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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, *Wrought Welding Fittings*, and the MSS Coordinating Committee. The content of this Standard Practice is the resulting efforts of knowledgeable and experienced industry 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 industry at large. It is the responsibility of the user of this Standard Practice to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use. 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 "normative" and essential to understand the standard's message. All appendices and footnotes, or any other information denoted as "supplemental", that may be included within this Standard Practice, DO NOT involve mandatory or normative requirements.

> **This Standard Practice has been substantially revised from the previous 2014 edition with input from the API task group on low strength fittings and flanges, CSA materials group, U.S. DOT PHMSA, and several transmission companies that use this document extensively. Consensus of all concerned was gained through multiple iterations of this document and addressed revisions to the design, proof testing, materials, chemistries, heat treatment, impact testing, and quality control. The intent of this revision is to clarify the requirements and help ensure consistent material properties, along with records required to demonstrate compliance with that intent. 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, certification, 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, reducing elbows, caps, tees, single or multiple-outlet extruded headers, reducers, and extensions and transition sections(1). Hot induction bends are outside the scope of this Standard Practice. 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.

1.5 Fittings specified as "PSL2" will automatically invoke the additional requirements of SR-24 which are intended to be complementary to PSL2 line pipe in the API 5L Specification.

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 mating pipe, psi;
t = nominal wall thickness of the mating pipe, inches;
D = outside diameter of the mating pipe, inches.

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

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. These considerations may require some portion of formed fittings to be thicker than the mating pipe wall.

2.5 The design of fittings shall be established by one of the following methods:

2.5.1 Mathematical analyses contained in nationally recognized pressure vessel or piping codes (e.g. ASME B31.3 Paragraph 304.2, 304.3; ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 2, Part 4); or

2.5.2 Proof testing in accordance with Section 4; or

2.5.3 Experimental stress analysis (e.g. ASME BPVC, Section VIII, Division 2, Annex 5F) with validation of results. Hydrostatic testing may be used to validate experimental stress analysis; or

2.5.4 Detailed stress analysis (e.g. ASME BPVC, Section VIII, Division 2, Part 5) with validation of results. Strain measurement, photo elastic testing, or hydrostatic testing may be used to validate detailed stress analysis.

Design report and/or calculations must be made available for purchaser's review when utilizing the methods in Sections 2.5.1, 2.5.3, or 2.5.4.

3. DEFINITIONS

***Hydrostatic test*:** A fluid test in which pressure vessels, such as pipelines, can be tested for strength and leaks.

***Lot*:** A lot shall consist of all fittings from the same heat of material of the same starting wall thickness, same method of manufacture and given the same heat treatment in a furnace. Same heat treatment condition means the same process (e.g. normalize, temper) and the same heat-treating cycles (temperatures, time at temperature, cooling method) are used.

***Proof test*:** A pressure test to failure or some predetermined minimum test pressure to demonstrate the reinforcement needed to make the part equal to or greater in strength than the intended mating pipe.

***Same basic design configuration*:** A specific type of fitting whose configuration can be qualified in Section 4.2.1.

***Same method of manufacture*:** The same basic forming and heating methods for forming used in making a specific type of fitting (elbows, tees, reducers, or caps).

***Size*:** Refers to the nominal outside diameter of the mating pipe to which the fitting is attached.

***Traceability*:** The manufacturer shall establish and follow documented procedures for maintaining the heat and lot identity throughout the entire supply chain. Traceability procedures shall provide means for tracing any fitting to the proper heat and lot, and the chemical and mechanical test results.

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 pressure design thickness, defined as the wall thickness required in critical areas so that the fitting can pass the design proof test, for each type of fitting shall be determined and recorded. The pressure design thickness for other sizes or wall thicknesses covered in Section 4.4 shall require similar percentage or reinforcement proportional by size or thickness. Critical areas are normally the inner radius of elbows, the crotch of tees, the knuckle radius of caps and the large ends of reducers. The proof test shall be based on the computed burst pressure of the fitting and its connecting piping as defined in Section 4.3.

4.2 ***Test Assembly Requirements*:**

4.2.1 Each fitting type shall be tested except the testing of certain types of fittings can qualify other fittings as described below:

Fitting Type Tested[a]	**Fitting Type Qualified (Provided same pressure design thickness used)**
Short radius elbows[b]	Short radius, long radius, reducing long radius, or 3R elbow
Long radius elbows[b]	Long radius, reducing long radius, or 3R elbow
3R elbows[b]	3R elbow
Straight tee	Straight or reducing tees of any reduction
Reducing tee	Reducing tee with the same or more reduction in outlet size
Caps	Caps of the same configuration
Concentric reducer	Concentric or eccentric reducers with the same or lesser included transition angle[c]
Eccentric reducer	Eccentric or concentric reducers with the same or lesser included transition angle[c]

NOTES:

(a) Section 4.4 applicability of test results apply to all tested and qualified fittings.

(b) A test of any angle elbow will qualify any other angle. A segmented elbow that has a test on a geometrically similar 45° or 90° elbow need not be tested separately.

(c) Transition angle is defined as the angle of the conical section and is calculated as follows:

Concentric Reducer: $\theta = atan\ (D_L - D_S) / 2L)$

Eccentric Reducer: $\theta = atan\ (D_L - D_S) / L)$

Where:

θ = Angle of transition;

D_L = Diameter of large end of conical section;

D_S = Diameter of small end of conical section;

L = Length of conical section.

Fittings that have the same basic design configuration[1] and method of manufacture[2] 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.

NOTES:

(1) Examples NOT considered the same basic design configurations are: Elbows with different radii, tees versus extruded outlet headers, bell shaped (i.e. with tangents) versus conical reducers, and caps of different shapes.

(2) Examples NOT considered the same method of manufacture are: Full formed tees versus extruded headers, cold formed versus hot formed or differential heating, and rolled and welded versus die formed reducers. Elbows of the same curvature radius, whether seamless, welded with a joint efficiency factor of 1.00, or bent from pipe, will have the same pressure design thickness and may be combined or mixed to achieve the testing factor *f* of 1.00.