

# Specification for High-Test, Wrought, Butt-Welding Fittings

**Standard Practice**  
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This MSS Standard Practice was developed under the consensus of the MSS Technical Committee 113 and the MSS Coordinating Committee. The content of this Standard Practice is the result of the efforts of competent and concerned volunteers to provide an effective, clear, and non-exclusive specification that will benefit the industry as a whole. This MSS Standard Practice is intended as a basis for common practice by the manufacturer, the user, and the general public. The existence of an MSS Standard Practice does not in itself preclude the manufacture, sale, or use of products not conforming to the Standard Practice. Mandatory conformance is established only by reference in a code, specification, sales contract, or public law, as applicable.

Unless otherwise specifically noted in this MSS SP, any standard referred to herein is identified by the date of issue that was applicable to the referenced standard(s) at the date of issue of this MSS SP. (See Annex A.)

In this Standard Practice all notes, annexes, tables, and figures are construed to be essential to the understanding of the message of the standard, and are considered part of the text unless noted as "supplemental". All appendices appearing in this document are construed as "supplemental". "Supplemental" information does not include mandatory requirements.

Substantive changes in this 2004 edition are "flagged" by parallel bars as shown on the margins of this paragraph. The specific detail of the change may be determined by comparing the material flagged with that in the previous edition.

Non-toleranced dimensions in this Standard Practice are nominal, and, unless otherwise specified, shall be considered "for reference only".

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## SPECIFICATION FOR HIGH-TEST, WROUGHT, BUTT-WELDING FITTINGS

### 1. SCOPE

1.1 This specification covers factory-made, seamless and electric fusion-welded carbon and low-alloy steel, butt-welding fittings for use in high pressure gas and oil transmission and distribution systems, including pipelines, compressor stations, metering and regulating stations, and mains.

1.2 This Standard Practice governs dimensions, tolerances, ratings, testing, materials, chemical and tensile properties, heat treatment, notch toughness properties, manufacture and marking for high-test, butt-welding fittings NPS 60 and smaller. Dimensional requirements for NPS 14 and smaller are provided by reference to ASME B16.9.

1.3 The term "welding fittings" applies to butt-welding fittings such as elbows, segments of elbows, return bends, caps, tees, single-or multiple-outlet extruded headers, reducers, and factory-welded extensions and transition sections.<sup>(1)</sup>

1.4 Fittings may be made to special dimensions, sizes, shapes, and tolerances, or of wrought materials other than those covered by this Standard Practice by agreement between the manufacturer and the purchaser. When such fittings meet all other stipulations of this Standard Practice they shall be considered as being in partial compliance therewith, providing they are appropriately marked.

1.4.1 Fittings manufactured in partial compliance, as provided in Section 1.4, shall be identified with "Part" following the respective grade designation.

### 2. PRESSURE RATING

2.1 The allowable internal-pressure ratings for pipe fittings designed in accordance with this Standard Practice shall be calculated as for straight seamless pipe (or welded pipe with a joint efficiency factor of

1.0) of equivalent grade, diameter and wall thickness in accordance with the rules established in the applicable sections of ASME B31.

2.2 All fittings produced in accordance with this Standard Practice shall be designed to withstand a field hydrostatic test pressure, after installation, at a pressure level equivalent to that required to develop a hoop stress equal to the specified-minimum yield strength for pipe of equivalent grade and wall thickness based on Barlow's Formula, without failure, leakage, or impairment of serviceability. Barlow's formula is defined as:

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

Where:

P is the internal design pressure, psig;

S is the specified minimum yield strength of the pipe, psi;

t is the nominal wall thickness of the pipe, in inches;

D is the outside diameter of the pipe, in inches.

2.3 By agreement between the manufacturer and the purchaser, fittings may be tested at a higher pressure providing the manufacturer is notified of the test pressure to be used.

2.4 The design shall take into consideration performance requirements prescribed above as well as additional factors dictated by the shape of the part.

2.5 The design of fittings may be established by mathematical analyses contained in nationally recognized pressure vessel or piping codes or, at the manufacturer's option, by proof testing in accordance with Section 4. The design of fittings that cannot be qualified by mathematical analyses shall be established by proof testing in accordance with Section 4.

<sup>(1)</sup> Lengths of extensions and transitions as agreed upon by purchaser and manufacturer.

### 3. SIZE

3.1 The nominal size of the fittings refers to the nominal O.D. of the pipe to which it is attached.

### 4. DESIGN PROOF-TEST

4.1 Proof tests shall be made as set forth herein as evidence of the adequacy of the design references in Section 2. Records of design or successful proof tests shall be available at the manufacturer's facility for inspection by the purchaser.

4.2 Unless otherwise agreed upon between manufacturer and purchaser, the only required proof test is a bursting strength test.

4.2.1 Prototype fittings that are representative of production and selected for test shall be identified as to material, grade, and lot, including heat treatment. They shall be inspected for dimensional compliance to this Standard Practice.

4.2.2 Straight seamless or welded pipe sections, with a calculated burst strength at least as great as that calculated for the fittings, shall be welded to each end of the fitting to be tested. Any internal misalignment greater than 0.06 inch shall be reduced by taper boring at a slope not over a 1 to 3 ratio. The length of pipe sections for closures shall be at least twice the pipe O.D.

4.2.2.1 Shorter lengths may be used as follows:

- 1) The assembly must withstand at least 105 per cent of the proof-test pressure computed in Section 4.2.4.
- 2) Minimum length of pipe shall be one pipe O.D. for NPS 14 and smaller.
- 3) Minimum length of pipe shall be one-half pipe O.D. for sizes larger than NPS 14.

4.2.2.2 Test fluid shall be water or other liquid used for hydrostatic testing.

4.2.3 Hydrostatic pressure shall be applied until the fitting ruptures. The actual test pressure prior to rupture must at least equal the computed proof-test pressure. Alternately, the test is successful if the assembly withstands, without rupture, 105 percent of the computed proof-test pressure defined in Section 4.2.4.

4.2.4 *Computed Proof-Test Pressure:*

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

which refers to the pipe which the fitting's marking identifies (see Section 8.1.1) and, where:

P is the computed minimum proof-test pressure; psig

S is the actual tensile strength of the test fitting material (determined on a specimen representative of the test fitting); psi

t is the nominal pipe wall thickness; in inches

D is the specified outside diameter of pipe; in inches

4.3 A successful proof test on a prototype fitting selected as required in Section 4.2.1 may be used to qualify other fittings to the extent described herein.

4.3.1 One test fitting may be used to qualify fittings of similar designs that are no smaller than one-half nor larger than two times the size of the test fitting.

4.3.2 The test of a non-reducing fitting qualifies reducing fittings that are of the same pattern.

4.3.3 The untested fitting must have a t / D ratio not less than one-half nor more than three times the t / D of the test fitting.

4.3.4 The pressure retaining capacity of a fitting made of various grades of steel will be essentially directly proportional to the tensile properties of the various grades. Hence, it is necessary to test a prototype in only a single grade to prove the geometric design of the fitting.



4.3.5 A test on a prototype elbow qualifies elbows having longer radii than the test fitting providing they qualify under Sections 4.3.1 and 4.3.3.

## 5. HYDROSTATIC TESTING

5.1 Welding fittings shall be capable of withstanding a hydrostatic test-pressure as specified in Section 2.2, but hydrostatic testing by the manufacturer is not required.

## 6. MATERIALS

6.1 The steel shall be fully killed and made using recognized melting practices to provide intended heat-treat response and notch-toughness properties. Steel shall be made by open hearth, basic oxygen, or electric furnace process and shall be suitable for field welding to other fittings, flanges, and pipe manufactured under the following specifications: ASTM A 53, A 106, A 381, A 234, A 420, A 105, A 694, or the corresponding ASME standard, or API 5L, and MSS SP-44.

6.2 The material for fittings shall consist of blooms, billets, slabs, forging quality bar, plate, seamless or fusion-welded tubular products with filler metal added.

6.3 The steel used shall be suitable welding-quality carbon steels or of a suitable welding-quality high-strength, low-alloy steel.

6.4 If preheating of the material is required to insure proper weldability under normal field conditions, the manufacturer shall state specific preheat requirements and permanently indicate this on the fitting.

## 7. CHEMICAL COMPOSITION

7.1 The determination of the chemical composition of the steel used in meeting the requirements of Table 1 shall be the responsibility of the manufacturer.

7.2 The choice and use of alloying elements for fittings made from high-strength, low-alloy steels to give the tensile properties prescribed in Table 2 shall be made by the manufacturer and included and reported to identify the type of steel.

7.3 Carbon equivalent shall be computed by the following equation:

$$C.E. = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

and shall not exceed 0.45%.

## 8. TENSILE PROPERTIES

8.1 Tensile properties shall meet the requirements as specified in Table 2.

8.1.1 A fitting may have thickness or yield strength or both unequal to the pipe with which it is intended to be used, provided the welding-end preparation at the joint assures wall thickness of the fitting is at least equal to the specified pipe-wall thickness times the ratio of the specified minimum yield strength of the pipe and the minimum-tested yield strength of the fitting (see Figures 3(a), (b), and (c) for joint preparation).

8.2 Tensile properties shall be determined in accordance with ASTM A 370.

8.3 Test specimens shall be taken from the fitting after final heat treatment or from a piece of pipe or plate of the same nominal thickness, same heat of steel from which the fitting is made, and which has been heat treated in a lot with any of the fitting(s) it represents (see Section 8.5).

8.4 Test specimens shall be in accordance with ASTM A 370 using full-size specimens or largest sub-size specimens allowable. Yield strength shall be determined either by the 0.2% offset or the 0.5% extension under load (EUL) method.

8.5 One tension test to determine yield strength, tensile strength, and percent elongation in 2 in. shall be made from each lot of fittings. A lot shall consist of all fittings from the same heat of material of the same starting wall thickness, given the same heat treatment in a furnace controlled within a range of 50°F. The adequacy of the furnace to achieve and maintain temperature uniformity shall be established by annual survey. Alternatively, thermocouples may be attached to a fitting in the lot or to a thermally equivalent mass of material in contact with a fitting in the lot. Thermocouples and other temperature measuring recording devices shall be calibrated quarterly.

8.6 When requested, fittings containing welds shall have one across the weld tension test made with the axis transverse to the weld seam for each heat of filler metal, or each heat of filler metal and batch of flux for submerged arc welds, and for a given heat treatment. Only the ultimate tensile strength need meet the minimum requirements of Table 2 (see Appendix X1c).

8.7 If the tension-test specimen from any lot fails to conform to the requirements for the particular grade ordered, the manufacturer may elect to make retests on two additional pieces from the same lot, each of which shall conform to the requirements specified in Table 2. If one or both of the retests fail to conform to the requirements, the manufacturer may elect to test each of the remaining pieces in the lot. Retests are required only for the particular test with which the specimen did not comply originally.

8.8 It shall be permissible to cold flatten test specimens.

## 9. HEAT TREATMENT

9.1 All fittings shall be furnished in the heat treated condition. Hot formed fittings shall be cooled below the lower critical temperature prior to heat treatment. Fittings shall be heat treated by one or more of the following procedures:

9.1.1 **Stress Relieving** Stress relieving shall be limited only to guide-bar welds or fabrication welds such as pup extensions, etc., *unless otherwise agreed upon between the manufacturer and the purchaser*. Fittings shall be heated to a suitable temperature below the transformation range, but not less than 1000°F, holding at temperature for not less than one hour per inch of maximum thickness, but never less than one-half hour and cooling in the furnace or in air.

9.1.2 **Normalizing** Fittings shall be uniformly reheated above the transformation range (austenite range), held at this temperature a sufficient time to achieve uniform temperature throughout the mass and cooled in air.

9.1.3 **Normalizing & Tempering** Fittings shall be normalized in accordance with Section 9.1.2. They shall then be tempered by reheating to a temperature below the transformation range, but not less than 1000°F, held at temperature for a minimum of one hour per inch of maximum thickness, but not less than one-half hour and cooled in the furnace or in air.

9.1.4 **Quenching & Tempering** Fittings shall be uniformly reheated above the transformation range, held at temperature sufficient to achieve uniform temperature throughout the mass and immediately immersion quenched in a suitable liquid medium. They shall then be reheated and tempered per Section 9.1.3. Quenching facilities shall be of sufficient size and equipped to assure proper and uniform cooling.

## 10. TRANSVERSE GUIDED-WELD BEND-TESTS

10.1 Transverse guided-weld bend-tests shall be performed only when specified on the order (see Appendix X1b).

10.2 Transverse-weld test specimens shall be subjected to face and root-guided bend-tests. The specimens shall be approximately 1.5 in. wide, at least 6

in. long with the weld at the center and shall be machined in accordance with Figure 4. The face-bend specimen shall be bent with the inside surface of the pipe against the plunger and the root-bend specimen with the outside surface against the plunger. The dimensions of the plunger for the bending jig shall be in accordance with Figure 5 and the other dimensions shall be substantially as shown in Figure 5.

10.3 The bend-test shall be acceptable if no cracks or other defects exceeding 0.12 in. in any direction are present in the weld metal or between the weld metal and the fitting metal after the bending. Cracks that originate along the edges of the specimen during testing and that are less than 0.25 in. measured in any direction, shall not be considered unless obvious defects are observed.

10.4 Two weld-bend test specimens, as described in Section 10.2, shall be cut from a specimen from each lot. The specimens may be taken from a fitting or from sample plates as described in Section 8.3.

10.5 If either test fails to conform to specified requirements, the manufacturer may elect to make retests on two additional specimens from the same lot, each of which shall conform to the requirements specified in Section 10.3. If any of these specimens fail to conform to the requirements, the manufacturer may elect to test prolongations from each of the remaining fittings in the lot.

10.6 If the test results of any tests of a lot do not conform to the requirements specified above, retests shall be made on additional fittings of double the original number from the same lot, each of which shall conform to the requirements specified.

## 11. NOTCH-TOUGHNESS PROPERTIES

11.1 Notch-toughness properties shall be determined with full size Charpy Type A-V notch specimens in accordance with ASTM A 370. Subsize specimens shall be used only when material to be tested is of insufficient thickness. All specimens shall be taken with the axis of the specimen transverse to the direction of flow (of medium) and with the notch per-

pendicular to the surface. For plate, specimens may be taken transverse to the direction of rolling.

11.2 Specimens shall be taken from representative heats of steel used in manufacture of fittings or from representative fittings, plates or pipe receiving the same heat treatment to determine the typical notch-toughness properties of a given material.

11.3 From each heat of steel, one set (three specimens) shall be tested at 20°F or lower and show 20 ft. lbs. minimum average. Percent shear shall be reported for informational purposes only.

11.4 Notch-toughness testing of NPS 14 and smaller is not required unless grades WPHY 65 or higher are supplied or the purchaser specifies testing.

## 12. FITTING DIMENSIONS

12.1 One of the principles of this Standard Practice is the maintenance of a fixed position for the welding ends with reference to the center line of the fittings or the overall dimensions, as the case may be. Dimensional standards for fittings NPS 16 and larger are shown in Tables 3 through 9. Dimensional standards and tolerances for NPS 14 and smaller sizes are contained in ASME B16.9.

## 13. TOLERANCES FOR WELDING FITTINGS

13.1 *Tolerances* The tolerances for fittings NPS 16 and larger are shown in Table 3 and are applicable to the nominal dimensions given in Tables 4 through 9 inclusive.

13.2 *Wall Thickness* The minimum wall thickness may be 0.01 in. under the nominal thickness, except that isolated non-continuous reductions are permitted, provided the remaining wall thickness is not diminished to less than 93.5% of the specified nominal. This tolerance does not apply to areas where the proof test has indicated the need for reinforcement.

13.3 *Welding Ends* Unless otherwise specified, the details of the welding end preparation shall be in accordance with Figures 1 and 2. The root face

of the fitting shall be machined flat and shall not vary from the plane by more than 0.03 in. at any point. Where the wall of the fitting exceeds that of matching pipe, the transition shall be in accordance with the details given in Figure 3.

**13.4 Angularity and Off Plane** The ends of fittings shall be cut in accordance with the tolerances listed in Table 3.

## 14. MANUFACTURE

14.1 Fittings may be made by forging, hammering, pressing, piercing, rolling, extruding, upsetting, welding, or by a combination of these operations. The forming procedure shall be so applied that it will not produce injurious defects in the fittings.

14.1.1 Fabricated tees, elbows, and other fittings employing circumferential or intersection welds, e.g., miter welds, are considered pipe fabrications, and are not within the scope of this Standard Practice.

14.2 When extensions or transitions are factory welded to the fittings by the manufacturer, they shall be post-weld heat treated in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or heat treated in accordance with Section 9 of this Standard Practice.

14.3 All outlets NPS 2 and larger shall be of integral contour type and ends of outlets shall match the joining pipe or fitting specified.

### 14.4 Welding Fabrication

14.4.1 Seam-welded pipe that is made in accordance with an ASTM or API specification shall comply with the welding requirements of the applicable material specification. All other welds, including those used in the manufacture of other pipe or cylinders, shall be made by welders, welding operators, and welding procedures qualified in accordance with the provisions of Section IX of the ASME Boiler and Pressure Vessel Code.

14.4.2 The joints shall be furnished in accordance with the requirements of Paragraph UW-35 (a) of Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

14.4.3 Machine welding shall be done by an electric process, preferably by submerged arc.

14.4.4 All butt welds shall have full penetration. Submerged-arc machine welding shall be done with at least one pass from the inside, except when accessibility makes this impossible, then, a manual or machine root-bead may be employed provided that a visual inspection of the root bead is possible. Backing rings shall not be used.

14.4.5 Repair, chipping, or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the original metal thickness by more than 6-1/2% of nominal specified wall.

14.4.6 Fillet welds shall have a full throat and, unless otherwise specified, the legs shall be of approximately equal length.

14.4.7 Welded-on braces, if used, should be removed before heat treatment and the weld spot shall be repaired and ground flush and smooth. However, when braces are required for heat treatment, they shall be cut out and the surface shall be ground flush and smooth after heat treatment. No welding shall be permitted after heat treatment.

14.4.8 Weld metal used in the construction of fittings shall be suitable to meet the tensile-strength and notch-toughness requirements of Sections 8 and 11 when heat treated in accordance with Section 9.

### 14.5 Workmanship and Finish

14.5.1 Fittings shall be free of injurious defects and shall have workmanlike finish.

14.5.2 Injurious defects are defined as those having a depth in excess of 6-1/2% of specified nominal wall.

14.5.3 *Machining and grinding of surface defects* shall be treated as follows: Sharp defects such as notches, scratches, scabs, seams, laps, tears, or slivers not deeper than 6-1/2% of nominal wall thickness shall be removed by grinding. Repair of injurious defects by welding shall be permitted, except that welding of injurious defects shall not be permitted when the depth of defect exceeds 33-1/3% of the nominal wall thickness, or the length of repair exceeds 25% of the specified diameter. Defects must be completely removed and welding performed by a welder qualified specifically for repair welding, as per Section 14.4.1. Such repair welding shall be ground flush with the surface and all welding shall be done before final heat treatment. Repair welding shall be done with low hydrogen electrodes, gas-metal-arc process, or submerged-arc process.

## 15. NONDESTRUCTIVE EXAMINATION

15.1 *Radiographic Examination* All butt welds shall be radiographically examined in accordance with Article 2 of ASME Section V using fine grain film and lead screens. Longitudinal weld seams shall meet the acceptance standards in ASME Section VIII, Division 1. Girth welds shall meet the acceptance standards in Section 9 of API 1104.

15.2 *Magnetic Particle or Ultrasonic Examination* Magnetic particle or ultrasonic examination shall be used for the examination of all fillet welds and all other welds where it is impossible or impractical to use radiographic examination. Methods and acceptance standards shall be by agreement between the manufacturer and purchaser.

15.3 *Magnetic Particle or Liquid Penetrant Examination* All butt-weld tees manufactured by cold-forming method(s) shall be subjected to magnetic particle or liquid penetrant examination. This examination shall be performed after final heat treatment.

Only the side wall area of the tees need be examined. This area is defined by a circle that covers the area from the weld bevel of the branch outlet to the center line of the body or run. Internal and external surfaces shall be examined, when size permits accessibility. No cracks shall be permitted. Other imperfections shall be treated in accordance with Section 14.5. Acceptable tees shall be marked with the symbol PT or MT, as applicable, to indicate compliance. Nondestructive examination personnel and procedures shall be qualified in accordance with ASME Section V.

## 16. INSPECTION

16.1 *Inspector* At all times while work on the contract of the purchaser is being performed, the inspector representing the purchaser shall have free entry to all parts of the manufacturer's facilities that involve the manufacture of the ordered fittings. All reasonable facilities shall be afforded the inspector to satisfy the inspector that the product is being furnished in accordance with these specifications. All tests and inspections called for by these specifications will be made in the manufacturer's plant prior to shipment and at the manufacturer's expense unless otherwise specified and shall be so conducted as not to interfere unnecessarily with the operations of the manufacturer's plant. The manufacturer shall notify the purchaser prior to completion or shipment of all fittings requiring such inspection.

16.2 *Certified Material Test Report (CMTR)* When specified on the purchase order, a Certified Material Test Report shall be furnished listing the actual results of chemical analysis, Section 7; mechanical properties, Section 8; notch-toughness properties, Section 11; heat treatment, Section 9; nondestructive examination, Section 15; and any special tests required by the purchase order.

16.3 *Rejection* Each fitting in which injurious defects are found during shop or field fabrication may be rejected, and the manufacturer shall be notified.

## 17. MARKING

17.1 All fittings furnished under this Standard Practice shall be clearly defined on the outside diameter with the following information marked with low-stress die stamps or interrupted-dot stamps except as noted:

- a) Manufacturer's name or trademark.
- b) Nominal wall thickness of fittings at bevel ends.
- c) Respective grade, yield and symbol as given in Table 2.

NOTE 1. In the case of unequal yield strength, as in Section 8.1.1, both grades of material shall be identified, for example: Y60/X75.

NOTE 2. Y represents marking for fittings: X represents marking for pipe.

- d) Heat code identity.
- e) Size. <sup>(1)</sup>

17.2 In addition to the above, extruded headers shall also include the following information:

- a) Design pressure.
- b) Temperature.
- c) Per ASME B31.8.

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### Supplementary Information

- <sup>(1)</sup> At the option of the manufacturer, size may be paint stenciled with 1 inch high letters in lieu of die stamping.

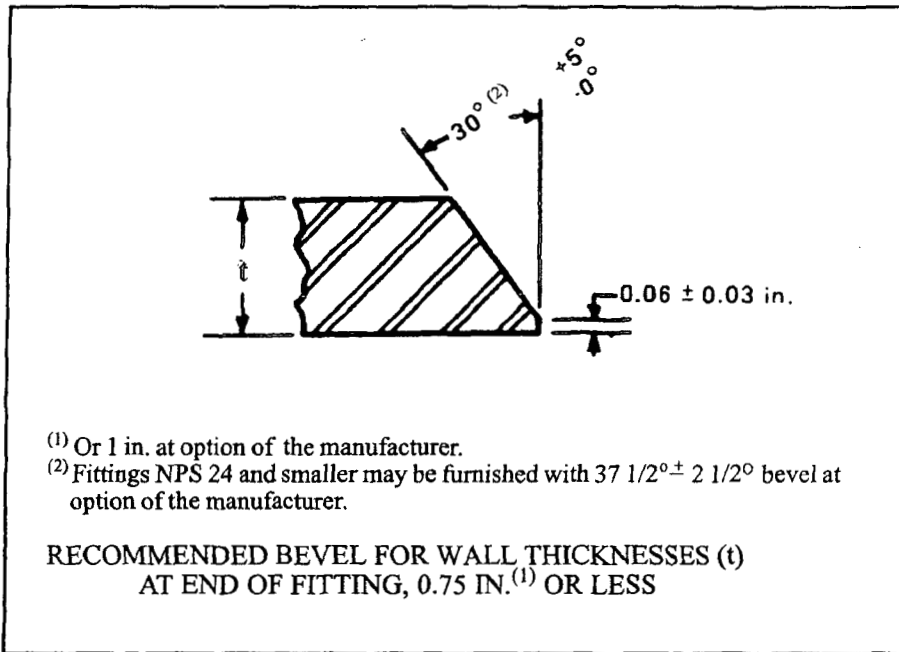


Figure 1

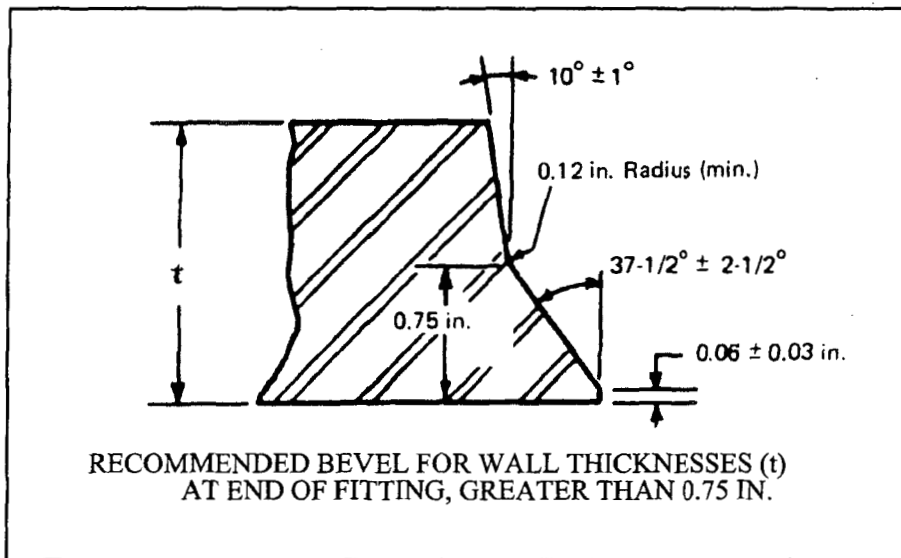


Figure 2

When the minimum-specified yield strengths of the sections to be joined are unequal, the deposited weld metal shall have mechanical properties at least equal to those of the section having the higher strength, and  $t_f$  shall at least equal  $t$  times the ratio of minimum-specified yield strength of pipe and fitting.

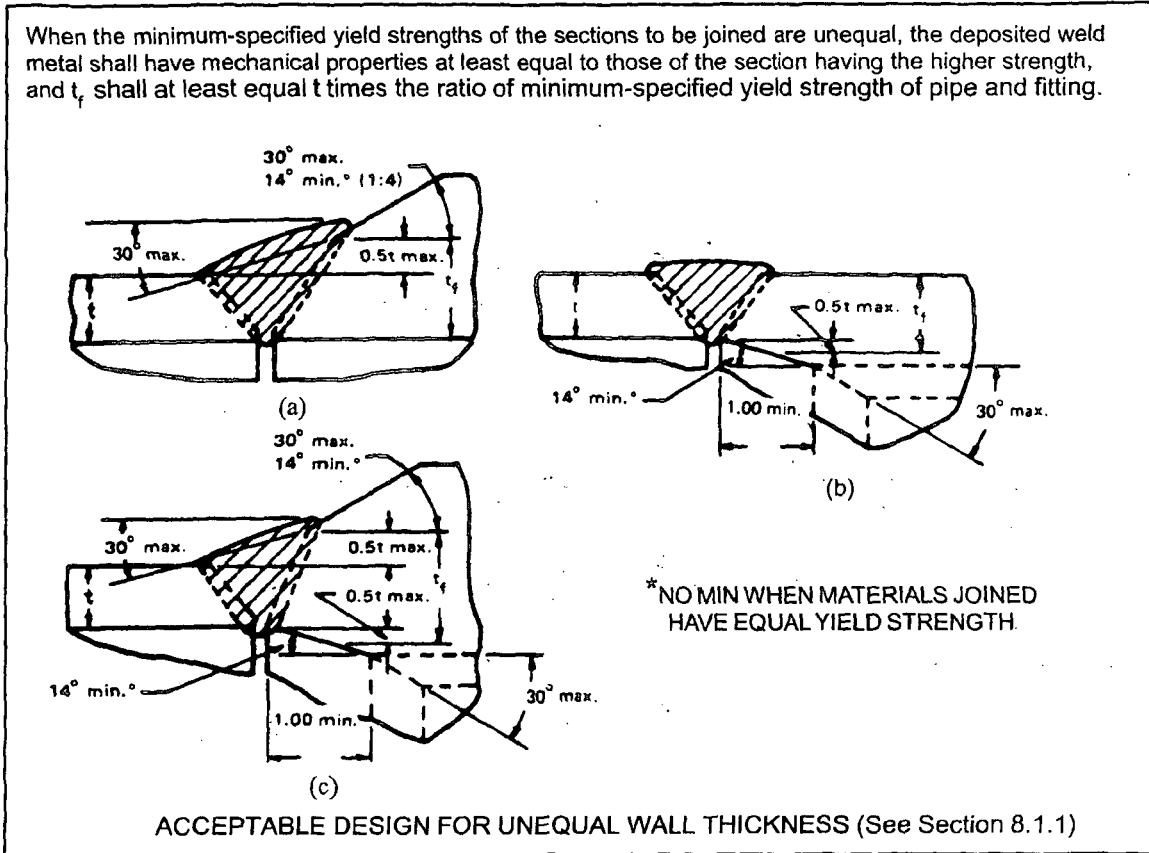


Figure 3

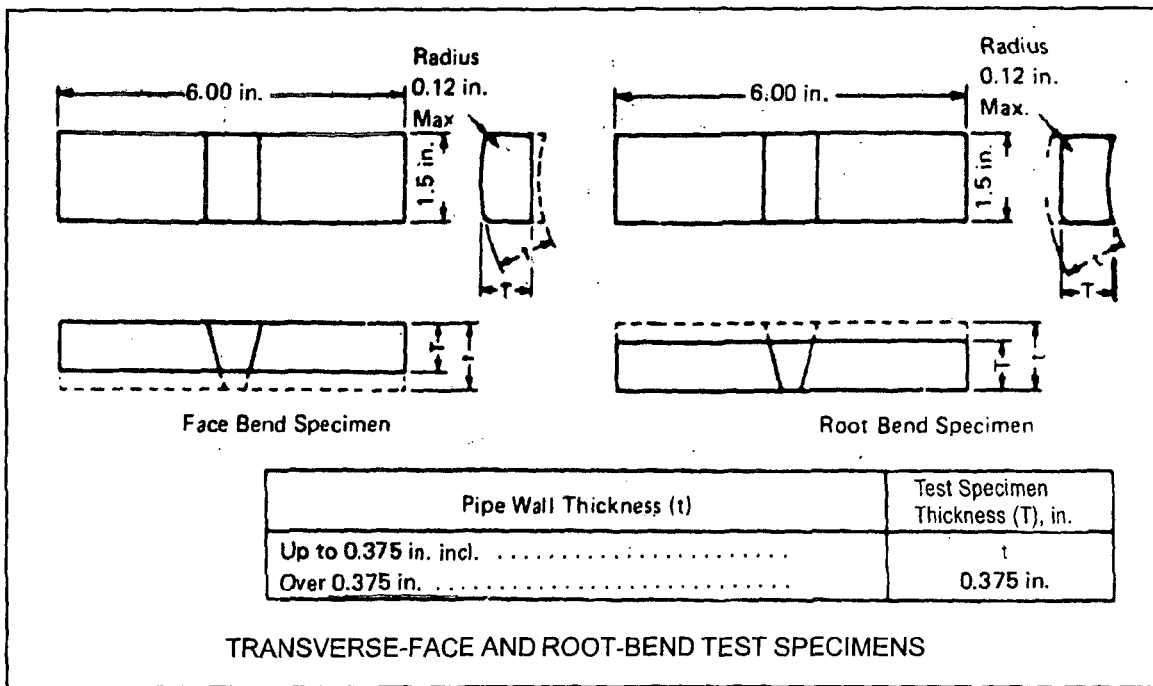
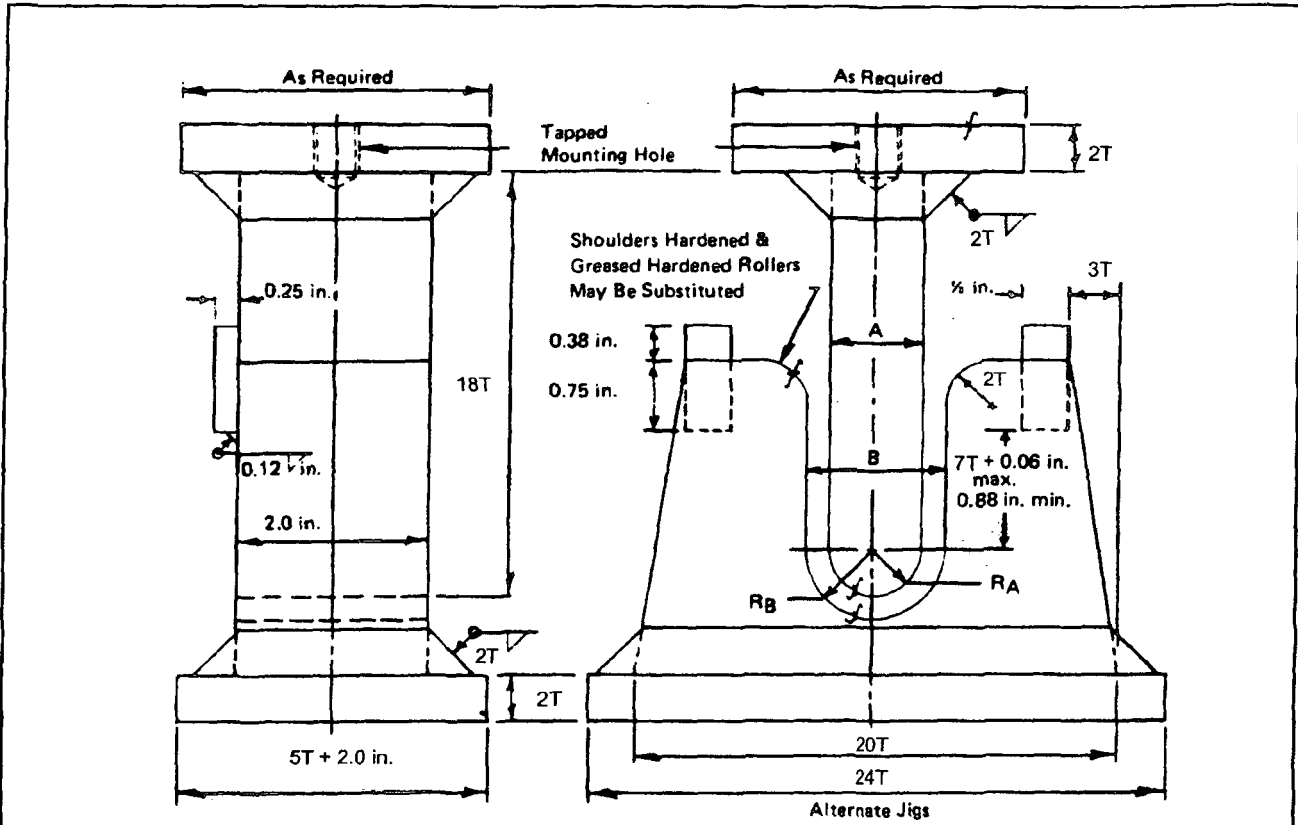


Figure 4





Guided-Bend Test Jig Dimensions

1	2	3	4	5
Class of Steel				
	Y-42	Y-46	Y-52 & Y-56	Y-60, Y-65, & Y-70
Radius of male member, $R_A$ . . . . .	3T	3-1/2T	4T	4-1/2 T
Radius of female member, $R_B$ . . . . .	4T + .06 in.	4-1/2T + .06 in.	5T + .06 in.	5 1/2T + .06 in.
Width of male member, A . . . . .	6T	7T	8T	9T
Width of groove in female member, B	8T + 0.12 in.	9T + 0.12 in.	10T + 0.12 in.	11T + 0.12 in.
T = specimen wall thickness				

GUIDED-BEND TEST JIG

Figure 5

**TABLE 1 Maximum Limit of Chemical Elements**

	(% Max.)
Carbon (C)	0.30
Manganese (Mn)	1.60
Phosphorus (P)	0.035
Sulphur (S)	0.035
Copper (Cu) {NOTE 1}	0.50
Nickel (Ni) {NOTE 1}	0.50
Silicon (Si)	0.50
Chromium (Cr) {NOTE 1}	0.25
Molybdenum (Mo) {NOTE 1}	0.13
Vanadium (V)	0.13
Columbium (Cb)	0.10
Titanium (Ti)	0.05

General Note: Alternate alloy elements may be used but they shall be discussed with the purchaser prior to delivery of the material. This table is not intended to represent the composition of any heat of steel, but merely to record the maximum permissible amounts of an element. The combination of elements of any heat must conform to carbon equivalent, Section 7.3.

Note 1: The sum of copper, nickel, chromium and molybdenum shall not exceed 1%.

**TABLE 2 Tensile Requirements**

Class Symbol	Yield Strength Min. psi	Tensile Strength, Min. psi	Minimum Elongation In 2 in., %
		All Thicknesses	
WPHY-42	42 000	60 000	25
WPHY-46	46 000	63 000	25
WPHY-52	52 000	66 000	25
WPHY-56	56 000	71 000	20
WPHY-60	60 000	75 000	20
WPHY-65	65 000	77 000	20
WPHY-70	70 000	82 000	18

TABLE 3 Tolerances

NPS	Inside <sup>(1)</sup> Diameter At End	Minimum <sup>(3)</sup> Wall Thickness	Out-of-Roundness <sup>(2)</sup>		Throughput <sup>(4)</sup> Body of Elbows	90°, 60°, 45°, & 30° Elbows & Tees Center-to-End Dimension A, B, C, M		Caps Overall Length E	Angularity Off Angle Q	Elbows Off Plane P	Eccentric and Concentric Reducers Off Plane P <sup>(6)</sup>
			At Ends of Fittings	Other		1- 1/2 R & Tee	3R				
16-24	± 0.09	Nominal	0.19	0.12	2.5%	± 0.09	± 0.12	± 0.25	0.09	0.25	2.5%
26-36	± 0.09	Nominal	(5)	0.12	2.5%	± 0.12	± 0.25	± 0.38	0.09	0.50	2.5%
38-48	± 0.12	-0.01	(5)	0.12	2.5%	± 0.19	± 0.38	± 0.38	0.12	0.75	2.5%
50-60	± 0.25		(5)	0.19	2.5%	± 0.25	± 0.38	± 0.38	0.19	0.75	2.5%

Note:

<sup>1</sup>The inside diameter at end shall be determined by circumferential measurement, and the tolerance refers to variations from nominal I.D. calculation by (OD nom -  $K_{nom}$ ).

<sup>2</sup>Out-of-roundness tolerances shall be the difference between the maximum and minimum diameters measured on any radial cross-section.

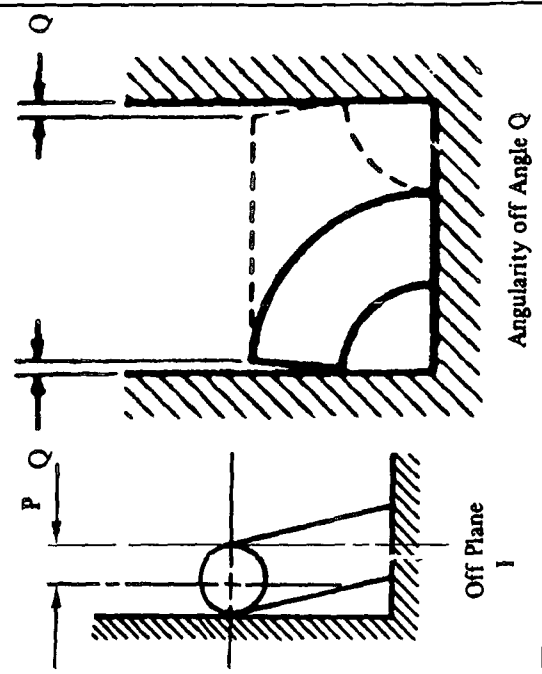
<sup>3</sup>Minus 0.01 in. except that isolated non-continuous reductions are permitted in accordance with Section 13.2. Excess thickness whether on inside or outside is to be treated in accordance with sketches given in Figure 3.

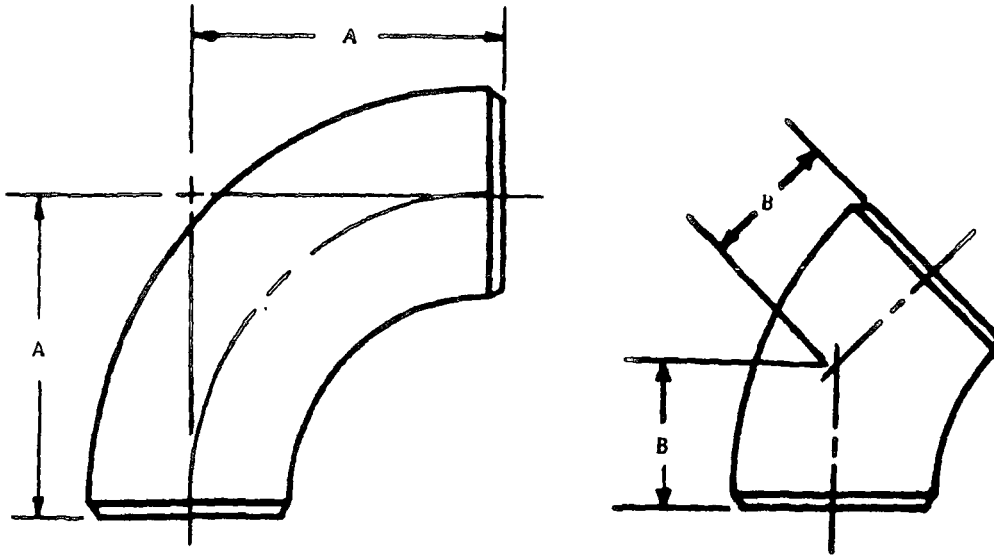
<sup>4</sup>When elbows are intended for field segmenting, out-of-roundness tolerance may be furnished to 1% by agreement between the Manufacturer and the Purchaser. It is recognized that extra thickness, if any, may be on the I.D.

<sup>5</sup>Out-of-roundness tolerances at ends shall be 1% of diameter for NPS 26 and larger.

<sup>6</sup>Percent of O.D.

Note: Outside diameter may be tapered at angle up to 30° beyond weld bevel.





**TABLE 4 Dimensions of Long-Radius Elbows**

NPS	Outside Diameter at Bevel	Dimensions in Inches	
		Center-to-End	
		90° Elbows A	45° Elbows B
16	16.00	24.00	10.00
18	18.00	27.00	11.25
20	20.00	30.00	12.50
22	22.00	33.00	13.50
24	24.00	36.00	15.00
26	26.00	39.00	16.00
28	28.00	42.00	17.25
30	30.00	45.00	18.50
32	32.00	48.00	19.75
34	34.00	51.00	21.00
36	36.00	54.00	22.25
38	38.00	57.00	23.62
40	40.00	60.00	24.88
42	42.00	63.00	26.00
44	44.00	66.00	27.38
46	46.00	69.00	28.62
48	48.00	72.00	29.88
50	50.00	75.00	31.00
52	52.00	78.00	32.25
54	54.00	81.00	33.50
56	56.00	84.00	34.75
58	58.00	87.00	36.00
60	60.00	90.00	37.25

TABLE 5. Dimensions of 3R Elbows

NPS	Outside Diameter at Bevel	Dimensions in Inches			
		Center-to-End			
		90° Elbows	60° Elbows	45° Elbows	30° Elbows
16	16.00	48.00	27.69	19.88	12.88
18	18.00	54.00	31.18	22.38	14.44
20	20.00	60.00	34.62	24.88	16.06
22	22.00	66.00	38.12	27.31	17.69
24	24.00	72.00	41.62	29.81	19.31
26	26.00	78.00	45.00	32.31	20.88
28	28.00	84.00	48.50	34.75	22.50
30	30.00	90.00	52.00	37.25	24.06
32	32.00	96.00	55.44	39.75	25.75
34	34.00	102.00	58.94	42.25	27.38
36	36.00	108.00	62.44	44.69	28.94
38	38.00	114.00	65.88	47.25	30.56
40	40.00	120.00	69.25	49.75	32.19
42	42.00	126.00	72.75	52.19	33.75
44	44.00	132.00	76.25	54.69	35.38
46	46.00	138.00	79.69	57.19	37.00
48	48.00	144.00	83.19	59.69	38.62
50	50.00	150.00	86.62	62.12	40.19
52	52.00	156.00	90.06	64.62	41.81
54	54.00	162.00	93.50	67.12	43.44
56	56.00	168.00	97.00	69.56	45.00
58	58.00	174.00	100.44	72.06	46.62
60	60.00	180.00	103.94	74.56	48.25

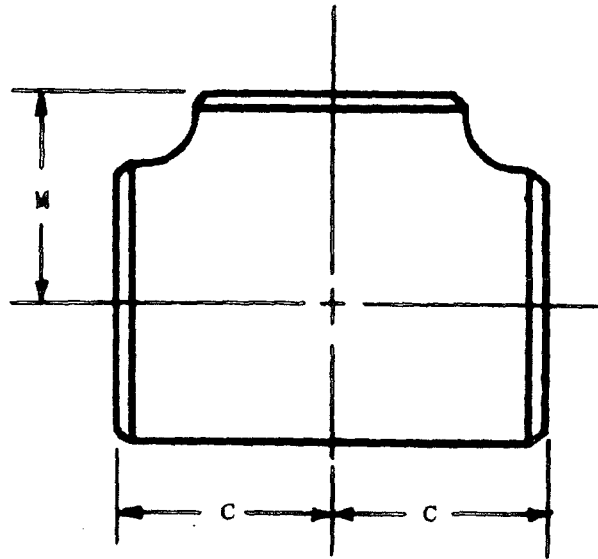


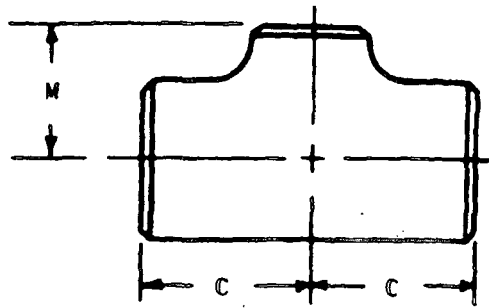
TABLE 6 Dimensions of Straight Tees

Dimensions in Inches

NPS	Outside Diameter at Bevel	Center-to-End	
		Run-C	Outlet-M <sup>(1)</sup>
16	16.00	12.00	12.00
18	18.00	13.50	13.50
20	20.00	15.00	15.00
22	22.00	16.50	16.50
24	24.00	17.00	17.00
26	26.00	19.50	19.50
28	28.00	20.50	20.50
30	30.00	22.00	22.00
32	32.00	23.50	23.50
34	34.00	25.00	25.00
36	36.00	26.50	26.50
38	38.00	28.00	28.00
40	40.00	29.50	29.50
42	42.00	30.00	28.00
44	44.00	32.00	30.00
46	46.00	33.50	31.50
48	48.00	35.00	33.00
50	50.00	36.75	34.50
52	52.00	38.50	35.00
54	54.00	40.00	37.00
56	56.00	41.50	38.50
58	58.00	43.00	40.00
60	60.00	44.00	41.00

NOTE:

<sup>(1)</sup> Outlet dimension M is recommended but not mandatory (consult fitting manufacturer).



**TABLE 7 Dimensions of Reducing Outlet Tees**

Dimensions in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet M <sup>(1)</sup>
16 x 16 x 14	16.00	14.00	12.00	12.00
16 x 16 x 12	16.00	12.75	12.00	11.62
16 x 16 x 10	16.00	10.75	12.00	11.12
16 x 16 x 8	16.00	8.62	12.00	10.75
16 x 16 x 6	16.00	6.62	12.00	10.38
18 x 18 x 16	18.00	16.00	13.50	13.00
18 x 18 x 14	18.00	14.00	13.50	13.00
18 x 18 x 12	18.00	12.75	13.50	12.62
18 x 18 x 10	18.00	10.75	13.50	12.12
18 x 18 x 8	18.00	8.62	13.50	11.75
20 x 20 x 18	20.00	18.00	15.00	14.50
20 x 20 x 16	20.00	16.00	15.00	14.00
20 x 20 x 14	20.00	14.00	15.00	14.00
20 x 20 x 12	20.00	12.75	15.00	13.62
20 x 20 x 10	20.00	10.75	15.00	13.12
20 x 20 x 8	20.00	8.62	15.00	12.75
22 x 22 x 20	22.00	20.00	16.50	16.00
22 x 22 x 18	22.00	18.00	16.50	15.50
22 x 22 x 16	22.00	16.00	16.50	15.00
22 x 22 x 14	22.00	14.00	16.50	15.00
22 x 22 x 12	22.00	12.75	16.50	14.62
22 x 22 x 10	22.00	10.75	16.50	14.12
24 x 24 x 22	24.00	22.00	17.00	17.00
24 x 24 x 20	24.00	20.00	17.00	17.00
24 x 24 x 18	24.00	18.00	17.00	16.50
24 x 24 x 16	24.00	16.00	17.00	16.00
24 x 24 x 14	24.00	14.00	17.00	16.00
24 x 24 x 12	24.00	12.75	17.00	15.62
24 x 24 x 10	24.00	10.75	17.00	15.12

NOTE:  
<sup>(1)</sup> Outlet dimension M is recommended but not mandatory (consult fitting manufacturer).

Dimensions in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet M <sup>(1)</sup>
26 x 26 x 24	26.00	24.00	19.50	19.00
26 x 26 x 22	26.00	22.00	19.50	18.50
26 x 26 x 20	26.00	20.00	19.50	18.00
26 x 26 x 18	26.00	18.00	19.50	17.50
26 x 26 x 16	26.00	16.00	19.50	17.00
26 x 26 x 14	26.00	14.00	19.50	17.00
26 x 26 x 12	26.00	12.75	19.50	16.62
28 x 28 x 26	28.00	26.00	20.50	20.50
28 x 28 x 24	28.00	24.00	20.50	20.00
28 x 28 x 22	28.00	22.00	20.50	19.50
28 x 28 x 20	28.00	20.00	20.50	19.00
28 x 28 x 18	28.00	18.00	20.50	18.50
28 x 28 x 16	28.00	16.00	20.50	18.00
28 x 28 x 14	28.00	14.00	20.50	18.00
28 x 28 x 12	28.00	12.75	20.50	17.62
30 x 30 x 28	30.00	28.00	22.00	21.50
30 x 30 x 26	30.00	26.00	22.00	21.50
30 x 30 x 24	30.00	24.00	22.00	21.00
30 x 30 x 22	30.00	22.00	22.00	20.50
30 x 30 x 20	30.00	20.00	22.00	20.00
30 x 30 x 18	30.00	18.00	22.00	19.50
30 x 30 x 16	30.00	16.00	22.00	19.00
30 x 30 x 14	30.00	14.00	22.00	19.00
30 x 30 x 12	30.00	12.75	22.00	18.62
30 x 30 x 10	30.00	10.75	22.00	18.12
32 x 32 x 30	32.00	30.00	23.50	23.00
32 x 32 x 28	32.00	28.00	23.50	22.50
32 x 32 x 26	32.00	26.00	23.50	22.50
32 x 32 x 24	32.00	24.00	23.50	22.00
32 x 32 x 22	32.00	22.00	23.50	21.50
32 x 32 x 20	32.00	20.00	23.50	21.00
32 x 32 x 18	32.00	18.00	23.50	20.50
32 x 32 x 16	32.00	16.00	23.50	20.00
32 x 32 x 14	32.00	14.00	23.50	20.00

NOTE:  
<sup>(1)</sup> Outlet dimension M is recommended but not mandatory (consult fitting manufacturer).

**TABLE 7 Dimensions of Reducing Outlet Tees (continued)**

NPS	Dimensions in inches			
	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet M <sup>(1)</sup>
34 x 34 x 32	34.00	32.00	25.00	24.50
34 x 34 x 30	34.00	30.00	25.00	24.00
34 x 34 x 28	34.00	28.00	25.00	23.50
34 x 34 x 26	34.00	26.00	25.00	23.50
34 x 34 x 24	34.00	24.00	25.00	23.00
34 x 34 x 22	34.00	22.00	25.00	22.50
34 x 34 x 20	34.00	20.00	25.00	22.00
34 x 34 x 18	34.00	18.00	25.00	21.50
34 x 34 x 16	34.00	16.00	25.00	21.00
36 x 36 x 34	36.00	34.00	26.50	26.00
36 x 36 x 32	36.00	32.00	26.50	25.50
36 x 36 x 30	36.00	30.00	26.50	25.00
36 x 36 x 28	36.00	28.00	26.50	24.50
36 x 36 x 26	36.00	26.00	26.50	24.50
36 x 36 x 24	36.00	24.00	26.50	24.00
36 x 36 x 22	36.00	22.00	26.50	23.50
36 x 36 x 20	36.00	20.00	26.50	23.00
36 x 36 x 18	36.00	18.00	26.50	22.50
36 x 36 x 16	36.00	16.00	26.50	22.00
38 x 38 x 36	38.00	36.00	28.00	28.00
38 x 38 x 34	38.00	34.00	28.00	27.50
38 x 38 x 32	38.00	32.00	28.00	27.00
38 x 38 x 30	38.00	30.00	28.00	26.50
38 x 38 x 28	38.00	28.00	28.00	25.50
38 x 38 x 26	38.00	26.00	28.00	25.50
38 x 38 x 24	38.00	24.00	28.00	25.00
38 x 38 x 22	38.00	22.00	28.00	24.50
38 x 38 x 20	38.00	20.00	28.00	24.00
38 x 38 x 18	38.00	18.00	28.00	23.50
40 x 40 x 38	40.00	38.00	29.50	29.50
40 x 40 x 36	40.00	36.00	29.50	29.00
40 x 40 x 34	40.00	34.00	29.50	28.50
40 x 40 x 32	40.00	32.00	29.50	28.00
40 x 40 x 30	40.00	30.00	29.50	27.50
40 x 40 x 28	40.00	28.00	29.50	26.50
40 x 40 x 26	40.00	26.00	29.50	26.50
40 x 40 x 24	40.00	24.00	29.50	26.00
40 x 40 x 22	40.00	22.00	29.50	25.50
40 x 40 x 20	40.00	20.00	29.50	25.00
40 x 40 x 18	40.00	18.00	29.50	24.50
42 x 42 x 36	42.00	36.00	30.00	28.00
42 x 42 x 34	42.00	34.00	30.00	28.00
42 x 42 x 32	42.00	32.00	30.00	28.00
42 x 42 x 30	42.00	30.00	30.00	28.00
42 x 42 x 28	42.00	28.00	30.00	27.50
42 x 42 x 26	42.00	26.00	30.00	27.50

NOTE:  
<sup>(1)</sup> Outlet dimension M is recommended but not mandatory (consult fitting manufacturer).

NPS	Dimensions in inches			
	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet M <sup>(1)</sup>
42 x 42 x 24	42.00	24.00	30.00	26.00
42 x 42 x 22	42.00	22.00	30.00	26.00
42 x 42 x 20	42.00	20.00	30.00	26.00
42 x 42 x 18	42.00	18.00	30.00	25.50
42 x 42 x 16	42.00	16.00	30.00	25.00
44 x 44 x 42	44.00	42.00	32.00	30.00
44 x 44 x 40	44.00	40.00	32.00	29.50
44 x 44 x 38	44.00	38.00	32.00	29.00
44 x 44 x 36	44.00	36.00	32.00	28.50
44 x 44 x 34	44.00	34.00	32.00	28.50
44 x 44 x 32	44.00	32.00	32.00	28.00
44 x 44 x 30	44.00	30.00	32.00	28.00
44 x 44 x 28	44.00	28.00	32.00	27.50
44 x 44 x 26	44.00	26.00	32.00	27.50
44 x 44 x 24	44.00	24.00	32.00	27.50
44 x 44 x 22	44.00	22.00	32.00	27.00
44 x 44 x 20	44.00	20.00	32.00	27.00
46 x 46 x 44	46.00	44.00	33.50	31.50
46 x 46 x 42	46.00	42.00	33.50	31.00
46 x 46 x 40	46.00	40.00	33.50	30.50
46 x 46 x 38	46.00	38.00	33.50	30.00
46 x 46 x 36	46.00	36.00	33.50	30.00
46 x 46 x 34	46.00	34.00	33.50	29.50
46 x 46 x 32	46.00	32.00	33.50	29.50
46 x 46 x 30	46.00	30.00	33.50	29.00
46 x 46 x 28	46.00	28.00	33.50	29.00
46 x 46 x 26	46.00	26.00	33.50	29.00
46 x 46 x 24	46.00	24.00	33.50	28.50
46 x 46 x 22	46.00	22.00	33.50	28.50
48 x 48 x 46	48.00	46.00	35.00	33.00
48 x 48 x 44	48.00	44.00	35.00	33.00
48 x 48 x 42	48.00	42.00	35.00	32.00
48 x 48 x 40	48.00	40.00	35.00	32.00
48 x 48 x 38	48.00	38.00	35.00	32.00
48 x 48 x 36	48.00	36.00	35.00	31.00
48 x 48 x 34	48.00	34.00	35.00	31.00
48 x 48 x 32	48.00	32.00	35.00	31.00
48 x 48 x 30	48.00	30.00	35.00	30.00
48 x 48 x 28	48.00	28.00	35.00	30.00
48 x 48 x 26	48.00	26.00	35.00	30.00
48 x 48 x 24	48.00	24.00	35.00	29.00
48 x 48 x 22	48.00	22.00	35.00	29.00
48 x 48 x 20	48.00	20.00	35.00	29.00
48 x 48 x 18	48.00	18.00	35.00	28.50
48 x 48 x 16	48.00	16.00	35.00	28.00

NOTE:  
<sup>(1)</sup> Outlet dimension M is recommended but not mandatory (consult fitting manufacturer).

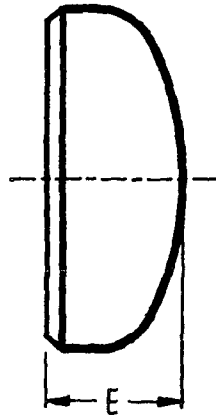


TABLE 7 Dimensions of Reducing Outlet Tees (continued)

Dimensions in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet- M <sup>(1)</sup>
50 x 50 x 48	50.00	48.00	36.75	34.50
50 x 50 x 42	50.00	42.00	36.75	33.00
50 x 50 x 36	50.00	36.00	36.75	32.50
50 x 50 x 30	50.00	30.00	36.75	31.50
50 x 50 x 24	50.00	24.00	36.75	30.00
50 x 50 x 20	50.00	20.00	36.75	30.00
52 x 52 x 50	52.00	50.00	38.50	35.75
52 x 52 x 48	52.00	48.00	38.50	35.75
52 x 52 x 42	52.00	42.00	38.50	34.50
52 x 52 x 36	52.00	36.00	38.50	34.00
52 x 52 x 30	52.00	30.00	38.50	32.75
52 x 52 x 24	52.00	24.00	38.50	31.25
54 x 54 x 52	54.00	52.00	40.00	37.25
54 x 54 x 48	54.00	48.00	40.00	37.25
54 x 54 x 42	54.00	42.00	40.00	35.63
54 x 54 x 36	54.00	36.00	40.00	35.00
54 x 54 x 30	54.00	30.00	40.00	34.00
54 x 54 x 24	54.00	24.00	40.00	31.38
56 x 56 x 54	56.00	54.00	41.50	38.50
56 x 56 x 48	56.00	48.00	41.50	37.00
56 x 56 x 42	56.00	42.00	41.50	36.50
56 x 56 x 36	56.00	36.00	41.50	35.50
56 x 56 x 30	56.00	30.00	41.50	33.75
56 x 56 x 24	56.00	24.00	41.50	33.75
58 x 58 x 56	58.00	56.00	43.00	40.00
58 x 58 x 54	58.00	54.00	43.00	40.00
58 x 58 x 48	58.00	48.00	43.00	38.50
58 x 58 x 42	58.00	42.00	43.00	37.50
58 x 58 x 36	58.00	36.00	43.00	36.50
58 x 58 x 30	58.00	30.00	43.00	35.00
60 x 60 x 58	60.00	58.00	44.00	41.50
60 x 60 x 54	60.00	54.00	44.00	40.50
60 x 60 x 48	60.00	48.00	44.00	40.00
60 x 60 x 42	60.00	42.00	44.00	39.00
60 x 60 x 36	60.00	36.00	44.00	38.00
60 x 60 x 30	60.00	30.00	44.00	36.00

NOTE:  
<sup>(1)</sup> Outlet dimension M is recommended but not mandatory (consult fitting manufacturer).

TABLE 8 Dimensions of Caps <sup>(1)</sup>

Dimensions in Inches

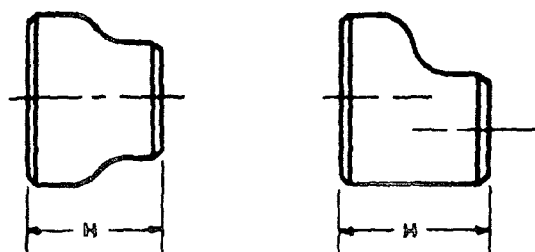
NPS	Outside Diameter at Bevel	End-to-End	
		E	E1 <sup>(2)</sup>
16	16.00	7.00	8.00
18	18.00	8.00	9.00
20	20.00	9.00	10.00
22	22.00	10.00	11.00
24	24.00	10.50	12.00
26	26.00	10.50	12.00
28	28.00	10.50	12.00
30	30.00	10.50	12.00
32	32.00	10.50	12.00
34	34.00	10.50	12.00
36	36.00	10.50	12.00
38	38.00	12.00	13.50
40	40.00	12.00	13.50
42	42.00	12.00	13.50
44	44.00	13.50	15.00
46	46.00	13.50	15.00
48	48.00	13.50	15.00
50	50.00	14.50	16.00
52	52.00	14.50	16.00
54	54.00	16.00	17.50
56	56.00	16.00	17.50
58	58.00	16.50	18.00
60	60.00	16.50	18.00

## NOTE:

<sup>(1)</sup> The shape of these caps shall be ellipsoidal and shall conform to the shape requirements as given in the ASME Boiler and Pressure Vessel Code.

<sup>(2)</sup> For t greater than 1.0 inch, caps may be furnished to length E1, at option of manufacturer.

TABLE 9 Dimensions of Reducers



Dimensions in Inches

NPS	Outside Diameter at Bevel		End-to-End
	Large End	Small End	Length H
38 x 36	38.00	36.00	24.00
38 x 34	38.00	34.00	24.00
38 x 32	38.00	32.00	24.00
38 x 30	38.00	30.00	24.00
38 x 28	38.00	28.00	24.00
38 x 26	38.00	26.00	24.00
38 x 24	38.00	24.00	24.00
38 x 22	38.00	22.00	24.00
38 x 20	38.00	20.00	24.00
40 x 38	40.00	38.00	24.00
40 x 36	40.00	36.00	24.00
40 x 34	40.00	34.00	24.00
40 x 32	40.00	32.00	24.00
40 x 30	40.00	30.00	24.00
40 x 28	40.00	28.00	24.00
40 x 26	40.00	26.00	24.00
40 x 24	40.00	24.00	24.00
40 x 22	40.00	22.00	24.00
40 x 20	40.00	20.00	24.00
42 x 40	42.00	40.00	24.00
42 x 38	42.00	38.00	24.00
42 x 36	42.00	36.00	24.00
42 x 34	42.00	34.00	24.00
42 x 32	42.00	32.00	24.00
42 x 30	42.00	30.00	24.00
42 x 28	42.00	28.00	24.00
42 x 26	42.00	26.00	24.00
42 x 24	42.00	24.00	24.00
42 x 22	42.00	22.00	24.00
44 x 42	44.00	42.00	24.00
44 x 40	44.00	40.00	24.00
44 x 38	44.00	38.00	24.00
44 x 36	44.00	36.00	24.00
44 x 34	44.00	34.00	24.00
44 x 32	44.00	32.00	24.00
44 x 30	44.00	30.00	24.00
44 x 28	44.00	28.00	24.00
44 x 26	44.00	26.00	24.00
44 x 24	44.00	24.00	24.00
44 x 22	44.00	22.00	24.00
46 x 44	46.00	44.00	28.00
46 x 42	46.00	42.00	28.00
46 x 40	46.00	40.00	28.00
46 x 38	46.00	38.00	28.00
46 x 36	46.00	36.00	28.00
46 x 34	46.00	34.00	28.00
46 x 32	46.00	32.00	28.00
46 x 30	46.00	30.00	28.00
46 x 28	46.00	28.00	28.00
46 x 26	46.00	26.00	28.00
46 x 24	46.00	24.00	28.00
48 x 46	48.00	46.00	28.00
48 x 44	48.00	44.00	28.00
48 x 42	48.00	42.00	28.00
48 x 40	48.00	40.00	28.00
48 x 38	48.00	38.00	28.00
48 x 36	48.00	36.00	28.00
48 x 34	48.00	34.00	28.00
48 x 32	48.00	32.00	28.00
48 x 30	48.00	30.00	28.00
48 x 28	48.00	28.00	28.00
48 x 26	48.00	26.00	28.00
48 x 24	48.00	24.00	28.00

Dimensions in Inches

NPS	Outside Diameters at Bevel		End-to-End
	Large End	Small End	Length H
16 x 14	16.00	14.00	14.00
16 x 12	16.00	12.75	14.00
16 x 10	16.00	10.75	14.00
16 x 8	16.00	8.62	14.00
18 x 16	18.00	16.00	15.00
18 x 14	18.00	14.00	15.00
18 x 12	18.00	12.75	15.00
18 x 10	18.00	10.75	15.00
20 x 18	20.00	18.00	20.00
20 x 16	20.00	16.00	20.00
20 x 14	20.00	14.00	20.00
20 x 12	20.00	12.75	20.00
22 x 20	22.00	20.00	20.00
22 x 18	22.00	18.00	20.00
22 x 16	22.00	16.00	20.00
22 x 14	22.00	14.00	20.00
24 x 22	24.00	22.00	20.00
24 x 20	24.00	20.00	20.00
24 x 18	24.00	18.00	20.00
24 x 16	24.00	16.00	20.00
26 x 24	26.00	24.00	24.00
26 x 22	26.00	22.00	24.00
26 x 20	26.00	20.00	24.00
26 x 18	26.00	18.00	24.00
28 x 26	28.00	26.00	24.00
28 x 24	28.00	24.00	24.00
28 x 22	28.00	22.00	24.00
28 x 20	28.00	20.00	24.00
28 x 18	28.00	18.00	24.00
30 x 28	30.00	28.00	24.00
30 x 26	30.00	26.00	24.00
30 x 24	30.00	24.00	24.00
30 x 22	30.00	22.00	24.00
30 x 20	30.00	20.00	24.00
32 x 30	32.00	30.00	24.00
32 x 28	32.00	28.00	24.00
32 x 26	32.00	26.00	24.00
32 x 24	32.00	24.00	24.00
34 x 32	34.00	32.00	24.00
34 x 30	34.00	30.00	24.00
34 x 28	34.00	28.00	24.00
34 x 26	34.00	26.00	24.00
34 x 24	34.00	24.00	24.00
36 x 34	36.00	34.00	24.00
36 x 32	36.00	32.00	24.00
36 x 30	36.00	30.00	24.00
36 x 28	36.00	28.00	24.00
36 x 26	36.00	26.00	24.00
36 x 24	36.00	24.00	24.00

TABLE 9 Dimensions of Reducers (continued)

Dimensions in inches

NPS	Outside Diameter at Bevel		End-to-End
	Large End	Small End	Length - H
50 x 48	50.00	48.00	28.00
50 x 42	50.00	42.00	28.00
50 x 36	50.00	36.00	28.00
50 x 30	50.00	30.00	28.00
50 x 24	50.00	24.00	28.00
50 x 20	50.00	20.00	28.00
52 x 50	52.00	50.00	28.00
52 x 48	52.00	48.00	28.00
52 x 42	52.00	42.00	28.00
52 x 36	52.00	36.00	28.00
52 x 30	52.00	30.00	28.00
52 x 24	52.00	24.00	28.00
54 x 52	54.00	52.00	28.00
54 x 48	54.00	48.00	28.00
54 x 42	54.00	42.00	28.00
54 x 36	54.00	36.00	28.00
54 x 30	54.00	30.00	28.00
54 x 24	54.00	24.00	28.00
56 x 54	56.00	54.00	28.00
56 x 48	56.00	48.00	28.00
56 x 42	56.00	42.00	28.00
56 x 36	56.00	36.00	28.00
56 x 30	56.00	30.00	28.00
56 x 24	56.00	24.00	28.00
58 x 56	58.00	56.00	28.00
58 x 54	58.00	54.00	28.00
58 x 48	58.00	48.00	28.00
58 x 42	58.00	42.00	28.00
58 x 36	58.00	36.00	28.00
58 x 30	58.00	30.00	28.00
60 x 58	60.00	58.00	28.00
60 x 54	60.00	54.00	28.00
60 x 48	60.00	48.00	28.00
60 x 42	60.00	42.00	28.00
60 x 36	60.00	36.00	28.00
60 x 30	60.00	30.00	28.00

**ANNEX A**  
**Referenced Standards and Applicable Dates**

This Annex is an integral part of this Standard Practice and is placed after the main text for convenience.

Standard Name or Description:

**ASME, ANSI/ASME, ANSI, ASME/ANSI**

B16.9 - 2001 Factory-Made Wrought Steel Butt welding Fittings  
B31 Code for Pressure Piping

**Boiler and Pressure Vessel Code**

Section V - 2001 Ed. Nondestructive Examination  
Section VIII Div. 1-2001 Ed. Rules for Construction of Pressure Vessels  
Section IX -2001 Ed. Welding & Brazing Qualifications

**ASTM**

A 53/A53M-02 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless  
A 105/A105M-02 Carbon Steel Forgings for Piping Applications  
A 106-02a Seamless Carbon Steel Pipe for High-Temperature Service  
A 234/A234M-02e Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High-Temperature Service  
A 370-02el Standard Test Methods and Definitions for Mechanical Testing of Steel Products  
A 381-96-01 Metal-Arc-Welded Steel Pipe for Use with High-Pressure Transmission Systems  
A 420/A420M-02 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service  
A 694/A694M-00 Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service

**Specifications for:**

**API**

5L - Forty-Second Ed., 2000 Specification for Line Pipe  
1104 - Nineteenth Ed., 1999 Welding of Pipelines and Related Facilities

**MSS**

SP-44-1996 (R 01) Steel Pipeline Flanges

Publications of the following organizations appear on the above list:

API American Petroleum Institute  
1220 L Street, N. W., Washington, D. C. 20005

ASME ASME International  
Three Park Avenue, New York, NY 10016-5990

ASTM ASTM International  
100 Barr Harbor Dr., West Conshohocken, PA 19428-2959

MSS Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.  
127 Park Street, NE, Vienna, VA 22180-4602

## APPENDIX X1

This Appendix is supplementary and does not include mandatory requirements.

### 1.0 SUPPLEMENTARY REQUIREMENTS

The supplementary requirements SR-1 through SR-14 are not applicable to product furnished to this Standard Practice, except when specified on the purchase order or otherwise agreed upon. The expense or cost of supplementary requirements shall be for the purchaser's account unless specified on the purchase order or otherwise agreed upon. When specified or agreed upon, supplementary requirements shall have the same force as requirements of the first seventeen sections of this Standard Practice. To be applicable, supplementary requirement details different from those of the SRs of this section must be agreed upon by both the purchaser and manufacturer.

- a) SR-1 Longitudinal-Bead Underbead Cracking Test in accordance with Appendix X2. Tests shall be performed on each heat of material.
- b) SR-2 Transverse Guided-Weld Bend-Tests shall be performed in accordance with Section 10 on each heat lot of fittings produced.
- c) SR-3 Transverse-Weld Tension Test(s) shall be performed on each heat lot of fittings in accordance with Section 8.6. Section 8.6 requires one test. This supplement would allow purchaser to specify additional tests.
- d) SR-4 Fitting base material and welds shall have a maximum hardness of 22 HRC (235 HB). Weld metal shall have a nickel content of less than 1.00%. One base metal and one weld hardness reading shall be made on each heat lot of fittings. Additional hardness readings shall be performed when specified on the purchase order.
- e) SR-5 Actual yield strength shall not exceed the specified minimum yield strength by more than 20,000 psi.
- f) SR-6 Notch-toughness requirements other than those specified shall be agreed upon between the purchaser and the manufacturer.

**APPENDIX X1 (Continued)**

- g) **SR-7** Notch-toughness tests shall be performed on each heat lot of fittings in accordance with the requirements of Sections 11.1 and 11.3.
- h) **SR-8** Each fitting shall be ultrasonically examined. Personnel and procedures shall be qualified in accordance with ASME Section V, Article 5. Acceptance standards shall be as agreed upon between the purchaser and the manufacturer.
- i) **SR-9** Fittings furnished in accordance with this Supplementary Requirement shall have purchase order identification marked with low-stress die stamps or interrupted-dot stamps.
- j) **SR-10** More restrictive chemical requirements and/or a lower Carbon Equivalent shall be as agreed to by purchaser and manufacturer.
- k) **SR-11** Repair Welding - Base metal repair welding may be performed subject to purchaser approval.
- l) **SR-12** Bar Stock Fittings - Bar Stock Fittings shall not be permitted.
- m) **SR-13** A deposited weld-metal chemical analysis shall be performed for each classification of filler metal or each submerged-arc electrode/flux classification identified in the welding procedure(s). Chemical analysis shall be furnished upon request.
- n) **SR-14** Butt-welding ends of fittings shall be subjected to liquid-penetrant or magnetic-particle examination. The purchaser shall specify acceptance limits. Nondestructive-examination personnel and procedures shall be qualified in accordance with ASME Section V.

APPENDIX X2

This Appendix is supplementary and does not include mandatory requirements unless invoked by SR-1 of Appendix X1.

LONGITUDINAL-BEAD UNDERBEAD CRACKING TEST

Specimen Size - 2 in. wide, 3 in. long, in direction of rolling, full thickness (t) of material. Grit blast to obtain uniform surface.

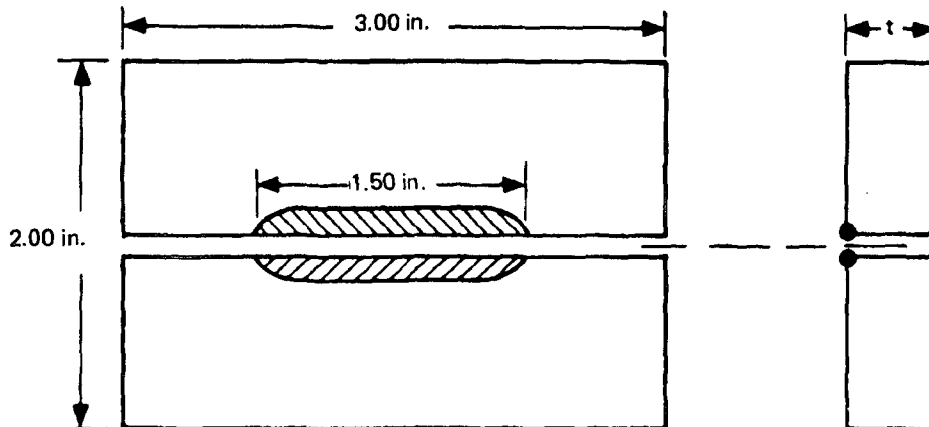
Weld Bead - Deposit bead 1.5 in. long on surface of specimen. (See Figure X2-1 below.)

Electrode - Deposit with a 0.12 in. diameter, E6010 electrode, at a current of 100 amperes and 24 to 26 volts, speed of 10 in. per minute (energy input of 15,000 joules per inch).

Pretempering - Preheat or precool to 100°F.

Post Treatment - Hold specimen after welding for 24 hours, at room temperature, approximately 100°F and then normalize at 1650°F + 25°F for one hour. This serves to normalize the microstructure and stress relieves simultaneously.

Examination - Saw cut so as to expose center of weld bead and prepare sawed surfaces using 240 grit wet belt grinder. Inspect by wet fluorescent magnetic particle technique. Measure lengths of cracks developed and express as percent of bead length. An average of 50% cracking or less for an average of 10 specimens at the specified temperature is considered acceptable for welding since it has been found that such procedures seldom cause cracking in full size girth welds.



Longitudinal-Bead Underbead Cracking Test Specimen

Figure X2-1



## List of MSS Standard Practices (Price List Available Upon Request)

Number	
SP-6-2001	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
SP-9-2001	Spot Facing for Bronze, Iron and Steel Flanges
SP-25-1998	Standard Marking System For Valves, Fittings, Flanges and Unions
SP-42-2004	Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
SP-43-1991	(R 01) Wrought Stainless Steel Butt-Welding Fittings
SP-44-1996	(R 01) Steel Pipeline Flanges
SP-45-2003	Bypass and Drain Connections
SP-51-2003	Class 150LW Corrosion Resistant Flanges and Cast Flanged Fittings
SP-53-1999	(R 02) Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components - Magnetic Particle Examination Method
SP-54-1999	(R 02) Quality Standard for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Radiographic Examination Method
SP-55-2001	Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
SP-58-2002	Pipe Hangers and Supports - Materials, Design, and Manufacture
SP-60-2004	Connecting Flange Joint Between Tapping Sleeves and Tapping Valves
SP-61-2003	Pressure Testing of Steel Valves
SP-65-2004	High Pressure Chemical Industry Flanges and Threaded Stubs for Use with Lens Gaskets
SP-67-2002a	Butterfly Valves
SP-68-1997	(R 04) High Pressure Butterfly Valves with Offset Design
SP-69-2003	ANSI/MSS Edition - Pipe Hangers and Supports- Selection and Application
SP-70-1998	Cast Iron Gate Valves, Flanged and Threaded Ends
SP-71-1997	Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-72-1999	Ball Valves with Flanged or Butt Welding Ends for General Service
SP-73-2003	Brazing Joints for Copper and Copper Alloy Pressure Fittings
SP-75-2004	Specification for High Test Wrought Butt Welding Fittings
SP-77-1995	(R 00) Guidelines for Pipe Support Contractual Relationships
SP-78-1998	Cast Iron Plug Valves, Flanged and Threaded Ends
SP-79-2004	Socket-Welding Reducer Inserts
SP-80-2003	Bronze Gate, Globe, Angle, and Check Valves
SP-81-2001	Stainless Steel, Bonnetless, Flanged Knife Gate Valves
SP-82-1992	Valve Pressure Testing Methods
SP-83-2001	Class 3000 Steel Pipe Unions, Socket Welding and Threaded
SP-85-2002	Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
SP-86-2002	Guidelines for Metric Data in Standards for Valves, Flanges, Fittings, and Actuators
SP-88-1993	(R 01) Diaphragm Valves
SP-89-2003	Pipe Hangers and Supports - Fabrication and Installation Practices
SP-90-2000	Guidelines on Terminology for Pipe Hangers and Supports
SP-91-1992	(R 96) Guidelines for Manual Operations of Valves
SP-92-1999	MSS Valve User Guide
SP-93-1999	(R 04) Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components-Liquid Penetrant Examination Method
SP-94-1999	(R 04) Quality Std for Ferritic and Martensitic Steel Castings for Valves, Flanges, and Fittings and Other Piping Components-Ultrasonic Examination Method
SP-95-2000	Swage(d) Nipples and Bull Plugs
SP-96-2001	Guidelines on Terminology for Valves and Fittings
SP-97-2001	Integrally Reinforced Forged Branch Outlet Fittings-Socket Welding, Threaded, and Buttwelding Ends
SP-98-2001	Protective Coatings for the Interior of Valves, Hydrants, and Fittings
SP-99-1994	(R 01) Instrument Valves
SP-100-2002	Qualification Requirements for Elastomer Diaphragms for Nuclear Service Diaphragm Valves
SP-101-1989	(R 01) Part-Turn Valve Actuator Attachment-Flange and Driving Component Dimensions and Performance Characteristics
SP-102-1989	(R 01) Multi-Turn Valve Actuator Attachment - Flange and Driving Component Dimensions and Performance Characteristics
SP-103-1995	(R 00) Wrought Copper and Copper Alloy Insert Fittings for Polybutylene Systems
SP-104-2003	Wrought Copper Solder Joint Pressure Fittings
SP-105-1996	(R 01) Instrument Valves for Code Applications
SP-106-2003	Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300
SP-108-2002	Resilient-Seated Cast-Iron Eccentric Plug Valves
SP-109-1997	Welded Fabricated Copper Solder Joint Pressure Fittings
SP-110-1996	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
SP-111-2001	Gray-Iron and Ductile-Iron Tapping Sleeves
SP-112-1999	(R 04) Quality Standard for Evaluation of Cast Surface Finishes - Visual and Tactile Method. This SP must be sold with a 10-surface, three dimensional Cast Surface Comparator, which is a necessary part of the Standard. Additional Comparators may be sold separately at \$70.00 each. Same quantity discounts apply on total order.
SP-113-2001	Connecting Joint between Tapping Machines and Tapping Valves
SP-114-2001	Corrosion Resistant Pipe Fittings Threaded and Socket Welding, Class 150 and 1000
SP-115-1999	Excess Flow Valves 1 1/4 NPS and Smaller, for Fuel Gas Service
SP-116-2003	Service-Line Valves and Fittings for Drinking Water Systems
SP-117-2002	Bellows Seals for Globe and Gate Valves
SP-118-2002	Compact Steel Globe & Check Valves - Flanged, Flangeless, Threaded, & Welding Ends (Chemical & Petroleum Refinery Service)
SP-119-2003	Factory-Made Wrought Belled End Socket-Welding Fittings
SP-120-2002	Flexible Graphite Packing System for Rising Stem Steel Valves (Design Requirements)
SP-121-1997	(R 02) Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves
SP-122-1997	Plastic Industrial Ball Valves
SP-123-1998	Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube
SP-124-2001	Fabricated Tapping Sleeves
SP-125-2000	Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
SP-126-2000	Steel In-Line Spring-Assisted Center Guided Check Valves
SP-127-2001	Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
SP-129-2003	Copper-Nickel Socket-Welding Fittings and Unions
SP-130-2003	Bellows Seals for Instrument Valves
SP-131-2004	Metallic Manually Operated Gas Distribution Valves
SP-132-2004	Compression Packing Systems for Instrument Valves
(R YEAR)	Indicates year standard reaffirmed without substantive changes

A large number of former MSS Practices have been approved by the ANSI or ANSI Standards, published by others. In order to maintain a single source of authoritative information, the MSS withdraws its Standard Practice in such cases.

**Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.**  
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