ANSI/AWWA C208

American Water Works Association
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AWWA Standard

Dimensions for Fabricated Steel Water Pipe Fittings

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard provides formulas to calculate overall dimensions of fittings for steel water transmission and distribution facilities.

Many configurations of fittings are possible, and alternatives to this standard may be agreed on between the purchaser and manufacturer. The fitting dimensions shown in Figures 1 through 5 are the minimum dimensions for fittings with plain ends. In practice, fittings are seldom provided as individual pieces as shown but are shop fabricated into full lengths or special lengths of pipe or fabricated into assemblies combining a number of fittings.

1.1.1 *Conditions not covered in this standard.* This standard is intended to serve as a dimensional guide only. It is not a design standard for wall thickness, pressure ratings, structural design, or hydraulic design. Reinforcement of fittings, which may include increased wall thickness, collars, wrapper plates, or crotch plates, is not described in this standard. The design of fittings should be performed in accordance with the applicable section(s) in AWWA Manual M11, *Steel Pipe: A Guide for Design and Installation*.

Sec. 1.2 Purpose

The purpose of this standard is to provide formulas for use in calculating the general minimum requirements for the dimensions of fabricated steel water pipe fittings.

Sec. 1.3 Application

This standard or sections of this standard can be referenced in the purchaser's documents for dimensions for fabricated steel water pipe fittings. The stipulations of this standard apply when this document has been referenced and then only to dimensions for fabricated steel water pipe fittings.

SECTION 2: REFERENCES

This standard references the following documents. In their latest editions, they form a part of this standard to the extent specified within the standard. In any case of conflict, the requirements of this standard shall prevail.

ANSI*/AWWA C200—Steel Water Pipe, 6 In. (150 mm) and Larger.

ASME† B16.9—Factory Made Wrought Buttwelding Fittings.

ASTM A234/A234M—Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

AWWA Manual M11—*Steel Pipe: A Guide for Design and Installation*.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Manufacturer:* The party that manufactures, fabricates, or produces materials or products.

2. *Nominal diameter:* The commercial designation or dimension by which pipe is designated for simplicity.

3. *Purchaser:* The person, company, or organization that purchases any materials or work to be performed.

SECTION 4: REQUIREMENTS

Sec. 4.1 Fittings

4.1.1 *General.* The formulas in this standard provide the flexibility to calculate dimensions for fittings of any size pipe based on the outside diameter of the pipe.

Values resulting from the formulas are general minimum dimensions of good practice for fittings with plain ends or beveled ends for field welding. Alternative dimensions may be necessary for other types of joint connections, such as mechanical couplings, grooved or shouldered couplings, bells, spigots, flanges, and so on, to maintain adequate distance from a reinforcement collar to the pipe end or to facilitate practical limits of fabrication. Other geometrically constrained ends, such as flanged ends, may be acceptable when furnished with dimensions shorter than those contained herein, subject to agreement of constructability between the purchaser and manufacturer. See appendix A for a reference listing of select fitting dimensions based on nominal pipe diameters.

4.1.2 *Symbols.* Symbols used in formulas and dimensions in this standard are as follows:

A = Length of tee or cross from centerline to end (Figures 1A, 1B, and 1C).

B = Length of reducing tee from centerline to end (Figure 1C).

d = Outside diameter of steel cylinder of a branch outlet of a reducing tee or lateral of unequal diameter.

D = Nominal diameter of pipe.

D_1 = Inside diameter of pipe at large end of reducing elbow (Figure 5).

D_2, D_4, D_6, D_x = Intermediate inside diameter of right circular cone segments of reducing elbow (Figure 5).

D_L = Outside diameter of steel cylinder of large end of a reducer (Figure 1F).

D_n = Inside diameter of pipe at small end of reducing elbow (Figure 5).

D_o = Outside diameter of steel cylinder.

D_S = Outside diameter of steel cylinder of small end of a reducer (Figure 1F).

F = Centerline length from the point of intersection of wye to the end of the pipe (Figure 1E).

f_d = Formula factor corresponding to d of a tee, lateral, or tangential outlet.

fD_o = Formula factor corresponding to D_O of a tee, lateral, wye, or elbow.

G = Centerline length of lateral from point of intersection of lateral to end of run and end of leg (Figure 1D).

G_1 = Short side centerline length of lateral from point of intersection of lateral to end of run (Figure 1D).

G_o = Centerline length of leg in unequal diameter lateral from point of intersection of lateral to end of leg (Figure 1D).

H_y = Overall length of branch leg of wye from the point of intersection to end (Figure 1E).

k = Scalar variable for elbow dimension calculations. k = (number of elbow segments) – 1

L = Centerline distance from the point of intersection of the elbow to the end of the pipe (Figures 2C, 2D, 2E, 2F, and 4).

L_L = Overall run length of a lateral (Figure 1D).

L_r = Length of a reducer (Figure 1F).

L_t = Length of tangential type outlet, centerline to end of pipe (Figure 3).

n = Number of angular divisions of reducing elbow (Figure 5).

n_e = Diameter multiplier for elbow radius calculation.

P.C. = Geometric point of beginning curvature of centerline for reducing elbow (Figure 5).

P.I. = Point of intersection.

P.T. = Geometric point of tangency of centerline for reducing elbow (Figure 5).

R = Radius to centerline of elbow (Figures 2D, 2E, 2F, and 5).

r_1 = Development radius for large end of reducing elbow (Figure 5).

r_3, r_5, r_x = Intermediate development radius of reducing elbow (Figure 5).

r_n = Development radius for small end of reducing elbow (Figure 5).

S = Length of inside segment of fabricated elbow (Figures 2D, 2E, and 2F).

T = Elbow length from point of intersection to tangent line (Figures 2D, 2E, 2F, and 5).

Y_3, Y_5, Y_x = Intermediate offset dimension of reducing elbow (Figure 5).

Z_1 = Offset dimension for large end of reducing elbow (Figure 5).

Z_n = Offset dimension for small end of reducing elbow (Figure 5).

α = Angle developed between vertical centerline of pipe run and intersection of outside diameter of top of outlet (Figure 3).

Δ = Total elbow or fitting deflection angle (Figures 1D, 2A, 2B, 2C, 2D, 2E, 2F, 4, and 5).

ϕ = Miter-cut angle of reducing elbow (Figure 5).

θ = Angle of inclination of right circular cone (Figure 5).

ρ = Division angle of reducing elbow (Figure 5).

4.1.3 *Formula factors.* Dimensional formulas contained herein include factors to provide for adequate minimum clearance between various attributes of fabricated fittings. The factors represent good practice that will assist in maintaining the

roundness of pipe end and are a function of the outside diameter of the pipe associated with the specific equation. The formulas for the factors are as follows

$$fD_o = 0.143D_o + 5$$
$$f_d = 0.143d + 5$$

NOTE: The above equations are for values in inches. For values in millimeters, replace 5 with 127.

4.1.4 *Tee and cross.* Minimum dimension A for a tee or a cross is calculated using the formula below. (Refer to Figures 1A and 1B.)

$$A = 0.5D_o + fD_o$$

4.1.5 *Reducing tee and reducing cross.* Minimum dimensions A and B for a reducing tee or a reducing cross are calculated using the formulas below. (Refer to Figure 1C.)

$$A = 0.5D_o + fD_o$$
$$B = 0.5d + f_d$$

4.1.6 *Tangential outlet.* The minimum length of a tangential outlet, L_t, is calculated by the formulas below. (Refer to Figure 3.) L_t should be kept as short as possible to avoid damage during shipping and handling but long enough to allow for flange clearance. If necessary to enable the valve operator to clear the outside diameter of the run pipe, a flanged spool should be used to extend the connection as required.

$$\alpha = \arccos\left(\frac{0.5D_o - d}{0.5D_o}\right)$$

$$L_t = 0.5D_o \sin\alpha + \frac{f_d}{\sin\alpha}$$

4.1.7 *Lateral, Case I (equal diameters).* Minimum dimensions G, G_1, and L_L for a lateral of equal diameters and suitable for angle Δ of 30° to 70° are calculated using the formulas below. (Refer to Figure 1D, Case I [equal diameters].) For an angle Δ greater than 70°, use the formulas provided for a tee. (Refer to Figure 1A.) For a required effective angle Δ less than 30°, use a 30° or larger lateral with an elbow fabricated into the outlet of the lateral (see Sec. 4.1.9). (Refer to Figure 4.)

$$G = \left(\frac{D_o}{2\tan(\Delta/2)}\right) + 2f_{Do}$$

$$G_1 = (D_o/2)\tan(\Delta/2) + fD_o$$

$$L_L = G + G_1$$

4.1.8 *Lateral, Case II (unequal diameters).* When the outlet diameter, d, is less than D_o, minimum dimensions G, G_o, G_1, and L_L for a lateral suitable for

angle Δ of 30° to 70° are calculated using the formulas below. (Refer to Figure 1D, Case II [unequal diameters].) For angles greater than 70°, use the formulas provided for a tee. (Refer to Figure 1C.) For a required effective angle Δ less than 30°, use a 30° or larger lateral with an elbow fabricated into the outlet of the lateral (see Sec. 4.1.9). (Refer to Figure 4.)

$$G = \frac{D_o}{2 \tan \Delta} + \frac{d}{2 \sin \Delta} + 2f_{Do}$$

$$G_o = \frac{D_o}{2 \sin \Delta} + \frac{d}{2 \tan \Delta} + 2f_d$$

$$G_1{}^* = d/(2 \sin \Delta) - D_o/(2 \tan \Delta) + f_{Do}$$

$$L_L = G + G_1$$

*Note: For unequal diameter laterals with small values of d, G_1 may be negative. Therefore, the intersection of the centerlines of the outlet and run pipe will not be within the minimum length L_L.

4.1.9 *Elbow fabricated into a lateral outlet.* Due to design, manufacturing, and installation constraints, a lateral should not be furnished with branch deflections less than 30°. When a lateral with a deflection angle less than 30° is desired, a combination fitting resulting in the desired angular deflection can be used. One configuration of such a fitting is shown in Figure 4, where the elbow portion of the lateral branch yields a resultant angle less than 30° for the fitting as a whole. Various combinations of lateral branch deflection and Δ angles may be used to yield the required effective deflection of less than 30°.

4.1.10 *Wye (bifurcation).* Minimum dimensions F and H_y for a wye are calculated using the formulas below. (Refer to Figure 1E for a wye with a 90° included angle.) Other included angles from less than 90° to 30° may be used. When a wye with an included angle less than 30° is desired, a combination wye with elbow fitting resulting in the desired angle can be used. A wye configuration such as this would be similar on each side to the lateral outlet with elbow combination shown in Figure 4. Various combinations of wye included angles and elbow Δ angles may be used to yield the desired deflection of less than 30°.

Where Δ = the included angle of the fitting as defined in Figure 1E:

$$F = \left(\frac{D_o}{2}\right) \tan\left(\frac{\Delta}{4}\right) + f_{Do}$$

$$H_y = \frac{f_{Do}}{\sin(\Delta/2)} + \frac{0.5D_o}{\tan(\Delta/2)}$$

4.1.11 *Concentric and eccentric reducers.* The minimum length of reducers, L_r, is calculated by the following formula. (Refer to Figure 1F.)

$$L_r = 4\ (D_L - D_S)$$

NOTE: If length must be less than the prior formula, consult AWWA Manual M11 for design stress considerations.

4.1.12 *Miter-cut end.*

4.1.12.1 Welded lap joint. A small deflection angle can be taken in a welded lap joint using a miter-cut bell end provided that the following are maintained: bell and spigot diameter tolerances, joint formation dimensional requirements, and joint engagement dimensional requirements. To form a miter-cut bell, the pipe end is miter cut, and then the bell is expanded square with the face of the miter cut (see Figure 2B). The limit for the maximum miter-cut angle of a weld bell is a function of design requirements and manufacturing constraints and cannot be defined explicitly in this standard. Although historically a value of 5° has been a good practice limit, the actual value can be larger or smaller depending on specific design and manufacturing parameters. It is recommended that the designer consult manufacturers regarding the actual limit for specific design requirements.

4.1.12.2 Welded butt joint. A deflection angle can be taken in a welded butt joint by miter-cutting one or both pipe ends provided that the maximum radial offset (misalignment) at any point around the resultant joint does not exceed the maximum allowed by the governing purchaser's documents, standard, or code to which the joint will be welded (see Figure 2A). It may be impractical to miter cut both pipe ends, but both pipe ends shall be properly prepared for butt-joint welding. Deflection angle of 22.5° maximum per miter weld is recommended. In no case shall the maximum deflection angle exceed 30° per miter weld.

4.1.13 *Elbows.*

4.1.13.1 Dimensions. In specifying dimensions of an elbow, the designer should consider the hydraulic characteristics, space requirements, manufacturing constraints, stress considerations, and cost–benefit ratio over the expected life of the pipeline. The optimum radius for a fabricated elbow based on these considerations is 2.5 pipe outside cylinder diameters. This radius is recommended as a standard for water transmission lines where space requirements permit. For an elbow in plant piping, where space is limited, a radius of less than $2.5D_o$ may be used, provided stress intensification factors are used. If the radius is less than $2.5D_o$, the thickness of the shell must be calculated using the method outlined in AWWA Manual M11.

4.1.13.2 Wrought steel. In small diameters (4 in. to 24 in. [100 mm to 600 mm]), steel butt-welding fittings in accordance with ASME B16.9 conforming to ASTM A234/A234M are available in schedules and grades suitable for the waterworks service and are often an economical alternative to fabricated elbows. Larger wrought steel fittings, up to 48 in. (1,200 mm), may be advantageous for applications where space is limited and the smaller footprint of the wrought steel fitting would be more appropriate. (Steel butt-welding fittings are available in sizes less than 4 in. [100 mm]. For these smaller fittings, the application of dimensions for 4-in. (100-mm) fittings would be conservative.)

4.1.13.3 Fabricated elbows. The following guidelines for dimensioning fabricated steel pipe elbows are recommended:

Referring to Figures 2C, 2D, 2E, and 2F,

1. R is the recommended elbow radius.
2. T is the tangent length of the elbow.
3. S is the elbow inside segment length. Minimum S = 1.5 in. (38 mm) or 6t, whichever is greater.

NOTE: This represents good practice to control welding stresses and dimensional tolerances.

4. Deflection angle of 22.5° maximum per miter weld is recommended. In no case shall the maximum deflection angle exceed 30° per miter weld.
5. L is the minimum recommended length of the elbow leg.

NOTE: Depending on the size of the radius, L may be less than T.

6. Recommended two-, three-, four-, and five-piece elbows:

   For $\Delta \leq 22.5°$, use two-piece elbow; $k^* = 1$.

   For $22.5° < \Delta \leq 45°$, use three-piece elbow; $k^* = 2$.

   For $45° < \Delta \leq 67.5°$, use four-piece elbow; $k^* = 3$.

   For $67.5° < \Delta \leq 90°$, use five-piece elbow; $k^* = 4$.

   *NOTE: For any elbow configuration k = (number of elbow segments) – 1.

7. n_e is the diameter multiplier for calculating the radius of an elbow. Recommended n_e for water mains is 2.5. In instances where n_e is less than 2.5, stress intensification factors need to be addressed as outlined in AWWA Manual M11. Values of n_e shall not be less than that which achieves the minimum S value noted above.

Where:

$R = n_e D_o$

$S = D_o\,(2n_e - 1)\tan[\Delta/(2k)]$

$L = n_e D_o \tan[\Delta/2] - D_o\,(n_e - 0.5)\tan\,[\Delta/(2k)] + f_{Do}$

$T = n_e D_o \tan\,[\Delta/2]$

Example: Given a 49.75-in. OD, three-piece, 45° elbow, with $n_e = 2.5$.

$22.5° < \Delta \leq 45°$, therefore, $k = 2$

$R = 2.5(49.75) = 124.375$ in.

$S = 49.75[2(2.5) - 1]\tan\{45/[2(2)]\} = 39.6$ in.

$L = 2.5(49.75)\tan(45/2) - 49.75(2.5 - 0.5)\tan\{45/[2(2)]\} + 0.143(49.75) + 5 = 43.8$ in.

$T = 2.5(49.75)\tan[45/2] = 51.5$ in.

In certain applications, compound elbows and reducing elbows may be used. See Figure 5 for geometric relationships of a reducing elbow. For computational methods and formulas for compound pipe elbows, refer to AWWA Manual M11.

SECTION 5: VERIFICATION

This standard has no applicable information for this section.

SECTION 6: DELIVERY

This standard has no applicable information for this section.

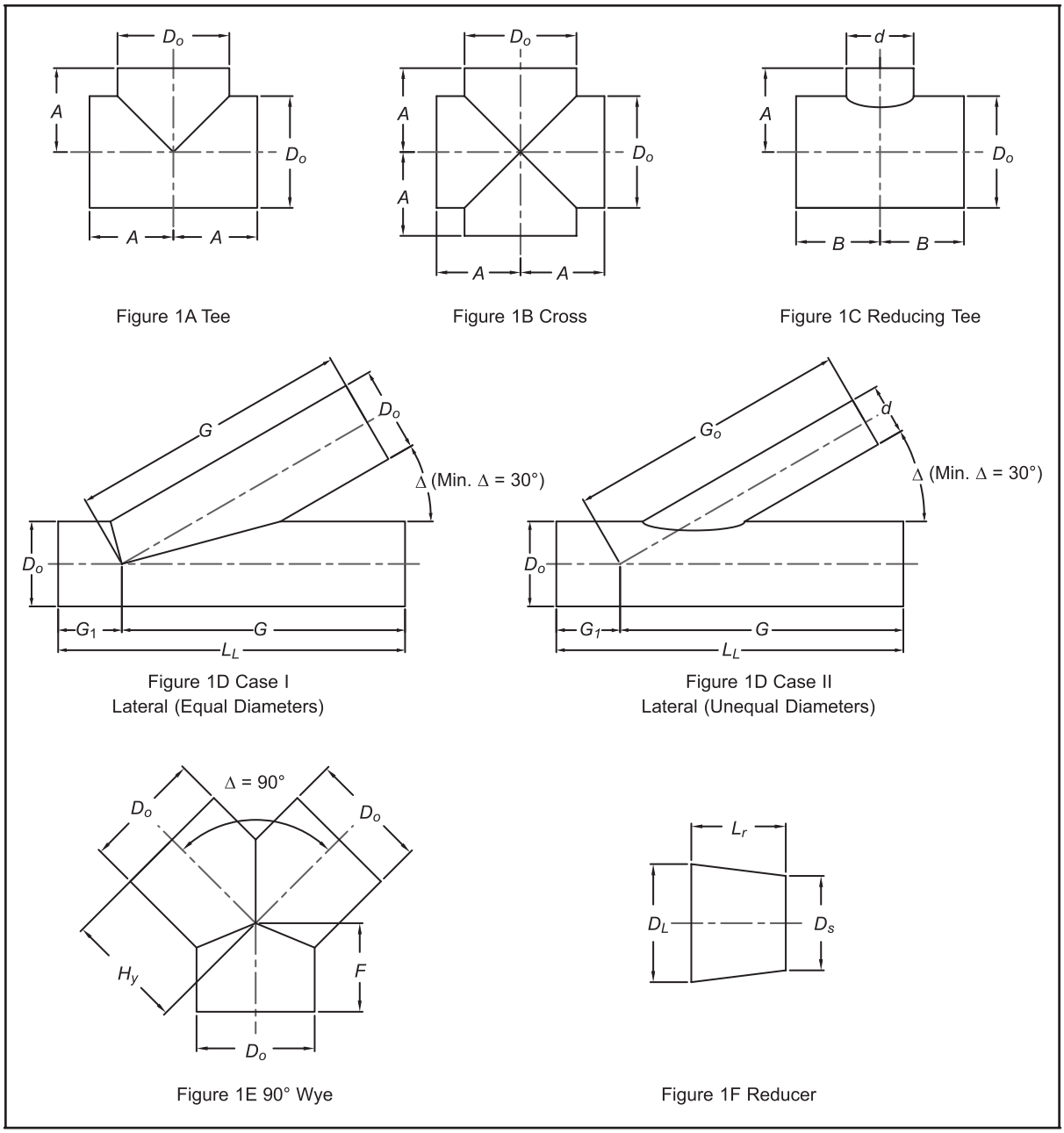


Figure 1A–1F Recommended dimensions for water pipe fittings (except elbows)

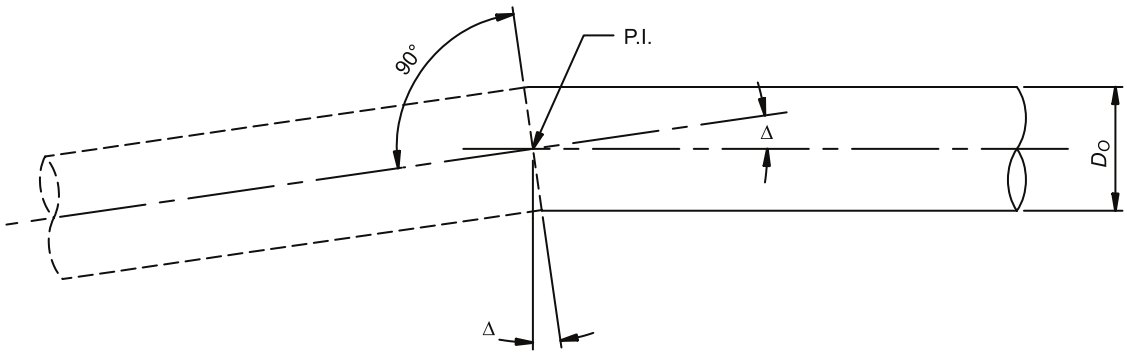


Figure 2A Miter-end cut—welded butt joint

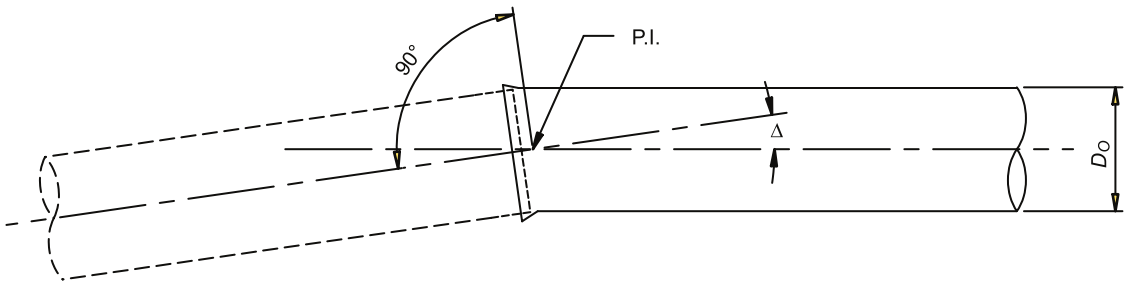


Figure 2B Miter-end cut—welded lap joint

Figure 2A–2B Recommended dimensions for water pipe elbows

(Figure continued next page)

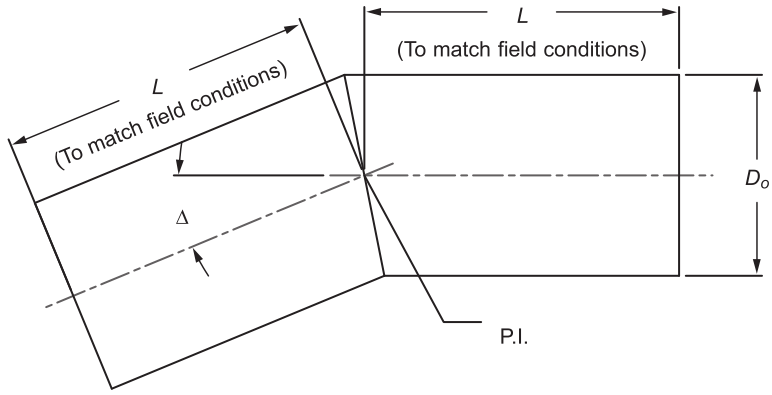


Figure 2C Two-piece elbow (0° to 22.5°)

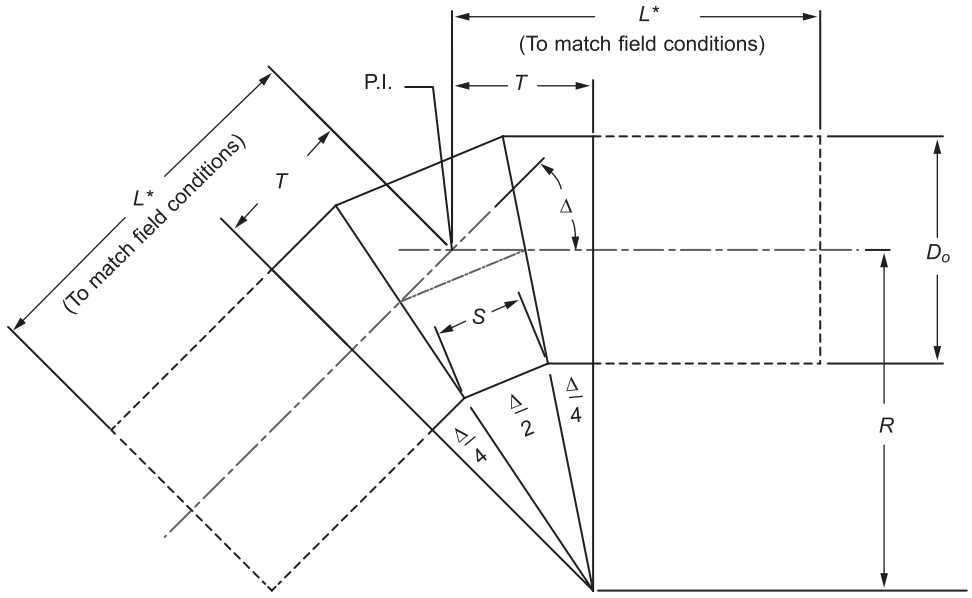


Figure 2D Three-piece elbow (more than 22.5° to 45°)

*NOTE: *L* may be less than *T*

Figure 2C–2D Recommended dimensions for water pipe elbows (continued)

(Figure continued next page)

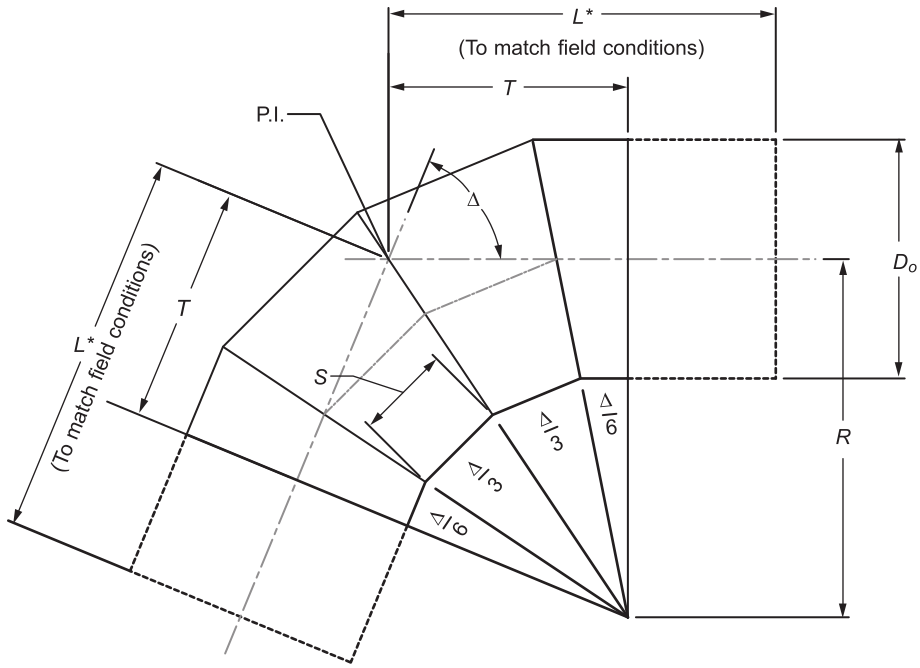


Figure 2E Four-piece elbow (more than 45° to 67.5°)
*Note: *L* may be less than *T*

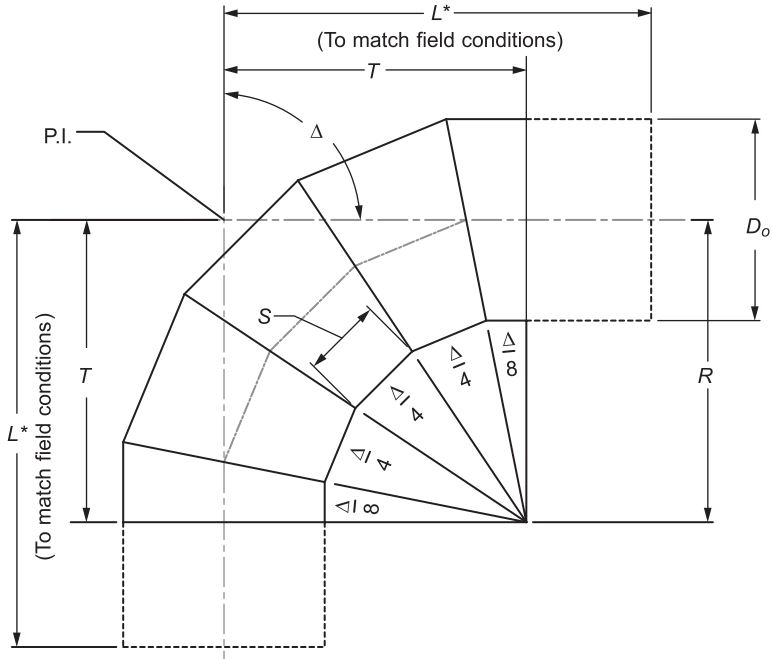


Figure 2F Five-piece elbow (more than 67.5° to 90°)
*Note: *L* may be less than *T*

Figure 2E–2F Recommended dimensions for water pipe elbows (continued)

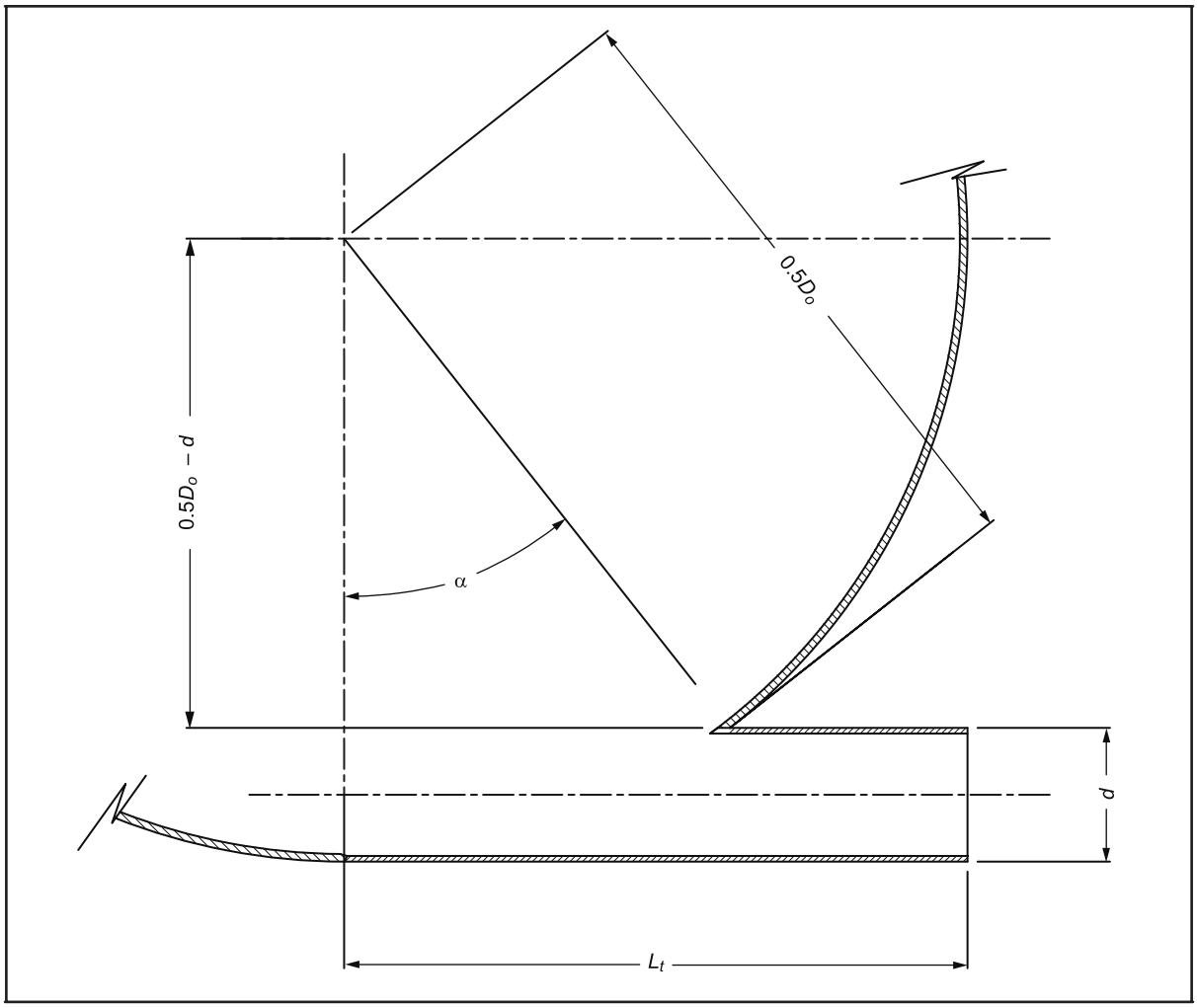


Figure 3 Tangential outlet

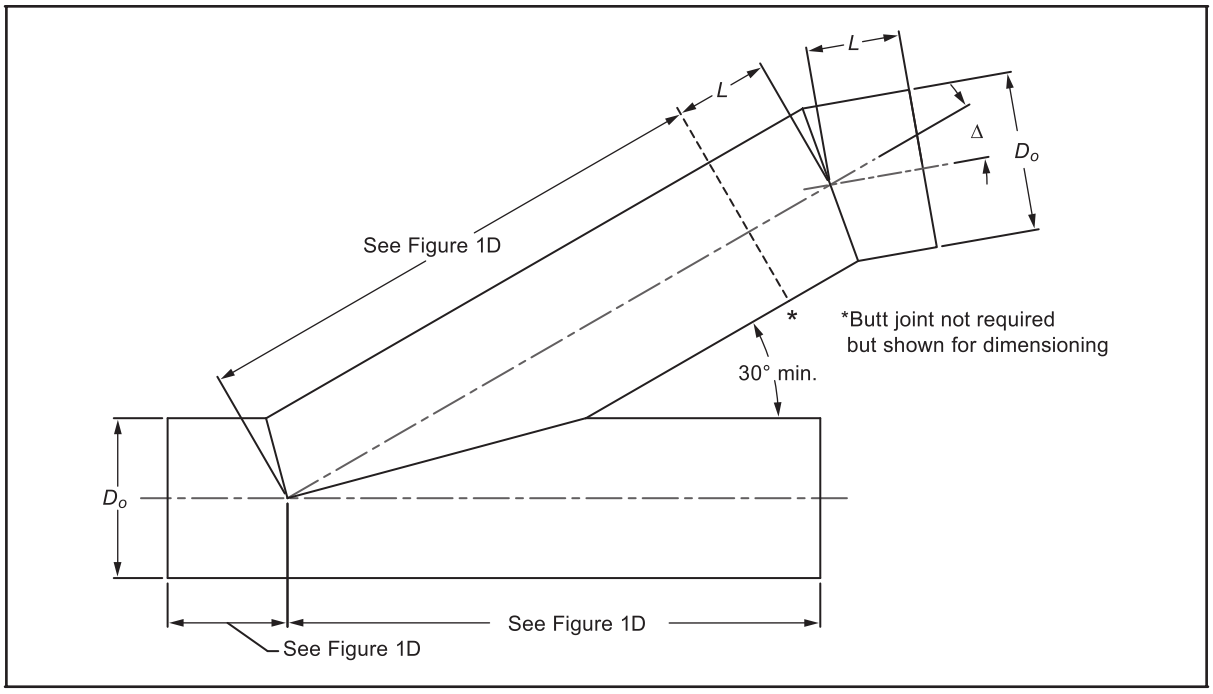
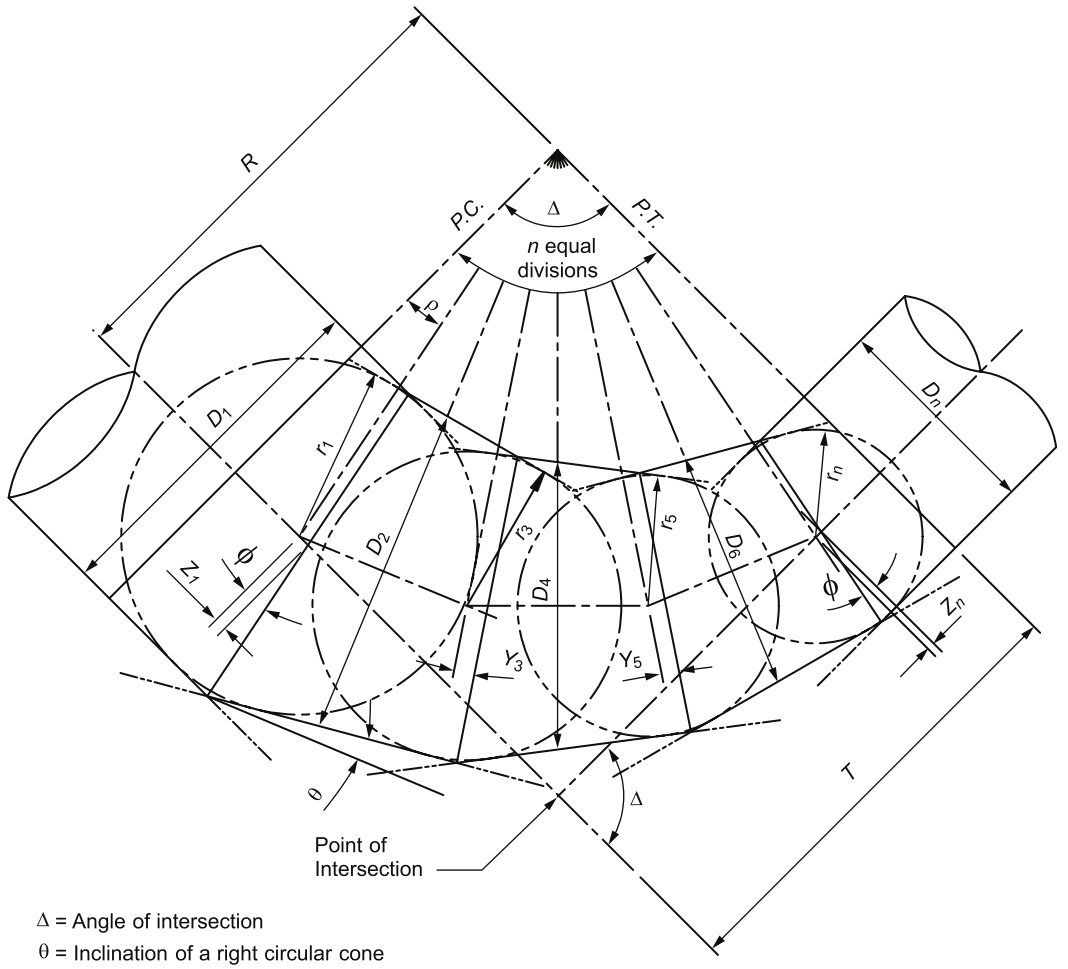


Figure 4 Lateral less than 30° (see Figure 1D for specific dimensions of lateral of equal or unequal diameters)



Δ = Angle of intersection

θ = Inclination of a right circular cone

R = Radius of bend

n = 2x the number of deflections

D_1 = Inside diameter of large pipe

D_n = Inside diameter of small pipe

$$\rho = \frac{\Delta}{n}$$

$$\sin\theta = \frac{D_1 - D_n}{2(n-2)R(\tan\rho)}$$

$$r_1 = \frac{D_1}{2}$$

$$r_n = \frac{D_n}{2}$$

$$r_x = r_1 - (x-1)R(\tan\rho)(\sin\theta)$$

$$D_x = \frac{D_1 - 2(x-1)R(\tan\rho)(\sin\theta)}{\cos\theta}$$

Where x = number of divisions from P.C. to point under consideration.

$$\tan\phi = \frac{\sin 2\rho}{\cos 2\rho + \cos\theta}$$

$$Z_1 = \frac{r_1(\sin\theta)}{\cos 2\rho + \cos\theta}$$

$$Z_n = \frac{r_n(\sin\theta)}{\cos 2\rho + \cos\theta}$$

$$Y_x = \frac{r_x(\sin\theta)}{\cos\rho}$$

$$T = R\tan\frac{\Delta}{2}$$

Figure 5 Reducing elbow

APPENDIX A

Dimensions of Steel Water Pipe Fittings

Table A.1 Dimensions of steel water pipe fittings

Nominal Diameter		Tee or Cross		Wye, 90°				Equal Diameter Lateral, Δ = 30°*					
D		*A*		*F*		H_y		*G*		G_1		L_L	
in.	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*
4 (4½ OD)	(100)	8	(203)	7	(178)	11	(279)	20	(508)	7	(178)	27	(686)
6 (6⅝ OD)	(150)	10	(254)	8	(203)	12	(305)	25	(635)	7	(178)	32	(813)
8 (8⅝ OD)	(200)	11	(279)	9	(229)	14	(356)	29	(737)	8	(203)	37	(940)
10 (10¾ OD)	(250)	12	(305)	9	(229)	15	(381)	34	(864)	8	(203)	42	(1,067)
12 (12¾ OD)	(300)	14	(356)	10	(254)	17	(432)	38	(965)	9	(229)	47	(1,194)
14	(350)	15	(381)	10	(254)	17	(432)	41	(1,041)	9	(229)	50	(1,270)
16	(400)	16	(406)	11	(279)	19	(483)	45	(1,143)	10	(254)	55	(1,397)
18	(450)	17	(432)	12	(305)	20	(508)	49	(1,245)	10	(254)	59	(1,499)
20	(500)	18	(457)	13	(330)	22	(559)	54	(1,372)	11	(279)	65	(1,651)
22	(550)	20	(508)	13	(330)	23	(584)	58	(1,473)	12	(305)	70	(1,778)
24	(600)	21	(533)	14	(356)	24	(610)	62	(1,575)	12	(305)	74	(1,880)
30	(750)	25	(635)	16	(406)	29	(737)	75	(1,905)	14	(356)	89	(2,261)
36	(900)	29	(737)	18	(457)	33	(838)	88	(2,235)	15	(381)	103	(2,616)
42	(1,050)	33	(838)	20	(508)	37	(940)	101	(2,565)	17	(432)	118	(2,997)
48	(1,200)	36	(914)	22	(559)	41	(1,041)	114	(2,896)	19	(483)	133	(3,378)
54	(1,350)	40	(1,016)	24	(610)	45	(1,143)	127	(3,226)	20	(508)	147	(3,734)
60	(1,500)	44	(1,118)	27	(686)	50	(1,270)	140	(3,556)	22	(559)	162	(4,115)
66	(1,650)	48	(1,219)	29	(737)	54	(1,372)	153	(3,886)	24	(610)	177	(4,496)
72	(1,800)	52	(1,321)	31	(787)	58	(1,473)	165	(4,191)	25	(635)	190	(4,826)

Notes:

1. All dimensions based on outside diameter of pipe equal to nominal diameter, *D*, except dimensions for 12-in. nominal and smaller pipe, which are based on pipe OD noted.
2. For elbow dimensions, see Sec. 4.1.13.3 and Figure 2.
3. Add additional length to these dimensions when necessary for flanged, mechanical couplings, or bell and spigot joints, or as needed to meet other design conditions.

*Lateral dimensions given are for an equal diameter, 30° angle fitting. For an angle greater than 30° through 70°, see equations in Sec. 4.1.7. For angles greater than 70°, use dimension given for a tee.

(Table continued next page)

Table A.1 Dimensions of steel water pipe fittings (continued)

Nominal Diameter		Tee or Cross		Wye, 90°				Equal Diameter Lateral, Δ = 30°*					
D		A		F		H_y		G		G_1		L_L	
in.	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*
78	(1,950)	56	(1,422)	33	(838)	62	(1,575)	178	(4,521)	27	(686)	205	(5,207)
84	(2,100)	60	(1,524)	35	(889)	67	(1,702)	191	(4,851)	29	(737)	220	(5,588)
90	(2,250)	63	(1,600)	37	(940)	71	(1,803)	204	(5,182)	30	(762)	234	(5,944)
96	(2,400)	67	(1,702)	39	(991)	75	(1,905)	217	(5,512)	32	(813)	249	(6,325)
102	(2,550)	71	(1,803)	41	(1,041)	79	(2,007)	230	(5,842)	34	(864)	264	(6,706)
108	(2,700)	75	(1,905)	43	(1,092)	83	(2,108)	243	(6,172)	35	(889)	278	(7,061)
114	(2,850)	79	(2,007)	45	(1,143)	88	(2,235)	256	(6,502)	37	(940)	293	(7,442)
120	(3,000)	83	(2,108)	48	(1,219)	92	(2,337)	269	(6,833)	39	(991)	308	(7,823)
126	(3,150)	87	(2,210)	50	(1,270)	96	(2,438)	282	(7,163)	40	(1,016)	322	(8,179)
132	(3,300)	90	(2,286)	52	(1,321)	100	(2,540)	295	(7,493)	42	(1,067)	337	(8,560)
138	(3,450)	94	(2,388)	54	(1,372)	104	(2,642)	307	(7,798)	44	(1,118)	351	(8,915)
144	(3,600)	98	(2,489)	56	(1,422)	109	(2,769)	320	(8,128)	45	(1,143)	365	(9,271)

Notes:

1. All dimensions based on outside diameter of pipe equal to nominal diameter, D, except dimensions for 12-in. nominal and smaller pipe, which are based on pipe OD noted.
2. For elbow dimensions, see Sec. 4.1.13.3 and Figure 2.
3. Add additional length to these dimensions when necessary for flanged, mechanical couplings, or bell and spigot joints, or as needed to meet other design conditions.

*Lateral dimensions given are for an equal diameter, 30° angle fitting. For an angle greater than 30° through 70°, see equations in Sec. 4.1.7. For angles greater than 70°, use dimension given for a tee.