



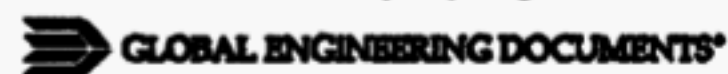
The American Society of
Mechanical Engineers

A N A M E R I C A N N A T I O N A L S T A N D A R D

FACTORY-MADE WROUGHT BUTTWELDING FITTINGS

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ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. The interpretations will be included with this edition.

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FOREWORD

In 1921, the American Engineering Standards Committee, later the 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 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 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 $\frac{1}{4}$ and $\frac{1}{2}$). 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 $\frac{3}{4}$ 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 ASME/ANSI B16.9-1986, the text was revised and inch dimensions were established as the standard.

In 1991, the Subcommittee reviewed the document and made a number of revisions that were included in ASME B16.9-1993. Dimensions for short pattern lap joints were also added.

In ASME B16.9-2001, short radius elbows and returns were added, which included all dimensions and tolerances of ASME B16.28-1994. Metric units were provided as an independent but parallel alternative standard to U.S. customary units and a Quality System Program appendix was added.

In 2003, the Subcommittee reviewed the document and made a number of revisions. The scope of the standard was changed to permit fabricated lap joint stub ends employing circumferential or intersection welds.

This Standard was approved as an American National Standard on October 15, 2003 and December 31, 2003.

ASME B16 COMMITTEE

Standardization of Valves, Flanges, Fittings, and Gaskets

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

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

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

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

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

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. 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 that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. 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.

Attending Committee Meetings. The B16 Standards Committee regularly holds meetings, which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B16 Standards Committee.

FACTORY-MADE WROUGHT BUTTWELDING FITTINGS

1 SCOPE

1.1 General

This Standard covers overall dimensions, tolerances, ratings, testing, and markings for wrought factory-made butt welding fittings in sizes NPS $\frac{1}{2}$ through 48 (DN 15 through 1200).

1.2 Special Fittings

Fittings may be made to special dimensions, sizes, shapes, and tolerances by agreement between the manufacturer and the purchaser.

1.3 Fabricated Fittings

Fabricated laterals and other fittings employing circumferential or intersection welds are considered pipe fabrication and are not within the scope of this Standard.

Fabricated lap joint stub ends are exempt from the above restrictions, provided they meet all the requirements of the applicable ASTM material specification listed in para. 5.

1.4 Standard Units

The values stated in either metric or U.S. customary units are to be regarded separately as standard. Within the text, the U.S. customary units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with this Standard.

The designation for size is NPS for both metric and customary dimensioned fittings. Fitting pressure rating is associated with the connecting wall thickness of pipe of equivalent size and material.

1.5 References

1.5.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Mandatory Appendix II. 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 Mandatory Appendix II. A product made in conformance with a prior edition of referenced standards and in all other respects conforming to this Standard will be considered to be in conformance.

1.5.2 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.

1.6 Service Conditions

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

1.7 Welding

Installation welding requirements are outside the scope of this Standard.

1.8 Quality Systems

Nonmandatory requirements relating to the fitting manufacturer's Quality System Program are described in Nonmandatory Appendix A.

1.9 Convention

For the purpose of determining conformance with this Standard, the convention for fixing significant digits where limits (maximum or minimum values) are specified shall be rounded off as defined in ASTM E 29. This requires that an observed or calculated value shall be rounded off to the nearest unit in the last right-hand digit used in expressing the limit. Decimal values and tolerances do not imply a particular method of measurement.

1.10 Pressure Rating Designation

Class, followed by a dimensionless number, is the designation for pressure-temperature ratings. Standardized designations for flanges per ASME B16.5 referenced in this Standard are Classes 150, 300, 600, 900, 1500, and 2500.

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 pipe size, wall thickness, and material that is equivalent to that of the fitting shall be used. Pipe size, 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 (e.g., ASME B16.49 for bends) contained in nationally recognized pressure vessel or piping codes, or at the manufacturer's option by proof testing in accordance with para. 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

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

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

NOTE: For NPS > 4, the equivalence is DN = 25(NPS).

4 MARKING

4.1 Standard Marking

Each fitting shall be permanently marked to show the following:

- (a) manufacturer's name or trademark
- (b) material identification, either the ASTM or ASME grade designation
- (c) schedule number¹ or nominal wall thickness in mm

¹ Schedule number is a dimensionless number that is widely used as a convenient designation for use in ordering pipe and fittings. It is normally associated with a group of standardized pipe wall thickness. Refer to ASME B36.10M and ASME B36.19M for complete details on pipe schedule numbers.

(d) size — the nominal pipe size (NPS) identification number related to the end connections shall be used

(e) compliance — see para 4.4 for standard and special fitting marking

A manufacturer may supplement these mandatory markings with others, including a DN size designation, but confusion with the required marking shall be avoided.

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 Compliance

4.4.1 Standard Fittings. That the fitting was manufactured in conformance with this Standard, including all dimensional requirements, is certified by a prefix "WP" in the material grade designation marking.

4.4.2 Special Fittings. That the fitting was manufactured in conformance with this Standard, except that dimensional requirements are as agreed between the purchaser and the manufacturer, is certified by a supplementary suffix to the material grade designation marking as follows:

(a) "S9" applies for fittings in accordance with ASTM A 234, A 403, A 420, and A 815.

(b) "SPLD" applies for fittings in accordance with ASTM B 361, B 363, and B 366.

5 MATERIAL

Wrought fittings covered by this Standard shall be in accordance with ASTM A 234, A 403, A 420, A 815, B 361, B 363, B 366, or the corresponding standard listed in Section II of the ASME Boiler and Pressure Vessel Code. 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 the manufacturer and purchaser. Such fittings need not meet the requirements of para. 7.

6 FITTING DIMENSIONS

6.1 General

This Standard provides for a fixed position for the welding ends with reference to either the centerline of the fittings or the overall dimensions. Dimensional requirements for these fittings are to be found in Tables

3 through 12 and Tables I2 through I11 of Mandatory Appendix I.

6.2 Special Dimensions

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

6.2.2 Bore Diameter. Bore diameters away from the ends are not specified. If special flow path requirements are needed, the bore dimensions shall be specified by the purchaser.

6.2.3 Stub Ends. Service conditions and joint construction often dictate stub end length requirements. Therefore, the purchaser must specify long or short pattern fitting when ordering. [See General Note (c) in Tables 10 and I9.]

7 SURFACE CONTOURS

Where adjacent openings in fittings are not in parallel planes, they shall be joined by a circular arc or radius on the external surfaces. The arc or radius may be terminated in tangents. Except as provided for block forgings (see para. 5), the projected profile of external surfaces of fittings shall not have sharp intersections (corners) and/or collapsed arcs.

8 END PREPARATION

Unless otherwise specified, the details of the welding end preparation shall be in accordance with Table 1. Transitions from the welding bevel to the 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. 1 are at the manufacturer's option, except as covered in Note (5) of Fig. 1 or unless otherwise specifically ordered.

9 DESIGN PROOF TEST

9.1 Required Tests

Proof tests shall be made as set forth in this Standard when the manufacturer chooses proof testing to qualify the fitting design. Unless otherwise agreed upon between the manufacturer and purchaser, the proof test shall be one based on the computed bursting pressure of the fitting and its connecting piping.

Lap joint stub ends are exempt from proof testing because they are used in a flange assembly, which will have different ratings depending on service application.

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 1.5 mm (0.06 in.) 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 (DN 350) and smaller.

(b) Minimum length of pipe shall be one-half pipe O.D. for NPS greater than 14 (DN 350).

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

D = specified outside diameter of pipe

P = computed minimum proof test pressure for fitting

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

t = nominal pipe wall thickness of the pipe that the fitting marking identifies

NOTE: Any dimensionally consistent system of units may be used.

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 in paras. 9.4.1, 9.4.2, and 9.4.3.

9.4.1 Size Range. One test fitting may be used to qualify similarly proportioned fittings with a size range from one-half to twice that for the tested fitting. The test of a nonreducing 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

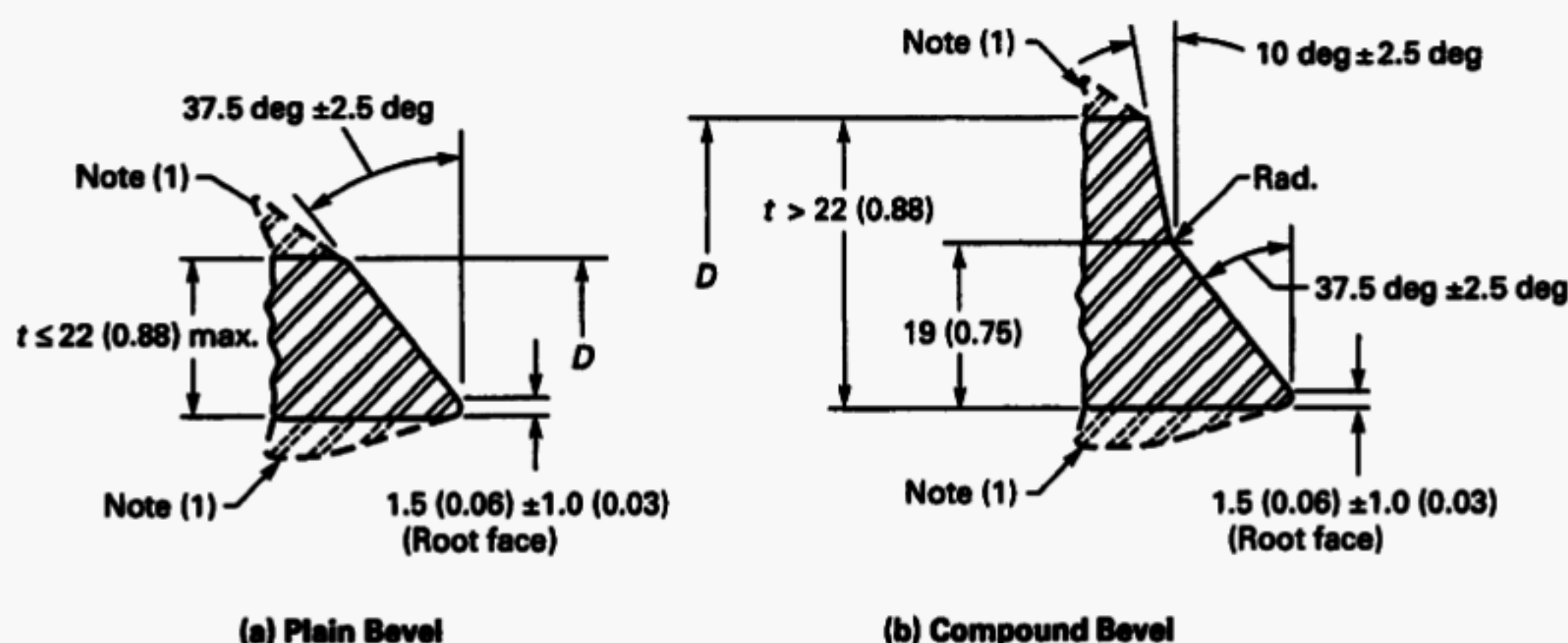


Table 1 Welding Bevels and Root Face

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

GENERAL NOTES:

- (a) Dimensions in parentheses are in inches.
 (b) Other dimensions are in millimeters.

NOTES:

- (1) See para. 8 and Fig. 1 for transition contours.
 (2) $x = 5$ (0.19) for carbon steel or ferritic alloy steel and 3 (0.12) for austenitic alloy steel.

grades of steel will be directly proportional to the tensile properties of the various grades; see para 2.1. Therefore, it is necessary to test only a single material grade in a representative fitting to prove the design of the fitting.

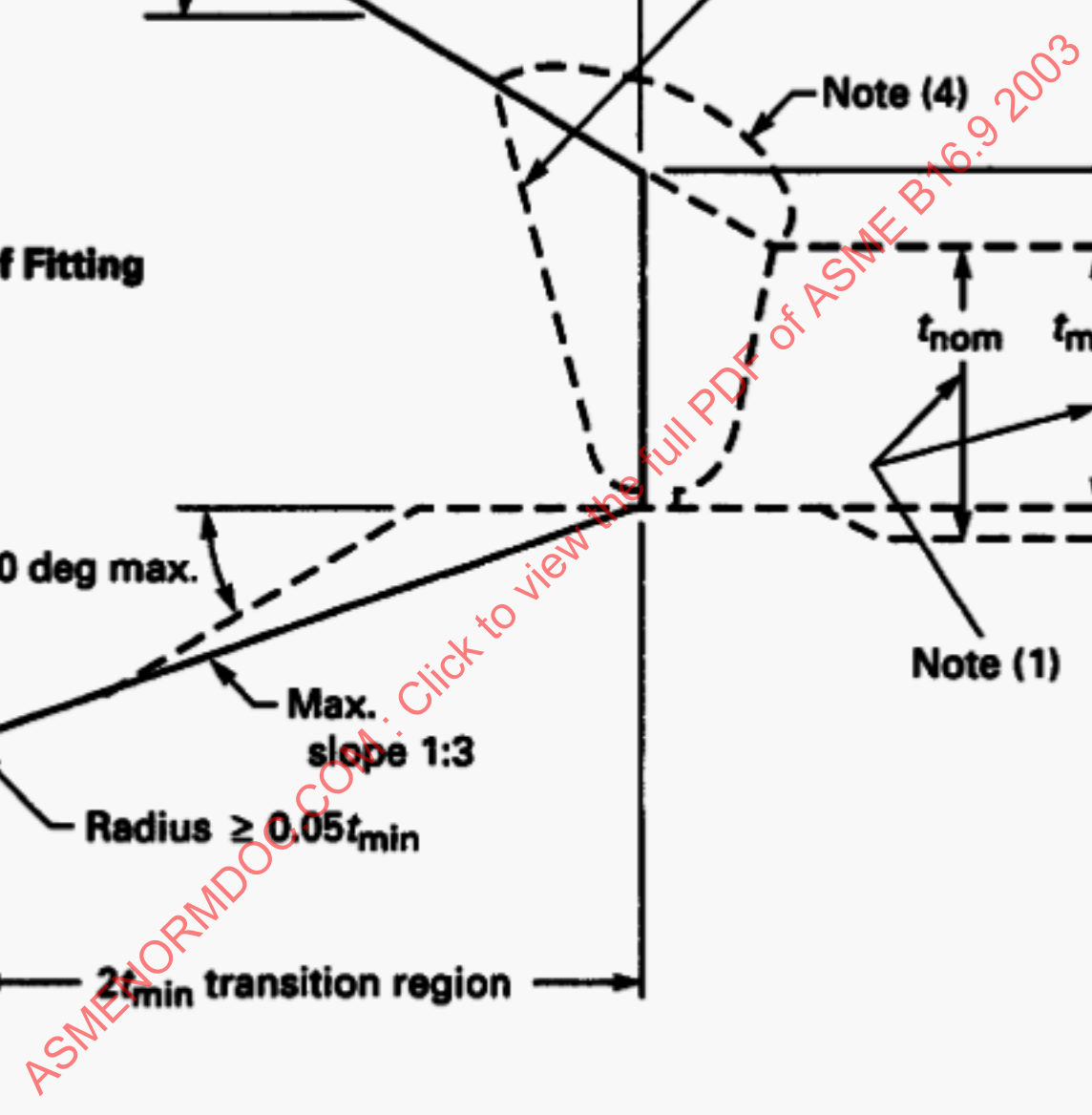
10 PRODUCTION TESTS

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 size and wall thickness the fitting marking identifies.

11 TOLERANCES

Tolerances for fittings are shown in Tables 2 and I1, and apply to the nominal dimensions given in Tables 3 through 12 and Tables I2 through I11. 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.



(1) The value of t_{min} is whichever of the following is applicable:

- (1) The value of t_{min} is whichever of the following is applicable:
 - (a) the minimum ordered wall thickness of the pipe, to include pipe that is purchased to a nominal wall thickness with an undertolerance other than 12.5%;
 - (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 $[t_{min} + 4 \text{ mm (0.16 in.)}]$ or $1.15t_{min}$ when ordered on a minimum wall basis;
 - (b) the greater of $[t_{min} + 4 \text{ mm (0.16 in.)}]$ or $1.10t_{min}$ 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 the inside or outside surfaces within the transition region, as shown by phantom outline, maximum slopes shall be used. Alternatively, radii lying within the envelope may be used.

Fig. 1 Maximum Envelope for Welding End Transitions

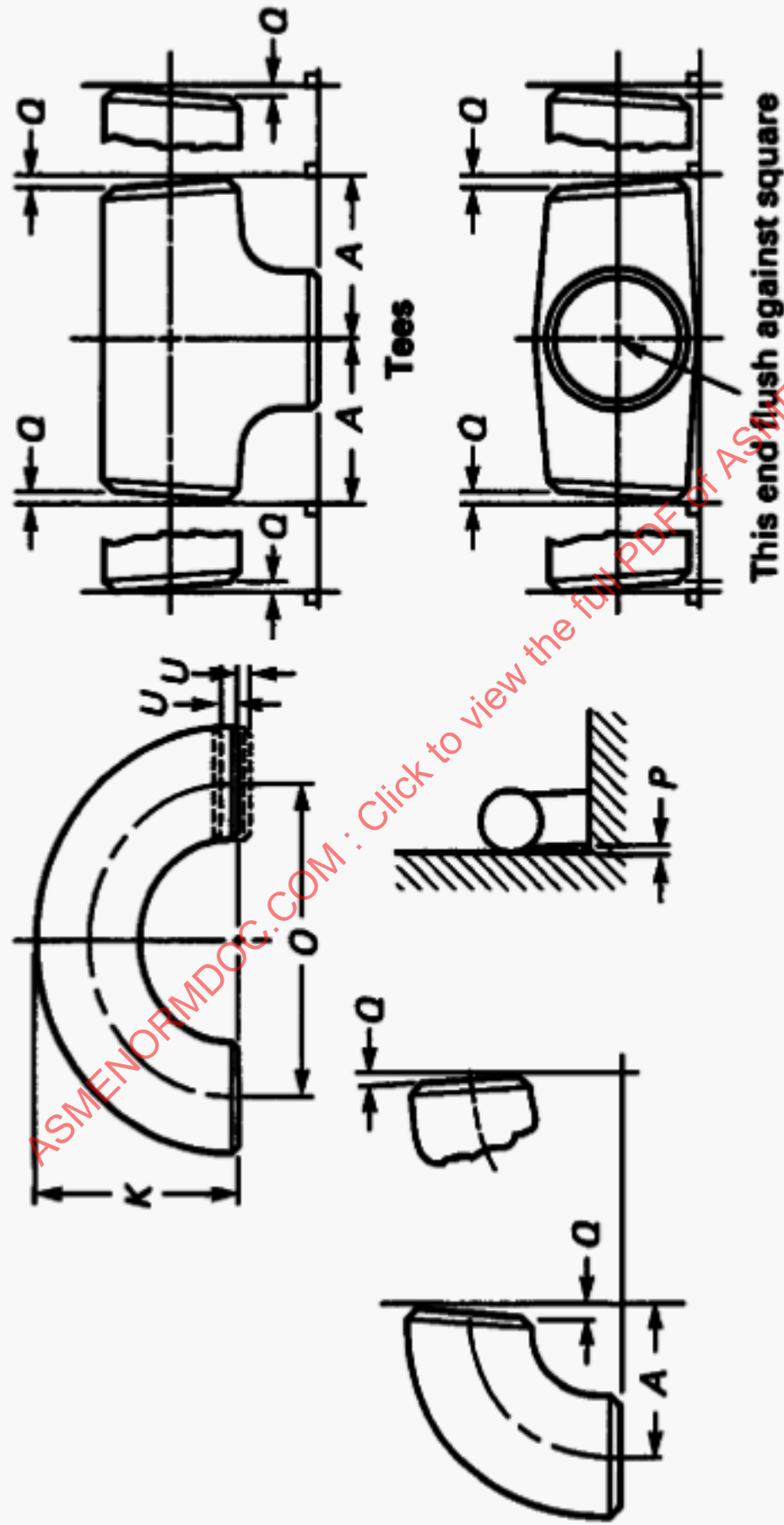


Table 2 Illustration

Table 2 Tolerances

All Fittings [Notes (1) and (2)]				Center-to-End Dimensions of 90 deg and 45 deg Elbows and Tees, A, B, C, M		Overall Length of Reducers and Lap Joint Stub Ends, F, H		Overall Length of Caps, E		180 deg Returns		
Nominal Pipe Size (NPS)	DN	Outside Diameter at Bevel, D [Notes (3) and (4)]	Inside Diameter at End [Notes (3) and (5)]							Center-to-Center Dimension, O	Back-to-Face Dimension, K	Alignment of Ends, U
1/2 to 2 1/2	15-65	+1.6, -0.8	0.8	2	2	2	3	6	1			
3 to 3 1/2	80-90	1.6	1.6	2	2	2	3	6	1			
4	100	1.6	1.6	2	2	2	3	6	1			
5 to 8	125-200	+2.4, -1.6	1.6	2	2	2	6	6	1			
10 to 18	250-450	+4.0, -3.2	3.2	2	2	2	6	6	1			
20 to 24	500-600	+6.4, -4.8	4.8	2	2	2	6	10	2			
26 to 30	650-750	+6.4, -4.8	4.8	2	2	2	6	10	2			
32 to 48	800-1 200	+6.4, -4.8	4.8	3	5	5	10	...	...			
				5	5	5	10	...	...			

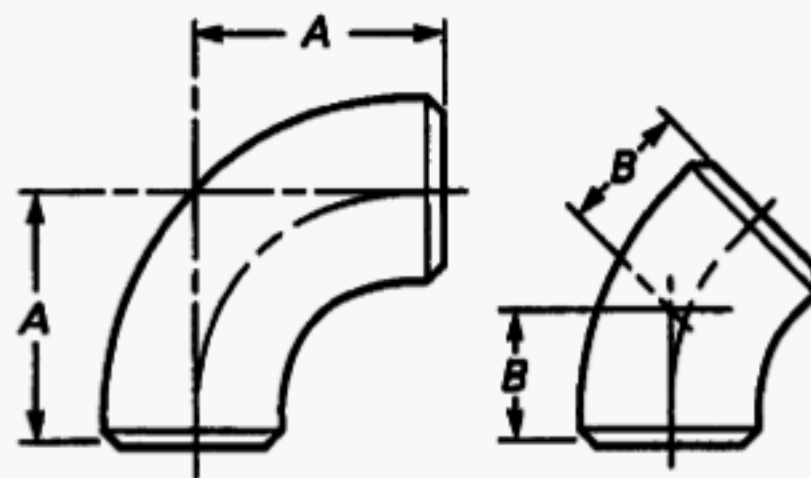
Nominal Pipe Size (NPS)	DN	Lap Joint Stub Ends [Note (6)]		Nominal Pipe Size (NPS)	DN	Angularity Tolerances	
		Outside Diameter of Lap, G	Fillet Radius of Lap, R			Off Angle, Q	Off Plane, P
1/2 to 2 1/2	15-65	+0, -1	+0, -1	1/2 to 4	15-100	1	2
3 to 3 1/2	80-90	+0, -1	+0, -1	5 to 8	125-200	2	4
4	100	+0, -1	+0, -2	10 to 12	250-300	3	5
5 to 8	125-200	+0, -1	+0, -2	14 to 16	350-400	3	6
10 to 18	250-450	+0, -2	+0, -2	18 to 24	450-600	4	10
20 to 24	500-600	+0, -2	+0, -2	26 to 30	650-750	5	10
26 to 30	650-750	...	...	32 to 42	800-1 050	5	13
32 to 48	800-1 200	...	...	44 to 48	1 100-1 200	5	19

GENERAL NOTES:

- (a) For reference, see Table 2 Illustration on page 6.
 (b) All dimensions are in millimeters.
 (c) Tolerances are equal plus and minus except as noted.

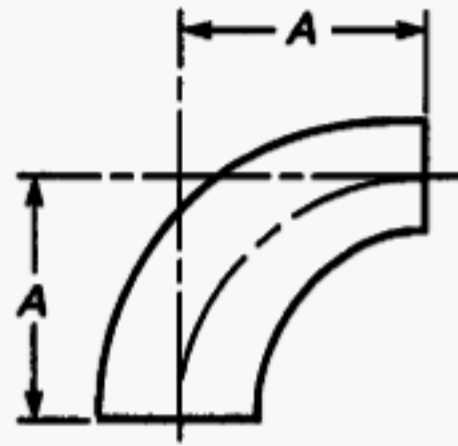
NOTES:

- (1) The inside diameter and the nominal wall thicknesses at ends are to be specified by the purchaser.
 (2) A minimum wall thickness of 87.5% applies unless the purchaser specifies a different wall thickness tolerance. See Fig. 1, Note (1)(a).
 (3) Out-of-round is the sum of absolute values of plus and minus tolerances.
 (4) This tolerance may not apply in localized areas of formed fittings where increased wall thickness is required to meet design requirements of para. 2.2.
 (5) 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.
 (6) See Table 10 for limiting dimensions of outside diameter of barrel.

**Table 3 Dimensions of Long Radius Elbows**

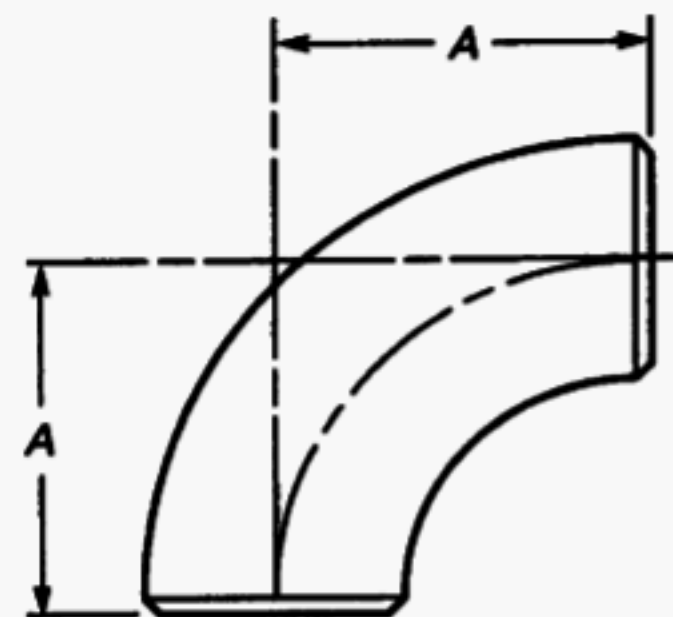
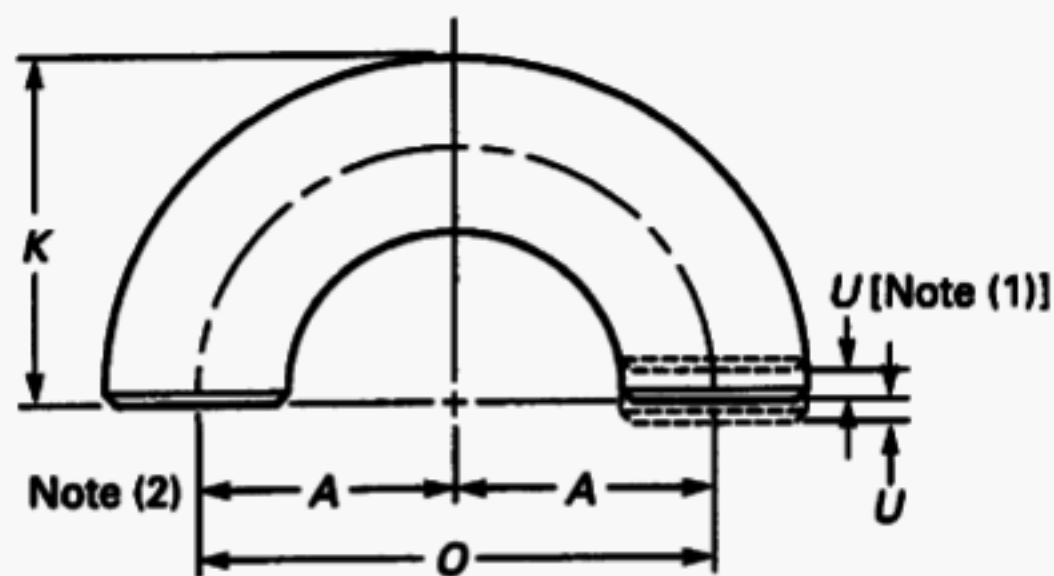
Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End	
		90 deg Elbows, A	45 deg Elbows, B
1/2	21.3	38	16
3/4	26.7	38	19
1	33.4	38	22
1 1/4	42.2	48	25
1 1/2	48.3	57	29
2	60.3	76	35
2 1/2	73.0	95	44
3	88.9	114	51
3 1/2	101.6	133	57
4	114.3	152	64
5	141.3	190	79
6	168.3	229	95
8	219.1	305	127
10	273.0	381	159
12	323.8	457	190
14	355.6	533	222
16	406.4	610	254
18	457	686	286
20	508	762	318
22	559	838	343
24	610	914	381
26	660	991	406
28	711	1 067	438
30	762	1 143	470
32	813	1 219	502
34	864	1 295	533
36	914	1 372	565
38	965	1 448	600
40	1 016	1 524	632
42	1 067	1 600	660
44	1 118	1 676	695
46	1 168	1 753	727
48	1 219	1 829	759

GENERAL NOTE: All dimensions are in millimeters.

**Table 4 Dimensions of Long Radius Reducing Elbows**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center- to-End, A	Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center- to-End, A
	Large End	Small End			Large End	Small End	
2 × 1½	60.3	48.3	76	10 × 8	273.0	219.1	381
2 × 1¼	60.3	42.2	76	10 × 6	273.0	168.3	381
2 × 1	60.3	33.4	76	10 × 5	273.0	141.3	381
2½ × 2	73.0	60.3	95	12 × 10	323.8	273.0	457
2½ × 1½	73.0	48.3	95	12 × 8	323.8	219.1	457
2½ × 1¼	73.0	42.2	95	12 × 6	323.8	168.3	457
3 × 2½	88.9	73.0	114	14 × 12	355.6	323.8	533
3 × 2	88.9	60.3	114	14 × 10	355.6	273.0	533
3 × 1½	88.9	48.3	114	14 × 8	355.6	219.1	533
3½ × 3	101.6	88.9	133	16 × 14	406.4	355.6	610
3½ × 2½	101.6	73.0	133	16 × 12	406.4	323.8	610
3½ × 2	101.6	60.3	133	16 × 10	406.4	273.0	610
4 × 3½	114.3	101.6	152	18 × 16	457	406.4	686
4 × 3	114.3	88.9	152	18 × 14	457	355.6	686
4 × 2½	114.3	73.0	152	18 × 12	457	323.8	686
4 × 2	114.3	60.3	152	18 × 10	457	273.0	686
5 × 4	141.3	114.3	190	20 × 18	508	457	762
5 × 3½	141.3	101.6	190	20 × 16	508	406.4	762
5 × 3	141.3	88.9	190	20 × 14	508	355.6	762
5 × 2½	141.3	73.0	190	20 × 12	508	323.8	762
				20 × 10	508	273.0	762
6 × 5	168.3	141.3	229	24 × 22	610	559	914
6 × 4	168.3	114.3	229	24 × 20	610	508	914
6 × 3½	168.3	101.6	229	24 × 18	610	457	914
6 × 3	168.3	88.9	229	24 × 16	610	406.4	914
8 × 6	219.1	168.3	305	24 × 14	610	355.6	914
8 × 5	219.1	141.3	305	24 × 12	610	323.8	914
8 × 4	219.1	114.3	305	...	...	...	...

GENERAL NOTE: All dimensions are in millimeters.

**Table 5 Dimensions of Long Radius Returns**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-Center, O	Back-to-Face, K
1/2	21.3	76	48
3/4 [Note (3)]	26.7	76	51
1	33.4	76	56
1 1/4	42.2	95	70
1 1/2	48.3	114	83
2	60.3	152	106
2 1/2	73.0	190	132
3	88.9	229	159
3 1/2	101.6	267	184
4	114.3	305	210
5	141.3	381	262
6	168.3	457	313
8	219.1	610	414
10	273.0	762	518
12	323.8	914	619
14	355.6	1 067	711
16	406.4	1 219	813
18	457	1 372	914
20	508	1 524	1 016
22	559	1 676	1 118
24	610	1 829	1 219

GENERAL NOTE: All dimensions are in millimeters.

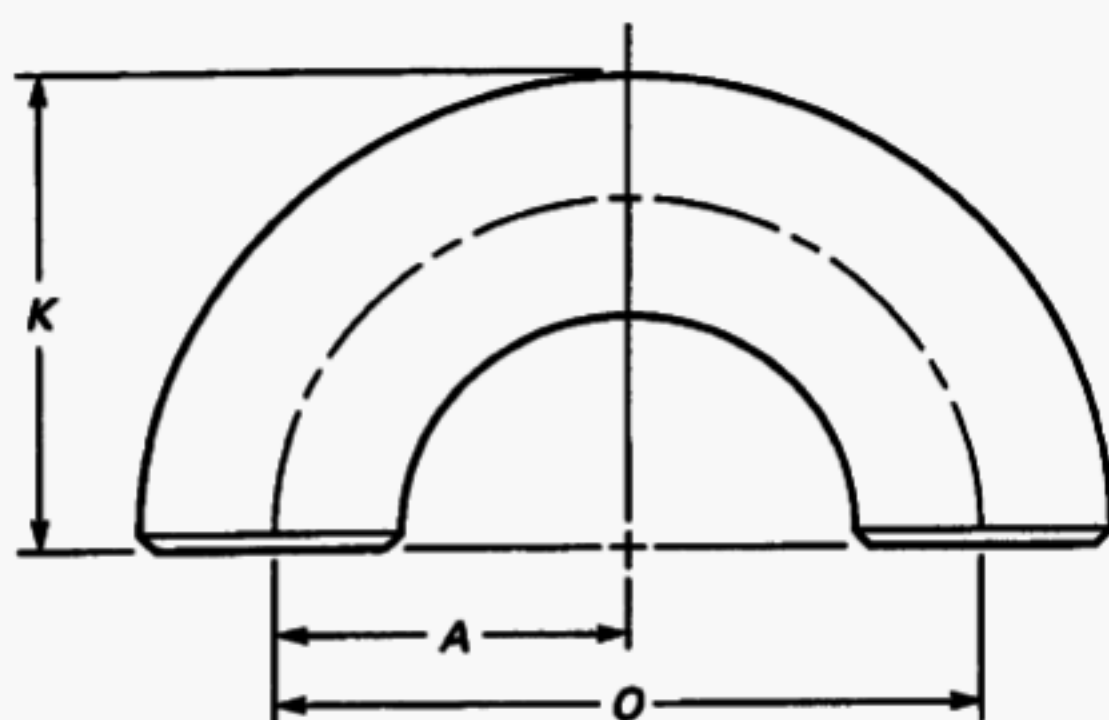
NOTES:

- (1) See Table 2 for tolerance for alignment of ends U.
 (2) Dimension A is equal to one-half of dimension O.
 (3) O and K dimensions of 57 mm and 43 mm, respectively, may be furnished for NPS 3/4 at the manufacturer's option.

Table 6 Dimensions of Short Radius Elbows

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End, A
1	33.4	25
1 1/4	42.2	32
1 1/2	48.3	38
2	60.3	51
2 1/2	73.0	64
3	88.9	76
3 1/2	101.6	89
4	114.3	102
5	141.3	127
6	168.3	152
8	219.1	203
10	273.0	254
12	323.8	305
14	355.6	356
16	406.4	406
18	457	457
20	508	508
22	559	559
24	610	610

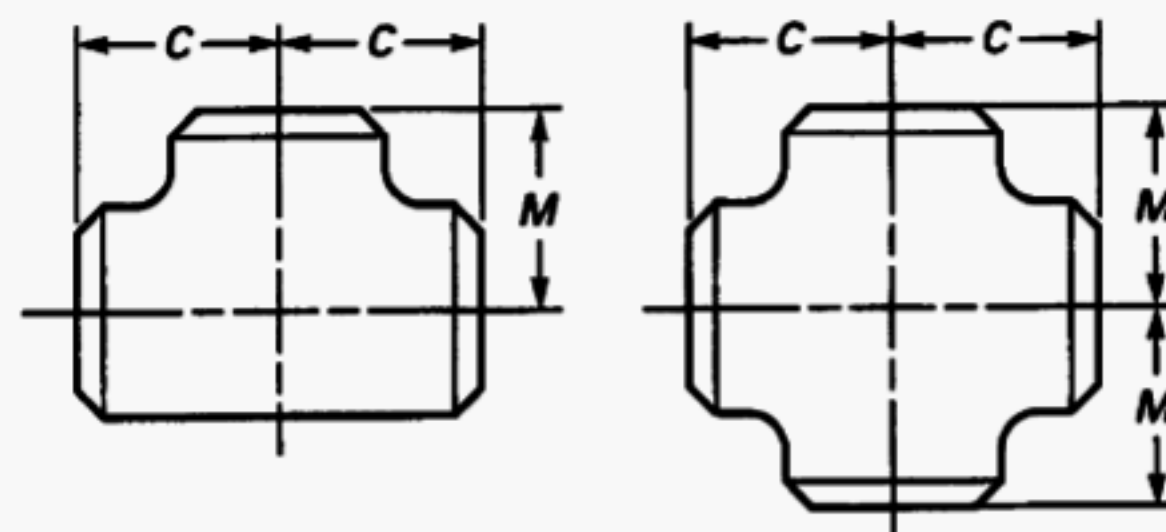
GENERAL NOTE: All dimensions are in millimeters.

**Table 7 Dimensions of Short Radius 180 deg Returns**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-Center, O	Back-to-Face, K
1	33.4	51	41
1 1/4	42.2	64	52
1 1/2	48.3	76	62
2	60.3	102	81
2 1/2	73.0	127	100
3	88.9	152	121
3 1/2	101.6	178	140
4	114.3	203	159
5	141.3	254	197
6	168.3	305	237
8	219.1	406	313
10	273.0	508	391
12	323.8	610	467
14	355.6	711	533
16	406.4	813	610
18	457	914	686
20	508	1 016	762
22	559	1 118	838
24	610	1 219	914

GENERAL NOTES:

- (a) All dimensions are in millimeters.
 (b) Dimension A is equal to one-half of dimension O.

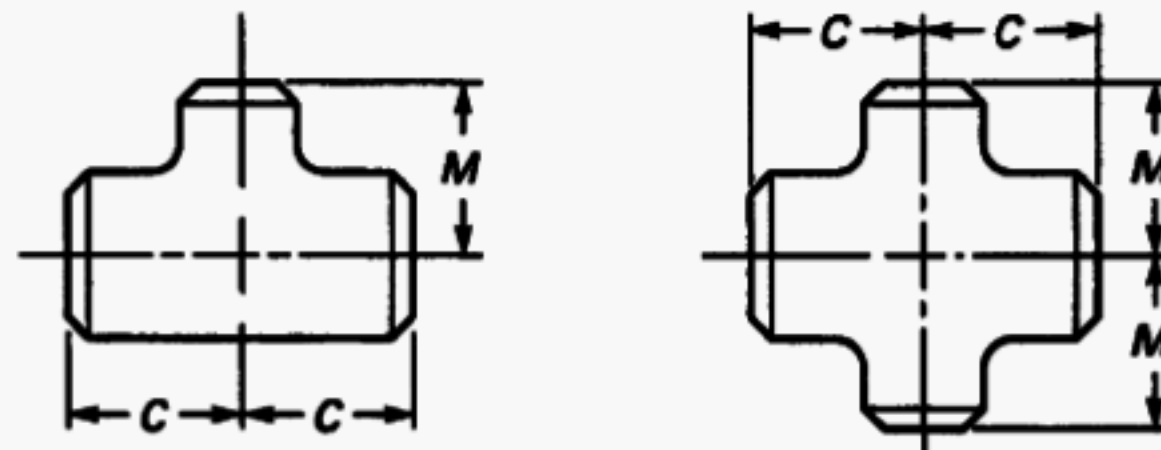
**Table 8 Dimensions of Straight Tees and Crosses**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End	
		Run, C	Outlet, M [Notes (1) and (2)]
1/2	21.3	25	25
3/4	26.7	29	29
1	33.4	38	38
1 1/4	42.2	48	48
1 1/2	48.3	57	57
2	60.3	64	64
2 1/2	73.0	76	76
3	88.9	86	86
3 1/2	101.6	95	95
4	114.3	105	105
5	141.3	124	124
6	168.3	143	143
8	219.1	178	178
10	273.0	216	216
12	323.8	254	254
14	355.6	279	279
16	406.4	305	305
18	457	343	343
20	508	381	381
22	559	419	419
24	610	432	432
26	660	495	495
28	711	521	521
30	762	559	559
32	813	597	597
34	864	635	635
36	914	673	673
38	965	711	711
40	1 016	749	749
42	1 067	762	711
44	1 118	813	762
46	1 168	851	800
48	1 219	889	838

GENERAL NOTE: All 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 9 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run, C	Outlet, M [Note (1)]		Run	Outlet	Run, C	Outlet, M [Note (1)]
$\frac{1}{2} \times \frac{1}{2} \times \frac{3}{8}$	21.3	17.3	25	25	$4 \times 4 \times 3\frac{1}{2}$	114.3	101.6	105	102
$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$	21.3	13.7	25	25	$4 \times 4 \times 3$	114.3	88.9	105	98
$\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2}$	26.7	21.3	29	29	$4 \times 4 \times 2\frac{1}{2}$	114.3	73.0	105	95
$\frac{3}{4} \times \frac{3}{4} \times \frac{3}{8}$	26.7	17.3	29	29	$4 \times 4 \times 2$	114.3	60.3	105	89
$1 \times 1 \times \frac{3}{4}$	33.4	26.7	38	38	$4 \times 4 \times 1\frac{1}{2}$	114.3	48.3	105	86
$1 \times 1 \times \frac{1}{2}$	33.4	21.3	38	38					
					$5 \times 5 \times 4$	141.3	114.3	124	117
$1\frac{1}{4} \times 1\frac{1}{4} \times 1$	42.2	33.4	48	48	$5 \times 5 \times 3\frac{1}{2}$	141.3	101.6	124	114
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{4}$	42.2	26.7	48	48	$5 \times 5 \times 3$	141.3	88.9	124	111
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{2}$	42.2	21.3	48	48	$5 \times 5 \times 2\frac{1}{2}$	141.3	73.0	124	108
					$5 \times 5 \times 2$	141.3	60.3	124	105
$1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{4}$	48.3	42.2	57	57	$6 \times 6 \times 5$	168.3	141.3	143	137
$1\frac{1}{2} \times 1\frac{1}{2} \times 1$	48.3	33.4	57	57	$6 \times 6 \times 4$	168.3	114.3	143	130
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$	48.3	26.7	57	57	$6 \times 6 \times 3\frac{1}{2}$	168.3	101.6	143	127
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{2}$	48.3	21.3	57	57	$6 \times 6 \times 3$	168.3	88.9	143	124
					$6 \times 6 \times 2\frac{1}{2}$	168.3	73.0	143	121
$2 \times 2 \times 1\frac{1}{2}$	60.3	48.3	64	60	$8 \times 8 \times 6$	219.1	168.3	178	168
$2 \times 2 \times 1\frac{1}{4}$	60.3	42.2	64	57	$8 \times 8 \times 5$	219.1	141.3	178	162
$2 \times 2 \times 1$	60.3	33.4	64	51	$8 \times 8 \times 4$	219.1	114.3	178	156
$2 \times 2 \times \frac{3}{4}$	60.3	26.7	64	44	$8 \times 8 \times 3\frac{1}{2}$	219.1	101.6	178	152
$2\frac{1}{2} \times 2\frac{1}{2} \times 2$	73.0	60.3	76	70	$10 \times 10 \times 8$	273.0	219.1	216	203
$2\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$	73.0	48.3	76	67	$10 \times 10 \times 6$	273.0	168.3	216	194
$2\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{4}$	73.0	42.2	76	64	$10 \times 10 \times 5$	273.0	141.3	216	191
$2\frac{1}{2} \times 2\frac{1}{2} \times 1$	73.0	33.4	76	57	$10 \times 10 \times 4$	273.0	114.3	216	184
$3 \times 3 \times 2\frac{1}{2}$	88.9	73.0	86	83	$12 \times 12 \times 10$	323.8	273.0	254	241
$3 \times 3 \times 2$	88.9	60.3	86	76	$12 \times 12 \times 8$	323.8	219.1	254	229
$3 \times 3 \times 1\frac{1}{2}$	88.9	48.3	86	73	$12 \times 12 \times 6$	323.8	168.3	254	219
$3 \times 3 \times 1\frac{1}{4}$	88.9	42.2	86	70	$12 \times 12 \times 5$	323.8	141.3	254	216
$3\frac{1}{2} \times 3\frac{1}{2} \times 3$	101.6	88.9	95	92	$14 \times 14 \times 12$	355.6	323.8	279	270
$3\frac{1}{2} \times 3\frac{1}{2} \times 2\frac{1}{2}$	101.6	73.0	95	89	$14 \times 14 \times 10$	355.6	273.0	279	257
$3\frac{1}{2} \times 3\frac{1}{2} \times 2$	101.6	60.3	95	83	$14 \times 14 \times 8$	355.6	219.1	279	248
$3\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{1}{2}$	101.6	48.3	95	79	$14 \times 14 \times 6$	355.6	168.3	279	238

Table 9 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses (Cont'd)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run, C	Outlet, M [Note (1)]		Run	Outlet	Run, C	Outlet, M [Note (1)]
16 × 16 × 14	406.4	355.6	305	305	28 × 28 × 26	711	660	521	521
16 × 16 × 12	406.4	323.8	305	295	28 × 28 × 24	711	610	521	508
16 × 16 × 10	406.4	273.0	305	283	28 × 28 × 22	711	559	521	495
16 × 16 × 8	406.4	219.1	305	273	28 × 28 × 20	711	508	521	483
16 × 16 × 6	406.4	168.3	305	264					
					28 × 28 × 18	711	457	521	470
18 × 18 × 16	457	406.4	343	330	28 × 28 × 16	711	406.4	521	457
18 × 18 × 14	457	355.6	343	330	28 × 28 × 14	711	355.6	521	457
18 × 18 × 12	457	323.8	343	321	28 × 28 × 12	711	323.8	521	448
18 × 18 × 10	457	273.0	343	308					
18 × 18 × 8	457	219.1	343	298	30 × 30 × 28	762	711	559	546
					30 × 30 × 26	762	660	559	546
20 × 20 × 18	508	457	381	368	30 × 30 × 24	762	610	559	533
20 × 20 × 16	508	406.4	381	356	30 × 30 × 22	762	559	559	521
20 × 20 × 14	508	355.6	381	356	30 × 30 × 20	762	508	559	508
20 × 20 × 12	508	323.8	381	346					
20 × 20 × 10	508	273.0	381	333	30 × 30 × 18	762	457	559	495
20 × 20 × 8	508	219.1	381	324	30 × 30 × 16	762	406.4	559	483
					30 × 30 × 14	762	355.6	559	483
22 × 22 × 20	559	508	419	406	30 × 30 × 12	762	323.8	559	473
22 × 22 × 18	559	457	419	394	30 × 30 × 10	762	273.0	559	460
22 × 22 × 16	559	406.4	419	381					
22 × 22 × 14	559	355.6	419	381	32 × 32 × 30	813	762	597	584
22 × 22 × 12	559	323.8	419	371	32 × 32 × 28	813	711	597	572
22 × 22 × 10	559	273.0	419	359	32 × 32 × 26	813	660	597	572
					32 × 32 × 24	813	610	597	559
24 × 24 × 22	610	559	432	432					
24 × 24 × 20	610	508	432	432	32 × 32 × 22	813	559	597	546
24 × 24 × 18	610	457	432	419	32 × 32 × 20	813	508	597	533
					32 × 32 × 18	813	457	597	521
24 × 24 × 16	610	406.4	432	406	32 × 32 × 16	813	406.4	597	508
24 × 24 × 14	610	355.6	432	406	32 × 32 × 14	813	355.6	597	508
24 × 24 × 12	610	323.8	432	397					
24 × 24 × 10	610	273.0	432	384	34 × 34 × 32	864	813	635	622
					34 × 34 × 30	864	762	635	610
26 × 26 × 24	660	610	495	483	34 × 34 × 28	864	711	635	597
26 × 26 × 22	660	559	495	470	34 × 34 × 26	864	660	635	597
26 × 26 × 20	660	508	495	457					
					34 × 34 × 24	864	610	635	584
26 × 26 × 18	660	457	495	444	34 × 34 × 22	864	559	635	572
26 × 26 × 16	660	406.4	495	432	34 × 34 × 20	864	508	635	559
26 × 26 × 14	660	355.6	495	432	34 × 34 × 18	864	457	635	546
26 × 26 × 12	660	323.8	495	422	34 × 34 × 16	864	406.4	635	533

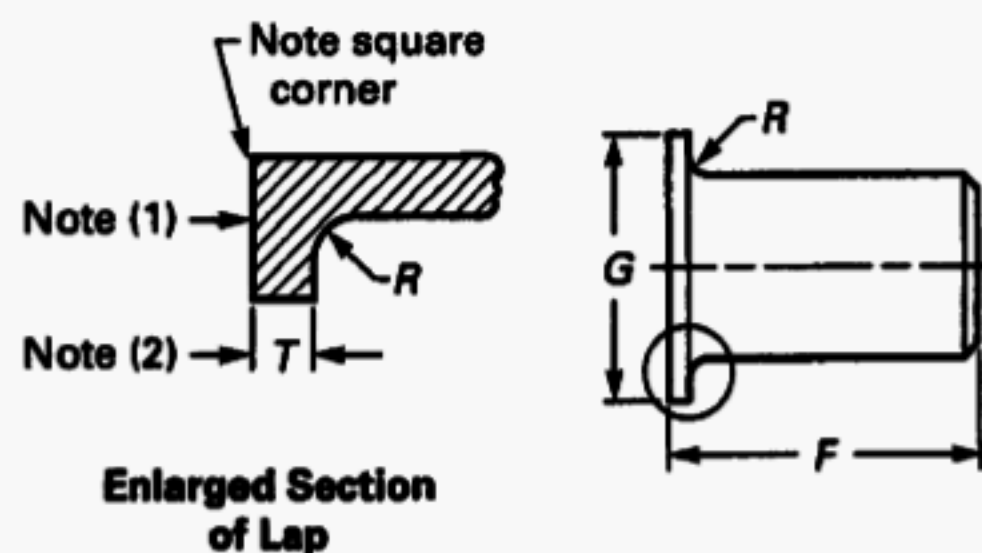
Table 9 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses (Cont'd)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run, C	Outlet, M [Note (1)]		Run	Outlet	Run, C	Outlet, M [Note (1)]
36 × 36 × 34	914	864	673	660	42 × 42 × 24	1 067	610	762	660
36 × 36 × 32	914	813	673	648	42 × 42 × 22	1 067	559	762	660
36 × 36 × 30	914	762	673	635	42 × 42 × 20	1 067	508	762	660
36 × 36 × 28	914	711	673	622	42 × 42 × 18	1 067	457	762	648
36 × 36 × 26	914	660	673	622	42 × 42 × 16	1 067	406.4	762	635
					44 × 44 × 42	1 118	1 067	813	762
36 × 36 × 24	914	610	673	610	44 × 44 × 40	1 118	1 016	813	749
36 × 36 × 22	914	559	673	597	44 × 44 × 38	1 118	965	813	737
36 × 36 × 20	914	508	673	584	44 × 44 × 36	1 118	914	813	724
36 × 36 × 18	914	457	673	572	44 × 44 × 34	1 118	864	813	724
36 × 36 × 16	914	406.4	673	559	44 × 44 × 32	1 118	813	813	711
					44 × 44 × 30	1 118	762	813	711
38 × 38 × 36	965	914	711	711	44 × 44 × 28	1 118	711	813	698
38 × 38 × 34	965	864	711	698	44 × 44 × 26	1 118	660	813	698
38 × 38 × 32	965	813	711	686	44 × 44 × 24	1 118	610	813	698
38 × 38 × 30	965	762	711	673	44 × 44 × 22	1 118	559	813	686
38 × 38 × 28	965	711	711	648	44 × 44 × 20	1 118	508	813	686
					46 × 46 × 44	1 168	1 118	851	800
38 × 38 × 26	965	660	711	648	46 × 46 × 42	1 168	1 067	851	787
38 × 38 × 24	965	610	711	635	46 × 46 × 40	1 168	1 016	851	775
38 × 38 × 22	965	559	711	622	46 × 46 × 38	1 168	965	851	762
38 × 38 × 20	965	508	711	610	46 × 46 × 36	1 168	914	851	762
38 × 38 × 18	965	457	711	597	46 × 46 × 34	1 168	864	851	749
					46 × 46 × 32	1 168	813	851	749
40 × 40 × 38	1 016	965	749	749	46 × 46 × 30	1 168	762	851	737
40 × 40 × 36	1 016	914	749	737	46 × 46 × 28	1 168	711	851	737
40 × 40 × 34	1 016	864	749	724	46 × 46 × 26	1 168	660	851	737
40 × 40 × 32	1 016	813	749	711	46 × 46 × 24	1 168	610	851	724
40 × 40 × 30	1 016	762	749	698	46 × 46 × 22	1 168	559	851	724
					48 × 48 × 46	1 219	1 168	889	838
40 × 40 × 28	1 016	711	749	673	48 × 48 × 44	1 219	1 118	889	838
40 × 40 × 26	1 016	660	749	673	48 × 48 × 42	1 219	1 067	889	813
40 × 40 × 24	1 016	610	749	660	48 × 48 × 40	1 219	1 016	889	813
40 × 40 × 22	1 016	559	749	648					
40 × 40 × 20	1 016	508	749	635	48 × 48 × 38	1 219	965	889	813
40 × 40 × 18	1 016	457	749	622	48 × 48 × 36	1 219	914	889	787
					48 × 48 × 34	1 219	864	889	787
42 × 42 × 40	1 067	1 016	762	711	48 × 48 × 32	1 219	813	889	787
42 × 42 × 38	1 067	968	762	711					
42 × 42 × 36	1 067	914	762	711	48 × 48 × 30	1 219	762	889	762
42 × 42 × 34	1 067	864	762	711	48 × 48 × 28	1 219	711	889	762
					48 × 48 × 26	1 219	660	889	762
42 × 42 × 32	1 067	813	762	711	48 × 48 × 24	1 219	610	889	737
42 × 42 × 30	1 067	762	762	711	48 × 48 × 22	1 219	559	889	737
42 × 42 × 28	1 067	711	762	698					
42 × 42 × 26	1 067	660	762	698					

GENERAL NOTE: All dimensions are in millimeters.

NOTE:

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

**Table 10 Dimensions of Lap Joint Stub Ends**

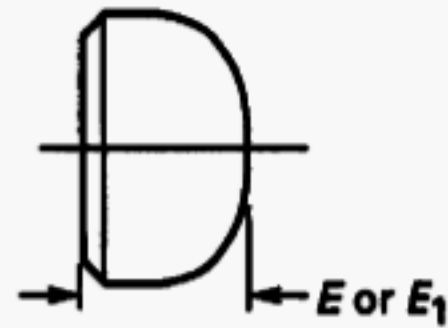
Nominal Pipe Size (NPS)	Outside Diameter of Barrel		Long Pattern Length, <i>F</i> [Notes (3), (4)]	Short Pattern Length, <i>F</i> [Notes (3), (4)]	Radius of Fillet, <i>R</i> [Note (5)]	Diameter of Lap, <i>G</i> [Note (6)]
	Max.	Min.				
1/2	22.8	20.5	76	51	3	35
3/4	28.1	25.9	76	51	3	43
1	35.0	32.6	102	51	3	51
1 1/4	43.6	41.4	102	51	5	64
1 1/2	49.9	47.5	102	51	6	73
2	62.4	59.5	152	64	8	92
2 1/2	75.3	72.2	152	64	8	105
3	91.3	88.1	152	64	10	127
3 1/2	104.0	100.8	152	76	10	140
4	116.7	113.5	152	76	11	157
5	144.3	140.5	203	76	11	186
6	171.3	167.5	203	89	13	216
8	222.1	218.3	203	102	13	270
10	277.2	272.3	254	127	13	324
12	328.0	323.1	254	152	13	381
14	359.9	354.8	305	152	13	413
16	411.0	405.6	305	152	13	470
18	462	456	305	152	13	533
20	514	507	305	152	13	584
22	565	558	305	152	13	641
24	616	609	305	152	13	692

GENERAL NOTES:

- (a) All dimensions are in millimeters.
- (b) See Table 2 for tolerances.
- (c) Service conditions and joint construction often dictate stub end length requirements. Therefore, the purchaser must specify long or short pattern fitting when ordering.

NOTES:

- (1) Gasket face finish shall be in accordance with ASME B16.5 for raised face flanges.
- (2) The lap thickness *T* shall not be less than nominal pipe wall thickness. See Table 2 for maximum tolerance.
- (3) 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.
- (4) 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*.
- (5) These dimensions conform to the radius established for lap joint flanges in ASME B16.5.
- (6) This dimension conforms to standard machined facings shown in ASME 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 B16.5.

**Table 11 Dimensions of Caps**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Length, <i>E</i> [Note (1)]	Limiting Wall Thickness for Length, <i>E</i>	Length, <i>E</i> ₁ [Note (2)]
1/2	21.3	25	4.57	25
3/4	26.7	25	3.81	25
1	33.4	38	4.57	38
1 1/4	42.2	38	4.83	38
1 1/2	48.3	38	5.08	38
2	60.3	38	5.59	44
2 1/2	73.0	38	7.11	51
3	88.9	51	7.62	64
3 1/2	101.6	64	8.13	76
4	114.3	64	8.64	76
5	141.3	76	9.65	89
6	168.3	89	10.92	102
8	219.1	102	12.70	127
10	273.0	127	12.70	152
12	323.8	152	12.70	178
14	355.6	165	12.70	191
16	406.4	178	12.70	203
18	457	203	12.70	229
20	508	229	12.70	254
22	559	254	12.70	254
24	610	267	12.70	305
26	660	267	...	...
28	711	267	...	...
30	762	267	...	...
32	813	267	...	...
34	864	267	...	...
36	914	267	...	...
38	965	305	...	...
40	1 016	305	...	...
42	1 067	305	...	...
44	1 118	343	...	...
46	1 168	343	...	...
48	1 219	343	...	...

GENERAL NOTES:

- (a) All dimensions are in millimeters.
 (b) The shape of these caps shall be ellipsoidal and shall conform to the requirements 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 the manufacturer and purchaser.

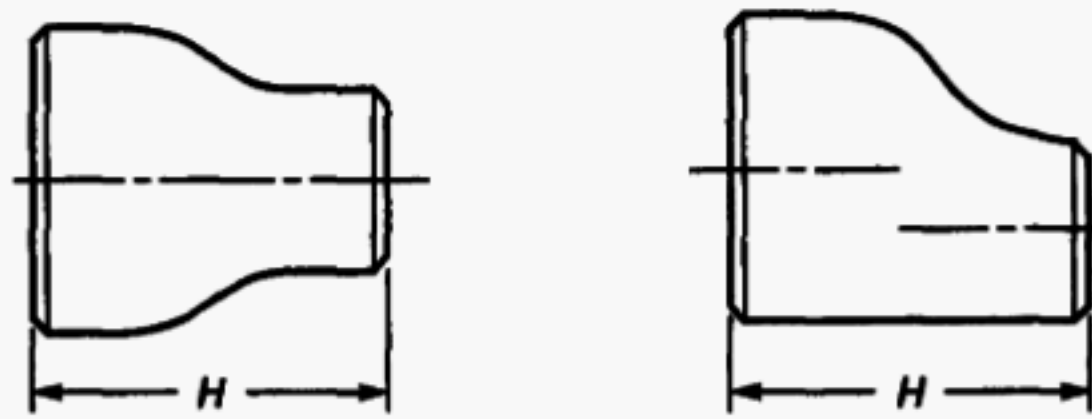


Table 12 Dimensions of Reducers

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, H	Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, H
	Large End	Small End			Large End	Small End	
$\frac{3}{4} \times \frac{1}{2}$	26.7	21.3	38	5 × 4	141.3	114.3	127
$\frac{3}{4} \times \frac{3}{8}$	26.7	17.3	38	5 × $3\frac{1}{2}$	141.3	101.6	127
1 × $\frac{3}{4}$	33.4	26.7	51	5 × 3	141.3	88.9	127
1 × $\frac{1}{2}$	33.4	21.3	51	5 × $2\frac{1}{2}$	141.3	73.0	127
				5 × 2	141.3	60.3	127
$1\frac{1}{4} \times 1$	42.2	33.4	51	6 × 5	168.3	141.3	140
$1\frac{1}{4} \times \frac{3}{4}$	42.2	26.7	51	6 × 4	168.3	114.3	140
$1\frac{1}{4} \times \frac{1}{2}$	42.2	21.3	51	6 × $3\frac{1}{2}$	168.3	101.6	140
$1\frac{1}{2} \times 1\frac{1}{4}$	48.3	42.2	64	6 × 3	168.3	88.9	140
$1\frac{1}{2} \times 1$	48.3	33.4	64	6 × $2\frac{1}{2}$	168.3	73.0	140
$1\frac{1}{2} \times \frac{3}{4}$	48.3	26.7	64				
$1\frac{1}{2} \times \frac{1}{2}$	48.3	21.3	64	8 × 6	219.1	168.3	152
				8 × 5	219.1	141.3	152
2 × $1\frac{1}{2}$	60.3	48.3	76	8 × 4	219.1	114.3	152
2 × $1\frac{1}{4}$	60.3	42.2	76	8 × $3\frac{1}{2}$	219.1	101.6	152
2 × 1	60.3	33.4	76				
2 × $\frac{3}{4}$	60.3	26.7	76	10 × 8	273.0	219.1	178
				10 × 6	273.0	168.3	178
$2\frac{1}{2} \times 2$	73.0	60.3	89	10 × 5	273.0	141.3	178
$2\frac{1}{2} \times 1\frac{1}{2}$	73.0	48.3	89	10 × 4	273.0	114.3	178
$2\frac{1}{2} \times 1\frac{1}{4}$	73.0	42.2	89				
$2\frac{1}{2} \times 1$	73.0	33.4	89	12 × 10	323.8	273.0	203
3 × $2\frac{1}{2}$	88.9	73.0	89	12 × 8	323.8	219.1	203
3 × 2	88.9	60.3	89	12 × 6	323.8	168.3	203
3 × $1\frac{1}{2}$	88.9	48.3	89	12 × 5	323.8	141.3	203
3 × $1\frac{1}{4}$	88.9	42.2	89				
$3\frac{1}{2} \times 3$	101.6	88.9	102	14 × 12	355.6	323.8	330
$3\frac{1}{2} \times 2\frac{1}{2}$	101.6	73.0	102	14 × 10	355.6	273.0	330
$3\frac{1}{2} \times 2$	101.6	60.3	102	14 × 8	355.6	219.1	330
$3\frac{1}{2} \times 1\frac{1}{2}$	101.6	48.3	102	14 × 6	355.6	168.3	330
$3\frac{1}{2} \times 1\frac{1}{4}$	101.6	42.2	102				
4 × $3\frac{1}{2}$	114.3	101.6	102	16 × 14	406.4	355.6	356
4 × 3	114.3	88.9	102	16 × 12	406.4	323.8	356
4 × $2\frac{1}{2}$	114.3	73.0	102	16 × 10	406.4	273.0	356
4 × 2	114.3	60.3	102	16 × 8	406.4	219.1	356
4 × $1\frac{1}{2}$	114.3	48.3	102				
				18 × 16	457	406.4	381
				18 × 14	457	355.6	381
				18 × 12	457	323.8	381
				18 × 10	457	273.0	381

Table 12 Dimensions of Reducers (Cont'd)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, <i>H</i>	Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, <i>H</i>
	Large End	Small End			Large End	Small End	
20 × 18	508	457	508	36 × 34	914	864	610
20 × 16	508	406.4	508	36 × 32	914	813	610
20 × 14	508	355.6	508	36 × 30	914	762	610
20 × 12	508	323.8	508	36 × 26	914	660	610
				36 × 24	914	610	610
22 × 20	559	508	508	38 × 36	965	914	610
22 × 18	559	457	508	38 × 34	965	864	610
22 × 16	559	406.4	508	38 × 32	965	813	610
22 × 14	559	355.4	508	38 × 30	965	762	610
				38 × 28	965	711	610
24 × 22	610	559	508	38 × 26	965	660	610
24 × 20	610	508	508				
24 × 18	610	457	508	40 × 38	1 016	965	610
24 × 16	610	406.4	508	40 × 36	1 016	914	610
				40 × 34	1 016	864	610
26 × 24	660	610	610	40 × 32	1 016	813	610
26 × 22	660	559	610	40 × 30	1 016	762	610
26 × 20	660	508	610				
26 × 18	660	457	610	42 × 40	1 067	1 016	610
				42 × 38	1 067	965	610
28 × 26	711	660	610	42 × 36	1 067	914	610
28 × 24	711	610	610	42 × 34	1 067	864	610
28 × 20	711	508	610	42 × 32	1 067	813	610
28 × 18	711	457	610	42 × 30	1 067	762	610
30 × 28	762	711	610	44 × 42	1 118	1 067	610
30 × 26	762	660	610	44 × 40	1 118	1 016	610
30 × 24	762	610	610	44 × 38	1 118	965	610
30 × 20	762	508	610	44 × 36	1 118	914	610
32 × 30	813	762	610	46 × 44	1 168	1 118	711
32 × 28	813	711	610	46 × 42	1 168	1 067	711
32 × 26	813	660	610	46 × 40	1 168	1 016	711
32 × 24	813	610	610	46 × 38	1 168	965	711
34 × 32	864	813	610	48 × 46	1 219	1 168	711
34 × 30	864	762	610	48 × 44	1 219	1 118	711
34 × 26	864	660	610	48 × 42	1 219	1 067	711
34 × 24	864	610	610	48 × 40	1 219	1 016	711

GENERAL NOTES:

(a) All dimensions are in millimeters.

(b) While the figure illustrates a bell-shaped reducer, the use of conical reducer is not prohibited.

MANDATORY APPENDIX I INCH TABLES

This Appendix provides tables of the standard inch dimensions for fittings.

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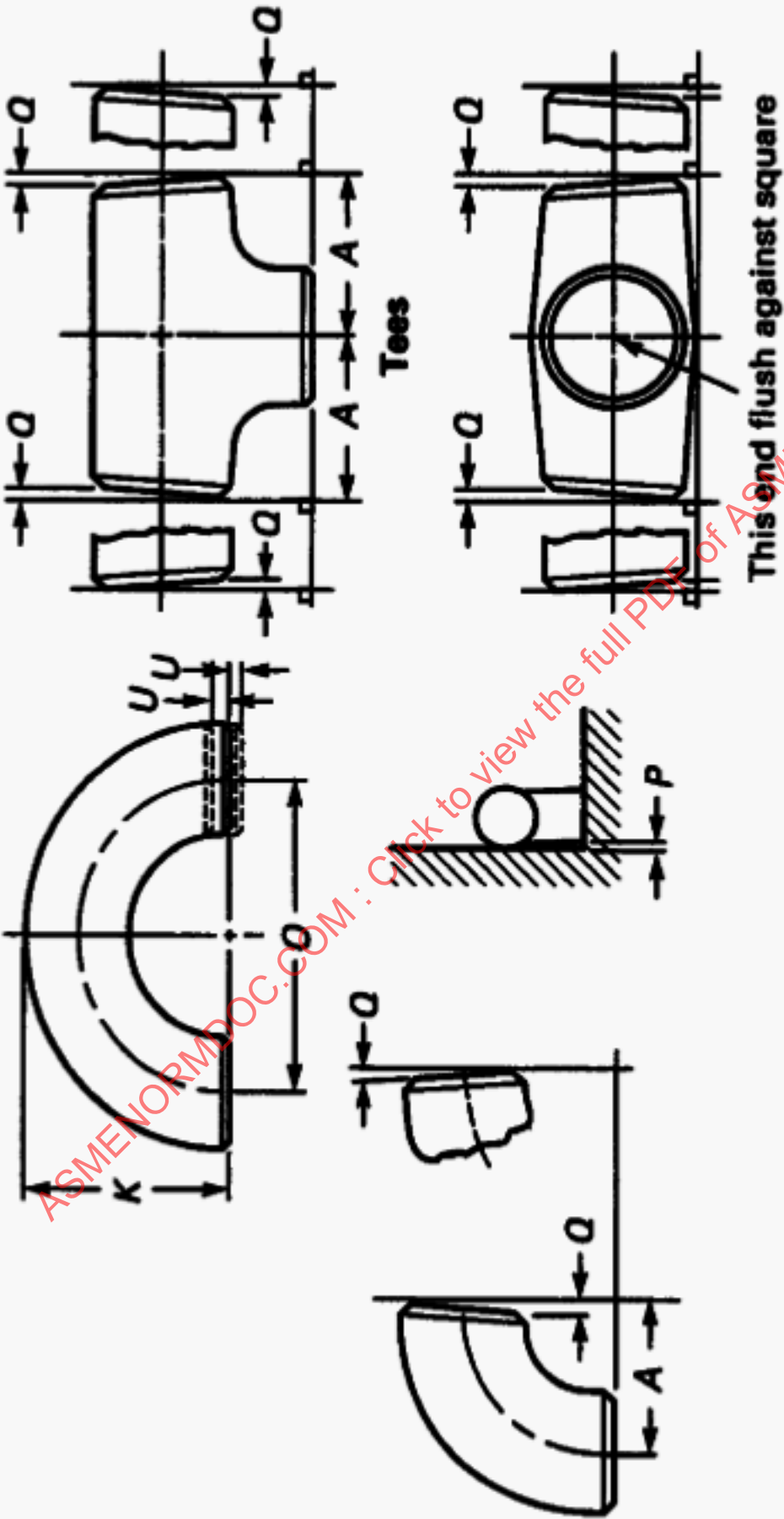


Table I1 Illustration

Table I1 Tolerances

All Fittings [Notes (1) and (2)]				Center-to-End Dimensions of 90 deg and 45 deg Elbows and Tees, A, B, C, M	Overall Length of Reducers and Lap Joint Stub Ends, F, H	180 deg Returns				Lap Joint Stub Ends [Note (6)]				Nominal Pipe Size (NPS)	Angularity Tolerances	
Nominal Pipe Size (NPS)	Outside Diameter at Bevel, D [Notes (3) and (4)]	Inside Diameter at End [Notes (3) and (5)]			Overall Length of Caps, E	Center-to-End Dimension, O	Back-to-Face Dimension, K	Alignment of Ends, U	Outside Diameter of Lap, G	Fillet Radius of Lap, R	Lap Thickness, T	Off Angle, Q	Off Plane, P			
1½ to 2½	+0.06, -0.03	0.03	0.06	0.06	0.12	0.25	0.25	0.03	+0, -0.03	+0, -0.03	+0.06, -0	½ to 4	0.03	0.06		
3 to 3½	0.06	0.06	0.06	0.06	0.12	0.25	0.25	0.03	+0, -0.03	+0, -0.03	+0.06, -0	5 to 8	0.06	0.12		
4	0.06	0.06	0.06	0.06	0.12	0.25	0.25	0.03	+0, -0.03	+0, -0.06	+0.06, -0	10 to 12	0.09	0.19		
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	+0.06, -0	14 to 16	0.09	0.25		
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	+0.12, -0	18 to 24	0.12	0.38		
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	+0.12, -0	26 to 30	0.19	0.38		
26 to 30	+0.25, -0.19	0.19	0.12	0.19	0.38	...	...	...	...	...	...	32 to 42	0.19	0.50		
32 to 48	+0.25, -0.19	0.19	0.19	0.19	0.38	...	...	...	...	...	...	44 to 48	0.19	0.75		

GENERAL NOTES:

(a) For reference, see Table I1 Illustration on page 20.

(b) All dimensions are in inches.

(c) Tolerances are equal plus and minus except as noted.

NOTES:

(1) The inside diameter and the nominal wall thicknesses at ends are to be specified by the purchaser.

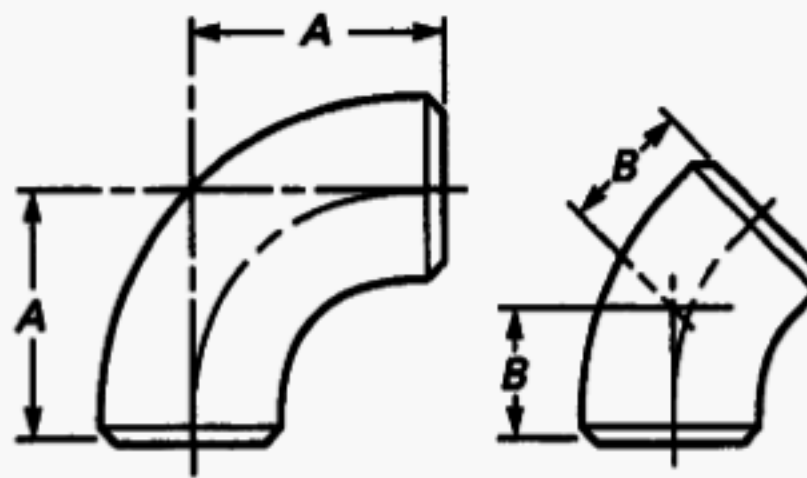
(2) A minimum wall thickness of 87.5% applies unless the purchaser specifies a different wall thickness tolerance. See Fig. 1, Note (1)(a).

(3) Out-of-round is the sum of absolute values of plus and minus tolerances.

(4) This tolerance may not apply in localized areas of formed fittings where increased wall thickness is required to meet design requirements of para. 2.2.

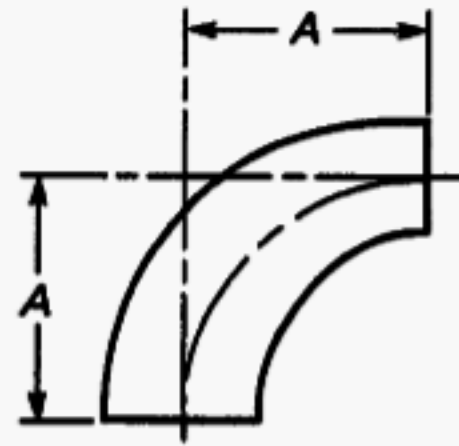
(5) Unless otherwise specified by the purchaser, these tolerances apply to the nominal inside diameter, which equals the difference between the nominal outside diameter and twice the nominal wall thickness.

(6) See Table I9 for limiting dimensions of outside diameter of barrel.

**Table I2 Dimensions of Long Radius Elbows**

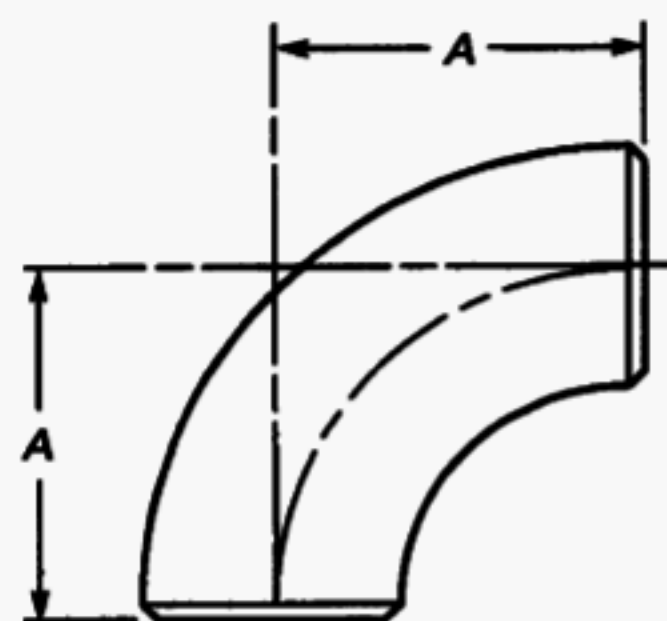
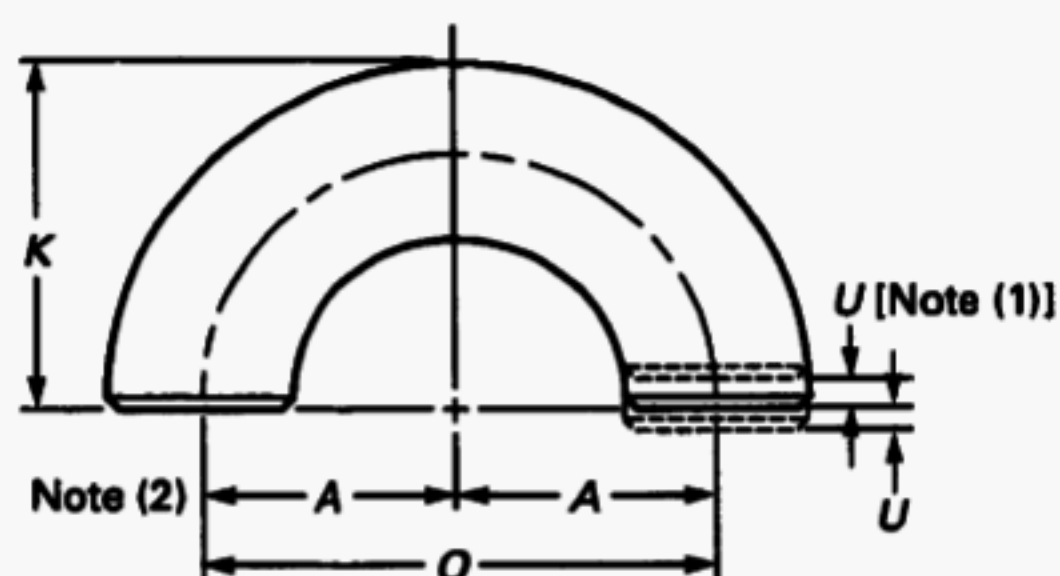
Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End	
		90 deg Elbows, A	45 deg Elbows, B
1/2	0.84	1.50	0.62
3/4	1.05	1.50	0.75
1	1.32	1.50	0.88
1 1/4	1.66	1.88	1.00
1 1/2	1.90	2.25	1.12
2	2.38	3.00	1.38
2 1/2	2.88	3.75	1.75
3	3.50	4.50	2.00
3 1/2	4.00	5.25	2.25
4	4.50	6.00	2.50
5	5.56	7.50	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: All dimensions are in inches.

**Table I3 Dimensions of Long Radius Reducing Elbows**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center- to- End, A	Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center- to- End, A
	Large End	Small End			Large End	Small End	
2 × 1½	2.38	1.90	3.00	10 × 8	10.75	8.62	15.00
2 × 1¼	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
2½ × 2	2.88	2.38	3.75	12 × 10	12.75	10.75	18.00
2½ × 1½	2.88	1.90	3.75	12 × 8	12.75	8.62	18.00
2½ × 1¼	2.88	1.66	3.75	12 × 6	12.75	6.62	18.00
3 × 2½	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 × 1½	3.50	1.90	4.50	14 × 8	14.00	8.62	21.00
3½ × 3	4.00	3.50	5.25	16 × 14	16.00	14.00	24.00
3½ × 2½	4.00	2.88	5.25	16 × 12	16.00	12.75	24.00
3½ × 2	4.00	2.38	5.25	16 × 10	16.00	10.75	24.00
4 × 3½	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 × 2½	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 × 3½	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 × 2½	5.56	2.88	7.50	20 × 12	20.00	12.75	30.00
				20 × 10	20.00	10.75	30.00
6 × 5	6.62	5.56	9.00	24 × 22	24.00	22.00	36.00
6 × 4	6.62	4.50	9.00	24 × 20	24.00	20.00	36.00
6 × 3½	6.62	4.00	9.00	24 × 18	24.00	18.00	36.00
6 × 3	6.62	3.50	9.00	24 × 16	24.00	16.00	36.00
8 × 6	8.62	6.62	12.00	24 × 14	24.00	14.00	36.00
8 × 5	8.62	5.56	12.00	24 × 12	24.00	12.75	36.00
8 × 4	8.62	4.50	12.00	...	...	...	...

GENERAL NOTE: All dimensions are in inches.

**Table I4 Dimensions of Long Radius Returns**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center- to-Center, <i>O</i>	Back- to-Face, <i>K</i>
$\frac{1}{2}$	0.84	3.00	1.88
$\frac{3}{4}$ [Note (3)]	1.05	3.00	2.00
1	1.32	3.00	2.19
$1\frac{1}{4}$	1.66	3.75	2.75
$1\frac{1}{2}$	1.90	4.50	3.25
2	2.38	6.00	4.19
$2\frac{1}{2}$	2.88	7.50	5.19
3	3.50	9.00	6.25
$3\frac{1}{2}$	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: All dimensions are in inches.

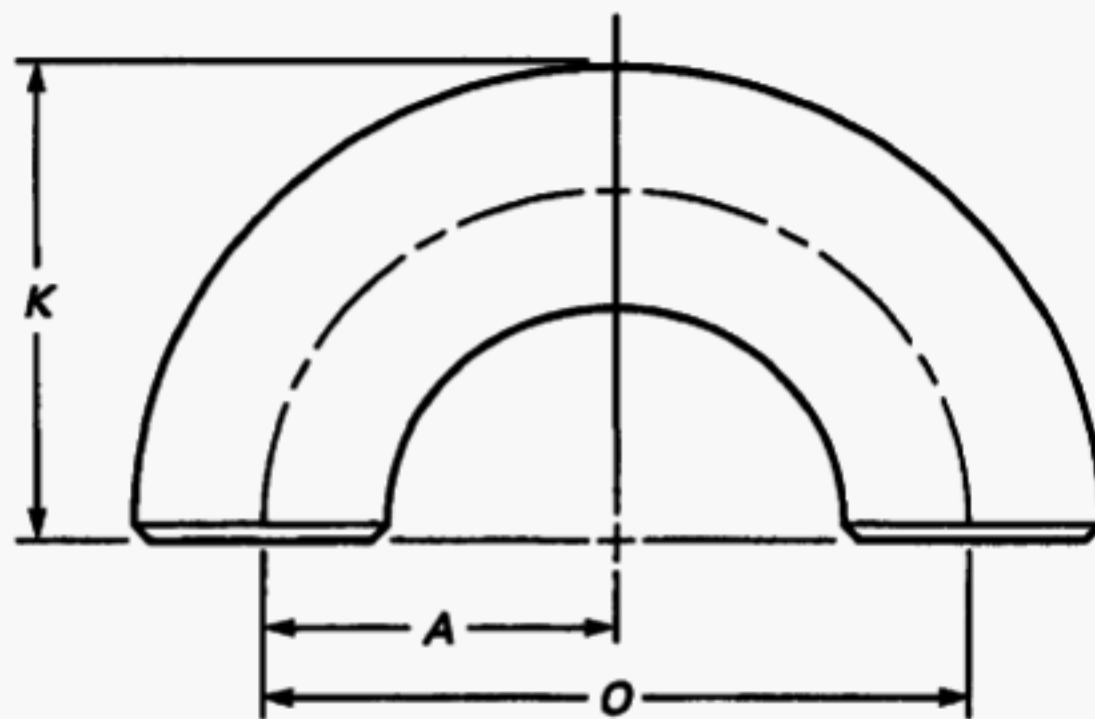
NOTES:

- (1) See Table I1 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 $\frac{3}{4}$ at the manufacturer's option.

Table I5 Dimensions of Short Radius Elbows

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center- to- End, <i>A</i>
1	1.32	1.00
$1\frac{1}{4}$	1.66	1.25
$1\frac{1}{2}$	1.90	1.50
2	2.38	2.00
$2\frac{1}{2}$	2.88	2.50
3	3.50	3.00
$3\frac{1}{2}$	4.00	3.50
4	4.50	4.00
5	5.56	5.00
6	6.62	6.00
8	8.62	8.00
10	10.75	10.00
12	12.75	12.00
14	14.00	14.00
16	16.00	16.00
18	18.00	18.00
20	20.00	20.00
22	22.00	22.00
24	24.00	24.00

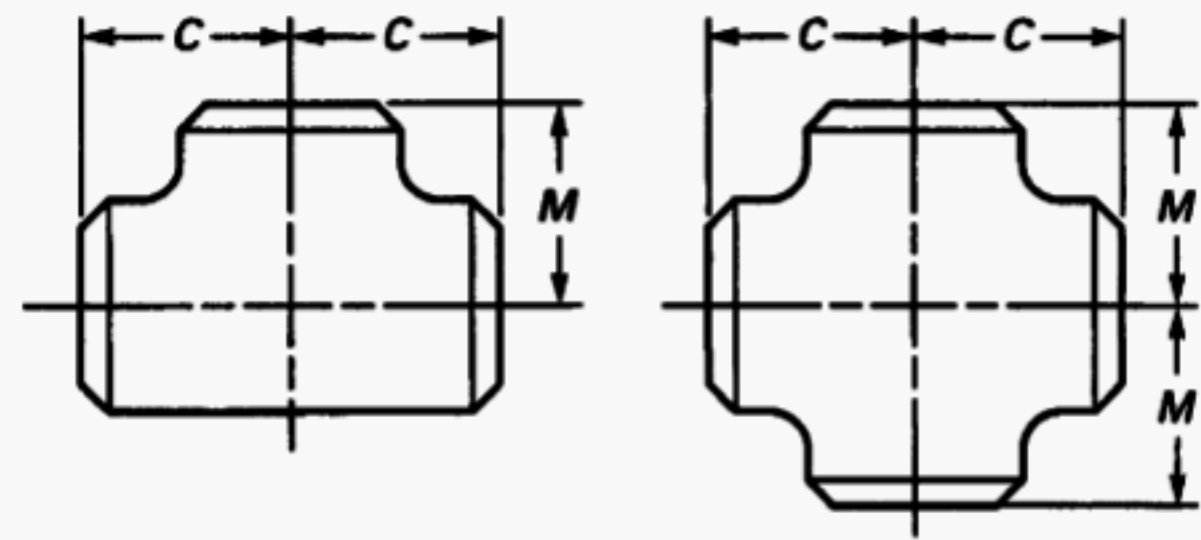
GENERAL NOTE: All dimensions are in inches.

**Table I6 Dimensions of Short Radius 180 deg Returns**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-Center, O	Back-to-Face, K
1	1.32	2.00	1.62
1 1/4	1.66	2.50	2.06
1 1/2	1.90	3.00	2.44
2	2.38	4.00	3.19
2 1/2	2.88	5.00	3.94
3	3.50	6.00	4.75
3 1/2	4.00	7.00	5.50
4	4.50	8.00	6.25
5	5.56	10.00	7.75
6	6.62	12.00	9.31
8	8.62	16.00	12.31
10	10.75	20.00	15.38
12	12.75	24.00	18.38
14	14.00	28.00	21.00
16	16.00	32.00	24.00
18	18.00	36.00	27.00
20	20.00	40.00	30.00
22	22.00	44.00	33.00
24	24.00	48.00	36.00

GENERAL NOTES:

- (a) All dimensions are in inches.
 (b) Dimension A is equal to one-half of dimension O.

**Table I7 Dimensions of Straight Tees and Crosses**

Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End	
		Run, C	Outlet, M [Notes (1) and (2)]
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: All 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.

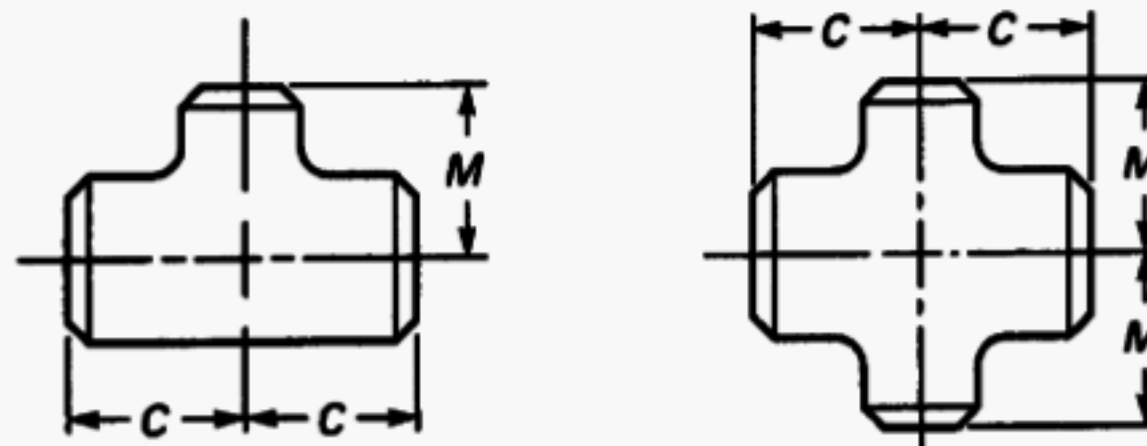


Table I8 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses

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

Table I8 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses (Cont'd)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run, C	Outlet, M [Note (1)]		Run	Outlet	Run, C	Outlet, M [Note (1)]
20 × 20 × 18	20.00	18.00	15.00	14.50	30 × 30 × 18	30.00	18.00	22.00	19.50
20 × 20 × 16	20.00	16.00	15.00	14.00	30 × 30 × 16	30.00	16.00	22.00	19.00
20 × 20 × 14	20.00	14.00	15.00	14.00	30 × 30 × 14	30.00	14.00	22.00	19.00
20 × 20 × 12	20.00	12.75	15.00	13.62	30 × 30 × 12	30.00	12.75	22.00	18.62
20 × 20 × 10	20.00	10.75	15.00	13.12	30 × 30 × 10	30.00	10.75	22.00	18.12
20 × 20 × 8	20.00	8.62	15.00	12.75					
22 × 22 × 20	22.00	20.00	16.50	16.00	32 × 32 × 30	32.00	30.00	23.50	23.00
22 × 22 × 18	22.00	18.00	16.50	15.50	32 × 32 × 28	32.00	28.00	23.50	22.50
22 × 22 × 16	22.00	16.00	16.50	15.00	32 × 32 × 26	32.00	26.00	23.50	22.50
22 × 22 × 14	22.00	14.00	16.50	15.00	32 × 32 × 24	32.00	24.00	23.50	22.00
22 × 22 × 12	22.00	12.75	16.50	14.62					
22 × 22 × 10	22.00	10.75	16.50	14.12	32 × 32 × 22	32.00	22.00	23.50	21.50
24 × 24 × 22	24.00	22.00	17.00	17.00	32 × 32 × 20	32.00	20.00	23.50	21.00
24 × 24 × 20	24.00	20.00	17.00	17.00	32 × 32 × 18	32.00	18.00	23.50	20.50
24 × 24 × 18	24.00	18.00	17.00	16.50	32 × 32 × 16	32.00	16.00	23.50	20.00
24 × 24 × 16	24.00	16.00	17.00	16.00	32 × 32 × 14	32.00	14.00	23.50	20.00
24 × 24 × 14	24.00	14.00	17.00	16.00					
24 × 24 × 12	24.00	12.75	17.00	15.62	34 × 34 × 32	34.00	32.00	25.00	24.50
24 × 24 × 10	24.00	10.75	17.00	15.12	34 × 34 × 30	34.00	30.00	25.00	24.00
26 × 26 × 24	26.00	24.00	19.50	19.00	34 × 34 × 28	34.00	28.00	25.00	23.50
26 × 26 × 22	26.00	22.00	19.50	18.50	34 × 34 × 26	34.00	26.00	25.00	23.50
26 × 26 × 20	26.00	20.00	19.50	18.00					
26 × 26 × 18	26.00	18.00	19.50	17.50	34 × 34 × 24	34.00	24.00	25.00	23.00
26 × 26 × 16	26.00	16.00	19.50	17.00	34 × 34 × 22	34.00	22.00	25.00	22.50
26 × 26 × 14	26.00	14.00	19.50	17.00	34 × 34 × 20	34.00	20.00	25.00	22.00
26 × 26 × 12	26.00	12.75	19.50	16.62	34 × 34 × 18	34.00	18.00	25.00	21.50
28 × 28 × 26	28.00	26.00	20.50	20.50	34 × 34 × 16	34.00	16.00	25.00	21.00
28 × 28 × 24	28.00	24.00	20.50	20.00					
28 × 28 × 22	28.00	22.00	20.50	19.50	36 × 36 × 34	36.00	34.00	26.50	26.00
28 × 28 × 20	28.00	20.00	20.50	19.00	36 × 36 × 32	36.00	32.00	26.50	25.50
28 × 28 × 18	28.00	18.00	20.50	18.50	36 × 36 × 30	36.00	30.00	26.50	25.00
28 × 28 × 16	28.00	16.00	20.50	18.00	36 × 36 × 28	36.00	28.00	26.50	24.50
28 × 28 × 14	28.00	14.00	20.50	18.00	36 × 36 × 26	36.00	26.00	26.50	24.50
28 × 28 × 12	28.00	12.75	20.50	17.62					
30 × 30 × 28	30.00	28.00	22.00	21.50	36 × 36 × 24	36.00	24.00	26.50	24.00
30 × 30 × 26	30.00	26.00	22.00	21.50	36 × 36 × 22	36.00	22.00	26.50	23.50
30 × 30 × 24	30.00	24.00	22.00	21.00	36 × 36 × 20	36.00	20.00	26.50	23.00
30 × 30 × 22	30.00	22.00	22.00	20.50	36 × 36 × 18	36.00	18.00	26.50	22.50
30 × 30 × 20	30.00	20.00	22.00	20.00	36 × 36 × 16	36.00	16.00	26.50	22.00
					38 × 38 × 36	38.00	36.00	28.00	28.00
					38 × 38 × 34	38.00	34.00	28.00	27.50
					38 × 38 × 32	38.00	32.00	28.00	27.00
					38 × 38 × 30	38.00	30.00	28.00	26.50
					38 × 38 × 28	38.00	28.00	28.00	25.50

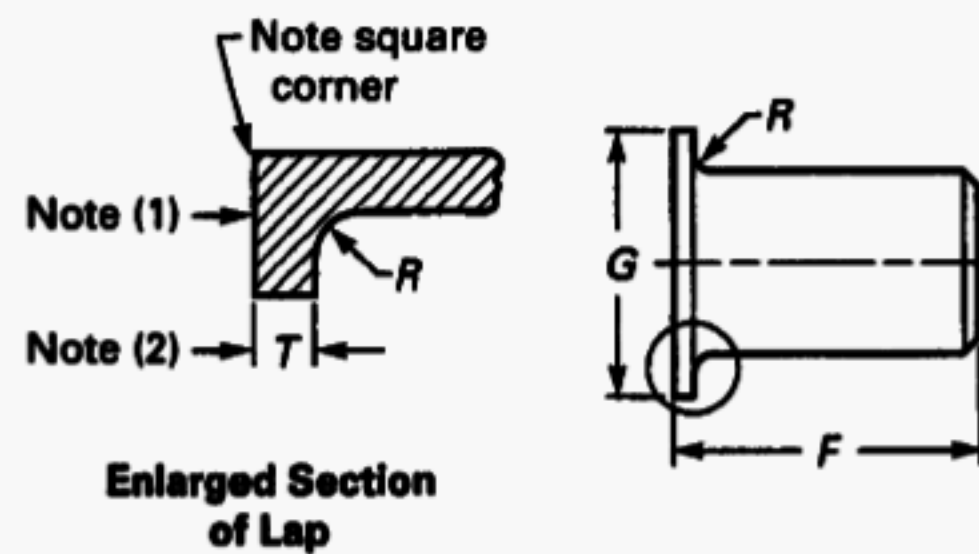
Table I8 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses (Cont'd)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End		Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run, C	Outlet, M [Note (1)]		Run	Outlet	Run, C	Outlet, M [Note (1)]
38 × 38 × 26	38.00	26.00	28.00	25.50	44 × 44 × 30	44.00	30.00	32.00	28.00
38 × 38 × 24	38.00	24.00	28.00	25.00	44 × 44 × 28	44.00	28.00	32.00	27.50
38 × 38 × 22	38.00	22.00	28.00	24.50	44 × 44 × 26	44.00	26.00	32.00	27.50
38 × 38 × 20	38.00	20.00	28.00	24.00	44 × 44 × 24	44.00	24.00	32.00	27.50
38 × 38 × 18	38.00	18.00	28.00	23.50	44 × 44 × 22	44.00	22.00	32.00	27.00
					44 × 44 × 20	44.00	20.00	32.00	27.00
40 × 40 × 38	40.00	38.00	29.50	29.50					
40 × 40 × 36	40.00	36.00	29.50	29.00	46 × 46 × 44	46.00	44.00	33.50	31.50
40 × 40 × 34	40.00	34.00	29.50	28.50	46 × 46 × 42	46.00	42.00	33.50	31.00
40 × 40 × 32	40.00	32.00	29.50	28.00	46 × 46 × 40	46.00	40.00	33.50	30.50
40 × 40 × 30	40.00	30.00	29.50	27.50	46 × 46 × 38	46.00	38.00	33.50	30.00
40 × 40 × 28	40.00	28.00	29.50	26.50	46 × 46 × 36	46.00	36.00	33.50	30.00
40 × 40 × 26	40.00	26.00	29.50	26.50	46 × 46 × 34	46.00	34.00	33.50	29.50
40 × 40 × 24	40.00	24.00	29.50	26.00					
40 × 40 × 22	40.00	22.00	29.50	25.50	46 × 46 × 32	46.00	32.00	33.50	29.50
40 × 40 × 20	40.00	20.00	29.50	25.00	46 × 46 × 30	46.00	30.00	33.50	29.00
40 × 40 × 18	40.00	18.00	29.50	24.50	46 × 46 × 28	46.00	28.00	33.50	29.00
42 × 42 × 40	42.00	40.00	30.00	28.00	46 × 46 × 26	46.00	26.00	33.50	29.00
42 × 42 × 38	42.00	38.00	30.00	28.00	46 × 46 × 24	46.00	24.00	33.50	28.50
42 × 42 × 36	42.00	36.00	30.00	28.00	46 × 46 × 22	46.00	22.00	33.50	28.50
42 × 42 × 34	42.00	34.00	30.00	28.00					
42 × 42 × 32	42.00	32.00	30.00	28.00	48 × 48 × 46	48.00	46.00	35.00	33.00
42 × 42 × 30	42.00	30.00	30.00	28.00	48 × 48 × 44	48.00	44.00	35.00	33.00
42 × 42 × 28	42.00	28.00	30.00	27.50	48 × 48 × 42	48.00	42.00	35.00	32.00
42 × 42 × 26	42.00	26.00	30.00	27.50	48 × 48 × 40	48.00	40.00	35.00	32.00
42 × 42 × 24	42.00	24.00	30.00	26.00					
42 × 42 × 22	42.00	22.00	30.00	26.00	48 × 48 × 38	48.00	38.00	35.00	32.00
42 × 42 × 20	42.00	20.00	30.00	26.00	48 × 48 × 36	48.00	36.00	35.00	31.00
42 × 42 × 18	42.00	18.00	30.00	25.50	48 × 48 × 34	48.00	34.00	35.00	31.00
42 × 42 × 16	42.00	16.00	30.00	25.00	48 × 48 × 32	48.00	32.00	35.00	31.00
44 × 44 × 42	44.00	42.00	32.00	30.00					
44 × 44 × 40	44.00	40.00	32.00	29.50	48 × 48 × 30	48.00	30.00	35.00	30.00
44 × 44 × 38	44.00	38.00	32.00	29.00	48 × 48 × 28	48.00	28.00	35.00	30.00
44 × 44 × 36	44.00	36.00	32.00	28.50	48 × 48 × 26	48.00	26.00	35.00	30.00
44 × 44 × 34	44.00	34.00	32.00	28.50	48 × 48 × 24	48.00	24.00	35.00	29.00
44 × 44 × 32	44.00	32.00	32.00	28.00	48 × 48 × 22	48.00	22.00	35.00	29.00

GENERAL NOTE: All dimensions are in inches.

NOTE:

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

**Table I9 Dimensions of Lap Joint Stub Ends**

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

GENERAL NOTES:

- (a) All dimensions are in inches.
- (b) See Table I1 for tolerances.
- (c) Service conditions and joint construction often dictate stub end length requirements. Therefore, the purchaser must specify long or short pattern fitting when ordering.

NOTES:

- (1) Gasket face finish shall be in accordance with ASME B16.5 for raised face flanges.
- (2) The lap thickness *T* shall not be less than nominal pipe wall thickness. See Table I1 for tolerance.
- (3) 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.
- (4) 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*.
- (5) These dimensions conform to the radius established for lap joint flanges in ASME B16.5.
- (6) This dimension conforms to standard machined facings shown in ASME 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 B16.5.