

ASME B16.11-2005
(Revision of ASME B16.11-2001)

Forged Fittings, Socket-Welding and Threaded

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AN AMERICAN NATIONAL STANDARD



The American Society of
Mechanical Engineers

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The American Society of Mechanical Engineers

Three Park Avenue • New York, NY 10016

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FOREWORD

The Sectional Committee on the Standardization of Pipe Flanges and Fittings, B16, organized in 1920 under the procedure of the American Standards Association (ASA) appointed a subgroup of Subcommittee 3 (now Subcommittee F) to initiate the standardization of welding fittings in May 1937. The first meeting of this group was held later that month, and at its meeting in December 1938, in New York, it was agreed to undertake the standardization of dimensions of socket-welding fittings and to refer this project to a new drafting subgroup. One of the most important dimensions of this type of fitting requiring standardization was considered to be the dimension from the centerline of the fitting to the bottom of the socket, since from the standpoint of the designing engineer, this dimension governs the location of adjacent pipe with reference to the entire piping layout. Another important item for consideration was the welding fillet dimensions.

The drafting subgroup held meetings in Chicago, Detroit, and New York in March 1939, and May and October 1940, respectively, and at the last named meeting, the completed draft of the proposed standard was discussed, and further revisions were suggested. When applied to the September 1940 draft, these changes produced the May 1941 draft, which was prepared for distribution to industry for criticism and comment.

This distribution resulted in a number of helpful comments. The members of the subgroup agreed by mail that many of the changes suggested should be incorporated in the revised draft (December 1941). Progress on the approval of the standard was delayed by the war, after which, a few more changes were added to make the proposal acceptable to all concerned. The revised draft (April 1946) was then submitted to the members of the sectional committee for letter ballot vote.

Following the approval of the sectional committee, the proposed standard was next approved by the sponsor bodies and presented to the ASA with recommendation for approval as an American Standard. This designation was given on December 9, 1946.

In 1960, it was agreed that the standard needed a complete revision and simultaneously that it should be expanded to cover threaded fittings and plugs, then covered by MSS SP-49 and SP-50. A Task Force worked diligently for four years before arriving at a draft that it felt was acceptable. They also found that ratings were outdated and eliminated the 4000-lb classes of threaded fittings, assigned pressure-temperature ratings for a number of materials, and converted the socket-weld fitting ratings to 3000 and 6000 lb. Following approval by the Sectional Committee and Sponsors, ASA approval was granted on January 28, 1966.

Following designation changes of ASA to ANSI and Sectional Committee to Standards Committee, Subcommittee 6 began consideration of changes in 1969. Early in 1972, changes in the pressure class designations, materials, and clarification of wording were agreed upon and submitted for approval. This approach was granted on June 20, 1973.

The work of development of the 1980 edition of B16.11 began in 1975 when the committee began consideration of comments and proposals for change that were received. The development procedure was arduous in that a number of ballots were taken which elicited many additional comments and counter proposals. The major changes included an expanded scope for better definition, requirements for conformance marking, a nonmandatory annex with provisions for proof or burst testing, and the inclusion of metric equivalents. Following approval by the Standards Committee and Co-Secretariat, final approval by ANSI was granted on October 6, 1980.

In 1982, American National Standards Committee B16 was reorganized as an ASME Committee operating under procedures accredited by ANSI. The 1991 edition of the standard, re-titled "Forged Fittings, Socket-Welding and Threaded," incorporated forging material listed in Table 1 of ASME B16.34-1988, including Group 3 material that was not previously covered in B16.11. The 1991 edition established U.S. Customary units as the standard. Other clarifying and editorial revisions were made in order to improve the text. Following approval by the Standards Committee and ASME, final approval by ANSI was granted on March 4, 1991.

In 1996, metric dimensions were added as an independent but equal standard to the inch units. Following approval by the Standards Committee and ASME, this revision to the 1991 edition of this Standard was approved as an American National Standard by ANSI on December 16, 1996, with the new designation ASME B16.11-1996.

In 2000, the Standards Committee, ASME, and ANSI approved an addenda to this Standard to remove partial compliance fittings and nonstandard material requirements. Due to an ASME policy change concerning the publishing of addenda, the intended addenda changes have been incorporated into this B16.11-2001 edition.

Suggestions for improvement of this Standard are welcome. They should be addressed to the Secretary, ASME B16 Standards Committee, Three Park Avenue, New York, NY 10016.

The Committee incorporated threaded street elbow requirements into the standard starting in 2004. Following approval by the Standards Committee and ASME, this revision to the 2001 edition was approved as an American National Standard by ANSI on September 30, 2005, with the designation ASME B16.11-2005.

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Standardization of Valves, Flanges, Fittings, and Gaskets

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

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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

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

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

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

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

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

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings, which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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

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

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FORGED FITTINGS, SOCKET-WELDING AND THREADED

1 SCOPE

1.1 General

This Standard covers ratings, dimensions, tolerances, marking, and material requirements for forged fittings, both socket-welding and threaded, as illustrated in Tables 4 through 8 and Tables I-1 through I-5, inclusive.

1.1.1 Fitting Types/Configuration. Types of fittings covered by this Standard are shown in Table 1, by class and size range. Fittings shown in Tables 4 through 8 and Tables I-1 through I-5 may also be made with combinations of 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 stipulations of this Standard, they shall be considered in compliance therewith, provided they are appropriately marked (see para. 4).

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

1.2 References

1.2.1 Referenced Standards. Standards and specifications adopted by reference in this Standard are shown in Mandatory Appendix II, which is part of this Standard. It is not considered practical to identify the specific edition of each standard and specification in the individual references. Instead, the specific edition reference is identified in Mandatory Appendix II. 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 addendum to or revision of the Standard.

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

1.3 Service Conditions

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

1.4 Welding

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

1.5 Standard Units

The values stated in either metric or inch units are to be regarded separately as standard. Within the text, the inch units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, each

Table 1 Types of Fittings by Class Designation and NPS Size Range

Description	Socket-Welding			Threaded		
	Class Designation			Class Designation		
	3000	6000	9000	2000	3000	6000
45-deg, 90-deg elbows,	1/8-4	1/8-2	1/2-2	1/8-4	1/8-4	1/8-4
tees, crosses, coupling,	1/8-4	1/8-2	1/2-2	1/8-4	1/8-4	1/8-4
half-coupling, and cap	1/8-4	1/8-2	1/2-2	...	1/8-4	1/8-4
	1/8-4	1/8-2	1/2-2	...	1/8-4	1/8-4
Street elbows	...	...	...	...	1/8-2	1/8-2
Square, hex, round plug,	...	...	...		1/8-4 [Note (1)]	
hex, and flush bushing	...	...	...		1/8-4 [Note (1)]	

NOTE:

- (1) Plugs and bushings are not identified by class designation. They may be used for ratings up through Class 6000 designation.

Table 2 Correlation of Fittings Class With Schedule Number or Wall Designation of Pipe for Calculation of Ratings

Class Designation of Fitting	Type of Fitting	Pipe Used for Rating Basis [Note (1)]	
		Schedule No.	Wall Designation
2000	Threaded	80	XS
3000	Threaded	160	...
6000	Threaded	...	XXS
3000	Socket-welding	80	XS
6000	Socket-welding	160	...
9000	Socket-welding	...	XXS

NOTE:

- (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. 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.

system must be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

Tables 4 through 8 show fittings dimensional requirements in millimeters. Tables I-1 through I-5 show the dimensional requirements for inch dimensioned fittings.

2 PRESSURE RATINGS

2.1 General

These fittings shall be designated as Class 2000, 3000, and 6000 for threaded end fittings and Class 3000, 6000, and 9000 for socket-weld end fittings.

2.1.1 Basis of Rating. The schedule of pipe corresponding to each Class of fitting for rating purposes is shown in Table 2. 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 maximum allowable pressure of a fitting shall be that computed for straight seamless pipe of equivalent material (as shown by comparison of composition and mechanical properties in the respective material specifications). The wall thickness used in such computation shall be that tabulated in ASME B36.10M for the size and applicable schedule of pipe reduced by a 12.5% manufacturing tolerance and other allowances (e.g., threaded allowances). Fittings are not suitable for use at pressures that are calculated for a pipe that requires larger minimum wall thickness. See Note (1), Table 2.

Any corrosion allowance and any variation in allowable stress due to temperature or other design shall be applied to the pipe and fitting alike.

Table 3 Nominal Wall Thickness of Schedule 160 and Double Extra Strong Pipe

NPS	Schedule 160		XXS	
	mm	in.	mm	in.
1/8	3.15	0.124	4.83	0.190
1/4	3.68	0.145	6.05	0.238
3/8	4.01	0.158	6.40	0.252

2.1.2 Nonstandard Pipe Wall Thickness. Since ASME B36.10M does not include Schedule 160 nor Double Extra Strong thickness for NPS 1/8, 1/4, and 3/8, the values in Table 3 may be used as the nominal wall thicknesses of the pipe for rating purposes.

2.1.3 Combination End Fittings. The Class for fittings made with combinations of socket-welding and threaded ends shall be based on the end configuration that has the lowest rating from Table 2.

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 Class and end connection of Table 2.

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
1/8	6
1/4	8
3/8	10
1/2	15
3/4	20
1	25
1 1/4	32
1 1/2	40
2	50
2 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.

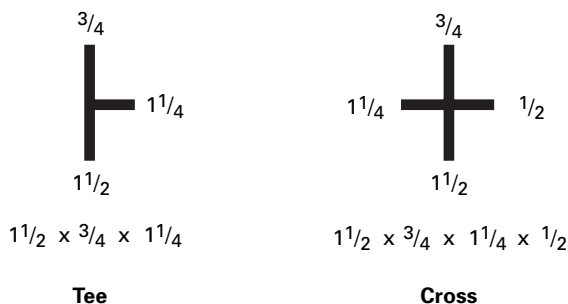


Fig. 1 Method of Designating Outlets of Reducing Tees and Crosses (See para. 3.2)

Where the fitting is a tee, the size of the branch is given last. Where the fitting is a cross, the largest side-outlet is the third dimension given, followed by the opening opposite. The line sketches, Fig. 1, illustrate how the reducing fittings are read.

4 MARKING

4.1 General

Each fitting shall be permanently marked with the required identification by raised lettering and/or stamping, electro-etching, or vibro-tool marking on the collar portion, raised pad, or raised boss portion of the forging. Cylindrical fittings shall be marked on the O.D. 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 plug 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 Fittings Specification A 234, A 403, A 420, A 815, or B 366, or the appropriate ASTM Forging Specifications A 105, A 182, A 350, B 160, B 164, B 462, B 564, or other applicable forging Specification of Table 1, ASME B16.34 (see para. 5.1).
- (c) *Product Conformance.* Fittings covered under para. 1.1.1 shall be marked with either the ASTM Fittings Specification material identification (e.g., "WP_____") or the symbol "B16" to denote conformance to this Standard. Fittings covered under para. 1.1.2 shall be marked B16SPLD.

(d) *Class Designation.* 2000, 3000, 6000, or 9000, as applicable. Alternatively, the designation 2M, 3M, 6M, or 9M, as applicable, may be used where M stands for 1000.

(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

The material for fittings shall consist of forgings, bars, seamless pipe, or tubular products which conform to the requirements for melting process, chemical composition requirements, and mechanical property requirements of the forging product form listed in Table 1, ASME B16.34, including applicable notes from Table 2. Tees, elbows, and crosses shall not be made from bar stock.

6 DIMENSIONS

6.1 General

Unless otherwise noted, the dimensions without tolerances for socket-welding fittings given in Tables 4 and I-1 and the dimensions without tolerances for threaded fittings given in Tables 5 through 8 and Tables I-2 through I-5 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 Tables 4 and I-1.

6.2.2 Socket Wall Thickness. The socket wall average thickness and minimum thickness shall be no less than the corresponding values, *C*, shown in Tables 4 and I-1.

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 dimensions, *A*, of Tables 4 and I-1. For reducing fittings, see para. 6.5.

6.2.4 Socket Depth. The socket depth shall be no less than the minimum values, *J*, shown in Tables 4 and I-1.

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 Fig. 2.

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

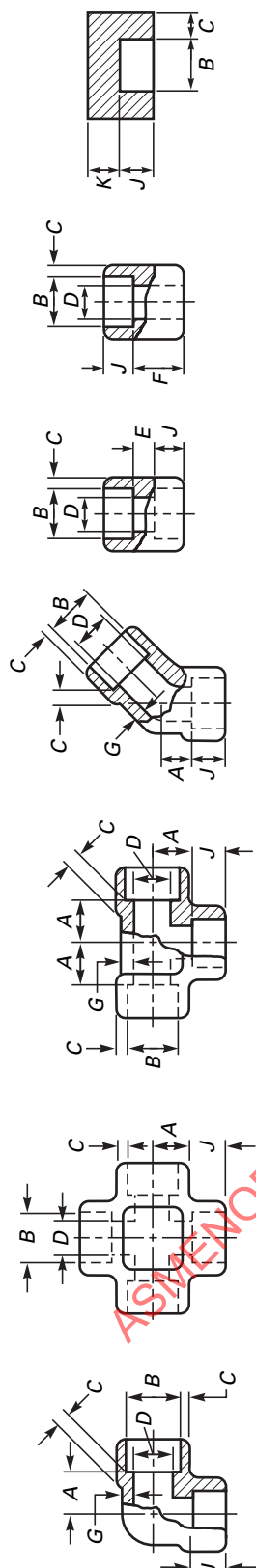


Table 4 Socket-Welding Fittings

Nominal Pipe Size	Socket Bore Diameter, B [Note (1)]	Bore Diameter of Fittings, D [Note (1)]		Socket Wall Thickness, C [Note (2)]								Body Wall, G Class Designation				Min. Depth of Socket, J	Center to Bottom of Socket, A 90-deg Elbows, Tees, and Crosses								Laying Lengths				Tolerances, $\pm$				End Wall Thickness, K_{min} Class Designation		
		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation			Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		
		3000	6000	9000	3000	6000	9000	3000	6000	9000	3000	6000	9000	3000	6000		9000	3000	6000	9000	3000	6000	9000	3000	6000	9000	3000	6000	9000	Class Designation					
																															Avg.	Min.		Avg.	Min.
1/8	11.2	7.6	4.8	...	3.18	3.96	3.43	...	2.41	3.15	...	11.0	11.0	...	8.0	8.0	...	6.5	16.0	1.0	1.5	1.0	4.8	6.4	...										
1/4	10.8	6.1	3.2	...	3.78	4.60	4.01	...	3.02	3.68	...	11.0	13.5	...	8.0	8.0	...	6.5	16.0	1.0	1.5	1.0	4.8	6.4	...										
3/8	14.2	8.5	5.6	...	4.01	5.03	4.37	...	3.20	4.01	...	13.5	15.5	...	8.0	11.0	...	6.5	17.5	1.5	3.0	1.5	4.8	6.4	...										
1/2	18.0	13.3	9.9	...	4.67	5.97	5.18	9.35	8.18	7.47	9.5	15.5	19.0	25.5	11.0	12.5	15.5	9.5	22.5	1.5	3.0	1.5	6.4	7.9	11.2										
3/4	22.2	16.6	12.5	7.2	4.90	6.04	6.04	9.78	8.56	5.56	7.82	19.0	22.5	28.5	13.0	14.0	19.0	9.5	24.0	1.5	3.0	1.5	6.4	7.9	12.7										
1	27.2	20.2	14.8	10.3	5.69	7.92	6.93	11.38	9.96	6.35	9.09	22.5	27.0	32.0	14.0	17.5	20.5	12.5	28.5	2.0	4.0	2.0	9.6	11.2	14.2										
1 1/4	33.9	25.9	19.9	14.4	6.07	8.92	7.92	12.14	10.62	6.35	9.70	27.0	32.0	35.0	17.5	20.5	22.5	12.5	30.0	2.0	4.0	2.0	9.6	11.2	14.2										
1 1/2	43.1	35.8	30.2	23.5	6.35	8.92	7.80	12.70	11.12	5.08	7.14	32.0	38.0	38.0	20.5	25.5	25.5	12.5	32.0	2.0	4.0	2.0	11.2	12.7	15.7										
2	49.2	41.6	34.7	28.7	6.35	8.92	7.80	12.70	11.12	5.08	7.14	32.0	38.0	38.0	20.5	25.5	25.5	12.5	32.0	2.0	4.0	2.0	11.2	12.7	15.7										
2 1/2	61.7	53.3	43.6	38.9	6.93	10.92	9.50	13.84	12.12	5.54	8.74	38.0	41.0	54.0	25.5	28.5	28.5	19.0	41.0	2.0	4.0	2.0	12.7	15.7	19.0										
3	74.4	64.2	...	...	8.76	7.67	...	...	...	7.01	...	41.0	...	...	28.5	...	...	19.0	43.0	2.5	5.0	2.5	15.7	19.0	...										
4	90.3	79.4	...	...	9.52	8.30	...	...	...	7.62	...	57.0	...	...	32.0	...	...	19.0	44.5	2.5	5.0	2.5	19.0	22.4	...										
4	89.8	76.4	...	...	10.69	9.35	...	...	...	8.56	...	66.5	...	...	41.0	...	...	19.0	48.0	2.5	5.0	2.5	22.4	28.4	...										
4	115.7	103.8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...										
4	100.7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...										

GENERAL NOTE: Dimensions are in millimeters.

NOTES:

- (1) Upper and lower values for each size are the respective maximum and minimum dimensions.
- (2) Average of socket wall thickness around periphery shall be no less than listed values. The minimum values are permitted in localized areas.

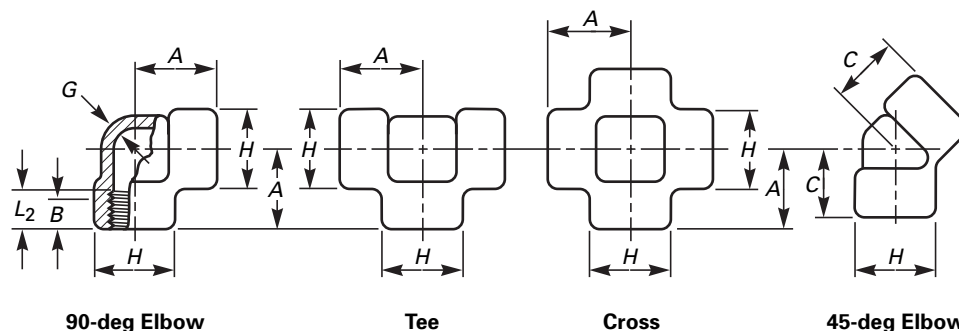


Table 5 Forged Threaded Fittings

Nominal Pipe Size	Center-to-End Elbows, Tees, Crosses, A			Center-to-End 45-deg Elbow, C			Outside Diameter of Band, H			Min. Wall Thickness, G			Min. Length of Thread [Note (1)]	
	2000	3000	6000	2000	3000	6000	2000	3000	6000	2000	3000	6000	B	L ₂
1/8	21	21	25	17	17	19	22	22	25	3.18	3.18	6.35	6.4	6.7
1/4	21	25	28	17	19	22	22	25	33	3.18	3.30	6.60	8.1	10.2
3/8	25	28	33	19	22	25	25	33	38	3.18	3.51	6.98	9.1	10.4
1/2	28	33	38	22	25	28	33	38	46	3.18	4.09	8.15	10.9	13.6
3/4	33	38	44	25	28	33	38	46	56	3.18	4.32	8.53	12.7	13.9
1	38	44	51	28	33	35	46	56	62	3.68	4.98	9.93	14.7	17.3
1 1/4	44	51	60	33	35	43	56	62	75	3.89	5.28	10.59	17.0	18.0
1 1/2	51	60	64	35	43	44	62	75	84	4.01	5.56	11.07	17.8	18.4
2	60	64	83	43	44	52	75	84	102	4.27	7.14	12.09	19.0	19.2
2 1/2	76	83	95	52	52	64	92	102	121	5.61	7.65	15.29	23.6	28.9
3	86	95	106	64	64	79	109	121	146	5.99	8.84	16.64	25.9	30.5
4	106	114	114	79	79	79	146	152	152	6.55	11.18	18.67	27.7	33.0

GENERAL NOTE: Dimensions are in millimeters.

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 American National Standard for Pipe Threads (ASME B1.20.1). See para. 6.3.

minimum values, G, as shown in Tables 5 through 7 or Tables I-2 through I-4.

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, providing 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.

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 the purpose of 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 4, 5, I-1, and I-2.

6.5 Reducing Fittings

Reducing fittings shall have the same center-to-end, center-to-bottom of socket, band diameter, and outside

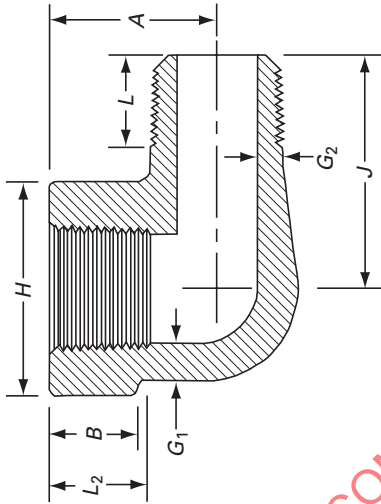


Table 6 Forged Threaded Fittings — Street Elbows

Nominal Pipe Size, NPS	Center-to-Female End Street Ells, A		Center-to-Male End Street Ells, J		Outside Diameter of Band, H [Note (2)]		Min. Wall Thickness, G ₁		Min. Wall Thickness, G ₂ [Note (3)]		Min. Length Internal Thread [Note (4)]		Min. Length Male Thread, L
	[Note (1)]												
	Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		B	L ₂	
	3000	6000	3000	6000	3000	6000	3000	6000	3000	6000	3000	6000	
1/8	19	22	25	32	19	25	3.18	5.08	4.22	2.74	6.4	6.7	10
1/4	22	25	32	38	25	32	3.30	5.66	5.28	3.22	8.1	10.2	11
3/8	25	28	38	41	32	38	3.51	6.98	5.59	3.50	9.1	10.4	13
1/2	28	35	41	48	38	44	4.09	8.15	6.53	4.16	10.9	13.6	14
3/4	35	44	48	57	44	51	4.32	8.53	6.86	4.88	12.7	13.9	16
1	44	51	57	66	51	62	4.98	9.93	7.95	5.56	14.7	17.3	19
1 1/4	51	54	66	71	62	70	5.28	10.59	8.48	5.56	17.0	18.0	21
1 1/2	54	64	71	84	70	84	5.56	11.07	8.89	6.25	17.8	18.4	21
2	64	83	84	105	84	102	7.14	12.09	9.70	7.64	19.0	19.2	22

GENERAL NOTE: Dimensions are in millimeters.

NOTES:

- (1) Dimension A of Table 5 for the appropriate fitting size may also be used at the option of the manufacturer.
- (2) Dimension H of Table 5 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 L₂ (effective length of external thread) required by American National Standard for Pipe Threads (ASME B1.20.1). See para. 6.3.

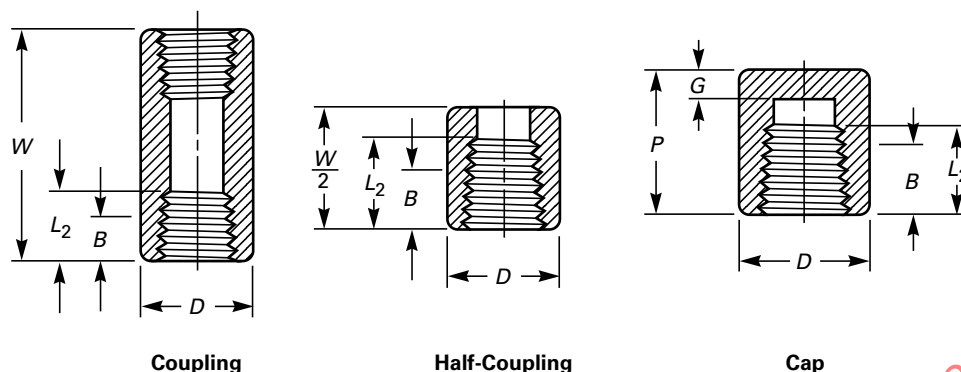


Table 7 Threaded Fittings

Nominal Pipe Size	End-to-End Couplings, <i>W</i>	End-to-End Caps, <i>P</i>		Outside Diameter, <i>D</i>		Min. End Wall Thickness, <i>G</i>		Min. Length of Thread [Note (1)]	
	3000 and 6000	3000	6000	3000	6000	3000	6000	<i>B</i>	<i>L₂</i>
1/8	32	19	...	16	22	4.8	...	6.4	6.7
1/4	35	25	27	19	25	4.8	6.4	8.1	10.2
3/8	38	25	27	22	32	4.8	6.4	9.1	10.4
1/2	48	32	33	28	38	6.4	7.9	10.9	13.6
3/4	51	37	38	35	44	6.4	7.9	12.7	13.9
1	60	41	43	44	57	9.7	11.2	14.7	17.3
1 1/4	67	44	46	57	64	9.7	11.2	17.0	18.0
1 1/2	79	44	48	64	76	11.2	12.7	17.8	18.4
2	86	48	51	76	92	12.7	15.7	19.0	19.2
2 1/2	92	60	64	92	108	15.7	19.0	23.6	28.9
3	108	65	68	108	127	19.0	22.4	25.9	30.5
4	121	68	75	140	159	22.4	28.4	27.7	33.0

GENERAL NOTES:

- Dimensions are in millimeters.
- Class 2000 and NPS 1/8 Class 6000 couplings, half couplings, and caps are not included in this Standard.
- The wall thickness away from the threaded ends shall meet the minimum wall thickness requirements of Table 5 for the appropriate NPS and Class Designation fitting.

NOTE:

- 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 American National Standard for Pipe Threads (ASME B1.20.1). See para. 6.3.

diameters as the uniform size fitting corresponding to the largest size end connection of the reducing fitting.

concentric within a tolerance of 1.5 mm (0.06 in.) for all sizes.

7 TOLERANCES

7.1 Additional Tolerances

Tolerances in addition to those listed in Tables 4 and I-1.

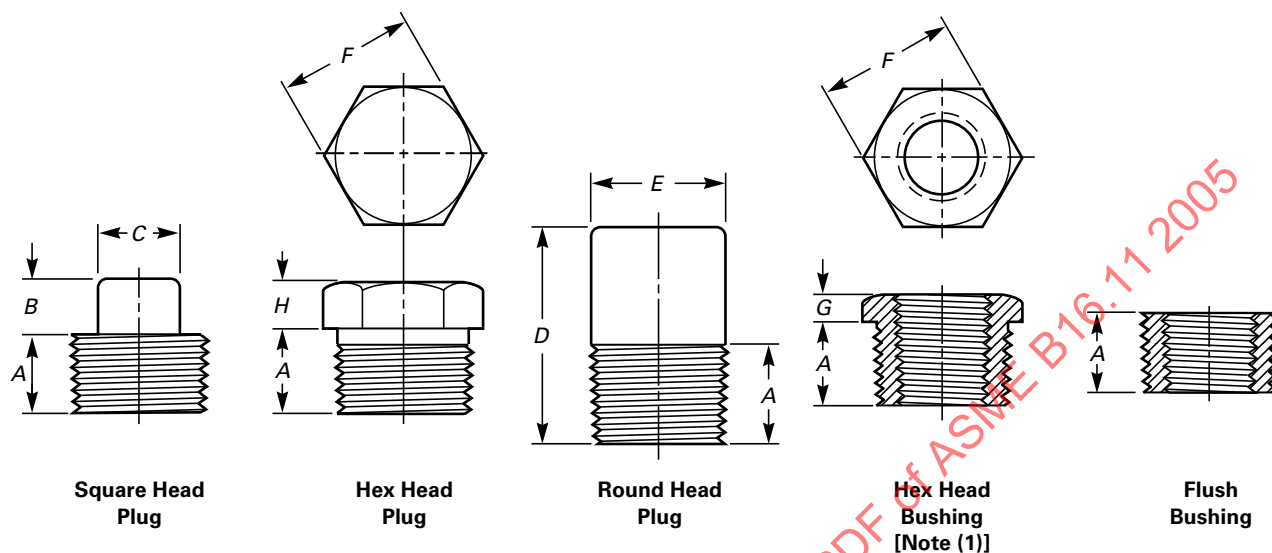
7.1.1 Concentricity of Bores. The socket and fitting bores shall be concentric within a tolerance of 0.8 mm (0.03 in.) for all sizes. Opposite socket bores shall be

7.1.2 Coincidence of Axes. The maximum allowable variation in the alignment of the fitting bore and socket bore axes shall be 1 mm in 200 mm (0.06 in. in 1 ft). The maximum allowable variation in alignment of threads shall be 1 mm in 200 mm (0.06 in. in 1 ft).

8 TESTING

8.1 Proof Testing

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

**Table 8 Plugs and Bushings**

Nominal Pipe Size	Min. Length, A	Square Head Plugs		Round Head Plugs		Hex Plugs and Bushings		
		Min. Square Height, B	Min. Width Flats, C	Nominal Head Diameter, E	Min. Length, D	Nominal Width Flats, F	Min. Hex Height	
							Bushing, G	Plug, H
1/8	10	6	7	10	35	11	...	6
1/4	11	6	10	14	41	16	3	6
3/8	13	8	11	18	41	18	4	8
1/2	14	10	14	21	44	22	5	8
3/4	16	11	16	27	44	27	6	10
1	19	13	21	33	51	36	6	10
1 1/4	21	14	24	43	51	46	7	14
1 1/2	21	16	28	48	51	50	8	16
2	22	18	32	60	64	65	9	18
2 1/2	27	19	36	73	70	75	10	19
3	28	21	41	89	70	90	10	21
4	32	25	65	114	76	115	13	25

GENERAL NOTE: Dimensions are in millimeters.

NOTE:

(1) *Cautionary Note Regarding Hex Bushings:* 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.

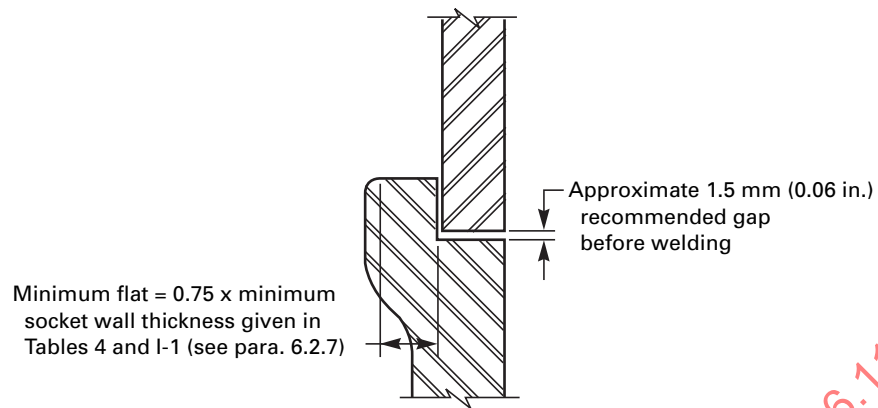


Fig. 2 Welding Gap and Minimum Flat Dimensions for Socket-Welding Fittings

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MANDATORY APPENDIX I INCH TABLES

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

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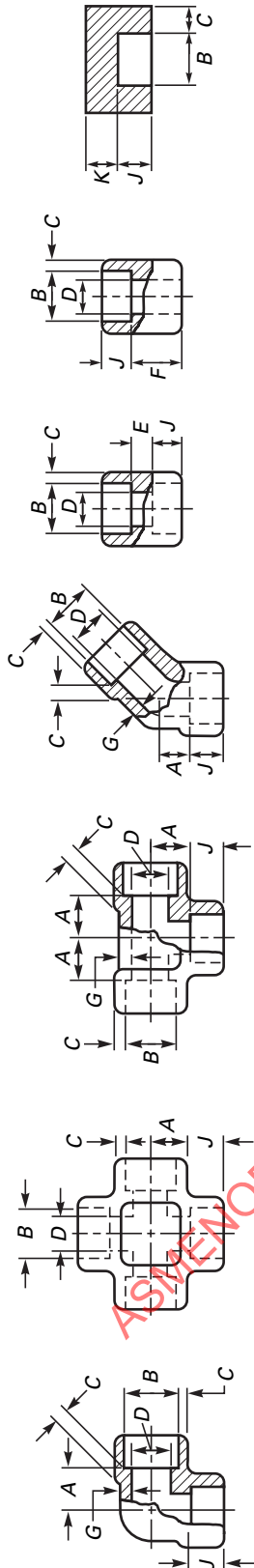


Table I-1 Socket-Welding Fittings

Nominal Pipe Size	Socket Bore Diameter, <i>B</i> [Note (1)]	Bore Diameter of Fittings, <i>D</i> [Note (1)]		Socket Wall Thickness, <i>C</i> [Note (2)]						Body Wall, <i>G</i>			Min. Depth of Socket, <i>J</i>	Center to Bottom of Socket, <i>A</i>						Tolerances, ±				End Wall Thickness, <i>K_{min.}</i>				
		Class Designation		Class Designation						Class Designation				Class Designation			Class Designation						<i>A</i>		<i>E</i>	<i>F</i>		
		3000	6000	9000	3000	6000	9000	3000	6000	9000	3000	6000		9000	3000	6000	9000	Couplings, <i>E</i>	Half Couplings, <i>F</i>									
																				Avg.	Min.	Avg.					Min.	Avg.
1/8	0.440	0.299	0.189	...	0.125	0.125	0.156	0.135	...	...	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	...
1/4	0.420	0.239	0.126	...	0.149	0.130	0.181	0.158	...	...	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	...
3/8	0.575	0.394	0.280	...	0.158	0.138	0.198	0.172	...	...	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	...
1/2	0.710	0.523	0.389	...	0.158	0.138	0.198	0.172	...	...	0.126	0.158	...	0.38	0.62	0.75	1.00	0.44	0.50	0.62	0.38	0.88	0.06	0.12	0.06	0.25	0.31	0.44
	0.690	0.463	0.329	...	0.184	0.161	0.235	0.204	0.368	0.322	0.147	0.188	0.294	0.38	0.62	0.75	1.00	0.44	0.50	0.62	0.38	0.88	0.06	0.12	0.06	0.25	0.31	0.44
	0.875	0.652	0.494	0.282	0.184	0.161	0.235	0.204	0.368	0.322	0.147	0.188	0.294	0.38	0.62	0.75	1.00	0.44	0.50	0.62	0.38	0.88	0.06	0.12	0.06	0.25	0.31	0.44
	0.855	0.592	0.434	0.222	0.193	0.168	0.274	0.238	0.385	0.337	0.154	0.219	0.308	0.50	0.75	0.88	1.12	0.50	0.56	0.75	0.38	0.94	0.06	0.12	0.06	0.25	0.31	0.50
3/4	1.085	0.854	0.642	0.464	0.224	0.196	0.312	0.273	0.448	0.392	0.179	0.250	0.358	0.50	0.88	1.06	1.25	0.56	0.69	0.81	0.50	1.12	0.08	0.16	0.08	0.38	0.44	0.56
1	1.350	1.079	0.845	0.629	0.224	0.196	0.312	0.273	0.448	0.392	0.179	0.250	0.358	0.50	0.88	1.06	1.25	0.56	0.69	0.81	0.50	1.12	0.08	0.16	0.08	0.38	0.44	0.56
1 1/4	1.695	1.410	1.190	0.926	0.239	0.208	0.312	0.273	0.478	0.418	0.191	0.250	0.382	0.50	1.06	1.25	1.38	0.69	0.81	0.88	0.50	1.19	0.08	0.16	0.08	0.38	0.44	0.56
	1.675	1.350	1.130	0.866	0.250	0.218	0.351	0.307	0.500	0.438	0.200	0.281	0.400	0.50	1.25	1.50	1.50	0.81	1.00	1.00	0.50	1.25	0.08	0.16	0.08	0.44	0.50	0.62
1 1/2	1.935	1.640	1.368	1.130	0.250	0.218	0.351	0.307	0.500	0.438	0.200	0.281	0.400	0.50	1.25	1.50	1.50	0.81	1.00	1.00	0.50	1.25	0.08	0.16	0.08	0.44	0.50	0.62
	1.915	1.580	1.308	1.070	0.273	0.238	0.430	0.374	0.545	0.477	0.218	0.344	0.436	0.62	1.50	1.62	2.12	1.00	1.12	1.12	0.75	1.62	0.08	0.16	0.08	0.50	0.62	0.75
2	2.426	2.097	1.717	1.533	0.273	0.238	0.430	0.374	0.545	0.477	0.218	0.344	0.436	0.62	1.50	1.62	2.12	1.00	1.12	1.12	0.75	1.62	0.08	0.16	0.08	0.50	0.62	0.75
	2.406	2.037	1.657	1.473	0.345	0.302	...	...	...	...	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	2.931	2.529	...	...	0.345	0.302	...	...	...	...	0.276	...	...	0.62	1.62	...	...	1.12	...	...	0.75	1.69	0.10	0.20	0.10	0.62	0.75	...
	2.906	2.409	...	...	0.375	0.327	...	...	...	...	0.300	...	...	0.62	2.25	...	...	1.25	...	...	0.75	1.75	0.10	0.20	0.10	0.75	0.88	...
3	3.560	3.128	...	...	0.375	0.327	...	...	...	...	0.300	...	...	0.62	2.25	...	...	1.25	...	...	0.75	1.75	0.10	0.20	0.10	0.75	0.88	...
	3.535	3.008	...	...	0.421	0.368	...	...	...	...	0.337	...	...	0.75	2.62	...	...	1.62	...	...	0.75	1.88	0.10	0.20	0.10	0.88	1.12	...
4	4.570	4.086	...	...	0.421	0.368	...	...	...	...	0.337	...	...	0.75	2.62	...	...	1.62	...	...	0.75	1.88	0.10	0.20	0.10	0.88	1.12	...
	4.545	3.966	...	...	0.421	0.368	...	...	...	...	0.337	...	...	0.75	2.62	...	...	1.62	...	...	0.75	1.88	0.10	0.20	0.10	0.88	1.12	...

GENERAL NOTE: Dimensions are in inches.

NOTES:

- (1) Upper and lower values for each size are the respective maximum and minimum dimensions.
- (2) Average of socket wall thickness around periphery shall be no less than listed values. The minimum values are permitted in localized areas.

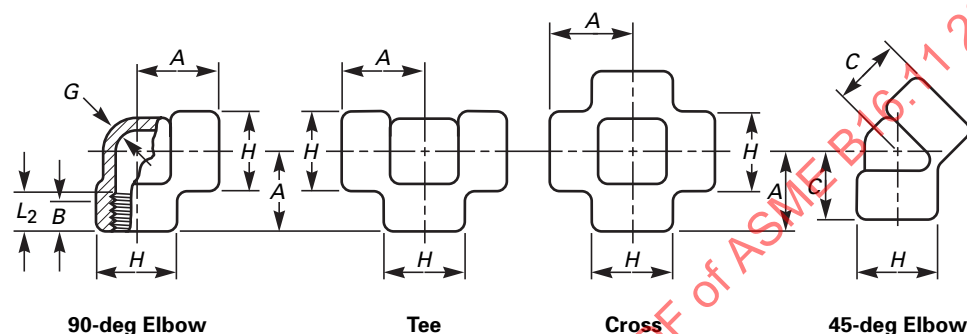


Table I-2 Forged Threaded Fittings

Nominal Pipe Size	Center-to-End Elbows, Tees, Crosses, A			Center-to-End 45-deg Elbow, C			Outside Diameter of Band, H			Min. Wall Thickness, G			Min. Length of Thread [Note (1)]	
	2000	3000	6000	2000	3000	6000	2000	3000	6000	2000	3000	6000	B	L ₂
1/8	0.81	0.81	0.97	0.69	0.69	0.75	0.88	0.88	1.00	0.125	0.125	0.250	0.25	0.2639
1/4	0.81	0.97	1.12	0.69	0.75	0.88	0.88	1.00	1.31	0.125	0.130	0.260	0.32	0.4018
3/8	0.97	1.12	1.31	0.75	0.88	1.00	1.00	1.31	1.50	0.125	0.138	0.275	0.36	0.4078
1/2	1.12	1.31	1.50	0.88	1.00	1.12	1.31	1.50	1.81	0.125	0.161	0.321	0.43	0.5337
3/4	1.31	1.50	1.75	1.00	1.12	1.31	1.50	1.81	2.19	0.125	0.170	0.336	0.50	0.5457
1	1.50	1.75	2.00	1.12	1.31	1.38	1.81	2.19	2.44	0.145	0.196	0.391	0.58	0.6828
1 1/4	1.75	2.00	2.38	1.31	1.38	1.69	2.19	2.44	2.97	0.153	0.208	0.417	0.67	0.7068
1 1/2	2.00	2.38	2.50	1.38	1.69	1.72	2.44	2.97	3.31	0.158	0.219	0.436	0.70	0.7235
2	2.38	2.50	3.25	1.69	1.72	2.06	2.97	3.31	4.00	0.168	0.281	0.476	0.75	0.7565
2 1/2	3.00	3.25	3.75	2.06	2.06	2.50	3.62	4.00	4.75	0.221	0.301	0.602	0.93	1.1380
3	3.38	3.75	4.19	2.50	2.50	3.12	4.31	4.75	5.75	0.236	0.348	0.655	1.02	1.2000
4	4.19	4.50	4.50	3.12	3.12	3.12	5.75	6.00	6.00	0.258	0.440	0.735	1.09	1.3000

GENERAL NOTE: Dimensions are in inches.

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 American National Standard for Pipe Threads (ASME B1.20.1). See para. 6.3.

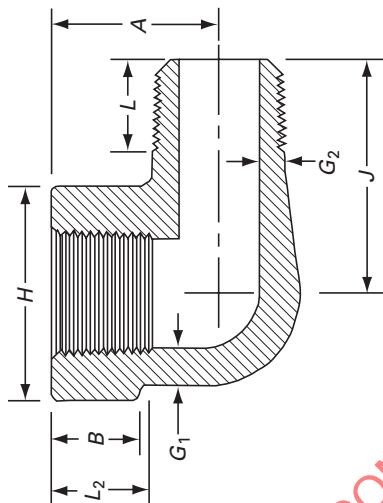


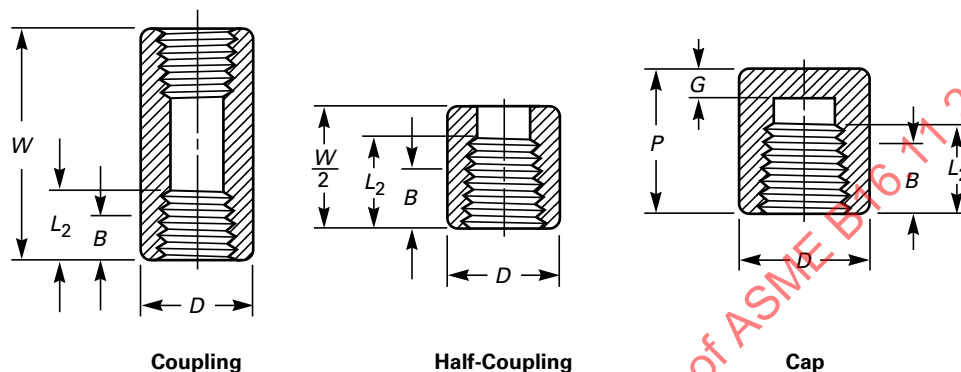
Table I-3 Forged Threaded Fittings — Street Elbows

Nominal Pipe Size, NPS	Center-to-Female End Street Ells, A		Center-to-Male End Street Ells, J		Outside Diameter of Band, H		Min. Wall Thickness, G ₁		Min. Wall Thickness, G ₂		Min. Length Internal Thread [Note (4)]		Min. Length Male Thread, L
	[Note (1)]		[Note (2)]		[Note (3)]		[Note (3)]		[Note (3)]		[Note (4)]		
	Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		Class Designation		
	3000	6000	3000	6000	3000	6000	3000	6000	3000	6000	3000	6000	
1/8	0.75	0.88	1.00	1.25	0.75	1.00	0.125	0.200	0.108	0.166	0.25	0.2639	0.38
1/4	0.88	1.00	1.25	1.50	1.00	1.25	0.130	0.223	0.127	0.208	0.32	0.4018	0.44
3/8	1.00	1.12	1.50	1.62	1.25	1.50	0.138	0.275	0.138	0.220	0.36	0.4078	0.50
1/2	1.12	1.38	1.62	1.88	1.50	1.75	0.161	0.321	0.164	0.257	0.43	0.5337	0.56
3/4	1.38	1.75	1.88	2.25	1.75	2.00	0.170	0.336	0.192	0.270	0.50	0.5457	0.62
1	1.75	2.00	2.25	2.62	2.00	2.44	0.196	0.391	0.219	0.313	0.58	0.6828	0.75
1 1/4	2.00	2.12	2.62	2.81	2.44	2.75	0.208	0.417	0.219	0.334	0.67	0.7068	0.81
1 1/2	2.12	2.50	2.81	3.31	2.75	3.31	0.219	0.436	0.246	0.350	0.70	0.7235	0.81
2	2.50	3.25	3.31	4.13	3.31	4.00	0.281	0.476	0.301	0.382	0.75	0.7565	0.88

GENERAL NOTE: Dimensions are in inches.

NOTES:

- (1) Dimension A of Table I-2 for the appropriate fitting size may also be used at the option of the manufacturer.
- (2) Dimension H of Table I-2 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 L₂ (effective length of external thread) required by American National Standard for Pipe Threads (ASME B1.20.1). See para. 6.3.

**Table I-4 Threaded Fittings**

Nominal Pipe Size	End-to-End Couplings, <i>W</i>	End-to-End Caps, <i>P</i>		Outside Diameter, <i>D</i>		Min. End Wall Thickness, <i>G</i>		Min. Length of Thread [Note (1)]	
	3000 and 6000	3000	6000	3000	6000	3000	6000	<i>B</i>	<i>L</i> ₂
1/8	1.25	0.75	...	0.62	0.88	0.19	...	0.25	0.2639
1/4	1.38	1.00	1.06	0.75	1.00	0.19	0.25	0.32	0.4018
3/8	1.50	1.00	1.06	0.88	1.25	0.19	0.25	0.36	0.4078
1/2	1.88	1.25	1.31	1.12	1.50	0.25	0.31	0.43	0.5337
3/4	2.00	1.44	1.50	1.38	1.75	0.25	0.31	0.50	0.5457
1	2.38	1.62	1.69	1.75	2.25	0.38	0.44	0.58	0.6828
1 1/4	2.62	1.75	1.81	2.25	2.50	0.38	0.44	0.67	0.7068
1 1/2	3.12	1.75	1.88	2.50	3.00	0.44	0.50	0.70	0.7235
2	3.38	1.88	2.00	3.00	3.62	0.50	0.62	0.75	0.7565
2 1/2	3.62	2.38	2.50	3.62	4.25	0.62	0.75	0.93	1.1380
3	4.25	2.56	2.69	4.25	5.00	0.75	0.88	1.02	1.2000
4	4.75	2.69	2.94	5.50	6.25	0.88	1.12	1.09	1.3000

GENERAL NOTES:

- (a) Dimensions are in inches.
- (b) Class 2000 and NPS 1/8 Class 6000 couplings, half couplings, and caps are not included in this Standard.
- (c) The wall thickness away from the threaded ends shall meet the minimum wall thickness requirements of Table I-2 for the appropriate NPS and Class Designation fitting.

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 be no less than *L*₂ (effective length of external thread) required by American National Standard for Pipe Threads (ASME B1.20.1). See para. 6.3.