

Specification for

Steel butt-welding pipe fittings for the petroleum industry —

**Part 1: Wrought carbon and ferritic
alloy steel fittings**

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Co-operating organizations

The Petroleum Equipment Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government department and scientific and industrial organizations:

- British Iron and Steel Federation*
- Council of British Manufacturers of Petroleum Equipment*
- Federation of British Rubber and Allied Manufacturers
- Institute of Petroleum
- Ministry of Power
- Oil Companies Materials Association*

The industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- British Valve Manufacturers' Association
- National Association of Drop Forgers and Stampers

This British Standard, having been approved by the Petroleum Equipment Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 12 December 1962

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Foreword

This British Standard makes reference to the following British Standards:

BS 131, *Methods for notched bar tests — Part 2: Charpy V-notch impact test.*

BS 1501-1506, *Steels for use in the chemical, petroleum and allied industries.*

BS 1510, *Steels for use in the chemical, petroleum and allied industries (low temperature supplementary requirements to BS 1501-1506).*

BS 1560, *Steel pipe flanges and flanged fittings (nominal sizes $\frac{1}{2}$ in to 24 in) for the petroleum industry.*

BS 1600, *Dimensions of wrought steel pipe for the petroleum industry.*

BS 2600, *General recommendations for the radiographic examination of fusion welded joints in thicknesses of steel up to 2 inches.*

BS 2910, *General recommendations for the radiographic examination of fusion welded circumferential butt joints in steel pipes.*

BS 3293, *Carbon steel pipe flanges (over 24 in nominal size) for the petroleum industry.*

BS 3351, *Piping systems for the petroleum industry.*

This British Standard is one of a series of standards for fittings prepared under the authority of the Petroleum Equipment Industry Standards Committee. It was first published in 1950, and the first revised edition was published in 1953.

One of the aims of this standard is to ensure interchangeability in service with similar products of American manufacture. Consequently in the present edition due consideration has been given to the latest editions of American Standards ASA.B16.9, ASA.B16.28, ASTM.A.234, ASTM.A.351, ASTM.A.403 and ASTM.A.420, and to the American Manufacturers' Standardisation Society of the Valve and Fittings Industry Standard Practice SP.43.

Account has also been taken of the work of the International Organization for Standardization (ISO) on this subject.

The standard no longer provides for cast carbon and cast ferritic alloy steel fittings. Provision is now made for austenitic stainless steel fittings, and also for fittings intended to be used for low temperature service.

The revised edition of BS 1640 is in two parts, of which this is Part 1.

Part 2 deals with wrought and cast austenitic stainless steel fittings.

Acknowledgment is made to the American Standards Association, the American Society for Testing and Materials, and the American Manufacturers' Standardisation Society of the Valve and Fittings Industry for data used in this standard.

NOTE In place of the customary, but incorrect, use of the pound as a unit of force, the unit called a pound-force (abbreviation lbf) has been used in this standard. This is the force which, when acting on a body of mass one pound, gives it an acceleration equal to that of standard gravity.

The unit called ton-force (abbreviation tonf) has also been used where appropriate.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

Part 1 of this British Standard specifies requirements for wrought seamless and fabricated carbon and ferritic alloy steel butt-welding pipe fittings for use in the petroleum industry.

The following types of fittings are provided for:

- a) 45° long radius elbows;
- b) 90° long and short radius elbows;
- c) 90° long radius tangent elbows;
- d) long and short radius return bends;
- e) equal and reducing tees;
- f) concentric and eccentric reducers;
- g) caps;
- h) lap-joint stub ends.

Welding-neck flanges are not included. They are included in BS 1560¹⁾ and BS 3293²⁾.

Attention is drawn to the appendix, which lists information to be supplied by the purchaser.

2 Size and size identification

A fitting to this standard shall be identified by the nominal size and wall thickness or schedule number of the pipe (see Table 3) to which it is intended to correspond in strength.

Dimensions are standardized for the sizes and to the extent given in Table 4 to Table 10.

3 Pressure ratings

All fittings shall be so designed that their pressure ratings may be calculated as for straight seamless pipe of the same or equivalent material, the same size and of the same nominal wall thickness.

For information regarding design stresses at given temperatures for seamless pipe, reference should be made to Table 3 in BS 3351³⁾.

4 Materials

Fittings to this standard shall be made of materials complying with one of the standards given in Table 1, unless the use of other materials is agreed between purchaser and manufacturer.

¹⁾ BS 1560, "Steel pipe flanges and flanged fittings (nominal sizes 1/2 in to 24 in) for the petroleum industry".

²⁾ BS 3293, "Carbon steel pipe flanges (over 24 in nominal size) for the petroleum industry".

³⁾ BS 3351, "Piping systems for the petroleum industry".

Table 1 — Materials and material identification symbols

Material	Identification symbol ^a	Material standards		
		Seamless pipe	Rolled plate	Forgings
Carbon steel	WPA WPB	ASTM A.106 Grade A Grade B	BS 1501-161 ^b Grade C	BS 1503-161 Grade B
Carbon-molybdenum steel	WP1	ASTM A.335 Grade P1	BS 1501-204	BS 1503-240 Grade A
1 1/4 per cent chromium — 1/2 per cent molybdenum steel	WP11	ASTM A.335 Grade P11	BS 1501-620 ^c Grade B	BS 1503-620 ^c
2 1/4 per cent chromium — 1/2 per cent molybdenum steel	WP22	ASTM A.335 Grade P22	—	BS 1503-622
5 per cent chromium — 1 per cent molybdenum steel	WP5	ASTM A.335 Grade P5	BS 1501-625	BS 1501-625 ^d
Carbon steel suitable for low temperature service	WPL0 ^e	ASTM A.333 ^f Grade 0	BS 1501-161C/ BS 1510-LT50 ^g	BS 1503-161B/ BS 1510-LT50
3 1/2 per cent nickel steel	WPL3 ^e	ASTM A.333 Grade 3	BS 1501-503/ BS 1510-LT100	BS 1503-503/ BS 1510-LT100

NOTE A comprehensive series of British Standards for steel piping for pressure purposes is in course of preparation. Pending publication of these British Standards, reference is made here to comparable ASTM specifications. For dimensions of pipe, see Table 3, extracted from BS 1600, "Dimensions of wrought steel pipe for the petroleum industry".

^a When fittings are of welded construction, the symbols shown in this column shall be supplemented by the suffix letter "W".

^b BS 1501-6, "Steels for use in the chemical, petroleum and allied industries".

^c This material shall be specified with a chromium content of 1.0 to 1.5 per cent.

^d This material shall be specified with a maximum carbon content of 0.15 per cent, and a minimum tensile strength of 27 tonf/in², and a minimum yield strength of 14 tonf/in².

^e These grades are intended for low-temperature service and are subject to impact testing (see Clause 16).

^f In order to meet the impact test requirements for finished fittings as specified in Clause 16, the chemical composition of ASTM 333 Grade 0 may be suitably modified.

^g BS 1510, "Steels for use in the chemical, petroleum and allied industries (Low temperature supplementary requirements to BS 1501-1506)".

5 Manufacture

Seamless fittings may be made by any suitable manufacturing process.

Fabricated fittings shall be welded by manual or automatic electric arc welding processes, using weld metal of similar composition to the parent metal, unless otherwise agreed between purchaser and manufacturer. If the submerged arc process is used, the alloys shall be introduced through the filler wire.

The qualification requirements for welders and welding operators, the welding procedure employed in the manufacture of fabricated fittings and welding materials shall be in accordance with BS 3351.

6 Heat treatment

a) *Seamless carbon steel fittings.* Seamless carbon steel fittings other than material WPLO, on which the final forming operation is completed in the range 620 °C to 980 °C (1 150 °F to 1 800 °F) need not be heat treated provided they are cooled in still air.

Fittings completed at temperatures above 980 °C (1 800 °F) shall subsequently be normalised, and fittings completed at temperatures below 620 °C (1 150 °F) shall be stress relieved in the range 580 °C to 620 °C (1 075 °F to 1 150 °F).

All fittings in material WPLO shall be normalised.

b) *Seamless ferritic alloy steel fittings.* Seamless carbon-molybdenum (WP1) steel fittings shall be tempered in the range 620 °C to 680 °C (1 150 °F to 1 255 °F).

Seamless 1 1/4 per cent chromium — 1/2 per cent molybdenum (WP11), 2 1/4 per cent chromium — 1 per cent molybdenum (WP22), and 5 per cent chromium — 1/2 per cent molybdenum (WP5) fittings shall be normalised and subsequently tempered in the range 620 °C to 750 °C (1 150 °F to 1 380 °F).

Seamless $3\frac{1}{4}$ per cent nickel steel (WPL3) fittings shall be normalised and subsequently tempered in the range 580 °C to 630 °C (1 080 °F to 1 170 °F).

c) *Fabricated carbon and ferritic alloy steel fittings.* The heat treatment of fabricated carbon and ferritic alloy steel fittings shall be in accordance with BS 3351.

Section 2. Dimensions and tolerances

7 Dimensions

a) *General.* The dimensions of butt-welding fittings shall be in accordance with Sub-clauses b) to e) of this clause, subject to the tolerances given in Clause 8.

b) *Body thickness of fittings.* The body thickness of fittings shall be such that their actual bursting pressure is not less than the computed bursting pressure of straight seamless pipe of the same or equivalent material the same size and the same nominal wall thickness.

The computed bursting pressure of straight pipe shall be determined by the following formula:

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

where P = bursting pressure of the pipe, psi;

S = minimum specified tensile strength of the pipe material, psi;

t = $87\frac{1}{2}$ per cent of the nominal pipe wall thickness, inches;

D = outside diameter of the pipe, inches.

To ensure adequacy of design the manufacturer shall carry out bursting tests on prototype fittings. These bursting tests shall be made as specified in Clause 13.

c) *Dimensions of welding ends.* The dimensions of the welding ends shall match those of the equivalent straight pipe in Table 3, subject to the tolerances in Clause 8.

In order to obtain the proper dimensions at the welding ends, it is permissible to machine the inside of the fittings to a taper of not less than 1 in 4.

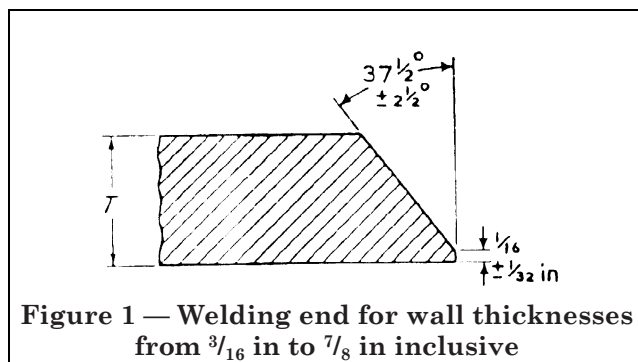
d) *Welding end preparation.* Unless otherwise specified by the purchaser the angle of bevel of the welding ends shall be as follows.

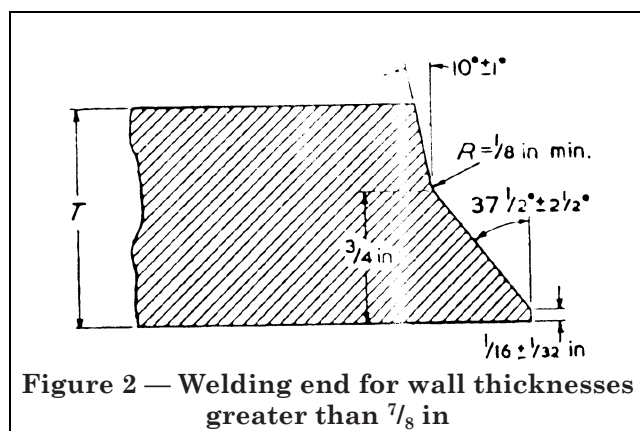
i) Where the wall thickness at the welding ends is less than $\frac{3}{16}$ in the ends shall be machined to a slight chamfer or may be square, at the manufacturer's option.

ii) Where the wall thickness at the welding ends is from $\frac{3}{16}$ in to $\frac{7}{8}$ in inclusive the ends shall be machined to the form indicated in Figure 1.

iii) Where the wall thickness at the welding ends is over $\frac{7}{8}$ in the ends shall be machined to the form indicated in Figure 2.

e) *Centre-to-centre, centre-to-end and end-to-end dimensions.* Centre-to-centre, centre-to-end and end-to-end dimensions shall be in accordance with Table 4 to Table 10.





8 Tolerances

a) *Wall thickness.* The wall thickness of a fitting shall at no point be less than 87½ per cent of the nominal thickness by which it is identified. (See Clauses 2 and 7 and Table 3.)

b) *Outside diameters at welding ends.* The following are the tolerances permitted on the outside diameters of fittings at their welding ends:

Nominal sizes 2½ in and smaller	+ 1/16 in – 1/32 in
Nominal sizes 3 in up to and including 4 in	± 1/16 in
Nominal sizes 5 in up to and including 8 in	+ 3/32 in – 1/16 in
Nominal sizes 10 in up to and including 18 in	+ 5/32 in – 1/8 in
Nominal sizes 20 in and larger	+ 1/4 in – 3/16 in

c) *Inside diameters at welding ends.* The following are the tolerances permitted on the inside diameters of fittings at their welding ends. For this purpose inside diameter equals outside diameter minus twice the nominal wall thickness, as given in Table 3:

Nominal sizes 2½ in and smaller	± 1/32 in
Nominal sizes 3 in up to and including 8 in	± 1/16 in
Nominal sizes 10 in up to and including 18 in	± 1/8 in
Nominal sizes 20 in and larger	± 3/16 in

Where closer inside diameter tolerances on sizes 10 inches and over are required, these shall be the subject of agreement between purchaser and manufacturer.

d) *Angle of bevel at welding ends.* Tolerances permitted on the angle of bevel of the welding ends of fittings shall be as indicated in Figure 1 and Figure 2.

e) *Off-square tolerances.* Off-square tolerances shall be as shown in Table 2 and Figure 3.

f) *Other dimensions.* The tolerances permitted on dimensions other than those shown above are as shown in Table 2.