ASME B16.9-2012
(Revision of ASME B16.9-2007)

Factory-Made Wrought Buttwelding Fittings

ORGANIZACIÓN EN VÁLVULAS S.A. DE C.V.
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AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers
Two Park Avenue • New York, NY • 10016 USA

FACTORY-MADE WROUGHT BUTTWELDING FITTINGS

1 SCOPE

1.1 General

This Standard covers overall dimensions, tolerances, ratings, testing, and markings for factory-made wrought buttwelding fittings in sizes NPS ½ through NPS 48 (DN 15 through DN 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 section 5.

1.4 Relevant Units

This Standard states values in both SI (Metric) and U.S. Customary units. These systems of units are to be regarded separately as standard. Within the text, the U.S. Customary units are shown in parentheses or in separate tables that appear in Mandatory Appendix I. The values stated in each system are not exact equivalents; therefore, it is required that each system of units be used independently of the other. Combining values from the two systems constitutes nonconformance with the 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 determining conformance with this Standard, the convention for fixing significant digits where limits (maximum and minimum values) are specified, shall be as defined in ASTM E29. This requires that an observed or calculated value be rounded off to the nearest unit in the last right-hand digit used for expressing the limit. Decimal values and tolerances do not imply a particular method of measurement.

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 are 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 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

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	½
20	¾
25	1
32	1¼
40	1½
50	2
65	2½
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 number[1] or nominal wall thickness in mm

(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 in para. 4.1.

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) "S58" of ASTM A960 applies for fittings in accordance with ASTM A234, A403, and A420.

(b) "S8" applies for fittings in accordance with ASTM A815.

(c) "SPLD" applies for fittings in accordance with ASTM B361, B363, and B366.

5 MATERIAL

Wrought fittings covered by this Standard shall be in accordance with ASTM A234, A403, A420, A815, B361, B363, B366, 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 section 7.

[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.

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 1 through 11 and Tables I-1 through I-11 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 9 and I-9.]

6.2.4 Segmental Elbows. Factory-made segments of short radius, long radius, and 3D radius elbows may be made to meet customer angle requirements. With the exception of the B dimension, factory-made segments of elbows shall meet all other requirements of this Standard. The B dimension for segmented elbows can be calculated as follows:

For segments of 90-deg elbows

$$B_s = A \times \tan(\theta/2)$$

where

A = dimension A for appropriate 90-deg elbow being segmented from
- *(a)* Table 1/Table I-1 for long radius elbow, mm (in.)
- *(b)* Table 4/Table I-4 for short radius elbow, mm (in.)
- *(c)* Table 6/Table I-6 for 3D elbow, mm (in.)

B_s = center-to-end dimension for segmented elbow

θ = angle of segmented elbow — 30 deg, 60 deg, 75 deg, etc.

When special elbows are intended for field segmenting, the outside or inside diameter tolerance shall be furnished throughout the fitting by agreement between the manufacturer and the purchaser. Any mismatch on the outside or inside diameter needs to be corrected in the field by grinding, back-welding, or bridging of weld to meet the applicable piping code requirements. Although the elbow intended for field-segmenting must meet the requirements of this Standard, once the field-segmented elbow is cut, it is not a B16.9 product.

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 section 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 12. 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 (12)

Proof tests shall be made as set forth in this Standard when the manufacturer chooses proof testing to qualify the fitting design. The proof test shall be based on the computed burst pressure of the fitting and its connecting piping as defined in para. 9.3. A factory-made segmented elbow (see para. 6.2.4) that has a proof test on a geometrically similar 90-deg elbow need not be tested separately.

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 have the same basic design configuration and method of manufacture shall be selected from production for testing and shall be identified as to material, grade, and lot, including heat treatment. They shall be inspected for dimensional compliance to this Standard. (12)

9.2.2 Other Components. Straight seamless or welded pipe 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. Pipe sections may have the nominal wall greater than the thickness indicated by the fitting markings. That greater thickness shall not exceed 1.5 times the fitting markings wall. Any internal misalignment greater than 1.5 mm (0.06 in.) shall be reduced by taper boring at a slope not over 1:3. Any other unequal wall (12)

welding preparation shall be in accordance with ASME B16.25. 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).

(12) 9.3 Test Procedure

The test fluid shall be water or other liquid. Hydrostatic pressure shall be applied to the assembly.

At least three specimen tests for each fitting, joint size, or configuration are recommended. The testing factor, f, based on the number of specimen tests performed in the table below is used in the computed test equations.

Number of Tests	Testing Factor, f
1	1.10
2	1.05
3	1.00

NOTE: Tests of geometrically identical fittings that meet the requirements specified in para. 9.4 may be combined to establish the test factor applied to a set of fittings.

The test shall be taken to rupture or held at or above the computed minimum proof pressure for a period of at least 3 min. The test is successful if for each of the tests, the fitting withstands without rupture a proof test pressure at least equal to the computed minimum.

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

where

D = specified outside diameter of pipe
f = testing factor from in-text table listed in para. 9.3
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 section 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 (12) capacity of a geometrically identical fitting made of various grades of steel as listed in section 5 will be directly proportional to the tensile properties of the materials, provided the yield-to-tensile ratio as specified in the applicable specification of that material is 0.84 or less. Therefore, it is necessary to test only a single material in a representative fitting to prove the design of the fitting.

9.5 Maintenance of Results (12)

The manufacturer shall have a quality control (QC) program that verifies the manufacturing process used and ensures that the resulting geometry of the fittings or joints manufactured reasonably conforms to the geometries tested. The QC program shall control the manufacturing drawings and maintain the QC records showing conformance to these drawings.

Tests made in accordance with and at the time of previous editions of this test are not intended to be nullified by the changes made in this edition's test procedure and requirement.

Whenever a significant change is made in the geometry or method of manufacture, the manufacturer shall either retest the new production or show by analysis that the change would not affect the results of prior tests.

9.6 Proof Test Report (12)

A report of the testing for each joint configuration shall be prepared and shall include

(a) description of the test, including the number of tests and f factor used to establish the target proof test

(b) instrumentation and methods of calibrations used

(c) material test reports for the assembly's materials

(d) actual final pressures for each test

(e) length of time from test initiation to the time of burst, or the hold time at or above the computed target pressure

(f) calculations performed

(g) location of rupture, if any, including a sketch

(h) certification by a registered Professional Engineer experienced in pressure component design or a licensed Authorized Inspector

The test report shall be made available at the manufacturer's facility for inspection by the purchaser or regulatory authority.

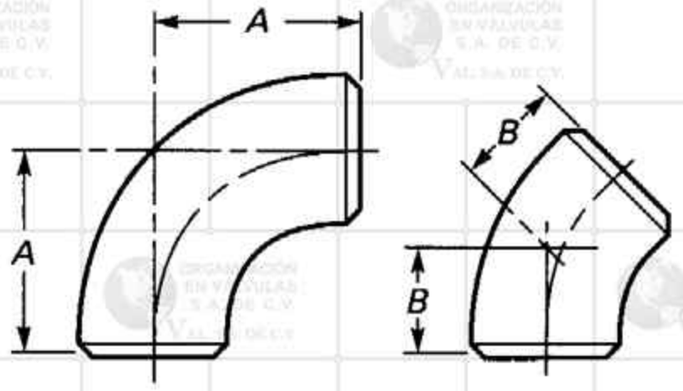
10 PRODUCTION TESTS

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 13 and I-12, and apply to the nominal dimensions given in Tables 1 through 11 and Tables I-1 through I-11. 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.

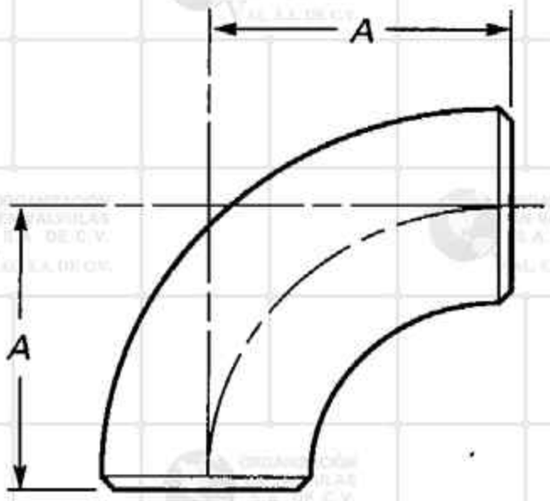
Table 1 Dimensions of Long Radius Elbows



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	457.0	686	286
20	508.0	762	318
22	559.0	838	343
24	610.0	914	381
26	660.0	991	406
28	711.0	1 067	438
30	762.0	1 143	470
32	813.0	1 219	502
34	864.0	1 295	533
36	914.0	1 372	565
38	965.0	1 448	600
40	1 016.0	1 524	632
42	1 067.0	1 600	660
44	1 118.0	1 676	695
46	1 168.0	1 753	727
48	1 219.0	1 829	759

GENERAL NOTE: All dimensions are in millimeters.

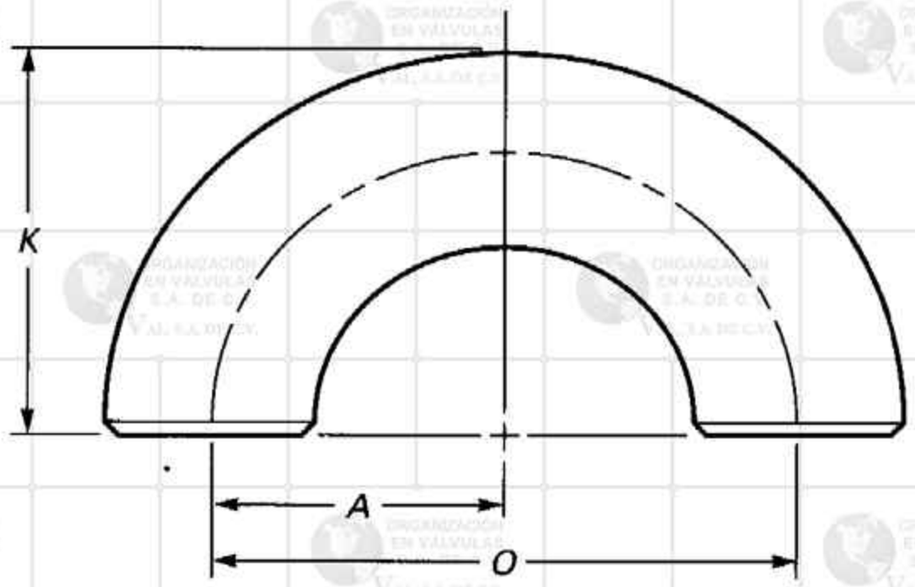
Table 4 Dimensions of Short Radius Elbows



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End, *A*
1	33.4	25
1¼	42.2	32
1½	48.3	38
2	60.3	51
2½	73.0	64
3	88.9	76
3½	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	457.0	457
20	508.0	508
22	559.0	559
24	610.0	610

GENERAL NOTE: All dimensions are in millimeters.

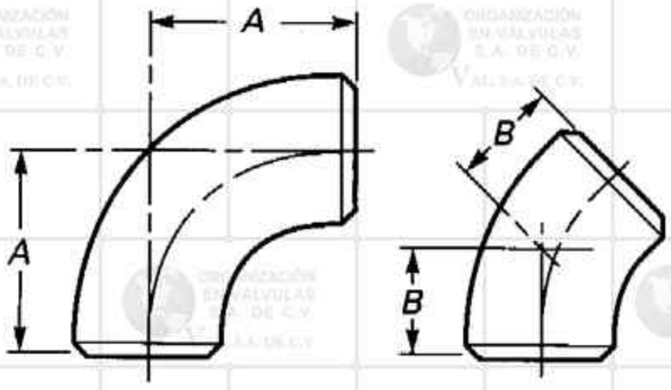
Table 5 Dimensions of Short Radius 180-deg Returns



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-Center, *O*	Back-to-Face, *K*
1	33.4	51	41
1¼	42.2	64	52
1½	48.3	76	62
2	60.3	102	81
2½	73.0	127	100
3	88.9	152	121
3½	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	457.0	914	686
20	508.0	1 016	762
22	559.0	1 118	838
24	610.0	1 219	914

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

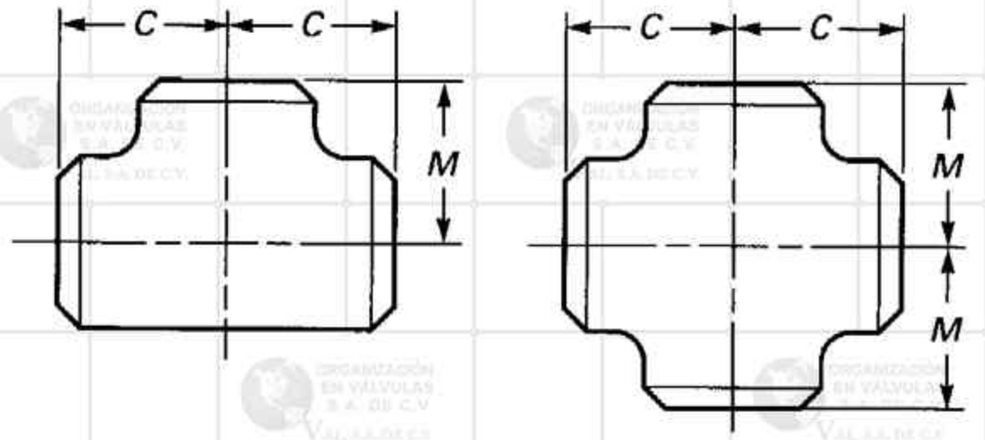
Table 6 Dimensions of 3D Elbows



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End	
		90-deg Elbows, *A*	45-deg Elbows, *B*
¾	26.7	57	24
1	33.4	76	31
1¼	42.2	95	39
1½	48.3	114	47
2	60.3	152	63
2½	73.0	190	79
3	88.9	229	95
3½	101.6	267	111
4	114.3	305	127
5	141.3	381	157
6	168.3	457	189
8	219.1	610	252
10	273.0	762	316
12	323.8	914	378
14	355.6	1 067	441
16	406.4	1 219	505
18	457.0	1 372	568
20	508.0	1 524	632
22	559.0	1 676	694
24	610.0	1 829	757
26	660.0	1 981	821
28	711.0	2 134	883
30	762.0	2 286	964
32	813.0	2 438	1 010
34	864.0	2 591	1 073
36	914.0	2 743	1 135
38	965.0	2 896	1 200
40	1 016.0	3 048	1 264
42	1 067.0	3 200	1 326
44	1 118.0	3 353	1 389
46	1 168.0	3 505	1 453
48	1 219.0	3 658	1 516

GENERAL NOTE: All dimensions are in millimeters.

Table 7 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)]
½	21.3	25	25
¾	26.7	29	29
1	33.4	38	38
1¼	42.2	48	48
1½	48.3	57	57
2	60.3	64	64
2½	73.0	76	76
3	88.9	86	86
3½	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	457.0	343	343
20	508.0	381	381
22	559.0	419	419
24	610.0	432	432
26	660.0	495	495
28	711.0	521	521
30	762.0	559	559
32	813.0	597	597
34	864.0	635	635
36	914.0	673	673
38	965.0	711	711
40	1 016.0	749	749
42	1 067.0	762	711
44	1 118.0	813	762
46	1 168.0	851	800
48	1 219.0	889	838

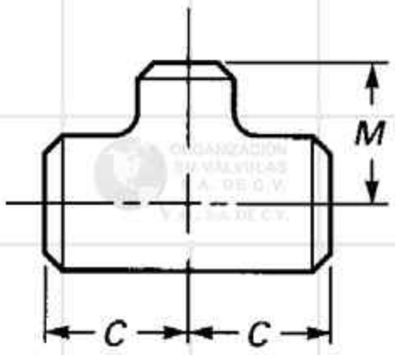
GENERAL NOTE: All dimensions are in millimeters.

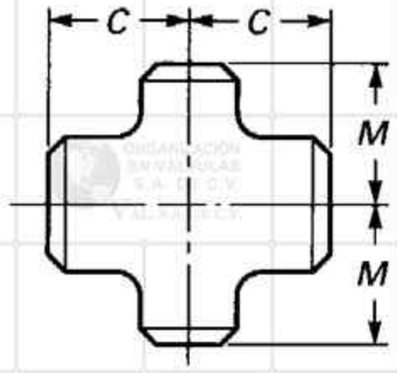
NOTES:

(1) Outlet dimension *M* for NPS 26 and larger is recommended but not required.

(2) Dimensions applicable to crosses NPS 24 and smaller.

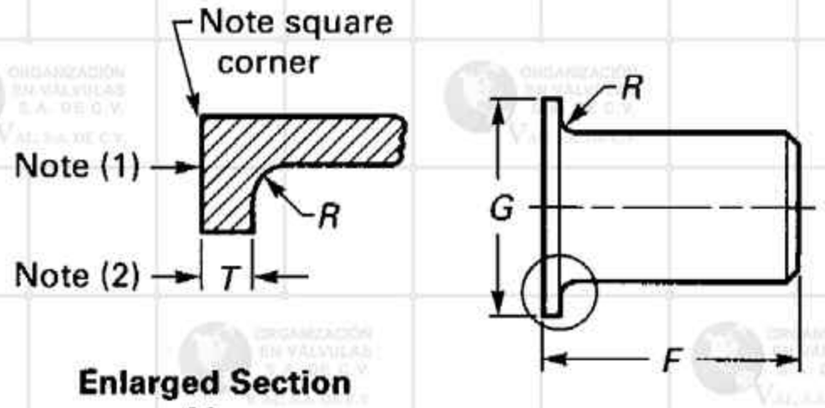
Table 8 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses





Nominal Pipe Size (NPS)	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run, *C*	Outlet, *M* [Note (1)]
½ × ½ × ⅜	21.3	17.3	25	25
½ × ½ × ¼	21.3	13.7	25	25
¾ × ¾ × ½	26.7	21.3	29	29
¾ × ¾ × ⅜	26.7	17.3	29	29
1 × 1 × ¾	33.4	26.7	38	38
1 × 1 × ½	33.4	21.3	38	38
1¼ × 1¼ × 1	42.2	33.4	48	48
1¼ × 1¼ × ¾	42.2	26.7	48	48
1¼ × 1¼ × ½	42.2	21.3	48	48
1½ × 1½ × 1¼	48.3	42.2	57	57
1½ × 1½ × 1	48.3	33.4	57	57
1½ × 1½ × ¾	48.3	26.7	57	57
1½ × 1½ × ½	48.3	21.3	57	57
2 × 2 × 1½	60.3	48.3	64	60
2 × 2 × 1¼	60.3	42.2	64	57
2 × 2 × 1	60.3	33.4	64	51
2 × 2 × ¾	60.3	26.7	64	44
2½ × 2½ × 2	73.0	60.3	76	70
2½ × 2½ × 1½	73.0	48.3	76	67
2½ × 2½ × 1¼	73.0	42.2	76	64
2½ × 2½ × 1	73.0	33.4	76	57
3 × 3 × 2½	88.9	73.0	86	83
3 × 3 × 2	88.9	60.3	86	76
3 × 3 × 1½	88.9	48.3	86	73
3 × 3 × 1¼	88.9	42.2	86	70
3½ × 3½ × 3	101.6	88.9	95	92
3½ × 3½ × 2½	101.6	73.0	95	89
3½ × 3½ × 2	101.6	60.3	95	83
3½ × 3½ × 1½	101.6	48.3	95	79
4 × 4 × 3½	114.3	101.6	105	102
4 × 4 × 3	114.3	88.9	105	98
4 × 4 × 2½	114.3	73.0	105	95
4 × 4 × 2	114.3	60.3	105	89
4 × 4 × 1½	114.3	48.3	105	86
5 × 5 × 4	141.3	114.3	124	117
5 × 5 × 3½	141.3	101.6	124	114
5 × 5 × 3	141.3	88.9	124	111
5 × 5 × 2½	141.3	73.0	124	108
5 × 5 × 2	141.3	60.3	124	105
6 × 6 × 5	168.3	141.3	143	137
6 × 6 × 4	168.3	114.3	143	130
6 × 6 × 3½	168.3	101.6	143	127
6 × 6 × 3	168.3	88.9	143	124
6 × 6 × 2½	168.3	73.0	143	121
8 × 8 × 6	219.1	168.3	178	168
8 × 8 × 5	219.1	141.3	178	162
8 × 8 × 4	219.1	114.3	178	156
8 × 8 × 3½	219.1	101.6	178	152
10 × 10 × 8	273.0	219.1	216	203
10 × 10 × 6	273.0	168.3	216	194
10 × 10 × 5	273.0	141.3	216	191
10 × 10 × 4	273.0	114.3	216	184
12 × 12 × 10	323.8	273.0	254	241
12 × 12 × 8	323.8	219.1	254	229
12 × 12 × 6	323.8	168.3	254	219
12 × 12 × 5	323.8	141.3	254	216
14 × 14 × 12	355.6	323.8	279	270
14 × 14 × 10	355.6	273.0	279	257
14 × 14 × 8	355.6	219.1	279	248
14 × 14 × 6	355.6	168.3	279	238

Table 9 Dimensions of Lap Joint Stub Ends



Enlarged Section of Lap

Nominal Pipe Size (NPS)	Outside Diameter of Barrel		Long Pattern Length, *F* [Notes (3), (4)]	Short Pattern Length, *F* [Notes (3), (4)]	Radius of Fillet, *R* [Note (5)]	Diameter of Lap, *G* [Note (6)]
	Max.	Min.				
½	22.8	20.5	76	51	3	35
¾	28.1	25.9	76	51	3	43
1	35.0	32.6	102	51	3	51
1¼	43.6	41.4	102	51	5	64
1½	49.9	47.5	102	51	6	73
2	62.4	59.5	152	64	8	92
2½	75.3	72.2	152	64	8	105
3	91.3	88.1	152	64	10	127
3½	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	462.0	456.0	305	152	13	533
20	514.0	507.0	305	152	13	584
22	565.0	558.0	305	152	13	641
24	616.0	609.0	305	152	13	692

GENERAL NOTES:

(a) All dimensions are in millimeters.

(b) See Table 13 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 13 for maximum tolerance.

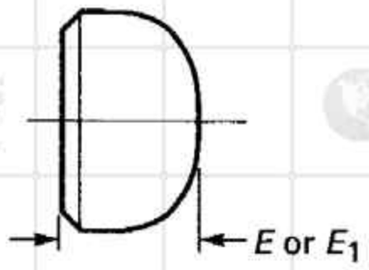
(3) When short pattern stub ends are used with larger flanges in Classes 300 and 600, with most sizes in Classes 900 and higher, and when long pattern stub ends are used with larger flanges in Classes 1500 and 2500, it may be necessary to increase the length of the stub ends in order to avoid covering 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 sits. Where ring joint facings are to be applied, use dimension *K* as given in ASME B16.5.

Table 10 Dimensions of Caps



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Length, E [Note (1)]	Limiting Wall Thickness for Length, E	Length, E_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	457.0	203	12.70	229
20	508.0	229	12.70	254
22	559.0	254	12.70	254
24	610.0	267	12.70	305
26	660.0	267	...	...
28	711.0	267	...	...
30	762.0	267	...	...
32	813.0	267	...	...
34	864.0	267	...	...
36	914.0	267	...	...
38	965.0	305	...	...
40	1 016.0	305	...	...
42	1 067.0	305	...	...
44	1 118.0	343	...	...
46	1 168.0	343	...	...
48	1 219.0	343	...	...

GENERAL NOTES:

(a) All dimensions are in millimeters.

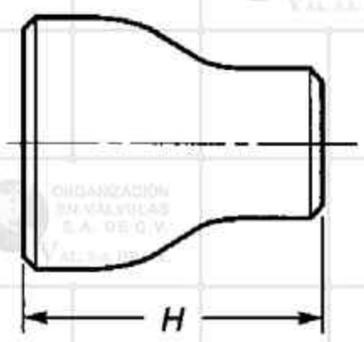
(b) The shape of these caps shall be ellipsoidal and shall conform to the requirements given in the ASME Boiler and Pressure Vessel Code.

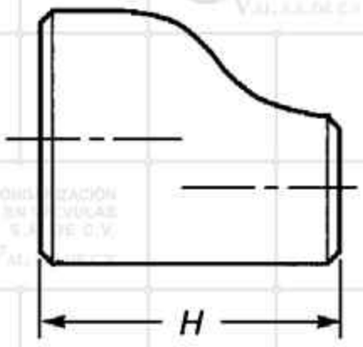
NOTES:

(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 11 Dimensions of Reducers





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

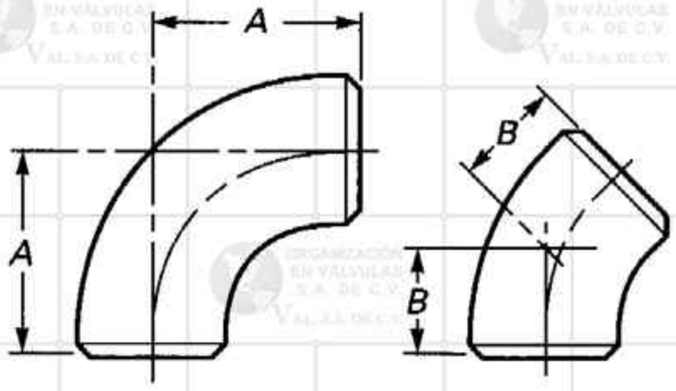
Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, *H*
	Large End	Small End	
20 × 18	508	457.0	508
20 × 16	508	406.4	508
20 × 14	508	355.6	508
20 × 12	508	323.8	508
22 × 20	559	508.0	508
22 × 18	559	457.0	508
22 × 16	559	406.4	508
22 × 14	559	355.4	508
24 × 22	610	559.0	508
24 × 20	610	508.0	508
24 × 18	610	457.0	508
24 × 16	610	406.4	508
26 × 24	660	610.0	610
26 × 22	660	559.0	610
26 × 20	660	508.0	610
26 × 18	660	457.0	610
28 × 26	711	660.0	610
28 × 24	711	610.0	610
28 × 20	711	508.0	610
28 × 18	711	457.0	610
30 × 28	762	711.0	610
30 × 26	762	660.0	610
30 × 24	762	610.0	610
30 × 20	762	508.0	610
32 × 30	813	762.0	610
32 × 28	813	711.0	610
32 × 26	813	660.0	610
32 × 24	813	610.0	610
34 × 32	864	813.0	610
34 × 30	864	762.0	610
34 × 26	864	660.0	610
34 × 24	864	610.0	610
36 × 34	914	864	610
36 × 32	914	813	610
36 × 30	914	762	610
36 × 26	914	660	610
36 × 24	914	610	610
38 × 36	965	914	610
38 × 34	965	864	610
38 × 32	965	813	610
38 × 30	965	762	610
38 × 28	965	711	610
38 × 26	965	660	610
40 × 38	1 016	965	610
40 × 36	1 016	914	610
40 × 34	1 016	864	610
40 × 32	1 016	813	610
40 × 30	1 016	762	610
42 × 40	1 067	1 016	610
42 × 38	1 067	965	610
42 × 36	1 067	914	610
42 × 34	1 067	864	610
42 × 32	1 067	813	610
42 × 30	1 067	762	610
44 × 42	1 118	1 067	610
44 × 40	1 118	1 016	610
44 × 38	1 118	965	610
44 × 36	1 118	914	610
46 × 44	1 168	1 118	711
46 × 42	1 168	1 067	711
46 × 40	1 168	1 016	711
46 × 38	1 168	965	711
48 × 46	1 219	1 168	711
48 × 44	1 219	1 118	711
48 × 42	1 219	1 067	711
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 a conical reducer is not prohibited.

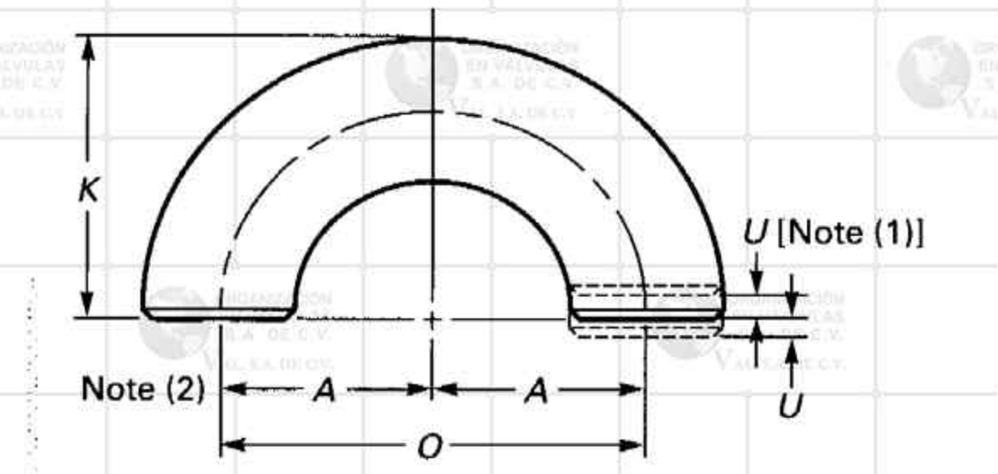
Table I-1 Dimensions of Long Radius Elbows



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End 90-deg Elbows, *A*	Center-to-End 45-deg Elbows, *B*
½	0.84	1.50	0.62
¾	1.05	1.50	0.75
1	1.32	1.50	0.88
1¼	1.66	1.88	1.00
1½	1.90	2.25	1.12
2	2.38	3.00	1.38
2½	2.88	3.75	1.75
3	3.50	4.50	2.00
3½	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 I-3 Dimensions of Long Radius Returns

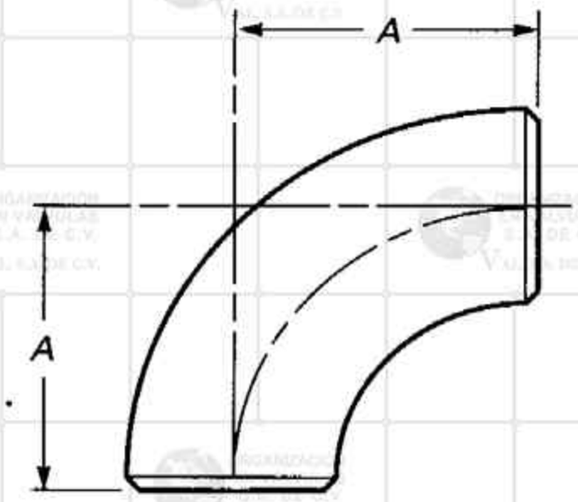


Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-Center, *O*	Back-to-Face, *K*
½	0.84	3.00	1.88
¾	1.05	3.00	2.00
1	1.32	3.00	2.19
1¼	1.66	3.75	2.75
1½	1.90	4.50	3.25
2	2.38	6.00	4.19
2½	2.88	7.50	5.19
3	3.50	9.00	6.25
3½	4.00	10.50	7.25
4	4.50	12.00	8.25
5	5.56	15.00	10.31
6	6.62	18.00	12.31
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 I-12 for tolerance for alignment of ends *U*.
(2) Dimension *A* is equal to one-half of dimension *O*.

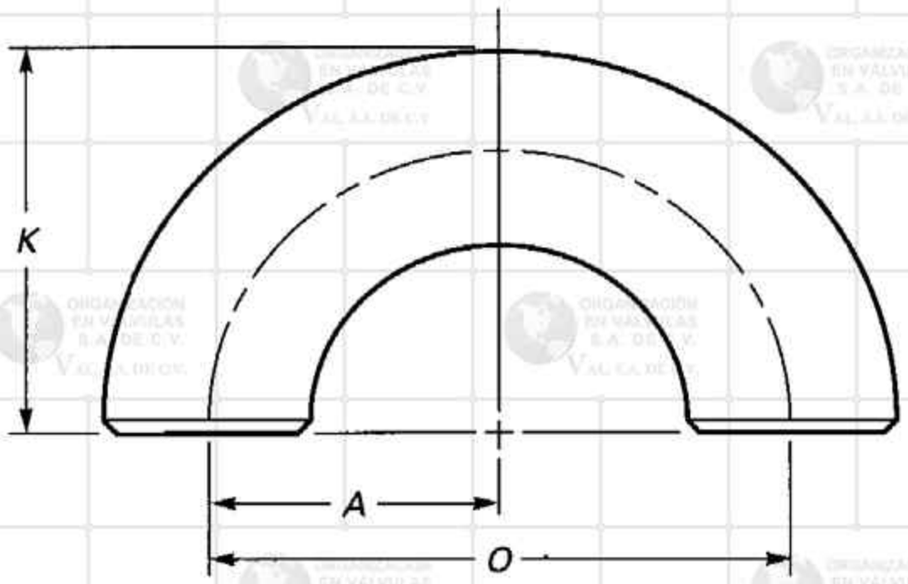
Table I-4 Dimensions of Short Radius Elbows



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End, *A*
1	1.32	1.00
1¼	1.66	1.25
1½	1.90	1.50
2	2.38	2.00
2½	2.88	2.50
3	3.50	3.00
3½	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.

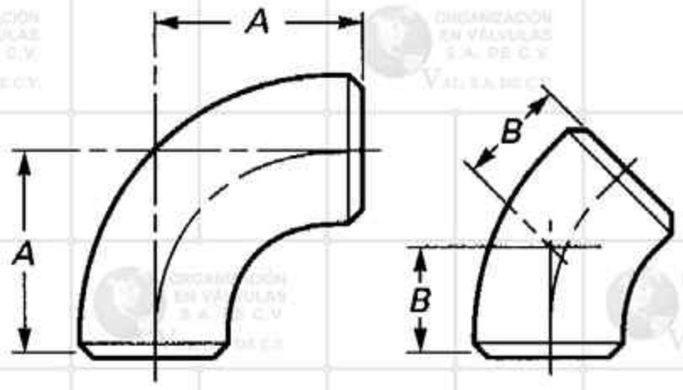
Table I-5 Dimensions of Short Radius 180-deg Returns



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-Center, *O*	Back-to-Face, *K*
1	1.32	2.00	1.62
1¼	1.66	2.50	2.06
1½	1.90	3.00	2.44
2	2.38	4.00	3.19
2½	2.88	5.00	3.94
3	3.50	6.00	4.75
3½	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*.

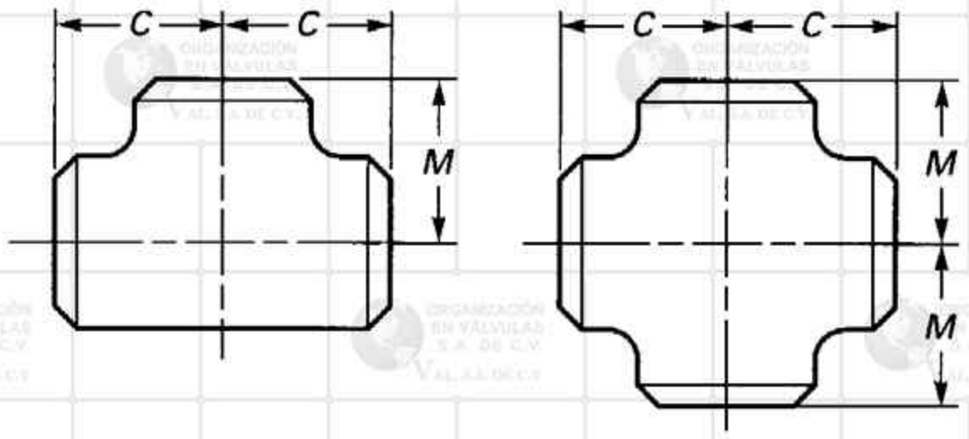
Table I-6 Dimensions of 3D Elbows



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Center-to-End	
		90-deg Elbows, *A*	45-deg Elbows, *B*
¾	1.05	2.25	0.94
1	1.32	3.00	1.25
1¼	1.66	3.75	1.56
1½	1.90	4.50	1.88
2	2.38	6.00	2.50
2½	2.88	7.50	3.12
3	3.50	9.00	3.75
3½	4.00	10.50	4.38
4	4.50	12.00	5.00
5	5.56	15.00	6.19
6	6.62	18.00	7.44
8	8.62	24.00	9.94
10	10.75	30.00	12.44
12	12.75	36.00	14.88
14	14.00	42.00	17.38
16	16.00	48.00	19.88
18	18.00	54.00	22.38
20	20.00	60.00	24.88
22	22.00	66.00	27.31
24	24.00	72.00	29.81
26	26.00	78.00	32.31
28	28.00	84.00	34.75
30	30.00	90.00	37.25
32	32.00	96.00	39.75
34	34.00	102.00	42.25
36	36.00	108.00	44.69
38	38.00	114.00	47.25
40	40.00	120.00	49.75
42	42.00	126.00	52.19
44	44.00	132.00	54.69
46	46.00	138.00	57.19
48	48.00	144.00	59.69

GENERAL NOTE: All dimensions are in inches.

Table I-7 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)]
½	0.84	1.00	1.00
¾	1.05	1.12	1.12
1	1.32	1.50	1.50
1¼	1.66	1.88	1.88
1½	1.90	2.25	2.25
2	2.38	2.50	2.50
2½	2.88	3.00	3.00
3	3.50	3.38	3.38
3½	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

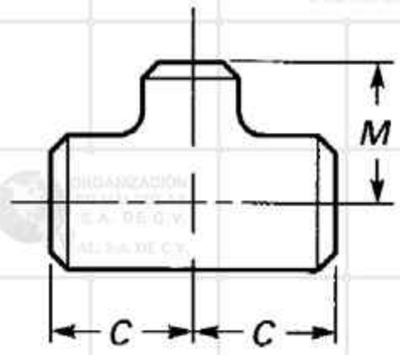
GENERAL NOTE: All dimensions are in inches.

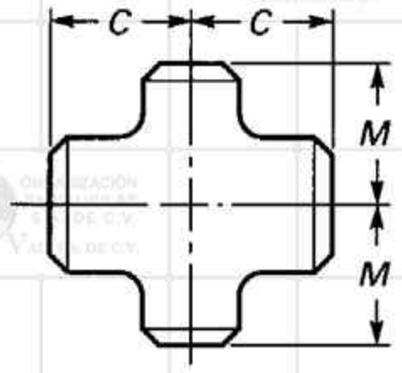
NOTES:

(1) Outlet dimension *M* for NPS 26 and larger is recommended but not required.

(2) Dimensions applicable to crosses NPS 24 and smaller.

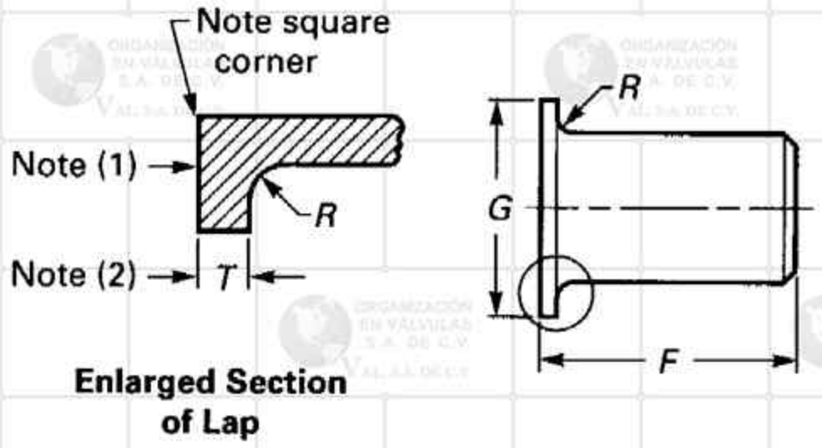
Table I-8 Dimensions of Reducing Outlet Tees and Reducing Outlet Crosses





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

Table I-9 Dimensions of Lap Joint Stub Ends



Enlarged Section of Lap

Nominal Pipe Size (NPS)	Outside Diameter of Barrel		Long Pattern Length, *F* [Notes (3), (4)]	Short Pattern Length, *F* [Notes (3), (4)]	Radius of Fillet, *R* [Note (5)]	Diameter of Lap, *G* [Note (6)]
	Max.	Min.				
½	0.896	0.809	3.00	2.00	0.12	1.38
¾	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
1¼	1.716	1.629	4.00	2.00	0.19	2.50
1½	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
2½	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
3½	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 I-12 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 I-12 for tolerance.

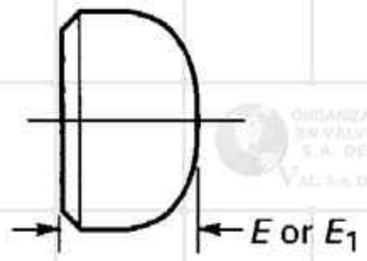
(3) When short pattern stub ends are used with larger flanges in Classes 300 and 600, with most sizes in Classes 900 and higher, and when long pattern stub ends are used with larger flanges in Classes 1500 and 2500, it may be necessary to increase the length of the stub ends in order to avoid covering 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 sits. Where ring joint facings are to be applied, use dimension *K* as given in ASME B16.5.

Table I-10 Dimensions of Caps



Nominal Pipe Size (NPS)	Outside Diameter at Bevel	Length, E [Note (1)]	Limiting Wall Thickness for Length, E	Length, E_1 [Note (2)]
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) All dimensions are in inches.

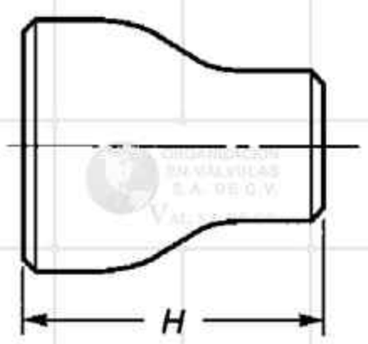
(b) The shape of these caps shall be ellipsoidal and shall conform to the requirements given in the ASME Boiler and Pressure Vessel Code.

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 I-11 Dimensions of Reducers



Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, *H*
	Large End	Small End	
$\frac{3}{4} \times \frac{1}{2}$	1.05	0.84	1.50
$\frac{3}{4} \times \frac{3}{8}$	1.05	0.68	1.50
$1 \times \frac{3}{4}$	1.32	1.05	2.00
$1 \times \frac{1}{2}$	1.32	0.84	2.00
$1\frac{1}{4} \times 1$	1.66	1.32	2.00
$1\frac{1}{4} \times \frac{3}{4}$	1.66	1.05	2.00
$1\frac{1}{4} \times \frac{1}{2}$	1.66	0.84	2.00
$1\frac{1}{2} \times 1\frac{1}{4}$	1.90	1.66	2.50
$1\frac{1}{2} \times 1$	1.90	1.32	2.50
$1\frac{1}{2} \times \frac{3}{4}$	1.90	1.05	2.50
$1\frac{1}{2} \times \frac{1}{2}$	1.90	0.84	2.50
$2 \times 1\frac{1}{2}$	2.38	1.90	3.00
$2 \times 1\frac{1}{4}$	2.38	1.66	3.00
2×1	2.38	1.32	3.00
$2 \times \frac{3}{4}$	2.38	1.05	3.00
$2\frac{1}{2} \times 2$	2.88	2.38	3.50
$2\frac{1}{2} \times 1\frac{1}{2}$	2.88	1.90	3.50
$2\frac{1}{2} \times 1\frac{1}{4}$	2.88	1.66	3.50
$2\frac{1}{2} \times 1$	2.88	1.32	3.50
$3 \times 2\frac{1}{2}$	3.50	2.88	3.50
3×2	3.50	2.38	3.50
$3 \times 1\frac{1}{2}$	3.50	1.90	3.50
$3 \times 1\frac{1}{4}$	3.50	1.66	3.50
$3\frac{1}{2} \times 3$	4.00	3.50	4.00
$3\frac{1}{2} \times 2\frac{1}{2}$	4.00	2.88	4.00
$3\frac{1}{2} \times 2$	4.00	2.38	4.00
$3\frac{1}{2} \times 1\frac{1}{2}$	4.00	1.90	4.00
$3\frac{1}{2} \times 1\frac{1}{4}$	4.00	1.66	4.00
$4 \times 3\frac{1}{2}$	4.50	4.00	4.00
4×3	4.50	3.50	4.00
$4 \times 2\frac{1}{2}$	4.50	2.88	4.00
4×2	4.50	2.38	4.00
$4 \times 1\frac{1}{2}$	4.50	1.90	4.00
5×4	5.56	4.50	5.00
$5 \times 3\frac{1}{2}$	5.56	4.00	5.00
5×3	5.56	3.50	5.00
$5 \times 2\frac{1}{2}$	5.56	2.88	5.00
5×2	5.56	2.38	5.00
6×5	6.62	5.56	5.50
6×4	6.62	4.50	5.50
$6 \times 3\frac{1}{2}$	6.62	4.00	5.50
6×3	6.62	3.50	5.50
$6 \times 2\frac{1}{2}$	6.62	2.88	5.50
8×6	8.62	6.62	6.00
8×5	8.62	5.56	6.00
8×4	8.62	4.50	6.00
$8 \times 3\frac{1}{2}$	8.62	4.00	6.00
10×8	10.75	8.62	7.00
10×6	10.75	6.62	7.00
10×5	10.75	5.56	7.00
10×4	10.75	4.50	7.00
12×10	12.75	10.75	8.00
12×8	12.75	8.62	8.00
12×6	12.75	6.62	8.00
12×5	12.75	5.56	8.00
14×12	14.00	12.75	13.00
14×10	14.00	10.75	13.00
14×8	14.00	8.62	13.00
14×6	14.00	6.62	13.00
16×14	16.00	14.00	14.00
16×12	16.00	12.75	14.00
16×10	16.00	10.75	14.00
16×8	16.00	8.62	14.00
18×16	18.00	16.00	15.00
18×14	18.00	14.00	15.00
18×12	18.00	12.75	15.00
18×10	18.00	10.75	15.00

Table I-11 Dimensions of Reducers (Cont'd)

Nominal Pipe Size (NPS)	Outside Diameter at Bevel		End-to-End, *H*
	Large End	Small End	
20 × 18	20.00	18.00	20.00
20 × 16	20.00	16.00	20.00
20 × 14	20.00	14.00	20.00
20 × 12	20.00	12.75	20.00
22 × 20	22.00	20.00	20.00
22 × 18	22.00	18.00	20.00
22 × 16	22.00	16.00	20.00
22 × 14	22.00	14.00	20.00
24 × 22	24.00	22.00	20.00
24 × 20	24.00	20.00	20.00
24 × 18	24.00	18.00	20.00
24 × 16	24.00	16.00	20.00
26 × 24	26.00	24.00	24.00
26 × 22	26.00	22.00.	24.00
26 × 20	26.00	20.00	24.00
26 × 18	26.00	18.00	24.00
28 × 26	28.00	26.00	24.00
28 × 24	28.00	24.00	24.00
28 × 20	28.00	20.00	24.00
28 × 18	28.00	18.00	24.00
30 × 28	30.00	28.00	24.00
30 × 26	30.00	26.00	24.00
30 × 24	30.00	24.00	24.00
30 × 20	30.00	20.00	24.00
32 × 30	32.00	30.00	24.00
32 × 28	32.00	28.00	24.00
32 × 26	32.00	26.00	24.00
32 × 24	32.00	24.00	24.00
34 × 32	34.00	32.00	24.00
34 × 30	34.00	30.00	24.00
34 × 26	34.00	26.00	24.00
34 × 24	34.00	24.00	24.00
36 × 34	36.00	34.00	24.00
36 × 32	36.00	32.00	24.00
36 × 30	36.00	30.00	24.00
36 × 26	36.00	26.00	24.00
36 × 24	36.00	24.00	24.00
38 × 36	38.00	36.00	24.00
38 × 34	38.00	34.00	24.00
38 × 32	38.00	32.00	24.00
38 × 30	38.00	30.00	24.00
38 × 28	38.00	28.00	24.00
38 × 26	38.00	26.00	24.00
40 × 38	40.00	38.00	24.00
40 × 36	40.00	36.00	24.00
40 × 34	40.00	34.00	24.00
40 × 32	40.00	32.00	24.00
40 × 30	40.00	30.00	24.00
42 × 40	42.00	40.00	24.00
42 × 38	42.00	38.00	24.00
42 × 36	42.00	36.00	24.00
42 × 34	42.00	34.00	24.00
42 × 32	42.00	32.00	24.00
42 × 30	42.00	30.00	24.00
44 × 42	44.00	42.00	24.00
44 × 40	44.00	40.00	24.00
44 × 38	44.00	38.00	24.00
44 × 36	44.00	36.00	24.00
46 × 44	46.00	44.00	28.00
46 × 42	46.00	42.00	28.00
46 × 40	46.00	40.00	28.00
46 × 38	46.00	38.00	28.00
48 × 46	48.00	46.00	28.00
48 × 44	48.00	44.00	28.00
48 × 42	48.00	42.00	28.00
48 × 40	48.00	40.00	28.00

GENERAL NOTES:

(a) All dimensions are in inches.

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