

ASME B16.52-2024
(Revision of ASME B16.52-2018)

Forged Nonferrous Fittings, Socket- Welding and Threaded

**(Titanium, Titanium Alloys,
Aluminum, and Aluminum Alloys)**

AN AMERICAN NATIONAL STANDARD



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Mechanical Engineers**

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Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: June 28, 2024

The next edition of this Standard is scheduled for publication in 2029.

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FOREWORD

During 2013, the B16 Subcommittee F began discussions on the addition of more nonferrous materials to ASME B16.11. After much deliberation, it was decided that a better approach was to develop a new standard that linked the nonferrous fitting design to a nonferrous pipe wall thickness of equivalent material, pipe schedule, and size as the fitting instead of using Class designation. This project gained momentum in 2016 and a new document was developed and balloting commenced. Several differences between this Standard and ASME B16.11 are provided to incorporate designated pipe schedule wall thickness to fitting designs and material marking requirements.

Following approval by the ASME B16 Standards Committee, ASME B16.52-2018 was approved as an American National Standard by the American National Standards Institute (ANSI) on March 29, 2018.

In the 2024 edition, [Mandatory Appendix I](#) has been updated. Following approval by the ASME B16 Committee, ASME B16.52-2024 was approved by ANSI as an American National Standard on June 10, 2024.

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Revisions and Errata. The committee processes revisions to this Standard on a continuous basis 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 in the next edition of the Standard.

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Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Standard

(4) to permit the use of a new material or process

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(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Standard and the paragraph, figure, or table number

(4) the editions of the Standard to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

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ASME B16.52-2024

SUMMARY OF CHANGES

Following approval by the ASME B16 Standards Committee and ASME, and after public review, ASME B16.52-2024 was approved by the American National Standards Institute on June 10, 2024.

ASME B16.52-2024 includes the following change identified by a margin note, **(24)**. The Record Number listed below is explained in more detail in the “List of Changes in Record Number Order” following this Summary of Changes.

<i>Page</i>	<i>Location</i>	<i>Change (Record Number)</i>
17	Mandatory Appendix I	Updated (23-592)

LIST OF CHANGES IN RECORD NUMBER ORDER

Record Number	Change
23-592	Updated references in Mandatory Appendix I.

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FORGED NONFERROUS FITTINGS, SOCKET-WELDING AND THREADED (Titanium, Titanium Alloys, Aluminum, and Aluminum Alloys)

1 SCOPE AND GENERAL

1.1 Scope

1.1.1 Standard Fittings. This Standard covers ratings, dimensions, tolerances, marking, and material requirements for titanium, titanium alloy, aluminum, and aluminum alloy forged fittings, both socket-welding and threaded ends.

1.1.2 Special Fittings. Fittings with special dimensions, threads, or counterbores may be made by agreement between the manufacturer and purchaser. When such fittings meet all other requirements of this Standard, they shall be considered in compliance with this Standard.

1.2 General

1.2.1 Fitting Types/Configuration. Types of fittings covered by this Standard are shown in [Table 1.2.1-1](#), by Designated Schedule Fitting by pipe schedule and size range. Fittings shown in [Tables 1.2.1-2](#) through [1.2.1-6](#) may also be made with combinations of socket-welding and threaded ends.

1.2.2 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in [Mandatory Appendix I](#). 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 I](#). A fitting made in conformance and conforming to this Standard, in all other respects, will be considered to be in conformance to the Standard, even though the edition reference may be changed in a subsequent revision of the Standard.

1.2.3 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, rule governing the use of a material at low temperature, or provisions for operation at a pressure exceeding the ratings in this Standard.

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

1.2.5 Quality Systems. Nonmandatory requirements relating to the product manufacturer's quality system program are described in [Nonmandatory Appendix A](#).

1.2.6 Welding. Installation welding requirements are not within the scope of this Standard. Installation welding shall be in accordance with the applicable piping code or regulation covering the piping system into which the fittings are installed.

1.2.7 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. The values stated in each system are not exact equivalents; therefore, it is required that each system be used independently of the other. Combining values from the two systems constitutes nonconformance with this Standard.

2 PRESSURE RATINGS

2.1 General

Fittings under this Standard shall be Designated Schedule 40, 80, or 160 for threaded end and socket-weld end fittings.

2.1.1 Basis of Rating. The schedule of pipe corresponding to each Designated Schedule Fitting for rating purposes is shown in [Table 2.1.1-1](#). Design temperature and other service conditions shall be limited as provided by the applicable piping code or regulation for the material of construction of the fitting. Within these limits, the minimum wall thickness for pipe to be used with a [Table 2.1.1-1](#) Designated Schedule Fitting shall be computed based on appropriate size straight seamless pipe of equivalent material as the fitting (as shown by comparison of composition and mechanical properties in the respective material specifications). The minimum pipe wall thickness calculation shall include pressure design and all applicable additional allowances (e.g., erosion, corrosion, and thread depth

for threaded pipe). The minimum wall thickness for selected pipe, considering manufacturing minus wall thickness tolerance (typically 12.5%), shall not be less than the minimum wall calculation. The fitting is suitable for the application if the wall thickness of the selected pipe equals or is less than the ASME B36.10M or ASME B36.19M Schedule No. pipe wall thickness correlated with the fitting in Table 2.1.1-1 [see Table 2.1.1-1, Notes (1) and (2)].

2.1.2 Nonstandard Pipe Wall Thickness. Since ASME B36.10M does not include Schedule 160 thickness for NPS $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{3}{8}$, the values in Table 2.1.2-1 shall be used as the nominal wall thicknesses of the pipe for rating purposes.

2.1.3 Combination End Fittings. The Designated Schedule Class designation for fittings made with combinations of socket-welding and threaded ends rating shall be based on the end configuration that has the lowest pipe schedule rating.

2.2 Pressure Test Capability

Pressure testing is not required by this Standard, but the fittings shall be capable of withstanding a hydrostatic test pressure required by the applicable piping code for seamless pipe of material equivalent to the fitting forging and of the schedule or wall thickness correlated with the fitting and end connection of Table 2.1.1-1.

3 SIZE AND TYPE

3.1 General

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:

NPS	DN
$\frac{1}{8}$	6
$\frac{1}{4}$	8
$\frac{3}{8}$	10
$\frac{1}{2}$	15
$\frac{3}{4}$	20
1	25
$1\frac{1}{4}$	32
$1\frac{1}{2}$	40
2	50
$2\frac{1}{2}$	65
3	80
4	100

3.2 Reducing Fitting Size

In the case of reducing tees and crosses, the size of the largest run opening shall be given first, followed by the size of the opening at the opposite end of the run. Where the fitting is a tee, the size of the branch is given last (e.g., $1\frac{1}{2} \times \frac{3}{4} \times 1\frac{1}{4}$). Where the fitting is a cross, the largest side outlet is the third dimension given, followed by the size of the opening at the opposite end (e.g., $1\frac{1}{2} \times \frac{3}{4} \times 1\frac{1}{4} \times \frac{1}{2}$). See Figure 3.2-1.

4 MARKING

4.1 General

Each fitting shall be permanently marked with the required identification by raised or stamped lettering, electroetching, or vibro-tool marking on the collar portion, raised pad, or raised boss portion of the forging.

Cylindrical fittings shall be marked on the outside diameter or end of the fitting in a location such that the marking will not be obliterated as a result of welding installation. The marking of bushings and plugs is not required by this Standard.

4.1.1 Specific Marking. The marking shall include (but is not limited to) the following:

- (a) manufacturer’s name or trademark.
- (b) *Material Identification.* Material shall be identified in accordance with the marking requirements of either the appropriate ASTM Fitting or ASTM Forging Specifications (see para. 5.1).

(c) *Product Conformance.* Fittings covered under para. 1.1.1 shall be marked with either the ASTM Fittings Specification material alloy designation (e.g., “WPxxxx” for aluminum or “WPTxxx” for titanium) or ASTM Forging Alloy (e.g., B247 xxxxTx) and the symbol “B16” to denote conformance to this Standard. Fittings covered under para. 1.1.2 shall be marked with a supplementary suffix as follows:

- (1) for ASTM Fitting Specifications B361 and B363, suffix “B16” with “SPLD”
- (2) for ASTM Forging Specifications B247 and B381, suffix “B16” with “SPLD”
- (d) Designated Schedule Fitting 40, 80, or 160, as applicable.
- (e) *Size.* The nominal pipe size related to the end connections.

4.1.2 Omission of Markings. Where size and shape of fittings do not permit all of the above markings, they may be omitted in the reverse order given above.

5 MATERIAL

5.1 Standard Materials

Fittings shall be made of materials consisting of forgings, bar, seamless pipe, or seamless tubular products, except tees, elbows, and crosses shall not be machined directly from bar stock. Aluminum and aluminum alloys shall conform to the requirements for the WP seamless construction materials of ASTM Fitting Specification B361 or ASTM Forging Specification B247. Titanium and titanium alloys shall conform to the requirements for the WP seamless construction materials of ASTM Fitting Specification B363 or ASTM Forging Specification B381.

6 DIMENSIONS

6.1 General

Unless otherwise noted, the dimensions without tolerances for socket-welding fittings given in [Table 1.2.1-2](#) and the dimensions without tolerances for threaded fittings given in [Tables 1.2.1-3](#) through [1.2.1-6](#) are nominal values and subject to the designated manufacturing tolerances.

6.2 Socket Fittings

6.2.1 Body Wall Thickness. The body wall thickness of socket-welding fittings shall be equal to or greater than the values, G , shown in [Table 1.2.1-2](#).

6.2.2 Socket Wall Thickness. The socket wall average thickness and minimum thickness shall not be less than the corresponding values, C , shown in [Tables 1.2.1-2](#) and [1.2.1-3](#).

6.2.3 Socket Position. The fixed position for the bottom of the socket with reference to the centerline of the socket-welding fitting shall be maintained as required by the dimension, A , of [Table 1.2.1-2](#). For reducing fittings, see [para. 6.5](#).

6.2.4 Socket Depth. The socket depth shall not be less than the minimum values, J , shown in [Tables 1.2.1-2](#) and [1.2.1-3](#).

6.2.5 Socket Bore. The inside surface of the socket bore shall present a good workmanlike finish that is free of burrs.

6.2.6 Perpendicularity. The end flats of socket-welding fittings shall be at right angles to the socket axis.

6.2.7 Width. The forging radius shall not reduce the width of the flat welding surface to less than the value shown in [Figure 6.2.7-1](#). The minimum flat length is not an indicator for fillet weld leg length.

6.3 Threaded Fittings

6.3.1 Wall Thickness. The body or end wall thickness of threaded fittings shall be equal to or greater than the minimum values, G , as shown in [Tables 1.2.1-4](#) through [1.2.1-6](#).

6.3.2 Internal Threading. All fittings with internal threads shall be threaded with American National Standard Taper Pipe Threads (ASME B1.20.1). Variations in threading shall be limited to one turn large or one turn small from the gaging notch when using working gages. The reference point for gaging is the starting end of the fitting, provided the chamfer does not exceed the major diameter of the internal thread. When a chamfer on the internal thread exceeds this limit, the reference point becomes the last thread scratch on the chamfer cone.

6.3.3 External Threads. All externally threaded fittings shall be threaded with American National Standard Taper Pipe Threads (ASME B1.20.1), and the variation in threading shall be limited to one turn large or one turn small from the gage face of ring when using working gages. The reference point for gaging is the end of the thread, provided the chamfer is not smaller than the minor diameter of the external thread. When a chamfer on the external thread exceeds this limit, the reference point becomes the last thread scratch on the chamfer cone.

6.3.4 Countersink or Chamfer. All internal threads shall be countersunk a distance not less than one-half the pitch of the thread at an angle of approximately 45 deg with the axis of the thread, and all external threads shall be chamfered at an angle of 30 deg to 45 deg from the axis, for easier entrance in making a joint and protection of the thread. Countersinking and chamfering shall be concentric with the threads. The length of threads specified in all tables shall be measured to include the countersink or chamfer.

6.4 Collars

End collars of both socket-welding and threaded fittings shall be such that they overlap the crotch area as illustrated in the sketches in [Tables 1.2.1-2](#) and [1.2.1-3](#).

6.5 Reducing Fittings

Reducing fittings, combination straight and reducing threaded \times threaded, threaded \times socket welding, and socket welding \times socket welding couplings shall have the same center-to-end dimension, center-to-bottom-of-socket dimension, band diameter, and outside diameters as the uniform size fitting corresponding to the largest size end connection of the reducing fitting.

7 ADDITIONAL TOLERANCES

These are additional tolerances to those listed in [Table 1.2.1-2](#).

7.1 Concentricity of Bores

The socket and fitting bores shall be concentric within a tolerance of 0.8 mm (0.03 in.) for all sizes. Opposite socket bores shall be concentric within a tolerance of 1.5 mm (0.06 in.) for all sizes.

7.2 Perpendicularity/Angularity of Threaded and Socket-Welding Connections

The maximum allowable variation in the perpendicularity of the socket weld 90-deg outlets to the face of the fitting shall be 1 mm in 200 mm (0.06 in. in 1 ft).

For 45-deg elbows, the maximum allowable variation in the angularity of the socket-welding connections shall be 1 mm in 200 mm (0.06 in. in 1 ft) to the face of fitting. For threaded fittings, the maximum allowable variation in perpendicularity of 90-deg threads or angularity of 45-deg threads shall be 1 mm in 200 mm (0.06 in. in 1 ft) to the opposite 90-deg or 45-deg thread.

8 PROOF TESTING

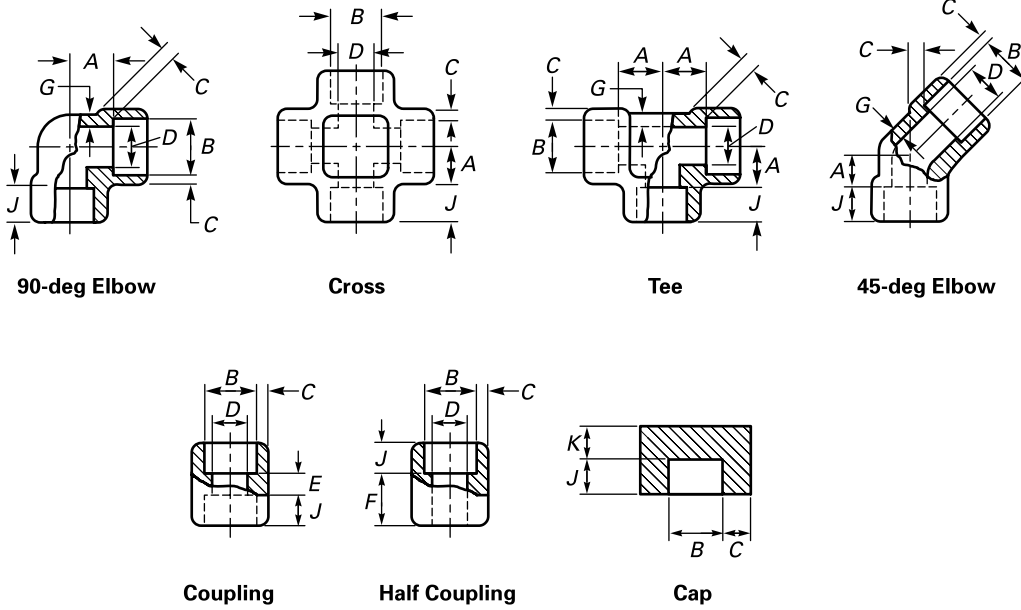
Proof testing for fittings made to this Standard is not required.

**Table 1.2.1-1
Types of Designated Schedule Fittings by Pipe Schedule and NPS Size Range**

Description	Socket-Welding		Threaded	
	Designated Schedule		Designated Schedule	
	40 and 80	160	80	160
45-deg, 90-deg elbows, tees, crosses, couplings, half couplings, and caps	1/8-4	1/8-2	1/8-4	1/8-4
	1/8-4	1/8-2	1/8-4	1/8-4
	1/8-4	1/8-2	...	1/8-4
	1/8-4	1/8-2	...	1/8-4
Street elbows	...	...	...	1/8-2
Square, hex, round plug, and flush bushing	...	...	1/8-4 [Note (1)]	1/8-4 [Note (1)]
	...	...	1/4-4 [Note (1)]	1/4-4 [Note (1)]

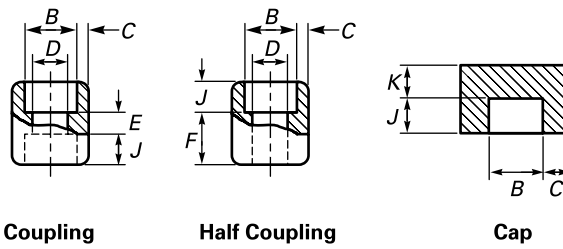
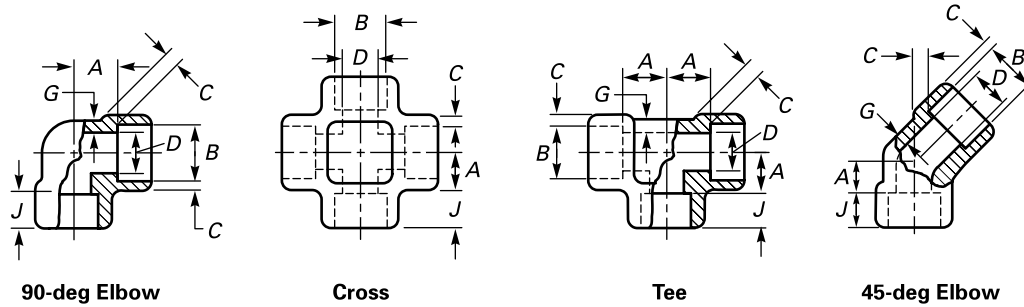
NOTE: (1) Plugs and bushings are not identified by Designated Schedule. They may be used with piping system of equivalent material grade as the fitting for ratings up to Designated Schedule 160.

**Table 1.2.1-2
Socket-Welding Fittings**



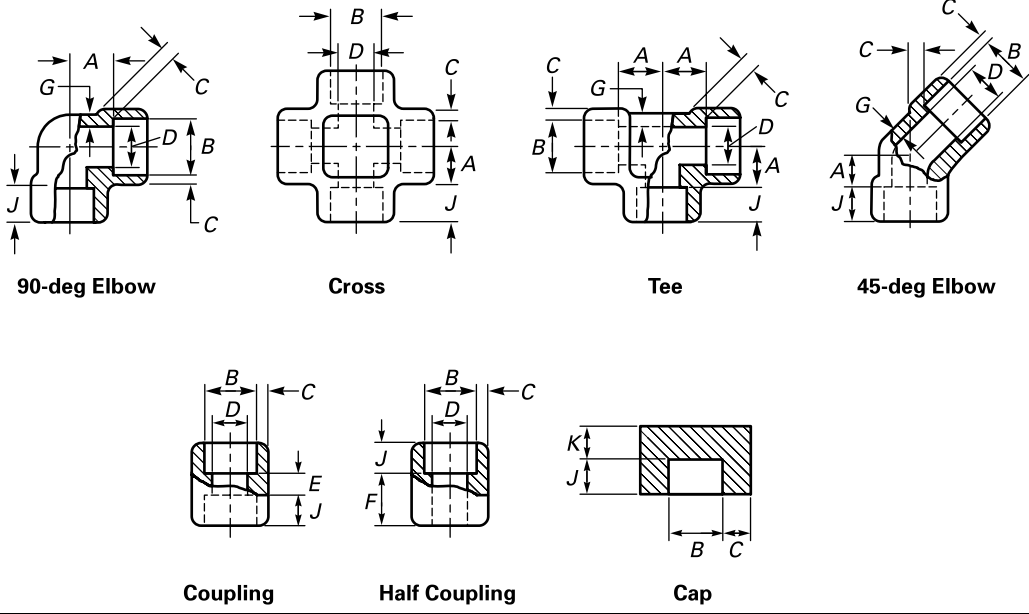
Nominal Pipe Size	Socket Bore Dia., <i>B</i>		Bore Diameter of Fittings, <i>D</i>						Socket Wall Thickness, <i>C</i> [Note (1)]					
			Designated Schedule						Designated Schedule					
			40		80		160		40		80		160	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Min.	Avg.	Min.	Avg.	Min.
SI Units, mm														
1/8	11.2	10.8	7.6	6.1	6.3	4.8	4.8	3.2	3.18	3.18	3.18	3.18	3.96	3.43
1/4	14.6	14.2	10.0	8.5	8.5	7.0	7.1	5.6	3.18	3.18	3.78	3.30	4.60	4.01
3/8	18.0	17.6	13.3	11.8	11.5	10.0	9.9	8.4	3.18	3.18	4.01	3.50	5.03	4.37
1/2	22.2	21.8	16.6	15.0	14.6	13.1	12.5	11.0	3.46	3.18	4.67	4.09	5.97	5.18
3/4	27.6	27.2	21.7	20.2	19.7	18.2	16.3	14.8	3.59	3.18	4.90	4.27	6.96	6.04
1	34.3	33.9	27.4	25.9	25.1	23.6	21.5	19.9	4.22	3.68	5.69	4.98	7.92	6.93
1 1/4	43.1	42.7	35.8	34.3	33.3	31.8	30.2	28.7	4.45	3.88	6.07	5.28	7.92	6.93
1 1/2	49.2	48.8	41.6	40.1	38.9	37.4	34.7	33.2	4.60	4.01	6.35	5.54	8.92	7.80
2	61.7	61.2	53.3	51.7	50.0	48.5	43.6	42.1	4.89	4.29	6.93	6.04	10.92	9.50
2 1/2	74.4	73.9	64.2	61.2	60.5	57.5	...	...	6.45	5.62	8.76	7.67	...	...
3	90.3	89.8	79.4	76.4	75.2	72.2	...	...	6.86	5.98	9.52	8.30	...	...
4	115.7	115.2	103.8	100.7	98.7	95.7	...	...	7.52	6.56	10.69	9.35	...	...

**Table 1.2.1-2
Socket-Welding Fittings**



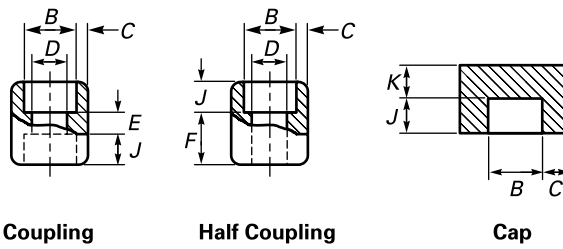
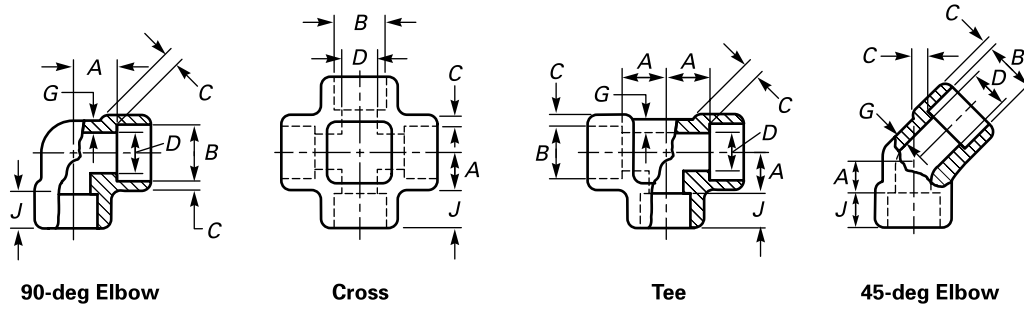
Body Wall, <i>G</i>			Socket, <i>J</i>	Center-to-Bottom of Socket, <i>A</i>				Laying Lengths		Tolerances, ±			End Wall Thickness, <i>K_{min}</i>		Nominal Pipe Size
Designated Schedule				90-deg Elbows, Tees, and Crosses		45-deg Elbows		Couplings, <i>E</i>	Half Couplings, <i>F</i>	<i>A</i>	<i>E</i>	<i>F</i>	Pipe Designation		
40	80	160		Designated Schedule	Designated Schedule	Designated Schedule	Designated Schedule						40/80	160	
Min.	Min.	Min.		40/80	160	40/80	160								
SI Units, mm															
1.73	2.41	3.15	9.5	11.0	11.0	8.0	8.0	6.5	16.0	1.0	1.5	1.0	4.8	6.4	1/8
2.24	3.02	3.68	9.5	11.0	13.5	8.0	8.0	6.5	16.0	1.0	1.5	1.0	4.8	6.4	1/4
2.31	3.20	4.01	9.5	13.5	15.5	8.0	11.0	6.5	17.5	1.5	3.0	1.5	4.8	6.4	3/8
2.77	3.73	4.78	9.5	15.5	19.0	11.0	12.5	9.5	22.5	1.5	3.0	1.5	6.4	7.9	1/2
2.87	3.91	5.56	12.5	19.0	22.5	13.0	14.0	9.5	24.0	1.5	3.0	1.5	6.4	7.9	3/4
3.38	4.55	6.35	12.5	22.5	27.0	14.0	17.5	12.5	28.5	2.0	4.0	2.0	9.6	11.2	1
3.56	4.85	6.35	12.5	27.0	32.0	17.5	20.5	12.5	30.0	2.0	4.0	2.0	9.6	11.2	1 1/4
3.68	5.08	7.14	12.5	32.0	38.0	20.5	25.5	12.5	32.0	2.0	4.0	2.0	11.2	12.7	1 1/2
3.91	5.54	8.74	16.0	38.0	41.0	25.5	28.5	19.0	41.0	2.0	4.0	2.0	12.7	15.7	2
5.16	7.01	...	16.0	41.0	...	28.5	...	19.0	43.0	2.5	5.0	2.5	15.7	19.0	2 1/2
5.49	7.62	...	16.0	57.0	...	32.0	...	19.0	44.5	2.5	5.0	2.5	19.0	22.4	3
6.02	8.56	...	19.0	66.5	...	41.0	...	19.0	48.0	2.5	5.0	2.5	22.4	28.4	4

**Table 1.2.1-2
Socket-Welding Fittings (Cont'd)**



Nominal Pipe Size	Socket Bore Dia., B		Bore Diameter of Fittings, D						Socket Wall Thickness, C [Note (1)]					
			Designated Schedule						Designated Schedule					
			40		80		160		40		80		160	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Avg.	Min.	Avg.	Min.	Avg.	Min.
U.S. Customary Units, in.														
1/8	0.440	0.420	0.299	0.239	0.245	0.185	0.189	0.126	0.125	0.125	0.125	0.125	0.156	0.135
1/4	0.575	0.555	0.394	0.334	0.332	0.272	0.280	0.220	0.125	0.125	0.149	0.130	0.181	0.158
3/8	0.710	0.690	0.523	0.463	0.453	0.393	0.389	0.329	0.125	0.125	0.158	0.138	0.198	0.172
1/2	0.875	0.855	0.652	0.592	0.576	0.516	0.494	0.434	0.136	0.125	0.184	0.161	0.235	0.204
3/4	1.085	1.065	0.854	0.794	0.772	0.712	0.642	0.582	0.141	0.125	0.193	0.168	0.274	0.238
1	1.350	1.330	1.079	1.019	0.987	0.927	0.845	0.785	0.166	0.145	0.224	0.196	0.312	0.273
1 1/4	1.695	1.675	1.410	1.350	1.308	1.248	1.190	1.130	0.175	0.153	0.239	0.208	0.312	0.273
1 1/2	1.935	1.915	1.640	1.580	1.530	1.470	1.368	1.308	0.181	0.158	0.250	0.218	0.351	0.307
2	2.426	2.406	2.097	2.037	1.969	1.909	1.717	1.657	0.193	0.169	0.273	0.238	0.430	0.374
2 1/2	2.931	2.906	2.529	2.409	2.383	2.263	...	...	0.254	0.222	0.345	0.302	...	...
3	3.560	3.535	3.128	3.008	2.960	2.840	...	...	0.270	0.236	0.375	0.327	...	...
4	4.570	4.545	4.086	3.966	3.886	3.766	...	...	0.296	0.258	0.421	0.368	...	...

**Table 1.2.1-2
Socket-Welding Fittings (Cont'd)**

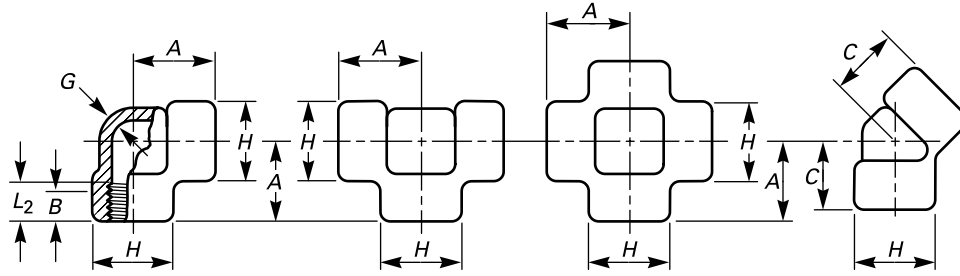


Body Wall, <i>G</i>			Socket, <i>J</i>	Center-to-Bottom of Socket, <i>A</i>				Laying Lengths		Tolerances, ±			End Wall Thickness, <i>K_{min}</i>		Nominal Pipe Size
Designated Schedule				90-deg Elbows, Tees, and Crosses		45-deg Elbows		Couplings, <i>E</i>	Half Couplings, <i>F</i>	<i>A</i>	<i>E</i>	<i>F</i>	Pipe Designation		
40	80	160		Designated Schedule	Designated Schedule	Designated Schedule	Designated Schedule						40/80	160	
Min.	Min.	Min.		40/80	160	40/80	160								
U.S. Customary Units, in.															
0.068	0.095	0.124	0.38	0.44	0.44	0.31	0.31	0.25	0.62	0.03	0.06	0.03	0.19	0.25	1/8
0.088	0.119	0.145	0.38	0.44	0.53	0.31	0.31	0.25	0.62	0.03	0.06	0.03	0.19	0.25	1/4
0.091	0.126	0.158	0.38	0.53	0.62	0.31	0.44	0.25	0.69	0.06	0.12	0.06	0.19	0.25	3/8
0.109	0.147	0.188	0.38	0.62	0.75	0.44	0.50	0.38	0.88	0.06	0.12	0.06	0.25	0.31	1/2
0.113	0.154	0.219	0.50	0.75	0.88	0.50	0.56	0.38	0.94	0.06	0.12	0.06	0.25	0.31	3/4
0.133	0.179	0.250	0.50	0.88	1.06	0.56	0.69	0.50	1.12	0.08	0.16	0.08	0.38	0.44	1
0.140	0.191	0.250	0.50	1.06	1.25	0.69	0.81	0.50	1.19	0.08	0.16	0.08	0.38	0.44	1 1/4
0.145	0.200	0.281	0.50	1.25	1.50	0.81	1.00	0.50	1.25	0.08	0.16	0.08	0.44	0.50	1 1/2
0.154	0.218	0.344	0.62	1.50	1.62	1.00	1.12	0.75	1.62	0.08	0.16	0.08	0.50	0.62	2
0.203	0.276	...	0.62	1.62	...	1.12	...	0.75	1.69	0.10	0.20	0.10	0.62	0.75	2 1/2
0.216	0.300	...	0.62	2.25	...	1.25	...	0.75	1.75	0.10	0.20	0.10	0.75	0.88	3
0.237	0.337	...	0.75	2.62	...	1.62	...	0.75	1.88	0.10	0.20	0.10	0.88	1.12	4

Table 1.2.1-2
Socket-Welding Fittings (Cont'd)

NOTE: (1) Average of socket wall thickness around periphery shall not be less than listed values. The minimum values are permitted in localized areas.

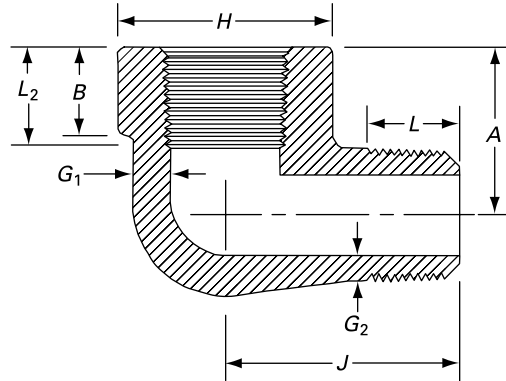
**Table 1.2.1-3
Forged Threaded Fittings**



Nominal Pipe Size	90-deg Elbow		Tee		Cross		45-deg Elbow		Minimum Length of Thread, mm (in.) [Note (1)]	
	Center-to-End Elbows, Tees, and Crosses, A, mm (in.)		Center-to-End 45-deg Elbow, C, mm (in.)		Outside Diameter of Band, H, mm (in.)		Minimum Wall Thickness, G, mm (in.)			
	Designated Schedule		Designated Schedule		Designated Schedule		Designated Schedule			
	80	160	80	160	80	160	80	160		
1/8	21 (0.81)	21 (0.81)	17 (0.69)	17 (0.69)	22 (0.88)	22 (0.88)	3.18 (0.125)	3.18 (0.125)	6.4 (0.25)	6.7 (0.2639)
1/4	21 (0.81)	25 (0.97)	17 (0.69)	19 (0.75)	22 (0.88)	25 (1.00)	3.18 (0.125)	3.30 (0.130)	8.1 (0.32)	10.2 (0.4018)
3/8	25 (0.97)	28 (1.12)	19 (0.75)	22 (0.88)	25 (1.00)	33 (1.31)	3.18 (0.125)	3.51 (0.138)	9.1 (0.36)	10.4 (0.4078)
1/2	28 (1.12)	33 (1.31)	22 (0.88)	25 (1.00)	33 (1.31)	38 (1.50)	3.18 (0.125)	4.09 (0.161)	10.9 (0.43)	13.6 (0.5337)
3/4	33 (1.31)	38 (1.50)	25 (1.00)	28 (1.12)	38 (1.50)	46 (1.81)	3.18 (0.125)	4.32 (0.170)	12.7 (0.50)	13.9 (0.5457)
1	38 (1.50)	44 (1.75)	28 (1.12)	33 (1.31)	46 (1.81)	56 (2.19)	3.68 (0.145)	4.98 (0.196)	14.7 (0.58)	17.3 (0.6828)
1 1/4	44 (1.75)	51 (2.00)	33 (1.31)	35 (1.38)	56 (2.19)	62 (2.44)	3.89 (0.153)	5.28 (0.208)	17.0 (0.67)	18.0 (0.7068)
1 1/2	51 (2.00)	60 (2.38)	35 (1.38)	43 (1.69)	62 (2.44)	75 (2.97)	4.01 (0.158)	5.56 (0.219)	17.8 (0.70)	18.4 (0.7235)
2	60 (2.38)	64 (2.50)	43 (1.69)	44 (1.72)	75 (2.97)	84 (3.31)	4.27 (0.168)	7.14 (0.281)	19.0 (0.75)	19.2 (0.7565)
2 1/2	76 (3.00)	83 (3.25)	52 (2.06)	52 (2.06)	92 (3.62)	102 (4.00)	5.61 (0.221)	7.65 (0.301)	23.6 (0.93)	28.9 (1.1380)
3	86 (3.38)	95 (3.75)	64 (2.50)	64 (2.50)	109 (4.31)	121 (4.75)	5.99 (0.236)	8.84 (0.348)	25.9 (1.02)	30.5 (1.2000)
4	106 (4.19)	114 (4.50)	79 (3.12)	79 (3.12)	146 (5.75)	152 (6.00)	6.55 (0.258)	11.18 (0.440)	27.7 (1.09)	33.0 (1.3000)

NOTE: (1) Dimension B is minimum length of perfect thread. The length of useful thread (B plus threads with fully formed roots and flat crests) shall not be less than L₂ (effective length of external thread) required by ASME B1.20.1 (see para. 6.3).

**Table 1.2.1-4
Forged Threaded Fittings — Street Elbows**

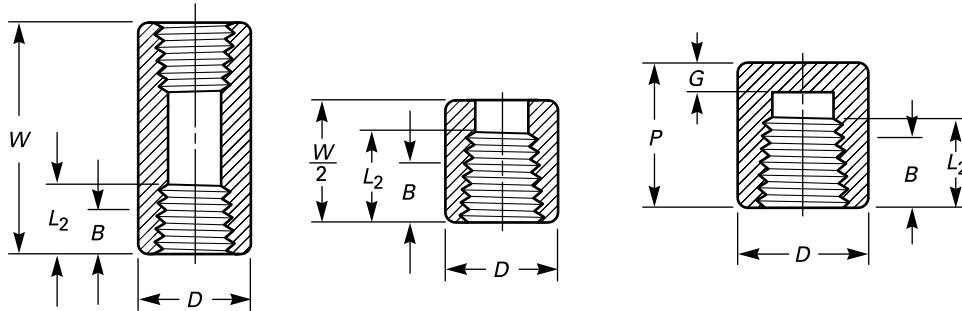


Nominal Pipe Size	Center-to-Female End Street Ells, A, mm (in.) [Note (1)]	Center-to-Male End Street Ells, J, mm (in.)	Outside Diameter of Band, H, mm (in.) [Note (2)]	Minimum Wall Thickness, G_1 , mm (in.)	Minimum Wall Thickness, G_2 , mm (in.) [Note (3)]	Minimum Length Internal Thread, mm (in.) [Note (4)]		Minimum Length Male Thread, L, mm (in.)
	Designated Schedule 160					B	L_2	
$\frac{1}{8}$	19 (0.75)	25 (1.00)	19 (0.75)	3.18 (0.125)	2.74 (0.108)	6.4 (0.25)	6.7 (0.2639)	10 (0.38)
$\frac{1}{4}$	22 (0.88)	32 (1.25)	25 (1.00)	3.30 (0.130)	3.22 (0.127)	8.1 (0.32)	10.2 (0.4018)	11 (0.44)
$\frac{3}{8}$	25 (1.00)	38 (1.50)	32 (1.25)	3.51 (0.138)	3.50 (0.138)	9.1 (0.36)	10.4 (0.4078)	13 (0.50)
$\frac{1}{2}$	28 (1.12)	41 (1.62)	38 (1.50)	4.09 (0.161)	4.16 (0.164)	10.9 (0.43)	13.6 (0.5337)	14 (0.56)
$\frac{3}{4}$	35 (1.38)	48 (1.88)	44 (1.75)	4.32 (0.170)	4.88 (0.192)	12.7 (0.50)	13.9 (0.5457)	16 (0.62)
1	44 (1.75)	57 (2.25)	51 (2.00)	4.98 (0.196)	5.56 (0.219)	14.7 (0.58)	17.3 (0.6828)	19 (0.75)
$1\frac{1}{4}$	51 (2.00)	66 (2.62)	62 (2.44)	5.28 (0.208)	5.56 (0.219)	17.0 (0.67)	18.0 (0.7068)	21 (0.81)
$1\frac{1}{2}$	54 (2.12)	71 (2.81)	70 (2.75)	5.56 (0.219)	6.25 (0.246)	17.8 (0.70)	18.4 (0.7235)	21 (0.81)
2	64 (2.50)	84 (3.31)	84 (3.31)	7.14 (0.281)	7.64 (0.301)	19.0 (0.75)	19.2 (0.7565)	22 (0.88)

NOTES:

- (1) Dimension A of Table 1.2.1-3 for the appropriate fitting size may also be used at the option of the manufacturer.
- (2) Dimension H of Table 1.2.1-3 for the appropriate fitting size may also be used at the option of the manufacturer.
- (3) Wall thickness before threading.
- (4) Dimension B is minimum length of perfect thread. The length of useful thread (B plus threads with fully formed roots and flat crests) shall not be less than L_2 (effective length of external thread) required by ASME B1.20.1 (see para. 6.3).

**Table 1.2.1-5
Threaded Fittings**



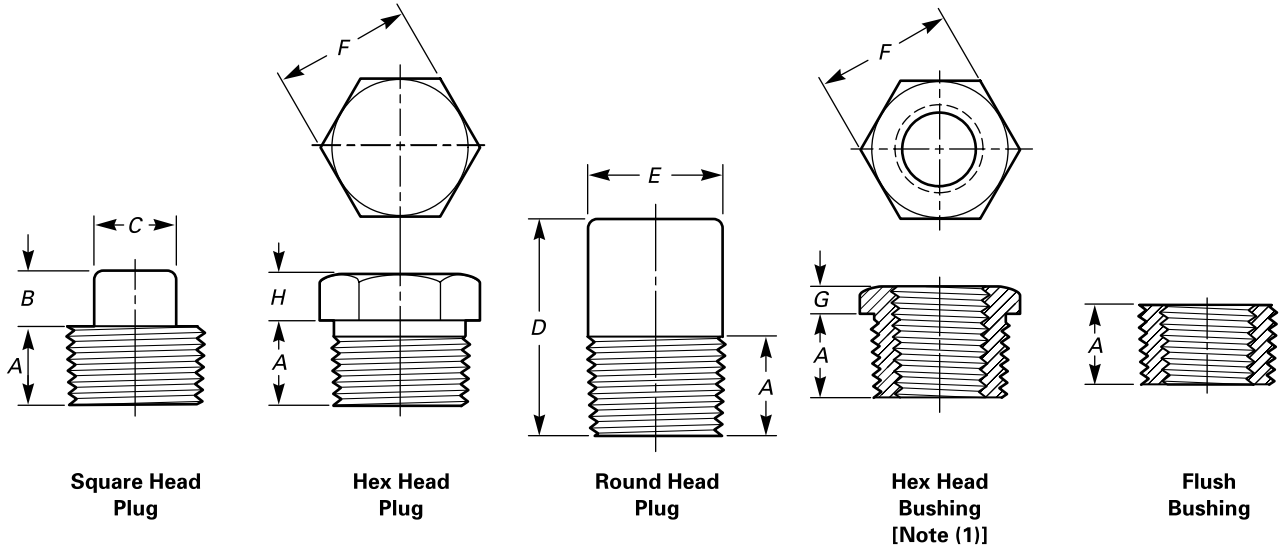
Nominal Pipe Size	Coupling		Half Coupling	Minimum End Wall Thickness, G, mm (in.)	Cap	
	End-to-End Couplings, W, mm (in.)	End-to-End Caps, P, mm (in.)	Outside Diameter, D, mm (in.)		Minimum Length of Thread, mm (in.) [Note (1)]	
	Designated Schedule 160				B	L ₂
1/8	32 (1.25)	19 (0.75)	16 (0.62)	4.8 (0.19)	6.4 (0.25)	6.7 (0.2639)
1/4	35 (1.38)	25 (1.00)	19 (0.75)	4.8 (0.19)	8.1 (0.32)	10.2 (0.4018)
3/8	38 (1.50)	25 (1.00)	22 (0.88)	4.8 (0.19)	9.1 (0.36)	10.4 (0.4078)
1/2	48 (1.88)	32 (1.25)	28 (1.12)	6.4 (0.25)	10.9 (0.43)	13.6 (0.5337)
3/4	51 (2.00)	37 (1.44)	35 (1.38)	6.4 (0.25)	12.7 (0.50)	13.9 (0.5457)
1	60 (2.38)	41 (1.62)	44 (1.75)	9.7 (0.38)	14.7 (0.58)	17.3 (0.6828)
1 1/4	67 (2.62)	44 (1.75)	57 (2.25)	9.7 (0.38)	17.0 (0.67)	18.0 (0.7068)
1 1/2	79 (3.12)	44 (1.75)	64 (2.50)	11.2 (0.44)	17.8 (0.70)	18.4 (0.7235)
2	86 (3.38)	48 (1.88)	76 (3.00)	12.7 (0.50)	19.0 (0.75)	19.2 (0.7565)
2 1/2	92 (3.62)	60 (2.38)	92 (3.62)	15.7 (0.62)	23.6 (0.93)	28.9 (1.1380)
3	108 (4.25)	65 (2.56)	108 (4.25)	19.0 (0.75)	25.9 (1.02)	30.5 (1.2000)
4	121 (4.75)	68 (2.69)	140 (5.50)	22.4 (0.88)	27.7 (1.09)	33.0 (1.3000)

GENERAL NOTES:

- (a) Designated Schedule 160 coupling, half coupling, and cap dimensions are included in this Standard. Coupling, half coupling, and cap wall thickness shall meet (b) except for the specified end wall thickness, G.
- (b) The wall thickness away from the threaded ends shall meet the minimum wall thickness requirements of Table 1.2.1-3 for the appropriate NPS and Designated Schedule Fitting.

NOTE: (1) Dimension B is minimum length of perfect thread. The length of useful thread (B plus thread with fully formed roots and flat crests) shall not be less than L₂ (effective length of external thread) required by ASME B1.20.1 (see para. 6.3).

**Table 1.2.1-6
Plugs and Bushings**



Nominal Pipe Size	Minimum Length, A, mm (in.)	Square Head Plugs		Round Head Plugs		Hex Plugs and Bushings		
		Minimum Square Height, B, mm (in.)	Minimum Width Flats, C, mm (in.) [Note (2)]	Nominal Head Diameter, E, mm (in.)	Minimum Length, D, mm (in.)	Nominal Width Flats, F, mm (in.) [Note (2)]	Minimum Hex Height	
							Bushing, G, mm (in.)	Plug, H, mm (in.)
1/8	10 (0.38)	6 (0.25)	7.15 (0.28)	10 (0.41)	35 (1.38)	11.11 (0.44)	...	6 (0.25)
1/4	11 (0.44)	6 (0.25)	9.53 (0.38)	14 (0.53)	41 (1.62)	15.88 (0.62)	3 (0.12)	6 (0.25)
3/8	13 (0.50)	8 (0.31)	11.11 (0.44)	18 (0.69)	41 (1.62)	17.46 (0.69)	4 (0.16)	8 (0.31)
1/2	14 (0.56)	10 (0.38)	14.29 (0.56)	21 (0.84)	44 (1.75)	22.23 (0.88)	5 (0.19)	8 (0.31)
3/4	16 (0.62)	11 (0.44)	15.88 (0.62)	27 (1.06)	44 (1.75)	26.99 (1.06)	6 (0.22)	10 (0.38)
1	19 (0.75)	13 (0.50)	20.64 (0.81)	33 (1.31)	51 (2.00)	34.93 (1.38)	6 (0.25)	10 (0.38)
1 1/4	21 (0.81)	14 (0.56)	23.81 (0.94)	43 (1.69)	51 (2.00)	44.45 (1.75)	7 (0.28)	14 (0.56)
1 1/2	21 (0.81)	16 (0.62)	28.58 (1.12)	48 (1.91)	51 (2.00)	50.80 (2.00)	8 (0.31)	16 (0.62)
2	22 (0.88)	18 (0.69)	33.27 (1.31)	60 (2.38)	64 (2.50)	63.50 (2.50)	9 (0.34)	18 (0.69)
2 1/2	27 (1.06)	19 (0.75)	38.10 (1.50)	73 (2.88)	70 (2.75)	76.20 (3.00)	10 (0.38)	19 (0.75)
3	28 (1.12)	21 (0.81)	42.86 (1.69)	89 (3.50)	70 (2.75)	88.90 (3.50)	10 (0.41)	21 (0.81)
4	32 (1.25)	25 (1.00)	63.50 (2.50)	114 (4.50)	76 (3.00)	117.48 (4.62)	13 (0.50)	25 (1.00)

NOTES:

- (1) **CAUTION:** Hex head bushings of one-size reduction should not be used in services where they might be subject to harmful loads and forces other than internal pressures.
- (2) Manufacturer's applied tolerance shall ensure dimension will fit U.S. Customary tooling.

**Table 2.1.1-1
Correlation of Designated Schedule Fittings
With Pipe Schedule for Calculation of Ratings**

Designated Schedule Fitting	Type of Fitting	Pipe Used for Rating Basis [Notes (1) and (2)]	
		Schedule No.	Wall Designation
80	Threaded	80/80S	XS
160	Threaded	160	...
40	Socket- welding	40/40S	Std.
80	Socket- welding	80/80S	XS
160	Socket- welding	160	...

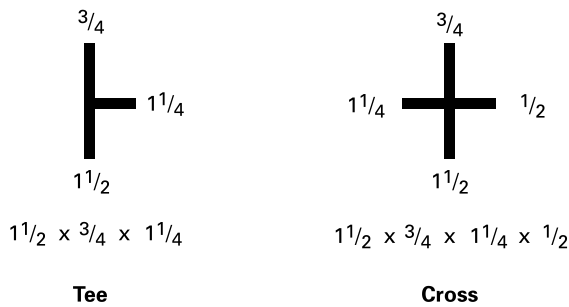
NOTES:

- (1) This table is not intended to restrict the use of pipe of thinner or thicker wall with fittings. Pipe actually used may be thinner or thicker in nominal wall than that shown in Table 2.1.1-1. When thinner pipe is used, its strength may govern the rating. When thicker pipe is used (e.g., for mechanical strength), the strength of the fitting governs the rating.
- (2) For NPS fittings in this Standard, Schedules 40S and 80S pipe have the same wall thickness and dimensions as Schedules 40 and 80 pipe, respectively.

**Table 2.1.2-1
Nominal Wall Thickness of Schedule 160 Pipe**

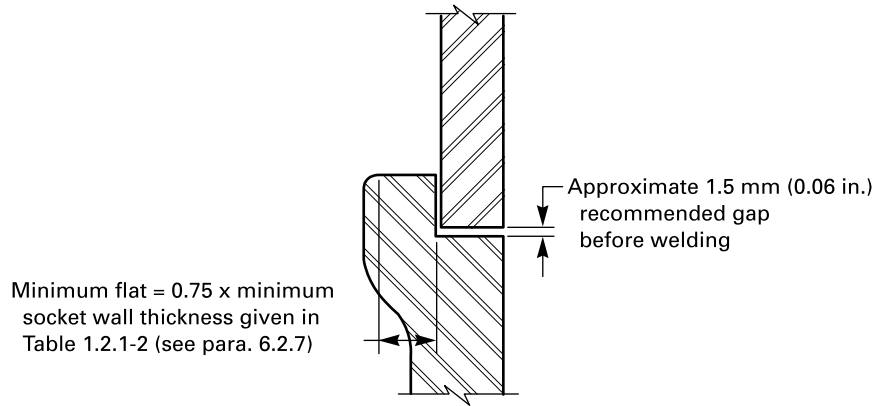
NPS	Schedule 160	
	mm	in.
1/8	3.15	0.124
1/4	3.68	0.145
3/8	4.01	0.158

**Figure 3.2-1
Method of Designating Outlets
of Reducing Tees and Crosses**



GENERAL NOTE: See para. 3.2.

Figure 6.2.7-1
Welding Gap and Minimum Flat Dimensions for Socket-Welding Fittings



MANDATORY APPENDIX I REFERENCES

(24)

The following is a list of publications referenced in this Standard.

ASME B1.20.1. Pipe Threads, General Purpose (Inch). The American Society of Mechanical Engineers.
 ASME B36.10M. Welded and Seamless Wrought Steel Pipe. The American Society of Mechanical Engineers.
 ASME B36.19M. Stainless Steel Pipe. The American Society of Mechanical Engineers.
 ASTM B247-20. Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings. ASTM International.
 ASTM B361-16. Specification for Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings. ASTM International.

ASTM B363-19. Specification for Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings. ASTM International.
 ASTM B381-21. Specification for Titanium and Titanium Alloy Forgings. ASTM International.
 ISO 9000:2015. Quality management systems — Fundamentals and vocabulary.¹ International Organization for Standardization.
 ISO 9001:2015. Quality management systems — Requirements.¹ International Organization for Standardization.
 ISO 9004:2018. Quality management — Quality of an organization — Guidance to achieve sustained success.¹ International Organization for Standardization

¹This publication may also be obtained from the American National Standards Institute (ANSI): www.ansi.org.

NONMANDATORY APPENDIX A QUALITY SYSTEM PROGRAM

The products manufactured in accordance with this Standard shall be produced under a quality system program following the principles of an appropriate standard from the ISO 9000 series.¹ A determination of the need for registration or certification of the product manufacturer's quality system program by an independent organization shall be the responsibility of the manufacturer.

The detailed documentation demonstrating program compliance shall be available to the purchaser at the manufacturer's facility. A written summary description of the program used by the product manufacturer shall be available to the purchaser upon request. The product manufacturer is defined as the entity whose name or trademark appears on the product in accordance with the marking or identification requirements of this Standard.

¹This series is also available from the American National Standards Institute (ANSI). The applicable standards from the series are listed under References in [Mandatory Appendix I](#).

B16 AMERICAN NATIONAL STANDARDS FOR PIPING, PIPE FLANGES, FITTINGS, AND VALVES

B16.1-2020	Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
B16.3-2021	Malleable Iron Threaded Fittings: Classes 150 and 300
B16.4-2021	Gray Iron Threaded Fittings: Classes 125 and 250
B16.5-2020	Pipe Flanges and Flanged Fittings: NPS ½ Through NPS 24 Metric/Inch Standard
B16.9-2024	Factory-Made Wrought Butt welding Fittings
B16.10-2022	Face-to-Face and End-to-End Dimensions of Valves
B16.11-2021	Forged Fittings, Socket-Welding and Threaded
B16.12-2019	Cast Iron Threaded Drainage Fittings
B16.14-2024	Ferrous Pipe Plugs, Bushings, and Locknuts With Pipe Threads
B16.15-2024	Cast Copper Alloy Threaded Fittings
B16.18-2021	Cast Copper Alloy Solder Joint Pressure Fittings
B16.20-2023	Metallic Gaskets for Pipe Flanges
B16.21-2021	Nonmetallic Flat Gaskets for Pipe Flanges
B16.22-2021	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
B16.23-2021	Cast Copper Alloy Solder Joint Drainage Fittings: DWV
B16.24-2021	Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500
B16.25-2022	Butt welding Ends
B16.26-2018	Cast Copper Alloy Fittings for Flared Copper Tubes
B16.29-2022	Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings — DWV
B16.33-2024	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 175 psi (Sizes NPS ½ Through NPS 2)
B16.34-2020	Valves — Flanged, Threaded, and Welding End
B16.36-2020	Orifice Flanges
B16.38-2023	Large Metallic Valves for Gas Distribution: Manually Operated, NPS 2½ (DN 65) to NPS 12 (DN 300), 125 psig (8.6 bar) Maximum
B16.39-2019	Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300
B16.40-2019	Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
B16.42-2021	Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300
B16.44-2023	Manually Operated Metallic Gas Valves for Use in Aboveground Piping Systems Up to 5 psi
B16.47-2020	Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard
B16.48-2020	Line Blanks
B16.49-2023	Factory-Made, Wrought Steel, Butt welding Induction Bends for Transportation and Distribution Systems
B16.50-2021	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
B16.51-2021	Copper and Copper Alloy Press-Connect Pressure Fittings
B16.52-2024	Forged Nonferrous Fittings, Socket-Welding and Threaded (Titanium, Titanium Alloys, Aluminum, and Aluminum Alloys)

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ASME B16.52-2024

ISBN 978-0-7918-7660-2

