British Standard

BRITISH STANDARD

BS 1640-1: 1962

Incorporating Amendment Nos. 1, 2 and 3

Specification for

Steel butt-welding pipe fittings for the petroleum industry —

Part 1: Wrought carbon and ferritic alloy steel fittings

UDC 621.643.4:621.791.053.6:665.5

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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Contents

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 $^1/_2$ 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 1560[1)] and BS 3293[2)].

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 3351[3)].

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/in^2, and a minimum yield strength of 14 tonf/in^2.

[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 $3^1/_4$ 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 lass 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 = $87^1/_2$ 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 $^3/_{16}$ 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 $^3/_{16}$ in to $^7/_8$ 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 $^7/_8$ 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.

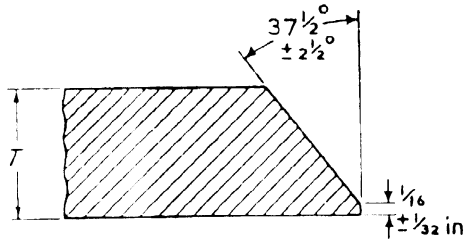

Figure 1 — Welding end for wall thicknesses from $^3/_{16}$ in to $^7/_8$ in inclusive

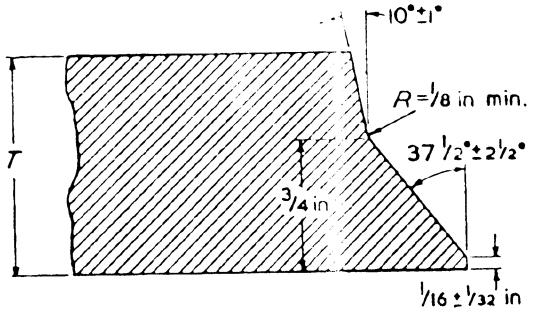

Figure 2 — Welding end for wall thicknesses greater than $^{7}/_{8}$ in

8 Tolerances

a) *Wall thickness.* The wall thickness of a fitting shall at no point be less than $87^{1}/_{2}$ 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 $2^{1}/_{2}$ 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 $2^{1}/_{2}$ 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.

Table 2 — Tolerances

1	2	3	4
Fitting	**Dimension**	**Sizes**	**Tolerance**
		in	in
90° elbows 45° elbows Tangent elbows Tees	Centre to end	Up to and including 8 10 and over	$\pm 1/16$ $\pm 3/32$
Return bends	Centre to center *O* Back to face *K* Alignment *F*	Up to and including 8 10 and over All sizes Up to and including 8 10 and over	$\pm 1/4$ $\pm 3/8$ $\pm 1/4$ $\pm 1/32$ $\pm 1/16$
Reducers	End to end *H*	Up to and including 8 10 and over	$\pm 1/16$ $\pm 3/32$
Caps	End to face *E* or E_1	Up to and including 4 5 and over	$\pm 1/8$ $\pm 1/4$
Lap-joint stub-ends[a]	End to end *F* Radius *R* Diameter of lap *G* Thickness of lap *T*	Up to and including 8 10 and over Up to and including $3\frac{1}{2}$ 4 and over Up to and including 8 10 and over All sizes	$\pm 1/16$ $\pm 3/32$ $+0-1/32$ $+0-1/16$ $+0-1/32$ $+0-1/16$ $+1/16-0$
All fittings	Off-square tolerance X between any two machined ends (see Figure 3)	Up to and including 4 5 and 6 8 to 24	$1/32$ $3/64$ $1/16$

[a] For maximum permissible diameter of lap joint stub-end barrel see Table 10.

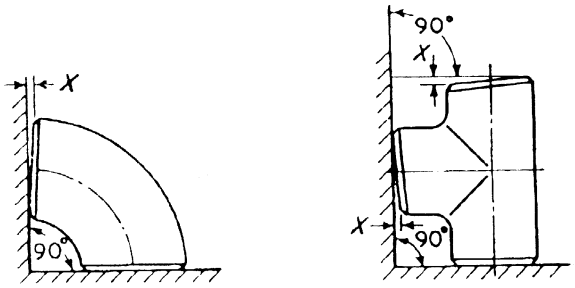

Figure 3 — Typical examples of off-square tolerance "*X*" checked against reference planes

Section 3. Workmanship, marking, inspection, testing and certification

9 Workmanship and finish

All fittings shall be free from harmful defects and shall have workmanlike finish.

10 Marking

All fittings shall be clearly and indelibly marked with the following:

a) Manufacturer's name or trade mark;

b) Nominal size in inches;

c) Nominal wall thickness in inches or schedule number;

d) Material identification symbol (see Table 1).

The method of marking used shall not be harmful to the fittings.

Hard Stamping is permissible only by roller stamping. Stamping shall be done lightly and carefully so as to minimise the notch effect and not so deep as to cause cracks or reduce the wall thickness of fittings below the minimum allowed. Stamping shall be applied prior to any final heat treatment when appropriate

Where the size of fittings does not permit of complete markings they may be omitted in the following sequence:

Nominal size;

Nominal wall thickness;

Manufacturer's name or trade mark.

11 Inspection

The purchaser or his representative shall, for the purpose of inspection, have free access, at all reasonable times, to those parts of the manufacturer's works engaged upon the purchaser's order. He shall be afforded all reasonable facilities for satisfying himself that the fittings are being manufactured in accordance with this standard.

12 Test facilities

The manufacturer shall supply the material required for testing and shall supply and prepare the necessary test pieces and supply the labour and appliances for such testing as may be carried out on his premises in accordance with this standard. In the absence of facilities at his own works for making the prescribed tests, the manufacturer shall arrange for the test to be carried out elsewhere.

13 Prototype bursting tests

These bursting tests shall be made in the following manner.

Straight seamless pipe of the same material and the same nominal wall thickness as the fitting to be tested and having a length equal to at least twice the pipe outside diameter shall be welded to each end of the fitting. Closures beyond the minimum length of the pipe shall be welded to the pipe ends.

Hydrostatic pressure shall be applied to the assembly and increased until either the fitting or one of the pipes bursts.

The fitting shall be considered satisfactory if the pressure attained on bursting is equal to or greater than the computed bursting pressure of the straight pipe as ascertained by the formula in Clause **7** b).

If so specified by the purchaser, the manufacturer shall supply certificates stating that satisfactory bursting tests have been carried out on prototype fittings of the types and sizes covered by the purchaser's order.

14 Radiographic examination of fittings fabricated by fusion welding

a) Fabricated carbon steel fittings having nominal wall thickness equal to or less than the Schedule 80 thickness given in Table 3, shall be examined radio-graphically throughout the entire length of all welds to the extent of a minimum of 4 fittings, selected at random, out of each 100 fittings or less in each production lot. If any of these selected fittings prove to be unacceptable they shall be rejected and for each rejected fitting two further fittings from the same batch of 100 or less shall be radio-graphed. If, however, by this process 10 fittings from the batch are found to be unacceptable then the whole batch shall be deemed not to comply with this specification or, alternatively, each fitting remaining therein be subjected to full radiographic examination.

b) Fabricated carbon steel fittings of nominal wall thicknesses greater than Schedule 80 and all fabricated carbon-molybdenum, chromium-molybdenum and $3^1/_2$ per cent nickel steel fittings in all thicknesses shall be radio-graphed individually throughout the entire length of their welds.

15 Radiographic technique and acceptance limits

The radiographic technique employed in the examination of fabricated fittings, and the quality of the films obtained thereby, shall be as specified in BS 2600[4] or BS 2910[5], whichever is applicable. The techniques 2, 7 or 11 quoted in these standards are recommended. The acceptance limits shall be as specified in BS 3351, except that incomplete penetration shall not be permitted in longitudinal seams.

16 Impact testing

Fittings made of materials of Grades WPL0 and WPL3 shall be impact tested in accordance with BS 131-2[6], and with the following requirements.

a) *Number of impact tests.* An impact test shall be made on three specimens taken from one fitting from each heat treated batch made from the same cast of steel. The fitting from which the test specimens are taken shall be selected from fittings having the greater wall thickness in the batch. In the case of welded fittings an additional set of three specimens shall be taken to represent the weld.

b) *Impact test specimens.* Test specimens shall be of the Charpy type. 10 mm square with 45° V-notch, 2 mm deep, 0.25 mm root radius and shall be prepared in accordance with BS 131-2.

If the wall thickness of the fitting does not permit the preparation of 10 mm square specimens the width of the specimens shall be made as large as possible.

Test specimens, other than those representing welds, shall be cut so that their longitudinal axis is parallel with the longitudinal axis of the fitting. Test specimens representing welds shall, so far as practicable, be taken transverse to the weld with the root of the notch located in weld metal. Specimens shall be obtained with their axial plane located at the mid point of the fitting wall. Notches shall be cut with their axis perpendicular to the original surface of the fitting.

c) *Impact test temperatures.* The test temperature shall be:

Grade WPL0 – 50 °C (– 58 °F)

Grade WPL3 – 100 °C (– 148 °F)

d) *Impact test values.* When tested in accordance with the above procedure, each set of three specimens shall show an average impact value of not less than 15 ft lbf and no individual value shall be less than 10 ft lbf. No reduction shall be made to these required values for specimens less than 10 mm wide but not less than 5 mm wide.

When the average value of the three specimens equals or exceeds the minimum value for a single specimen and the value for more than one specimen is below the required average value, or the value for one specimen is below the minimum value permitted for a single specimen; the test may be repeated on three additional specimens, each of which shall equal or exceed the required average value.

When an erratic result is caused by a defective specimen, or there is an uncertainty in the test procedure, that result may be discarded and a further specimen substituted.

e) *Retests.* Should a fitting fail to meet the impact test requirements of d) above, the batch of fittings which it represents shall be deemed not to comply with this standard unless:

i) two further fittings, from the same batch, are tested and both satisfactorily meet the specified impact test requirements,

or unless:

ii) all the fittings represented are re-heat treated and samples are selected and tested in accordance with Clause **16** a), b), c) and d) and satisfy the requirements.

[4] BS 2600, "*General recommendations for the radiographic examination of fusion welded joints in thickness of steel up to 2 inches*".
[5] BS 2910, "*General recommendations for the radiographic examination of fusion welded circumferential butt joints in steel pipes*".
[6] BS 131, "*Methods for notched bar tests*", Part 2, "*Charpy V-notch impact test*"

17 Hydrostatic testing

a) Hydrostatic testing of seamless fittings is not required by this standard.

b) Hydrostatic testing of fabricated fittings shall be applied if specified by the purchaser in his order.

The test pressure shall be determined by the following formula:

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

where p = minimum test pressure, psi;

s = 60 per cent of the minimum specified yield stress of the material of which the fitting is made, psi;

t = nominal wall thickness of the fitting, inches;

d = outside diameter of the fitting at the bevel, inches.

18 Certification

By agreement between the purchaser and the manufacturer the basis of acceptance by the purchaser of the fittings covered by his order may be a certificate stating that such fittings comply with the requirements of this standard and that the materials from which they are made have the chemical and physical characteristics specified in the appropriate standard or standards in Table 1.

Table 3 — Outside diameter and nominal wall thickness of wrought steel pipe[a]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Nominal pipe size	Outside diameter	Nominal wall thickness:																
		Schedule 5S	Schedule 10S	Schedule 10	Schedule 20	Schedule 30	Schedule 40S	Schedule 40	Schedule 60	Schedule 80S	Schedule 80	Schedule 100	Schedule 120	Schedule 140	Schedule 160	Standard weight	Extra strong	Double extra strong
in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in	in
1/2	0.840	0.065	0.083	—	—	—	0.109	0.109	—	0.147	0.147	—	—	—	0.187	0.109(40)	0.147(80)	0.294
3/4	1.050	0.065	0.083	—	—	—	0.113	0.113	—	0.154	0.154	—	—	—	0.218	0.113(40)	0.154(80)	0.308
1	1.315	0.065	0.109	—	—	—	0.133	0.133	—	0.179	0.179	—	—	—	0.250	0.133(40)	0.179(80)	0.358
1 1/4[b]	1.660	0.065	0.109	—	—	—	0.140	0.140	—	0.191	0.191	—	—	—	0.250	0.140(40)	0.191(80)	0.382
1 1/2	1.900	0.065	0.109	—	—	—	0.145	0.145	—	0.200	0.200	—	—	—	0.281	0.145(40)	0.200(80)	0.400
2	2.375	0.065	0.109	—	—	—	0.154	0.154	—	0.218	0.218	—	—	—	0.343	0.154(40)	0.218(80)	0.436
2 1/2[b]	2.875	0.083	0.120	—	—	—	0.203	0.203	—	0.276	0.276	—	—	—	0.375	0.203(40)	0.276(80)	0.552
3	3.500	0.083	0.120	—	—	—	0.216	0.216	—	0.300	0.300	—	—	—	0.438	0.216(40)	0.300(80)	0.600
3 1/2[b]	4.000	0.083	0.120	—	—	—	0.226	0.226	—	0.318	0.318	—	—	—	—	0.226(40)	0.318(80)	—
4	4.500	0.083	0.120	—	—	—	0.237	0.237	—	0.337	0.337	—	0.438	—	0.531	0.237(40)	0.337(80)	0.674
5[b]	5.563	0.109	0.134	—	—	—	0.258	0.258	—	0.375	0.375	—	0.500	—	0.625	0.258(40)	0.375(80)	0.750
6	6.625	0.109	0.134	—	—	—	0.280	0.280	—	0.432	0.432	—	0.562	—	0.718	0.280(40)	0.432(80)	0.864
8	8.625	0.109	0.148	—	0.250	0.277	0.322	0.322	0.406	0.500	0.500	0.593	0.718	0.812	0.906	0.322(40)	0.500(80)	0.875
10	10.750	0.134	0.165	—	0.250	0.307	0.365	0.365	0.500	0.500	0.593	0.718	0.843	1.000	1.125	0.365(40)	0.500(60)	1.000(140)
12	12.750	0.156	0.180	—	0.250	0.330	0.375	0.406	0.562	0.500	0.687	0.843	1.000	1.125	1.312	0.375	0.500	1.000(120)
14	14.000	0.156	0.188	0.250	0.312	0.375	—	0.438	0.593	—	0.750	0.937	1.093	1.250	1.406	0.375(30)	0.500	—
16	16.000	0.165	0.188	0.250	0.312	0.375	—	0.500	0.656	—	0.843	1.031	1.218	1.438	1.593	0.375(30)	0.500(40)	—
18	18.000	0.165	0.188	0.250	0.312	0.438	—	0.562	0.750	—	0.937	1.156	1.375	1.562	1.781	0.375	0.500	—
20	20.000	0.188	0.218	0.250	0.375	0.500	—	0.593	0.812	—	1.031	1.281	1.500	1.750	1.968	0.375(20)	0.500(30)	—
22[b]	22.000	0.188	0.218	0.250	0.375	0.500	—	0.625	0.875	—	1.125	1.375	1.625	1.875	2.125	0.375(20)	0.500(30)	—
24	24.000	0.218	0.250	0.250	0.375	0.562	—	0.687	0.968	—	1.218	1.531	1.812	2.062	2.343	0.375(20)	0.500	—

NOTE 1 Schedules 5S, 10S, 40S and 80S are normally supplied in austenitic chromium-nickel steel only (see Part 2 of this standard).

NOTE 2 In Columns 17, 18 and 19 numbers in brackets are the corresponding Schedule numbers.

[a] Abstracted from BS 1600, "*Dimensions of wrought steel pipe for the petroleum industry*".

[b] The use of these sizes should be avoided wherever possible.

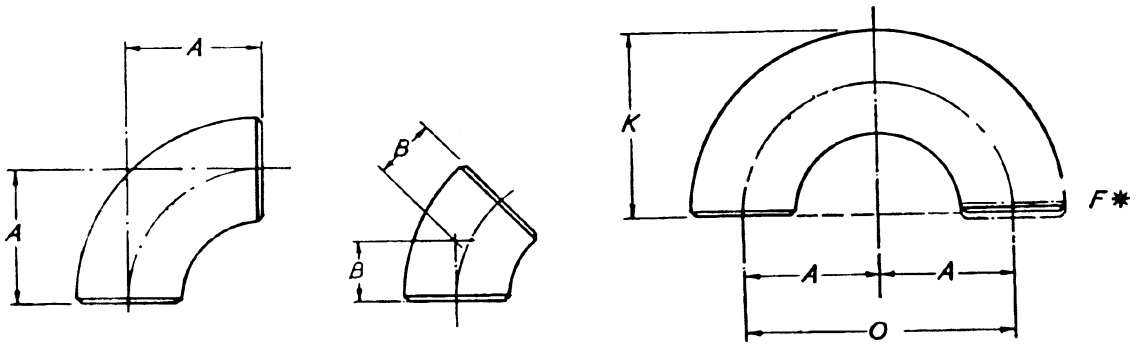

Table 4 — Dimensions of elbows and return bends

1	2	3	4	5	6	7	8
Nominal pipe size	90° elbow		45° elbow	Return bend			
	Centre to end *A*		Centre to end *B*	Centre to centre *O*		Back to face *K*	
	Short radius	Long radius	Long radius	Short radius	Long radius	Short radius	Long radius
in	in	in	in	in	in	in	in
$^3/_4$	$^3/_4$	$1^1/_8$	$^7/_{16}$	$1^1/_2$	$2^1/_4$	$1^5/_{16}$	$1^{11}/_{16}$
1	1	$1^1/_2$	$^7/_8$	2	3	$1^5/_8$	$2^3/_{16}$
$1^1/_4$	$1^1/_4$	$1^7/_8$	1	$2^1/_2$	$3^3/_4$	$2^1/_{16}$	$2^3/_4$
$1^1/_2$	$1^1/_2$	$2^1/_4$	$1^1/_8$	3	$4^1/_2$	$2^7/_{16}$	$3^1/_4$
2	2	3	$1^3/_8$	4	6	$3^3/_{16}$	$4^3/_{16}$
$2^1/_2$	$2^1/_2$	$3^3/_4$	$1^3/_4$	5	$7^1/_2$	$3^{15}/_{16}$	$5^3/_{16}$
3	3	$4^1/_2$	2	6	9	$4^3/_4$	$6^1/_4$
$3^1/_2$	$3^1/_2$	$5^1/_4$	$2^1/_4$	7	$10^1/_2$	$5^1/_2$	$7^1/_4$
4	4	6	$2^1/_2$	8	12	$6^1/_4$	$8^1/_4$
5	5	$7^1/_2$	$3^1/_8$	10	15	$7^3/_4$	$10^5/_{16}$
6	6	9	$3^3/_4$	12	18	$9^5/_{16}$	$12^5/_{16}$
8	8	12	5	16	24	$12^5/_{16}$	$16^5/_{16}$
10	10	15	$6^1/_4$	20	30	$15^3/_8$	$20^3/_8$
12	12	18	$7^1/_2$	24	36	$18^3/_8$	$24^3/_8$
14	14	21	$8^3/_4$	28	42	21	28
16	16	24	10	32	48	24	32
18	18	27	$11^1/_4$	36	54	27	36
20	20	30	$12^1/_2$	40	60	30	40
22	22	33	$13^1/_2$	44	66	33	44
24	24	36	15	48	72	36	48

* For tolerances on alignment, F, see Table 2.

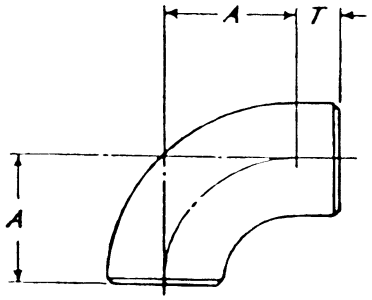

Table 5 — Dimension of 90° long radius tangent elbows

1	2	3
Nominal pipe size	**Centre to end** *A*	**Tangent** *T*
in	in	in
$1\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{4}$
2	3	$1\frac{1}{4}$
$2\frac{1}{2}$	$3\frac{3}{4}$	$1\frac{1}{4}$
3	$4\frac{1}{2}$	$1\frac{1}{4}$
$3\frac{1}{2}$	$5\frac{1}{4}$	$1\frac{1}{2}$
4	6	$1\frac{1}{2}$
5	$7\frac{1}{2}$	$1\frac{1}{2}$
6	9	$1\frac{3}{4}$
8	12	2
10	15	$2\frac{1}{2}$
12	18	3
14	21	$3\frac{1}{2}$
16	24	4
18	27	$4\frac{1}{2}$
20	30	5
24	36	6

NOTE 1 The tangent length *T* makes it possible to fit a slip-on welding flange to the elbow.
NOTE 2 Tangent elbows having a tangent length at one end only are to be regarded as the standard type of fitting, but elbows having tangent lengths at both ends may be supplied when specified by the purchaser.

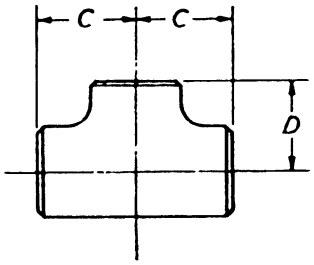

Table 6 — Dimensions of equal tees

1	2	3
Nominal pipe size	Centre to end	
	Run *C*	Branch *D*
in	in	in
$^3/_4$	$1^1/_8$	$1^1/_8$
1	$1^1/_2$	$1^1/_2$
$1^1/_4$	$1^7/_8$	$1^7/_8$
$1^1/_2$	$2^1/_4$	$2^1/_4$
2	$2^1/_2$	$2^1/_2$
$2^1/_2$	3	3
3	$3^3/_8$	$3^3/_8$
$3^1/_2$	$3^3/_4$	$3^3/_4$
4	$4^1/_8$	$4^1/_8$
5	$4^7/_8$	$4^7/_8$
6	$5^5/_8$	$6^5/_8$
8	7	7
10	$8^1/_2$	$8^1/_2$
12	10	10
14	11	11
16	12	12
18	$13^1/_2$	$13^1/_2$
20	15	15
22	$16^{1/2}$	$16^1/_2$
24	17	17

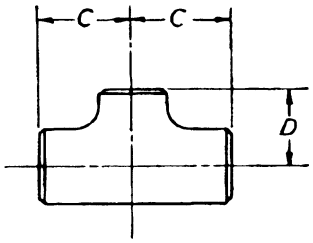

Table 7 — Dimensions of reducing tees

1	2	3	1	2	3	1	2	3
Nominal pipe size	Center to end		Nominal pipe size	Center to end		Nominal pipe size	Center to end	
	Run *C*	Branch *D*		Run *C*	Branch *D*		Run *C*	Branch *D*
in	in	in	in	in	in	in	in	in
1 × 1 × 3/4	1 1/2	1 1/2	5 × 5 × 4	4 7/8	4 5/8	16 × 16 × 14	12	12
1 × 1 × 1/2	1 1/2	1 1/2	5 × 5 × 3 1/2	4 7/8	4 1/2	16 × 16 × 12	12	11 5/8
			5 × 5 × 3	4 7/8	4 3/8	16 × 16 × 10	12	11 1/8
1 1/4 × 1 1/4 × 1	1 7/8	1 7/8	5 × 5 × 2 1/2	4 7/8	4 1/4	16 × 16 × 8	12	10 3/4
1 1/4 × 1 1/4 × 3/4	1 7/8	1 7/8	5 × 5 × 2	4 7/8	4 1/8	16 × 16 × 6	12	10 3/8
1 1/4 × 1 1/4 × 1/2	1 7/8	1 7/8						
			6 × 6 × 5	5 5/8	5 3/8	18 × 18 × 16	13 1/2	13
1 1/2 × 1 1/2 × 1 1/4	2 1/4	2 1/4	6 × 6 × 4	5 5/8	5 1/8	18 × 18 × 14	13 1/2	13
1 1/2 × 1 1/2 × 1	2 1/4	2 1/4	6 × 6 × 3 1/2	5 5/8	5	18 × 18 × 12	13 1/2	12 5/8
1 1/2 × 1 1/2 × 3/4	2 1/4	2 1/4	6 × 6 × 3	5 5/8	4 7/8	18 × 18 × 10	13 1/2	12 1/8
1 1/2 × 1 1/2 × 1/2	2 1/4	2 1/4	6 × 6 × 2 1/2	5 5/8	4 3/4	18 × 18 × 8	13 1/2	11 3/4
2 × 2 × 1 1/2	2 1/2	2 3/8	8 × 8 × 6	7	6 5/8	20 × 20 × 18	15	14 1/2
2 × 2 × 1 1/4	2 1/2	2 1/4	8 × 8 × 5	7	6 3/8	20 × 20 × 16	15	14
2 × 2 × 1	2 1/2	2	8 × 8 × 4	7	6 1/8	20 × 20 × 14	15	14
2 × 2 × 3/4	2 1/2	1 3/4	8 × 8 × 3 1/2	7	6	20 × 20 × 12	15	13 5/8
						20 × 20 × 10	15	13 1/8
2 1/2 × 2 1/2 × 2	3	2 3/4	10 × 10 × 8	8 1/2	8	20 × 20 × 8	15	12 3/4
2 1/2 × 2 1/2 × 1 1/2	3	2 5/8	10 × 10 × 6	8 1/2	7 5/8			
2 1/2 × 2 1/2 × 1 1/4	3	2 1/2	10 × 10 × 5	8 1/2	7 1/2	22 × 22 × 20	16 1/2	16
2 1/2 × 2 1/2 × 1	3	2 1/4	10 × 10 × 4	8 1/2	7 1/4	22 × 22 × 18	16 1/2	15 1/2
						22 × 22 × 16	16 1/2	15
3 × 3 × 2 1/2	3 3/8	3 1/4	12 × 12 × 10	10	9 1/2	22 × 22 × 14	16 1/2	15
3 × 3 × 2	3 3/8	3	12 × 12 × 8	10	9	22 × 22 × 12	16 1/2	14 5/8
3 × 3 × 1 1/2	3 3/8	2 7/8	12 × 12 × 6	10	8 5/8	22 × 22 × 10	16 1/2	14 1/8
3 × 3 × 1 1/4	3 3/8	2 3/4	12 × 12 × 5	10	8 1/2			
						24 × 24 × 22	17	17
3 1/2 × 3 1/2 × 3	3 3/4	3 5/8	14 × 14 × 12	11	10 5/8	24 × 24 × 20	17	17
3 1/2 × 3 1/2 × 2 1/2	3 3/4	3 1/2	14 × 14 × 10	11	10 1/8	24 × 24 × 18	17	16 1/2
3 1/2 × 3 1/2 × 2	3 3/4	3 1/4	14 × 14 × 8	11	9 3/4	24 × 24 × 16	17	16
3 1/2 × 3 1/2 × 1 1/2	3 3/4	3 1/8	14 × 14 × 6	11	9 3/8	24 × 24 × 14	17	16
						24 × 24 × 12	17	15 5/8
4 × 4 × 3 1/2	4 1/8	4				24 × 24 × 10	17	15 1/8
4 × 4 × 3	4 1/8	3 7/8						
4 × 4 × 2 1/2	4 1/8	3 3/4						
4 × 4 × 2	4 1/8	3 1/2						
4 × 4 × 1 1/2	4 1/8	3 3/8						

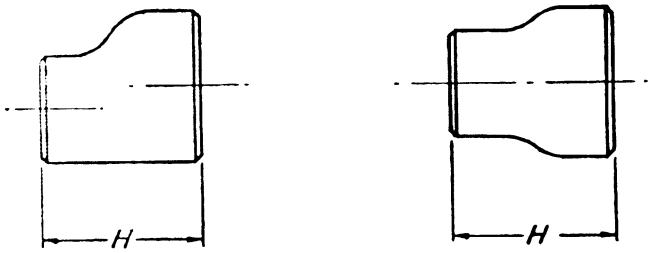

Table 8 — Dimensions of reducers (concentric and eccentric)

1	2	1	2	1	2	1	2
Nominal pipe size	**End-to-end *H***	**Nominal pipe size**	**End-to-end *H***	**Nominal pipe size**	**End-to-end *H***	**Nominal pipe size**	**End-to-end *H***
in	in	in	in	in	in	in	in
$^3/_4 \times {}^1/_2$	2	3 × $2^1/_2$	$3^1/_2$	6 × 5	$5^1/_2$	16 × 14	14
1 × $^3/_4$	2	3 × 2	$3^1/_2$	6 × 4	$5^1/_2$	16 × 12	14
1 × $^1/_2$	2	3 × $1^1/_2$	$3^1/_2$	6 × $3^1/_2$	$5^1/_2$	16 × 10	14
		3 × $1^1/_4$	$3^1/_2$	6 × 3	$5^1/_2$	16 × 8	14
$1^1/_4 \times 1$	2			6 × $2^1/_2$	$5^1/_2$		
$1^1/_4 \times {}^3/_4$	2	$3^1/_2 \times 3$	4			18 × 16	15
$1^1/_4 \times {}^1/_2$	2	$3^1/_2 \times 2^1/_2$	4	8 × 6	6	18 × 14	15
		$3^1/_2 \times 2$	4	8 × 5	6	18 × 12	15
$1^1/_2 \times 1^1/_4$	$2^1/_2$	$3^1/_2 \times 1^1/_2$	4	8 × 4	6	18 × 10	15
$1^1/_2 \times 1$	$2^1/_2$	$3^1/_2 \times 1^1/_4$	4	8 × $3^1/_2$	6		
$1^1/_2 \times {}^3/_4$	$2^1/_2$					20 × 18	20
$1^1/_2 \times {}^1/_2$	$2^1/_2$	4 × $3^1/_2$	4	10 × 8	7	20 × 16	20
		4 × 3	4	10 × 6	7	20 × 14	20
2 × $1^1/_2$	3	4 × $2^1/_2$	4	10 × 5	7	20 × 12	20
2 × $1^1/_4$	3	4 × 2	4	10 × 4	7		
2 × 1	3	4 × $1^1/_2$	4			22 × 20	20
2 × $^3/_4$	3			12 × 10	8	22 × 18	20
		5 × 4	5	12 × 8	8	22 × 16	20
$2^1/_2 \times 2$	$3^1/_2$	5 × $3^1/_2$	5	12 × 6	8	22 × 14	20
$2^1/_2 \times 1^1/_2$	$3^1/_2$	5 × 3	5	12 × 5	8		
$2^1/_2 \times 1^1/_4$	$3^1/_2$	5 × $2^1/_2$	5			24 × 22	20
$2^1/_2 \times 1$	$3^1/_2$	5 × 2	5	14 × 12	13	24 × 20	20
				14 × 10	13	24 × 18	20
				14 × 8	13	24 × 16	20
				14 × 6	13		

NOTE For reducers having wall thicknesses greater than Schedule 80, dimension *H* is to be subject to agreement between purchaser and manufacturer.

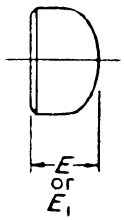

Table 9 — Dimensions of caps

1	2	3	4
Nominal pipe size	**Length E (see Note 3)**	**Limiting wall thickness for length E**	**Length E_1 (see Note 3)**
in	in	in	in
$^3/_4$	1	0.154	1
1	$1^1/_2$	0.179	$1^1/_2$
$1^1/_4$	$1^1/_2$	0.191	$1^1/_2$
$1^1/_2$	$1^1/_2$	0.200	$1^1/_2$
2	$1^1/_2$	0.218	$1^3/_4$
$2^1/_2$	$1^1/_2$	0.276	2
3	2	0.300	$2^1/_2$
$3^1/_2$	$2^1/_2$	0.318	3
4	$2^1/_2$	0.337	3
5	3	0.375	$3^1/_2$
6	$3^1/_2$	0.432	4
8	4	0.500	5
10	5	0.500	6
12	6	0.500	7
14	$6^1/_2$	0.500	$7^1/_2$
16	7	0.500	8
18	8	0.500	9
20	9	0.500	10
22	10	0.500	10
24	$10^1/_2$	0.500	12

NOTE 1 Caps are to be of semi-ellipsoidal shape and are to have a length of straight to make the overall length as specified in Columns 2 and 4. The height of the semi-ellipsoidal portion, measured externally, is to be not less than one quarter of the internal diameter of the cap.

NOTE 2 Lengths E_1 apply to caps of wall thicknesses not exceeding those given in Column 3.

NOTE 3 Lengths E apply to caps of wall thicknesses greater than those given in Column 3.

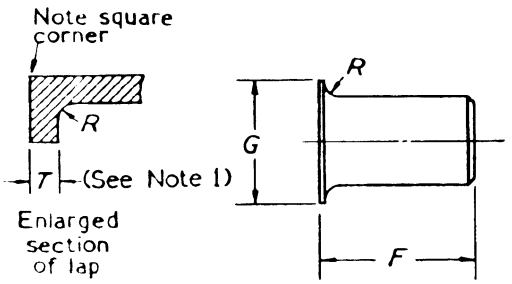

Table 10 — Dimensions of lap-joint stub-ends

1	2		3	4	5
Nominal pipe size	**Outside diameter of barrel**		**Length *F* (see Notes 1 and 3)**	**Radius of fillet *R* (see Note 4)**	**Diameter of lap *G* (see Note 2)**
	max.	**min.**			
in	in	in	in	in	in
$^3/_4$	1.111	1.019	3	$^1/_8$	$1^{11}/_{16}$
1	1.376	1.284	4	$^1/_8$	2
$1^1/_4$	1.716	1.629	4	$^3/_{16}$	$2^1/_2$
$1^1/_2$	1.966	1.869	4	$^1/_4$	$2^7/_8$
2	2.456	2.344	6	$^5/_{16}$	$3^5/_8$
$2^1/_2$	2.966	2.844	6	$^5/_{16}$	$4^1/_8$
3	3.596	3.469	6	$^3/_8$	5
$3^1/_2$	4.096	3.969	6	$^3/_8$	$5^1/_2$
4	4.593	4.469	6	$^7/_{16}$	$6^3/_{16}$
5	5.683	5.532	8	$^7/_{16}$	$7^5/_{16}$
6	6.743	6.594	8	$^1/_2$	$8^1/_2$
8	8.743	8.594	8	$^1/_2$	$10^5/_8$
10	10.913	10.719	10	$^1/_2$	$12^3/_4$
12	12.913	12.719	10	$^1/_2$	15
14	14.170	13.969	12	$^1/_2$	$16^1/_4$
16	16.180	15.969	12	$^1/_2$	$18^1/_2$
18	18.190	17.969	12	$^1/_2$	21
20	20.240	19.969	12	$^1/_2$	23
22	22.240	21.969	12	$^1/_2$	$25^1/_4$
24	24.240	23.969	12	$^1/_2$	$27^1/_4$

NOTE 1 The lap thickness *T* of a stub-end is to be not less than the nominal pipe wall or barrel thickness except that, where it is required to constitute the male facing of a large male/female type joint, it is not to be less than $^1/_4$ in.
Where the lap of a stub-end is required to carry a large female, large of small tongue, large or small groove or a ring-joint facing, the height of any such facing is to be additional to the basic lap thickness *T* and to the appropriate overall length *F*. For heights of female, tongue/groove and ring-joint facings refer to BS 1560[a].
In each case the backface of the lap is to be machined to conform to the surface of the flange on which it is to seat.
NOTE 2 Lap diameters *G* in Column 5 correspond to the diameters of raised, large male and large tongue facings specified in BS 1560[a]. Reference should be made to BS 1560, Tables 2 to 9, for diameters of other types of facing for lap joints.
NOTE 3 When stub-ends of nominal sizes 12 in and larger are used with higher pressure flanges, it may be necessary to increase the lengths *F* given in Column 3. This is to be a matter for agreement between purchaser and manufacturer.
NOTE 4 Radius *R* is the same as on a lap flange of corresponding size in BS 1560.

[a] BS 1560, "*Steel pipe flanges and flanged fittings (nominal sizes $^1/_2$ in to 24 in) for the petroleum industry*".

Appendix Information to be supplied by the purchaser

Certain clauses of this standard permit alternatives. It is recommended that the following information be supplied by the purchaser in the enquiry or order:

a) Type and quantity of fittings (Clause **1**);

b) Nominal size(s) and wall thickness or schedule number (Clause **2**);

c) Material identification symbol (Table 1);

d) Seamless or fabricated (Clause **5**);

e) End preparation for welding if other than standard [Clause **7** d)];

f) Specify hydrostatic test requirements for wrought fabricated fittings (Clause **17**);

g) Specify if tangent lengths at both ends are required (Table 5, Note 2).

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