MSS SP-75-2014

High-Strength, 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. Input from the user community and the Regulatory body responsible for pipeline safety compliance was requested and the task group assigned to revising this Standard Practice had very important input from these groups in preparing this edition of SP-75. The content of this Standard Practice is the resulting efforts of competent and experienced volunteers to provide an effective, clear, and non-exclusive standard that will benefit the industry as a whole. This MSS Standard Practice describes minimal requirements and 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 to this Standard Practice is established only by reference in other documents such as a code, specification, sales contract, or public law, as applicable. MSS has no power, nor does it undertake, to enforce or certify compliance with this document. Any certification or other statement of compliance with the requirements of this Standard Practice shall not be attributable to MSS and is solely the responsibility of the certifier or maker of the statement.

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In this Standard Practice, all text, notes, annexes, tables, figures, and references are construed to be essential to the understanding of the message of the standard, and are considered normative unless indicated as "supplemental". All appendices, if included, that appear in this document are construed as "supplemental". Note that supplemental information does not include mandatory requirements.

> **This Standard Practice has been substantially revised from the previous 2008 edition. It is suggested that if the user is interested in knowing what changes have been made, that direct page by page comparison should be made of this document and that of the previous edition.**

Non-toleranced dimensions in this Standard Practice are nominal unless otherwise specified.

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HIGH-STRENGTH, WROUGHT, BUTT-WELDING FITTINGS

1. SCOPE

1.1 This Standard Practice covers factory-made, seamless and electric 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, inspection and marking for high-strength, 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 extensions and transition sections(1). Girth weld requirements are outside the scope of this Standard Practice and are covered by the applicable ASME B31 Code for Pressure Piping and/or customer specifications.

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.

NOTE: (1) Lengths of extensions and transitions as agreed upon by purchaser and manufacturer.

2. PRESSURE RATINGS

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 Codes.

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 = internal design pressure, psig;

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

t = nominal wall thickness of the pipe, inches;

D = outside diameter of the pipe, 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.

3. **SIZE**

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 in this Standard Practice when the manufacturer chooses proof testing to qualify the fitting design. The proof test shall be based on the computed burst pressure of the fitting and its connecting piping as defined in Section 4.3. A factory-made segmented elbow that has a proof test on a geometrically similar 90-deg elbow need not be tested separately.

4.2 ***Test Assembly Requirements:***

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

4.2.2 Straight seamless or welded pipe whose calculated bursting strength is at least as great as the proof test pressure as calculated in Section 4.3, shall be welded to each end of the fitting to be tested. Pipe sections may have the nominal wall greater than the thickness indicated by the fitting markings. That greater thickness shall not exceed 1.5 times the nominal pipe wall thickness of the pipe that the fitting marking identifies. Any internal misalignment greater than 0.06 in. shall be reduced by taper boring at a slope not exceeding 1:3 (18°). Any other unequal wall welding preparation shall be in accordance with Figure 3. The minimum length of pipe sections for closures shall be one-half pipe O.D. for greater than NPS 14 and one pipe O.D. for NPS 14 and smaller.

4.3 The test fluid shall be water or other liquid. Hydrostatic pressure shall be applied to the assembly. At least three (3) proof tests for each fitting, joint size, or configuration are recommended.

The testing factor, f, based on the number of specimen tests performed in the table below is used in the computed test equations:

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

NOTE: Tests of similarly proportioned fittings that meet the requirements specified in Section 4.4 may be combined to establish the test factor applied to a set of fittings.

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

$$P = 2fSt/D$$

Where:

D = specified outside diameter of pipe;

f = testing factor from table listed in Section 4.3;

P = computed minimum proof test pressure for fitting;

S = actual tensile strength of the test fitting, determined on a specimen representative of the test fitting, which shall meet the tensile strength requirements of the applicable material of Section 6;

t = nominal pipe wall thickness of the pipe that the fitting marking identifies.

4.4 It is not necessary to conduct an individual test of fittings with all combinations of sizes, wall thicknesses, and materials. A successful proof test on one representative fitting may represent others to the extent described in Sections 4.4.1, 4.4.2, 4.4.3, and 4.4.4.

4.4.1 One test fitting may be used to qualify similarly proportioned fittings with a size range from one-half to twice that for the tested fitting. The test of a non-reducing fitting qualifies reducing fittings of the same pattern. The test of a reducing fitting qualifies reductions to smaller sizes.

4.4.2 One test fitting may be used to qualify similarly proportioned fittings with t/D ranges from one-half to three times that for the tested fitting.

4.4.3 The pressure retaining capacity of a geometrically identical fitting made of various grades of steel as listed in Section 6 will be directly proportional to the tensile properties of the materials, provided the yield-to-tensile ratio is 0.90 or less. Therefore, it is necessary to test only a single material in a representative fitting to prove the design of the fitting. For yield-to-tensile ratios greater than 0.84, additional testing should be considered.

4.4.4 A test on a prototype elbow qualifies elbows having longer radii than the test fitting providing they qualify under Sections 4.4.1 and 4.4.3.

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

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

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

4.6 A report of the testing for each test assembly shall be prepared and shall include:

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

(b) Instrumentation and methods of calibrations used;

(c) Material test reports for the assembly's materials;

(d) Actual final pressures for each test;

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

(f) Calculations performed;

(g) Location of rupture, if any, including a sketch.

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

5. HYDROSTATIC TESTING

5.1 Unless otherwise agreed upon as per Section 2.3, welding fittings shall be capable of withstanding a hydrostatic test pressure as specified in Section 2.2; however, 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 suitable for field welding to other fittings, flanges, and pipe manufactured to applicable specifications listed in the ASME B31 Codes.

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 each heat of steel used in meeting the requirements of Table 1 shall be determined by a product analysis controlled by the fitting manufacturer.

7.2 The choice and use of alloying elements for fittings made from high-strength, low-alloy steels to give the tensile properties that are 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 one of the following equations:

For: C > 0.17%

1)
$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

For: C ≤ 0.17%

2)
$$CE = C + F\left(\frac{Mn}{6} + \frac{Si}{24} + \frac{Cu}{15} + \frac{Ni}{20} + \frac{Cr+Mo+V+Nb}{5} + 5B\right)$$

Where:

F is a compliance factor dependent upon carbon content defined as follows:

Carbon Content, %	*F*	Carbon Content, %	*F*
<0.06	0.53	0.12	0.75
0.06	0.54	0.13	0.80
0.07	0.56	0.14	0.85
0.08	0.58	0.15	0.88
0.09	0.62	0.16	0.92
0.10	0.66	0.17	0.94
0.11	0.70		

The maximum CE by either equation above shall not exceed 0.45%. If the actual CE is greater than 0.42 %, the parts shall be stamped or paint marked with the actual CE.

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), 3(b), and 3(c) for joint preparation.

8.2 Test specimens shall be taken from the fitting after final heat treatment or from a piece of pipe or plate which has been heat treated in a lot with any of the fitting(s) it represents (see Section 8.4).

If the fittings will be exposed to an assembly Post-Weld Heat Treatment (PWHT) or a field PWHT and the PWHT temperature is higher than the final tempering temperature for the fitting, additional tensile testing shall be requested by the purchaser to ensure the fitting meets the requirements of Section 8 after the PWHT thermal cycle.

8.3 Test specimens shall be in accordance with ASTM A370 using full-size specimens or largest sub-size specimens obtainable. Yield strength shall be determined either by the 0.2% offset or the 0.5% extension under load (EUL) method. Test specimen orientation shall be taken transverse to the major axis of the fitting using NPS 8 or larger material and shall be longitudinal to the major axis for smaller sizes. Test specimen axial location shall be 1/2 *t* for thicknesses less than or equal to 1½ in., and 1/4 *t* for thicknesses greater than 1½ in.

8.4 One base metal tension test to determine yield strength, tensile strength, and percent (%) elongation 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. The adequacy of the furnace working zone to achieve and maintain temperature uniformity within a range of 50 °F shall be established by annual survey in accordance with a recognized procedure such as ASTM A991/A991M.

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.

8.5 Fittings containing welds shall have one tension test specimen taken from across the weld with the axis transverse to the weld seam for each lot of fittings. Only the ultimate tensile strength need meet the minimum requirements of Table 2.

8.6 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.

8.7 It shall be permissible to cold flatten test specimens.

9. HEAT TREATMENT

9.1 All fittings shall be furnished in a heat treated condition done by a trained operator. 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 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.

9.2 ***Heat Treat Procedures*** Heat treat procedures shall be available for review at the facility and shall include requirements for furnace temperatures and soak times at temperature. For quench treatments, cooling medium temperature before and after quench shall be controlled along with time to the quench tank. Cooling medium temperature and agitation should be considered to ensure proper cooling rate based on maximum mass being heat treated. Furnaces shall be visually inspected regularly for scale build-up, burner malfunction, loss of refractory material, or hot spots on the shell of the furnace.

9.3 ***Heat Treat Records*** A record of each heat treat load shall be recorded and reviewed for consistency to previous loads of the same lot. Records shall, at a minimum, include furnace number, date, heat codes of all pieces in the load, procedure used, order number and part descriptions.

10. TRANSVERSE GUIDED-WELD BEND-TESTS

10.1 Transverse guided-weld bend-tests shall be performed only when specified on the order (see Appendix X1 SR-2).

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 tests 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 8.2.

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.

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 A370 for base metal and weld. Sub-size specimens shall be used only when material to be tested is of insufficient thickness.

11.2 Impact specimens shall be taken at the same frequency, location and orientation as the tensile tests (see Section 8.3). One set (three specimens) of base metal and weld metal shall be tested at +20 °F or lower and show 20 ft-lb minimum average with no one specimen less than 15 ft-lb. Percent shear shall be reported on base metal only for informational purposes.

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

11.4 If the acceptance requirements of Section 11.2 are not met, one retest of three additional specimens from the same test location may be performed. Each individual test value of the retested specimens shall be equal to or greater than the specified minimum average value.

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 (including minimum wall thickness of 87½%) 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.

13.5 ***Segmentable Elbows*** When elbows are intended for segmenting in the field they shall be furnished with a 1% maximum out-of-round (OOR) based on the nominal mating pipe outside diameter throughout the length of the elbow. The inside diameter in all measured locations shall be no larger than the mating pipe nominal inside diameter to the high tolerance given in Table 3 based on circumferential readings. The outside or inside diameter and out-of-round shall be measured at both ends, the middle and at least every 22½ degrees of remaining elbow. Both ends of the elbow shall be stamped or paint marked "SEGM" to signify elbows are intended to be segmented. The requirements stated above are requisite on shop manufactured elbows before segmenting. To minimize the difficulties of elbow segmenting in the field, recommendations in Appendix X3 should be considered.

13.6 ***Minimum Bore*** Minimum bore throughout any fittings shall be at least 93% of nominal pipe inside diameter, unless otherwise agreed between purchaser and manufacturer.

14. MANUFACTURE

14.1 Fittings shall be manufactured in accordance with a documented Manufacturing Procedure Specification (MPS). If specified by the purchaser, manufacturing shall not proceed until the MPS has been accepted by the purchaser.

The MPS shall specify the following items, as applicable:

a) For the starting material:
   1) Product form (seamless or welded) and dimensions,
   2) Welding NDE results, if not completed by the fitting manufacturer;

b) For fitting manufacture:
   1) Forming method,
   2) Welding procedure specification and approval record, if applicable,
   3) Heat treatment procedure including thermal cycles,
   4) Machining requirements,
   5) Inspection, dimensions and test requirements,
   6) Proof test results if requested,
   7) Traceability;

c) Additional requirements such as end preparation, coating, and marking.

14.2 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.

14.2.1 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.

14.3 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.

Qualified Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR) shall be available for review or acceptance by the purchaser, if requested.

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 6½% 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 6½% 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 6½% 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 33⅓% 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. Stress relieving may be used as the final heat treatment after repair welding provided the fitting has previously undergone a heat treatment in accordance with Section 9 and the base material and welds meet the mechanical properties of Sections 8 and 11 after the entire thermal cycle. Repair welding shall be done with low hydrogen electrodes, gas-metal-arc process or submerged-arc process.

15. NONDESTRUCTIVE EXAMINATION (NDE)

15.1 ***Radiographic Examination*** Unless otherwise agreed between purchaser and manufacturer (see Appendix X1 SR-15), all butt welds shall be radiographically examined in accordance with Article 2 of ASME Boiler and Pressure Vessel Code, Section V, using fine grain film and lead screens. Longitudinal weld seams shall meet the acceptance standards in ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

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 Boiler and Pressure Vessel Code, 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 access to facilities shall be afforded 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.

16.2 ***Inspection Test Plan (ITP)*** The inspection and testing to be performed during qualification and production shall be as summarized in Section 16.2.1 below. When requested, hold points by the purchaser should be identified on a submitted ITP plan.

16.2.1 ***Inspection Test Plan Requirements*** See *Inspection Test Plan Requirements* table on page 10.

16.3 ***Certified Material Test Report (CMTR)*** A Certified Material Test Report shall be furnished listing the actual results of the chemical product analysis , including carbon equivalent, Section 7; mechanical properties of each lot of steel and tensile strength of weld (if applicable), Section 8; notch-toughness properties of all specimens, Section 11; heat treatment used including temperatures, Section 9; nondestructive examination reports as applicable, Section 15; and any special or supplemental tests required by the purchase order. The CMTR shall include a part description that matches the marking on the part. Any applicable customer specification may be listed on the CMTR. Unless otherwise specified, the latest edition of SP-75 shall apply and be indicated on the CMTR.

16.4 ***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 using 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

Note that in the case of unequal thickness, as in Section 8.1.1, the actual wall thickness of the fitting at the bevel ends shall be identified.

c) Respective grade as given in Table 2

Note that in the case of unequal yield strength, as in Section 8.1.1, both the minimum-tested yield strength of the fitting and the specified minimum yield strength of the pipe shall be identified, for example;

WPHY60/X70

Also note that the designation "WPHY" represents marking for fittings, "X" represents marking for mating pipe grade.

d) Heat code identity

e) Size[1]

f) SEGM[1] when appropriate, see Section 13.5

g) CE[1] if greater than 0.42%

h) "Part" for partial compliance fitting if applicable, see Section 1.4.1

i) Preheat conditions if applicable, see Section 6.4

j) PT or MT as applicable, see Section 15.3

Any deviation from these mandatory requirements will need agreement between manufacturer and purchaser.

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

a) Design pressure

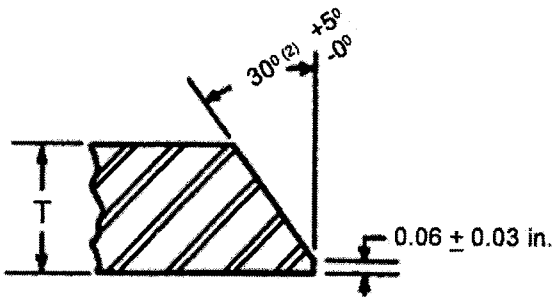
b) Temperature

c) Per ASME B31.8

NOTE: (1) At the option of the manufacturer, this information may be paint stenciled in lieu of die stamping.

SUPPLEMENTAL INFORMATION:
Appendix X1 (*Supplementary Requirements*), X2 (*Longitudinal-Bead Underbead Cracking Test*), and X3 (*Recommendations for Segmenting*) are "supplemental information" and located after the normative text (including Tables and Annex A), starting on page 26.

INSPECTION TEST PLAN REQUIREMENTS (From Section 16.2.1)		
Type of Test Mandatory Requirements:	**Section, Appendix XI SR**	**Number of Tests**
Chemical Analysis – base metal	7.1	1 per heat
Tensile – base metal	8.4	1 per lot
Tensile – weld	8.5	1 per lot
Impact Testing – base metal & weld	11.2	2 sets of 3
Visual Inspection	14.5	Each fitting
RT/UT – weld seam	15.1, SR-15	100% of all welds
MP/LP – cold formed tees	15.3	Each tee
Dimensional Checks	12 & Tables 3 to 9	Per MPS
Type of Test If specified by purchaser:	**Section, Appendix XI SR**	**Number of Tests**
Chemical Analysis – weld metal combination	SR-13	Each filler metal/flux
Impacts – weld seam HAZ	SR-17	By agreement
Hardness Test – base/weld metal	SR-22	1 per lot or each fitting
Underbead Crack Test	SR-1	Per heat
Guided-Bend Test – weld	10.2, SR-2	2 per lot
MP/UT – welds	15.2	Only if RT not practical
MP/LP End Bevels	SR-14	Each end or by agreement
UT Fitting Body	SR-8	Each fitting or by agreement
Sour Gas Applications	SR-4	Per Customer PO
No Repair Weld	SR-11	By agreement
No Wall Substitution	8.1.1, SR-18	By agreement



NOTES:

(1) Or 1 in. at the option of the manufacturer.

(2) Fittings NPS 24 and smaller may be furnished with 37½° ± 2½° bevel, at the option of the manufacturer.

FIGURE 1
RECOMMENDED BEVEL FOR WALL THICKNESSES (T) AT END OF FITTING, 0.75 IN.(1) OR LESS

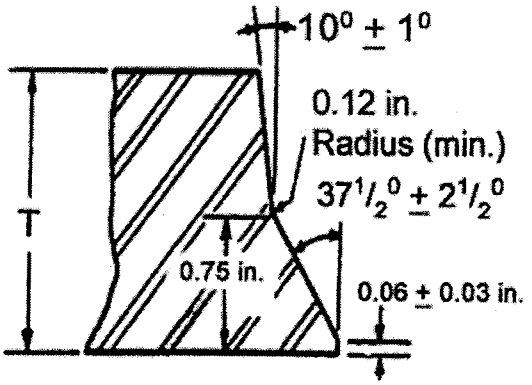
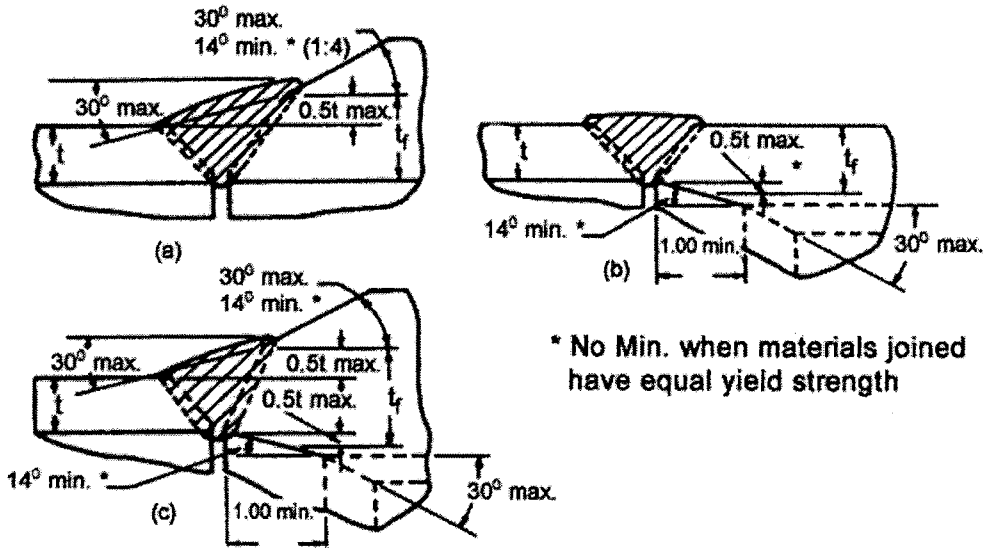


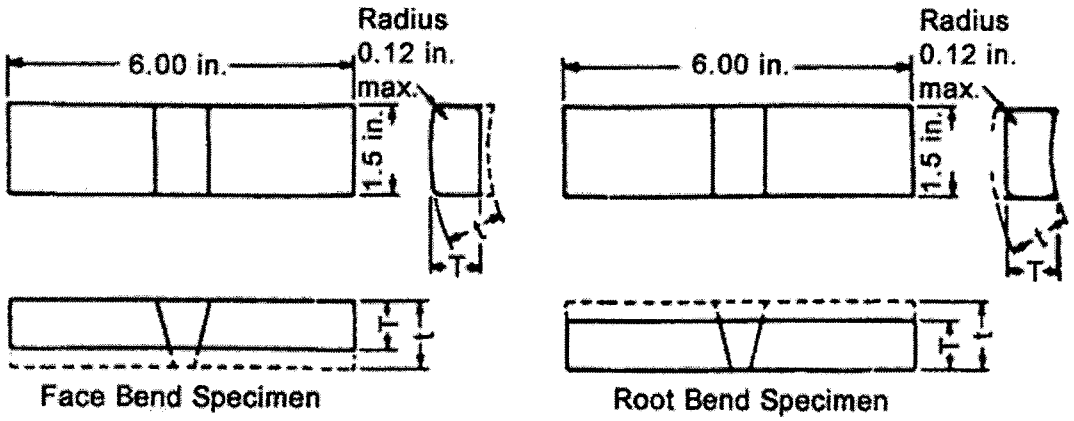
FIGURE 2
RECOMMENDED BEVEL FOR WALL THICKNESSES (T) AT END OF FITTING, GREATER THAN 0.75 IN.



NOTE: 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 the t_f shall at least equal t times the ratio of minimum-specified yield strength of pipe and fitting.

FIGURE 3

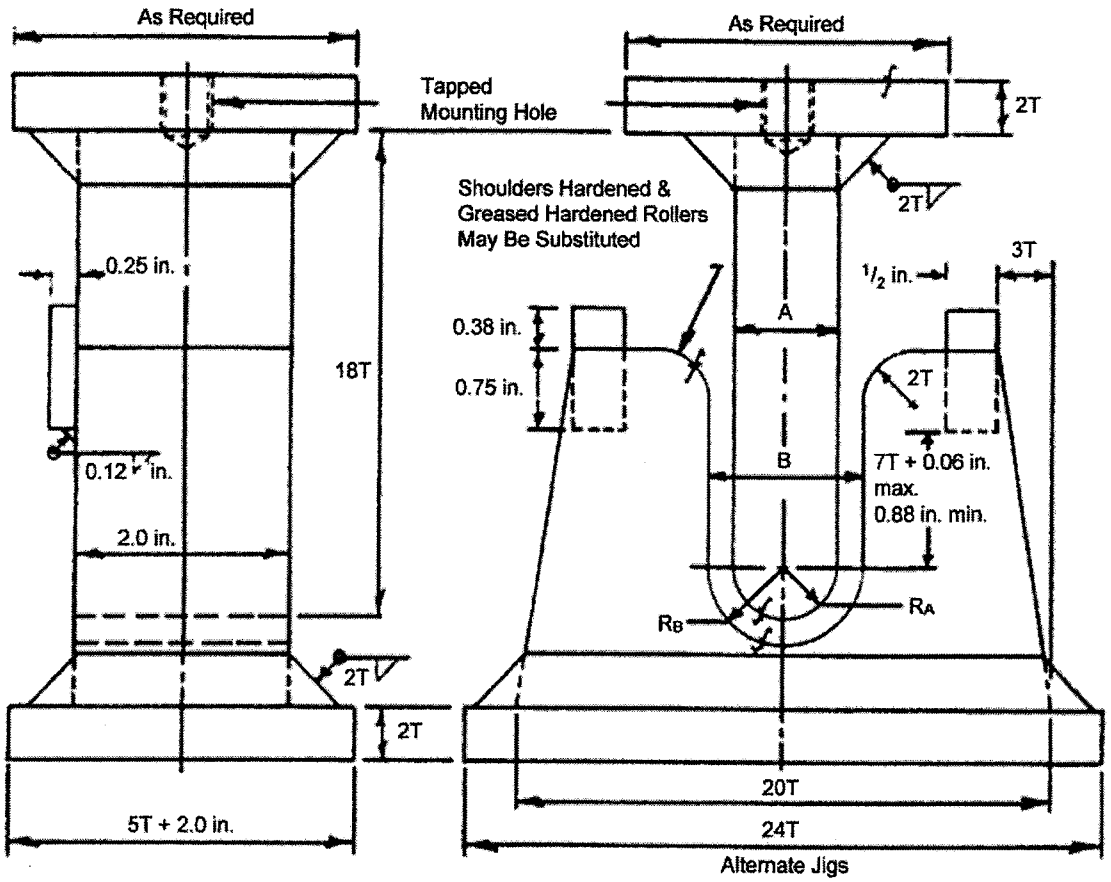
ACCEPTABLE DESIGN FOR UNEQUAL WALL THICKNESS (See Section 8.1.1)



Pipe Wall Thickness (t)	Test Specimen Thickness (T) (in.)
Up to 0.375 in. incl.	t
Over 0.375 in.	0.375 in.

FIGURE 4

TRANSVERSE FACE AND ROOT-BEND TEST SPECIMENS



Guided-Bend Test Jig Dimensions

	WPHY Grade of Steel			
	42	46	52, 56	60, 65, 70, 80
Radius of male member, R_A	3T	3½T	4T	4½T
Radius of female member, R_B	4T + .06 in.	4½T + 0.06 in.	5T + .06 in.	5½T + 0.06 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

FIGURE 5
GUIDED-BEND TEST JIG

TABLE 1
Maximum Limit of Chemical Elements

Element		(% 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)}	0.25
Vanadium (V)		0.13
Niobium (Columbium) (Nb)		0.10
Titanium (Ti)		0.05
Boron (B)		0.001

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

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.

TABLE 2
Tensile Requirements

Grade	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
WPHY-80	80,000	90,000	16

NOTE: The tensile requirements for intermediate grades shall be obtained by linear interpolation between those specified for standard grades. The minimum elongation value shall be as given in the Table for next higher standard grade.

TABLE 3
Tolerances

Dimensions are in inches

NPS	Inside[1] Diameter at End	Minimum[3] Wall Thickness	Out-of-Roundness[2]			90°, 60°, 45° & 30° Elbows & Tees Center-to-End Dimension A, B, C, M		Reducers Overall Length H	Caps Overall Length E	Angularity Off Angle Q	Elbows Off Plane P	Eccentric and Concentric Reducers Off Plane P[6]
			At Ends of Fittings		Throughout[4] Body of Elbows							
			Elbows[5]	Other		1½ R & Tee	3R					
16 – 24	± 0.09	Nominal (-0.01)	0.19	0.12	2.5%	± 0.09	± 0.12	± 0.09	± 0.25	0.09	0.25	2.5%
26 – 36	± 0.09		(5)	0.12	2.5%	± 0.12	± 0.25	± 0.19	± 0.38	0.09	0.50	2.5%
38 – 48	± 0.12		(5)	0.12	2.5%	± 0.19	± 0.38	± 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	± 0.38	0.19	0.75	2.5%

NOTES:

(1) The inside diameter at end shall be determined by circumferential measurements, and the tolerance refers to variations from nominal I.D. calculation by (O.D. nom. – 2*t*nom.).

(2) Out-of-roundness tolerances shall be the difference between the maximum and minimum diameters measured on any radial cross-section.

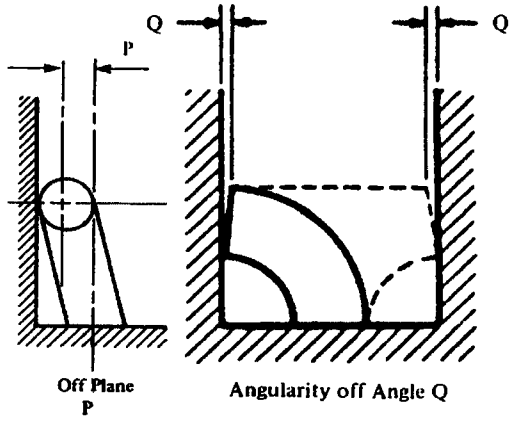
(3) Minus 0.01 in. except that isolated non-continuous reductions are permitted in accordance with Section 13.2. Excess thickness whether on inside or outside is to be treated in accordance with sketches given in Figure 3.

(4) When elbows are intended for segmenting, see Section 13.5

(5) Out-of-roundness tolerances at ends shall he 1% of mating pipe outside diameter for NPS 26 and larger.

(6) Percent (%) of nominal O.D.

GENERAL NOTE: The O.D. may be tapered at an angle up to 30° beyond weld bevel.



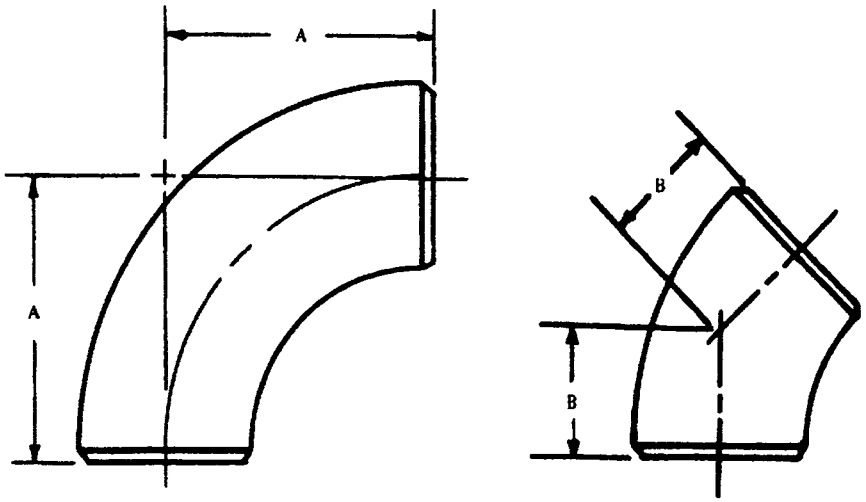


TABLE 4
Dimensions of Long-Radius Elbows

Dimensions are in inches

NPS	Outside Diameter at Bevel	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

Dimensions are in inches

NPS	O.D. at Bevel	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

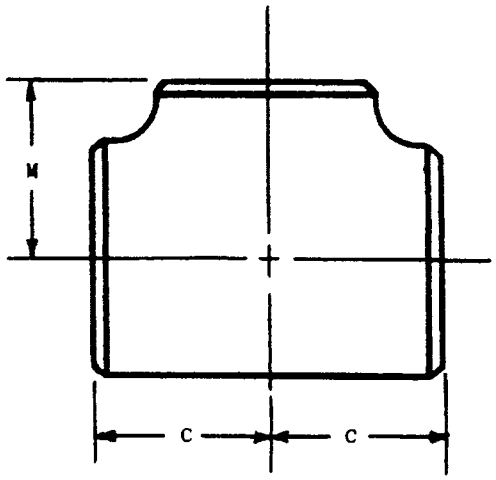


TABLE 6
Dimensions of Straight Tees

Dimensions are in inches

NPS	Outside Diameter at Bevel	Center-to-End	
		Run-C	Outlet-M[1]
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	35.75
54	54.00	40.00	37.25
56	56.00	41.50	38.50
58	58.00	43.00	40.00
60	60.00	44.00	41.50

NOTE: (1) Outlet Dimension "M" is recommended but not mandatory (consult fitting manufacturer).

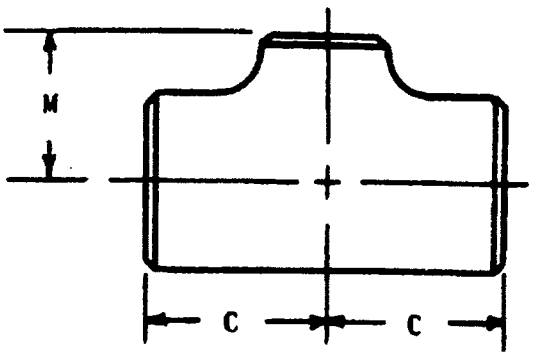


TABLE 7
Dimensions of Reducing Outlet Tees

Dimensions are in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet-M[1]
16×16×14	16.00	14.00	12.00	12.00
16×16×12	16.00	12.75	12.00	11.62
16×16×10	16.00	10.75	12.00	11.12
16×16×8	16.00	8.62	12.00	10.75
16×16×6	16.00	6.62	12.00	10.38
18×18×16	18.00	16.00	13.50	13.00
18×18×14	18.00	14.00	13.50	13.00
18×18×12	18.00	12.75	13.50	12.62
18×18×10	18.00	10.75	13.50	12.12
18×18×8	18.00	8.62	13.50	11.75
20×20×18	20.00	18.00	15.00	14.50
20×20×16	20.00	16.00	15.00	14.00
20×20×14	20.00	14.00	15.00	14.00
20×20×12	20.00	12.75	15.00	13.62
20×20×10	20.00	10.75	15.00	13.12
20×20×8	20.00	8.62	15.00	12.75
22×22×20	22.00	20.00	16.50	16.00
22×22×18	22.00	18.00	16.50	15.50
22×22×16	22.00	16.00	16.50	15.00
22×22×14	22.00	14.00	16.50	15.00
22×22×12	22.00	12.75	16.50	14.62
22×22×10	22.00	10.75	16.50	14.12
24×24×22	24.00	22.00	17.00	17.00
24×24×20	24.00	20.00	17.00	17.00
24×24×18	24.00	18.00	17.00	16.50
24×24×16	24.00	16.00	17.00	16.00
24×24×14	24.00	14.00	17.00	16.00
24×24×12	24,00	12.75	17.00	15.62
24×24×10	24.00	10.75	17.00	15.12

NOTE: (1) Outlet Dimension "M" is recommended but not mandatory (consult fitting manufacturer)

Dimensions are in inches

NPS	Outside Diameter At Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet-M[1]
26×26×24	26.00	24.00	19.50	19.00
26×26×22	26.00	22.00	19.50	18.50
26×26×20	26.00	20.00	19.50	18.00
26×26×18	26.00	18.00	19.50	17.50
26×26×16	26.00	16.00	19.50	17.00
26×26×14	26.00	14.00	19.50	17.00
26×26×12	26.00	12.75	19.50	16.62
28×28×26	28.00	26.00	20.50	20.50
28×28×24	28.00	24.00	20.50	20.00
28x28x22	28.00	22.00	20.50	19.50
28x28x20	28.00	20.00	20.50	19.00
28×28×18	28.00	18.00	20.50	18.50
28×28×16	28.00	16.00	20.50	18.00
28×28×14	28.00	14.00	20.50	18.00
28×28×12	28.00	12.75	20.50	17.62
30×30×28	30.00	28.00	22.00	21.50
30x30x26	30.00	26.00	22.00	21.50
30×30×24	30.00	24.00	22.00	21.00
30×30×22	30.00	22.00	22.00	20.50
30×30×20	30.00	20.00	22.00	20.00
30×30×18	30.00	18.00	22.00	19.50
30×30×16	30.00	16.00	22.00	19.00
30×30×14	30.00	14.00	22.00	19.00
30×30×12	30.00	12.75	22.00	18.62
30×30×10	30.00	10.75	22.00	18.12
32x32x30	32.00	30.00	23.50	23.00
32x32x28	32.00	28.00	23.50	22.50
32x32x26	32.00	26.00	23.50	22.50
32x32x24	32.00	24.00	23.50	22.00
32x32x22	32.00	22.00	23.50	21.50
32x32x20	32.00	20.00	23.50	21.00
32x32x18	32.00	18.00	23.50	20.50
32x32x16	32.00	16.00	23.50	20.00
32x32x14	32.00	14.00	23.50	20.00

NOTE: (1) Outlet Dimension "M" is recommended but not mandatory (consult fitting manufacturer)

TABLE 7 (Continued)
Dimensions of Reducing Outlet Tees

Dimensions are in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet-M[1]
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: (1) Outlet dimension "M" is recommended but not mandatory (consult fitting manufacturer).

Dimensions are in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet-M[1]
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: (1) Outlet dimension "M" is recommended but not mandatory (consult fitting manufacturer).

TABLE 7 (Continued)
Dimensions of Reducing Outlet Tees

Dimensions are in inches

NPS	Outside Diameter at Bevel		Center-to-End	
	Run	Outlet	Run-C	Outlet-M[1]
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: (1) Outlet dimension "M" is recommended but not mandatory (consult fitting manufacturer).

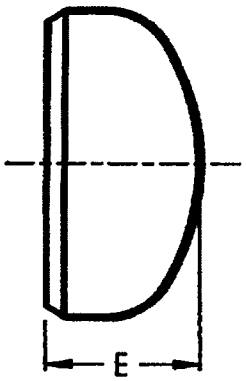


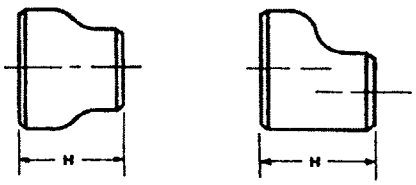
TABLE 8
Dimensions of Caps (1)

Dimensions are in inches

NPS	Outside Diameter at Bevel	End-to-End	
		E	E1 (2)
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

NOTES:
(1) 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.
(2) For t greater than 1.0 inch, caps may be furnished to length "E1", at option of manufacturer.

TABLE 9
Dimensions of Reducers



Dimensions are in inches

NPS	Outside Diameter 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

Dimensions are 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

TABLE 9 (Continued)
Dimensions of Reducers

Dimensions are 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	Description
ASME; ANSI/ASME	
B16.9-2012	Factory-Made Wrought Buttwelding Fittings
B31	Code for Pressure Piping
B31.8-2012	Gas Transmission and Distribution Piping Systems
BPVC-2013	Boiler and Pressure Vessel Code (2013 edition)
Section V-2013	Nondestructive Examination
Section VIII, Div. 1-2013	Rules for Construction of Pressure Vessels
Section IX-2013	Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators
ASTM	**Standard Specification for:**
A370-13	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
A991/A991M-10	Standard Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products

The following organizations appear on the above list or are generally referenced within this Standard Practice:

API
American Petroleum Institute
1220 L Street, N.W.
Washington, D.C. 20005-4070

ASME
American Society of Mechanical Engineers (ASME International)
Two Park Avenue
New York, NY 10016-5990

ASTM
ASTM International
100 Bar Harbor Drive, P.O. Box C700
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.

SUPPLEMENTARY REQUIREMENTS

The supplementary requirements SR-1 through SR-22 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 appendix must be agreed upon by both the purchaser and manufacturer.

When a supplementary requirement is incorporated in the base standard or dropped the number will be retired and other supplementary requirement numbers will be retained.

a) SR-1 Longitudinal-Bead Underbead Cracking Test in accordance with Appendix X2. Tests shall be performed on each heat of material (either from the starting material or a fitting).

b) SR-2 Transverse Guided-Weld Bend-Tests shall be performed in accordance with Section 10 on each lot of fittings produced.

c) *SR-3* *Deleted – Transverse weld tensile test is part of SP-75, Section 8.6.*

d) SR-4 Fittings intended for sour service should be identified by the purchaser at time of order including testing and acceptance criteria.

e) SR-5 Actual yield strength of base material 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.

g) *SR-7* *Deleted – Notch toughness tests are part of SP-75, Section 11.*

h) SR-8 Each fitting shall be ultrasonically examined. Personnel and procedures shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, 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.

APPENDIX X1 (Continued)

m) SR-13 A deposited weld-metal chemical analysis shall be performed for each classification of filler metal or each filler metal/flux classification identified in the WPS. 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 Boiler and Pressure Vessel Code, Section V.

o) SR-15 Ultrasonic examination of butt welds in lieu of the radiographic examination specified in Section 15.1. Ultrasonic examination shall be in accordance with Article 4 of ASME Boiler and Pressure Vessel Code, Section V. Longitudinal weld seams shall meet the Appendix 12 acceptance standards of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

p) SR-16 Simulated Post-Weld Heat Treatment (PWHT) of mechanical test coupons. Details of the PWHT thermal cycle shall be furnished by the purchaser and the extent of mechanical testing required shall be as agreed upon between the purchaser and manufacturer.

q) SR-17 Notch-toughness tests on the weld heat affected zone shall be performed on each lot in accordance with requirements of Sections 11.1 and 11.2. Impact retest as per Section 11.4.

r) SR-18 Substitution of wall thickness for yield strength in accordance with Section 8.1.1 shall not be allowed unless approved by the purchaser.

s) SR-19 In addition to the CMTR required for each lot of fittings, copies of the starting raw material mill certification shall be furnished with the documentation package.

t) SR-20 In addition to the CMTR required for each lot of fittings, copies of the heat treat charts shall be furnished with the documentation package.

u) SR-21 In addition to the CMTR required for each lot of fittings, copies of the lab stress strain curves and tensile test results shall be furnished with the documentation package.

v) SR-22 Each quench and tempered fitting shall be individually hardness tested and the results reported on the CMTR for each fitting.

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).

Pre-tempering – 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 percentage (%) 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.

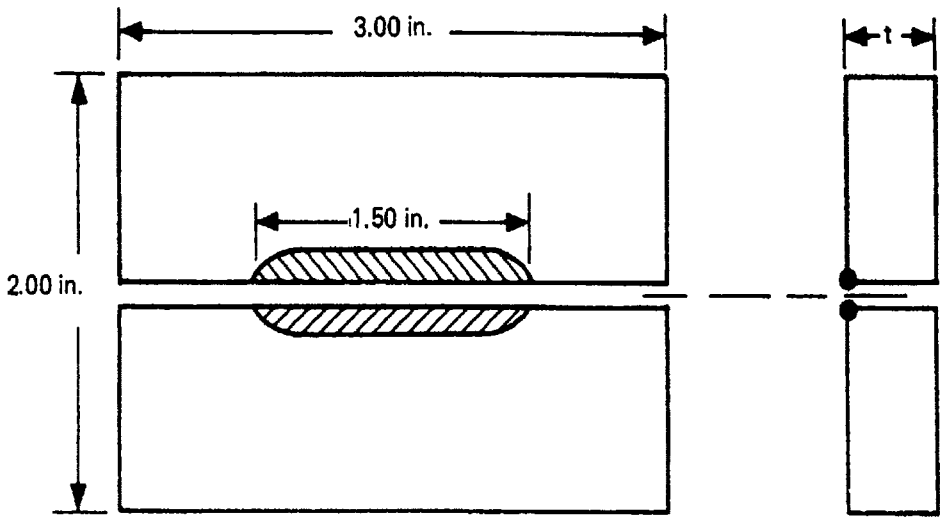


FIGURE X2-1
Longitudinal-Bead Underbead Cracking Test Specimen

APPENDIX X3

This Appendix is supplementary and does not include mandatory requirements.

RECOMMENDATIONS FOR SEGMENTING

Because of the residual stresses in an elbow due to heat treatment or body sizing, or the heat put into cutting in the field, elbows may have a tendency to spring when cut such that the 1% OOR is no longer met. Such spring back shall not be cause for rejection of the elbow unless otherwise agreed between the manufacturer and purchaser. Any resulting mismatch on either the outside or inside diameter needs to be corrected in the field by grinding, back-welding or bridging of weld to meet the appropriate piping code requirements for fit-up.

1.0 The following recommendations should be considered:

A) Purchase the desired segments required.

B) Arrange with manufacturer to cut desired segments from rough elbows produced for the job once the angle has been determined by the field. The timing of providing such elbows should be by agreement.

C) Order segments of varying degrees with the intent of using where possible and cold bending pipe to make up small differences in degrees of bend needed.

D) If cutting in the field is necessary, welding of a short segment of transition pipe to the cut end is recommended. This will result in better control of the fit-up and any grinding or back welding to transition the weld will be easier to make. Then the elbow can be installed in the ditch with a pipe to pipe weld which is easier to make using line-up clamps. A maximum of two cuts per elbow should be made leaving a factory end for one weld.

NOTE: The above recommendations are in descending order of ease of use in the field.

2.0 Some pipeline companies have ordered their elbows with short pipe transitions on each end to ensure pipe to pipe welds in the field in all cases. This can be done on all elbows including segments.

3.0 It should be recognized that elbows will usually have thicker walls than the mating pipe and that the extra wall could be positioned to the inside diameter. This extra wall can be used to help prevent the elbow from springing when heat treated or cut and will help offset the out-of-round by allowing transition grinding or back welding.

4.0 Even with 1% out-of-round, cut elbows can still have difficulty in maintaining the maximum offset allowed by code around the entire circumference. In most cases, the elbow was produced with a uniform circumference throughout the elbow and with some minimal mechanical "jacking" in the field can be rounded to make a good fit with minimal stress on the resulting girth weld. This should be discussed with the contractor prior to start of construction and guidelines for such corrections should be set.

Listing of MSS Standard Practices (as of September, 2014)

TITLE	
SP-6-2012	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
SP-9-2013	Spot Facing for Bronze, Iron, and Steel Flanges
SP-25-2013	Standard Marking System for Valves, Fittings, Flanges, and Unions
SP-42-2013	Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300 & 600)
SP-43-2013	Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications
SP-44-2010	Steel Pipeline Flanges (incl. 2011 Errata Sheet)
SP-45-2003	(R 2008) Bypass and Drain Connections
SP-51-2012	Class 150LW Corrosion Resistant Flanges and Cast Flanged Fittings
SP-53-2012	Quality Standard for Steel Castings and Forgings for Valves, Flanges, Fittings, and Other Piping Components – Magnetic Particle Examination Method
SP-54-2013	Quality Standard for Steel Castings and Forgings for Valves, Flanges, Fittings, and Other Piping Components – Radiographic Examination Method
SP-55-2011	Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components – Visual Method for Evaluation of Surface Irregularities **(ANSI-approved American National Standard)**
SP-58-2009	Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation (incorporates content of SP-69, 77, 89, and 90) **(ANSI-approved American National Standard)**
SP-60-2012	Connecting Flange Joints between Tapping Sleeves and Tapping Valves
SP-61-2013	Pressure Testing of Valves
SP-65-2012	High Pressure Chemical Industry Flanges and Threaded Stubs for Use with Lens Gaskets
SP-67-2011	Butterfly Valves
SP-68-2011	High Pressure Butterfly Valves with Offset Design
SP-70-2011	Gray Iron Gate Valves, Flanged and Threaded Ends
SP-71-2011	Gray Iron Swing Check Valves, Flanged and Threaded Ends (incl. 2013 Errata Sheet)
SP-72-2010a	Ball Valves with Flanged or Butt-Welding Ends for General Service
SP-75-2014	High-Strength, Wrought, Butt-Welding Fittings
SP-78-2011	Gray Iron Plug Valves, Flanged and Threaded Ends
SP-79-2011	Socket Welding Reducer Inserts
SP-80-2013	Bronze Gate, Globe, Angle, and Check Valves
SP-81-2013	Stainless-Steel or Stainless-Steel-Lined, Bonnetless, Knife Gate Valves with Flanged Ends
SP-83-2006	Class 3000 Steel Pipe Unions Socket Welding and Threaded
SP-85-2011	Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
SP-86-2009	Guidelines for Metric Data in Standards for Valves, Flanges, Fittings, and Actuators (Incl. 2011 Errata Sheet)
SP-87-1991	(R 1996 – Reinstated 2011) Factory-Made Butt-Welding Fittings for Class I Nuclear Piping Applications
SP-88-2010	Diaphragm Valves
SP-91-2009	Guidelines for Manual Operation of Valves
SP-92-2012	MSS Valve User Guide
SP-93-2014	Quality Standard for Steel Castings and Forgings for Valves, Flanges, Fittings, and Other Piping Components – Liquid Penetrant Examination Method
SP-94-2008	Quality Standard for Ferritic and Martensitic Steel Castings and Forgings for Valves, Flanges, Fittings, and Other Piping Components – Ultrasonic Examination Method
SP-95-2014	Swage(d) Nipples and Bull Plugs
SP-96-2011	Guidelines on Terminology for Valves and Fittings
SP-97-2012	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends
SP-98-2012	Protective Coatings for the Interior of Valves, Hydrants, and Fittings
SP-99-2010	Instrument Valves
SP-100-2009	Qualification Requirements for Elastomer Diaphragms for Nuclear Service Diaphragm Valves
SP-101-2014	Part-Turn Valve Actuator Attachment – FA Flange and Driving Component Dimensions and Performance Characteristics
SP-102-1989	(R 2001) Multi-Turn Valve Actuator Attachment – Flange and Driving Component Dimensions and Performance Characteristics
SP-104-2012	Wrought Copper Solder-Joint Pressure Fittings
SP-105-2010	Instrument Valves for Code Applications
SP-106-2012	Cast Copper Alloy Flanges and Flanged Fittings: Class 125, 150, and 300
SP-108-2012	Resilient-Seated Cast Iron Eccentric Plug Valves
SP-109-2012	Weld-Fabricated Copper Solder-Joint Pressure Fittings (incl. 2012 Errata Sheet)
SP-110-2010	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends (incl. 2010 Errata Sheet)
SP-111-2012	Gray-Iron and Ductile-Iron Tapping Sleeves
SP-112-2010	Quality Standard for Evaluation of Cast Surface Finishes – Visual and Tactile Method. This SP must be used with a 10-surface, three dimensional Cast Surface Comparator, which is a necessary part of the standard. Additional Comparators available separately.
SP-113-2012	Connecting Joints between Tapping Machines and Tapping Valves
SP-114-2007	Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000 **(ANSI-approved American National Standard)**
SP-115-2010	Excess Flow Valves, 1¼ NPS and Smaller, for Fuel Gas Service
SP-116-2011	Service-Line Valves and Fittings for Drinking Water Systems
SP-117-2011	Bellows Seals for Globe and Gate Valves
SP-119-2010	Factory-Made Wrought Belled End Pipe Fittings for Socket-Welding
SP-120-2011	Flexible Graphite Packing System for Rising Stem Valves – Design Requirements
SP-121-2006	Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves
SP-122-2012	Plastic Industrial Ball Valves
SP-123-2013	Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube
SP-124-2012	Fabricated Tapping Sleeves
SP-125-2010	Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
SP-126-2013	In-Line, Spring-Assisted, Center-Guided Check Valves (Carbon, Alloy Steel, Stainless Steel, & Nickel Alloys)
SP-127-2014a	Bracing for Piping Systems: Seismic-Wind-Dynamic Design, Selection, and Application
SP-128-2012	Ductile Iron Gate Valves
SP-129-2014	Copper-Nickel Socket-Welding, Fittings, and Unions
SP-130-2013	Bellows Seals for Instrument Valves
SP-131-2010	Metallic Manually Operated Gas Distribution Valves
SP-132-2010	Compression Packing Systems for Instrument Valves
SP-133-2010	Excess Flow Valves for Low Pressure Fuel Gas Appliances
SP-134-2012	Valves for Cryogenic Service, including Requirements for Body/Bonnet Extensions
SP-135-2010	High Pressure Knife Gate Valves
SP-136-2014	Ductile Iron Swing Check Valves
SP-137-2013	Quality Standard for Positive Material Identification of Metal Valves, Flanges, Fittings, and Other Piping Components
SP-138-2009	Quality Standard Practice for Oxygen Cleaning of Valves & Fittings
SP-139-2014	Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications
SP-140-2012	Quality Standard Practice for Preparation of Valves and Fittings for Silicone-Free Service
SP-141-2012	Multi-Turn and Check Valve Modifications
SP-142-2012	Excess Flow Valves for Fuel Gas Service, NPS 1½ through 12
SP-143-2012	Live-Loaded Valve Stem Packing Systems
SP-144-2013	Pressure Seal Bonnet Valves
SP-145-2013	Metal Ball Valves for Low Pressure/Low Temperature Plumbing Applications
SP-146-2014	High Pressure, Lug- and Wafer-Type, Iron and Ductile Iron Knife Gate Valves
SP-147-2014	Quality Standard for Steel Castings Used in Standard Class Steel Valves – Sampling Method for Evaluating Casting Quality
SP-148-2014	Low Pressure Flanged or Lugged Carbon Steel and Iron or Ductile Iron, Cast or Fabricated, Bonnetless, Knife Gate Valves without Liners

(R *YEAR*) Indicates year reaffirmed • **Price List Available Upon Request** • MSS is an ANSI-accredited American National Standards developer

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