME/ANSI B16.9, Section 8 shall be met. The referencing Code may have additional requirements.

Interpretation: 1-21

Subject: Table 1, Tolerances

Date Issued: July 31, 1992

File: B16-92-006

Question: Do the inside, outside diameters, and minimum wall thickness tolerances of B16.9-1978, Table 1 apply throughout the fitting?

Reply: Table 1 tolerances for the I.D. and O.D. dimensions apply at the ends of the fitting. The wall thickness tolerance applies throughout the fitting.

Interpretation: 1-22

Subject: Test Procedures

Date Issued: August 19, 1992

File: B16-92-014

Question: When calculating the adjusted proof test pressure $P_{(adj.)}$ per ASME/ANSI B16.9-1986, para. 9.3, for a filler metal added welded test fitting, can a welded tensile test specimen, representative of the test fitting, be used in determining the actual tensile strength of the test fitting material $S_{(act)}$?

Reply: Yes, provided the tensile specimen and tensile strength meet the applicable material requirements of para. 5.0.

AMERICAN NATIONAL STANDARDS FOR PIPING, PIPE FLANGES, FITTINGS, AND VALVES

Scheme for the Identification of Piping Systems ..... A13.1-1981(R1985)
Pipe Threads, General Purpose (Inch) ..... B1.20.1-1983(R1992)
Dryseal Pipe Threads (Inch) ..... B1.20.3-1976(R1991)
Cast Iron Pipe Flanges and Flanged Fittings B16.1-1989
Malleable Iron Threaded Fittings B16.3-1992
Gray Iron Threaded Fittings B16.4-1992
Pipe Flanges and Flanged Fittings B16.5-1988
Factory-Made Wrought Steel Buttwelding Fittings B16.9-1993
Face-to-Face and End-to-End Dimensions of Valves B16.10-1992
Forged Fittings, Socket-Welding and Threaded B16.11-1991
Cast Iron Threaded Drainage Fittings B16.12-1991
Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads B16.14-1991
Cast Bronze Threaded Fittings, Class 125 and 250 ..... B16.15-1985
Cast Copper Alloy Solder Joint Pressure Fittings B16.18-1984
Ring-Joint Gaskets and Grooves for Steel Pipe Flanges B16.20-1973
Nonmetallic Flat Gaskets for Pipe Flanges B16.21-1992
Wrought Copper and Copper Alloy Solder Joint Pressure Fittings B16.22-1989
Cast Copper Alloy Solder Joint Drainage Fittings — DWV B16.23-1992
Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500, and 2500 ..... B16.24-1991
Buttwelding Ends B16.25-1992
Cast Copper Alloy Fittings for Flared Copper Tubes B16.26-1988
Wrought Steel Buttwelding Short Radius Elbows and Returns B16.28-1986
Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings — DWV B16.29-1986
Cast Copper Alloy Solder Joint Fittings for Sovent Drainage Systems B16.32-1992
Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (Sizes ½ Through 2) B16.33-1990
Valves — Flanged, Threaded, and Welding End B16.34-1988
Orifice Flanges B16.36-1988
Large Metallic Valves for Gas Distribution (Manually Operated, NPS 2½ to 12, 125 psig Maximum) ... B16.38-1985
Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300 ..... B16.39-1986
Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems B16.40-1985
Functional Qualification Requirements for Power Operated Active Valve Assemblies for Nuclear Power Plants ..... B16.41-1983(R1989)
Ductile Iron Pipe Flanges and Flanged Fittings, Class 150 and 300 ..... B16.42-1987
Wrought Copper and Copper Alloy Solder Joint Fittings for Sovent® Drainage Systems B16.43-1982
Cast Iron Fittings for Sovent® Drainage Systems B16.45-1987
Large Diameter Steel Flanges (NPS 26 Through NPS 60) B16.47-1990
Power Piping B31.1-1992
Fuel Gas Piping B31.2-1968
Chemical Plant and Petroleum Refinery Piping B31.3-1993
Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols B31.4-1992
Refrigeration Piping B31.5-1992
Gas Transmission and Distribution Piping Systems B31.8-1992
Building Services Piping B31.9-1988
Slurry Transportation Piping Systems B31.11-1989
ASME Guide for Gas Transmission and Distribution Piping Systems — 1986 (not an ANSI Standard) .....
Manual for Determining the Remaining Strength of Corroded Pipelines (not an ANSI Standard) B31G-1991
Welded and Seamless Wrought Steel Pipe B36.10M-1985
Stainless Steel Pipe B36.19M-1985
Self-Operated and Power-Operated Safety-Related Valves Functional Specification Standard .. N278.1-1975(R1984)

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