

BRITISH STANDARD 10 : 1962

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SPECIFICATION FOR FLANGES AND BOLTING FOR PIPES, VALVES AND FITTINGS

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SPECIFICATION FOR FLANGES AND BOLTING FOR PIPES, VALVES AND FITTINGS

B.S. 10 : 1962

Incorporating amendments issued
January 1965 (PD 5413), April 1966 (PD 5823),
November 1966 (PD 5949) and September 1970 (AMD 585)

Obsolescence

In view of the change to the metric system in the U.K., B.S.10 should now be regarded as obsolescent. It will be made obsolete in due course.

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THIS BRITISH STANDARD, having been approved by the Mechanical Engineering Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 17th December, 1962.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 5000, indexed and cross-indexed for reference, together with an abstract of each standard, will be found in the Institution's Yearbook.

This standard makes reference to the following British Standards:

- B.S. 18. Methods for tensile testing of metals.**
- B.S. 21. Pipe threads.**
- B.S. 78. Cast iron spigot and socket pipes (vertically cast) and spigot and socket fittings: Part 1. Pipes.**
- B.S. 84. Parallel screw threads of Whitworth form.**
- B.S. 309. Whiteheart malleable iron castings.**
- B.S. 310. Blackheart malleable iron castings.**
- B.S. 350. Conversion factors and tables.**
- B.S. 806. Ferrous pipes and piping installations for and in connection with land boilers.**
- B.S. 916. Black bolts, screws and nuts.**
- B.S. 970. Wrought steels in the form of bars, billets, and forgings, up to 6 in ruling section, for automobile and general engineering purposes. En series.**
- B.S. 1083. Precision hexagon bolts, screws and nuts.**
- B.S. 1211. Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.**
- B.S. 1306. Non-ferrous pipes and tubes for steam services. Part 2. Seamless copper tubes for steam services.**

- B.S. 1400. Schedule of copper alloy ingots and copper and copper alloy castings.**
- B.S. 1452. Grey iron castings.**
- B.S. 1501–6. Steels for use in the chemical, petroleum and allied industries.**
- B.S. 1580. Unified screw threads. Parts 1 and 2. Diameters $\frac{1}{4}$ in and larger.**
- B.S. 1633. Steel for land boilers, receivers and other pressure vessels.**
- B.S. 1723. Brazing.**
- B.S. 1724. Bronze welding by gas.**
- B.S. 1768. Unified precision hexagon bolts, screws and nuts (UNC and UNF threads)—normal series.**
- B.S. 1769. Unified black hexagon bolts, screws and nuts (UNC and UNF threads)—heavy series.**
- B.S. 2035. Cast iron flanged pipes and flanged fittings.**
- B.S. 2060. Copper alloy globe valves for general purposes.**
- B.S. 2708. Unified black square and hexagon bolts, screws and nuts (UNC and UNF threads)—normal series.**
- B.S. 2789. Iron castings with spheroidal or nodular graphite.**
- B.S. 2856. Precise conversion of inch and metric sizes on engineering drawings.**
- B.S. 3100. Steel castings for general engineering purposes.**
- B.S. 3410. Metal washers for general engineering purposes.**
- B.S. 3601. Steel pipes and tubes for pressure purposes: carbon steel: ordinary duties.**
- B.S. 3602. Steel pipes and tubes for pressure purposes: carbon steel: high duties.**
- B.S. 3604. Steel pipes and tubes for pressure purposes: low and medium alloy.**

The following B.S.I. references relate to the work on this standard ·
Committee references MEE/11, MEE/11/1, MEE/11/1/1/1 and MEE/11/2.
Draft for comment A(MEE)151.

CO-OPERATING ORGANIZATIONS

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

- *Admiralty
 - Air Ministry
 - *Associated Offices Technical Committee
 - *Association of Consulting Engineers (Incorporated)
 - Association of Mining Electrical & Mechanical Engineers
 - British Chemical Plant Manufacturers' Association
 - British Compressed Air Society
 - *British Electrical and Allied Manufacturers' Association
 - British Engineers' Association
 - British Gear Manufacturers' Association
 - British Internal Combustion Engine Manufacturers' Association
 - *British Iron and Steel Federation
 - British Railways, The British Transport Commission
 - Crown Agents for Oversea Governments and Administrations
 - *D.S.I.R.—National Engineering Laboratory
 - *Electricity Council, the Generating Board and the Area Boards in England and Wales
 - *Engineering Equipment Users' Association
 - Gas Council
 - High Commission of India
 - Institute of Marine Engineers
 - Institute of Petroleum
 - *Institution of Civil Engineers
 - *Institution of Gas Engineers
 - Institution of Heating and Ventilating Engineers
 - *Institution of Mechanical Engineers
 - Institution of Mechanical Engineers (Automobile Division)
 - Institution of Production Engineers
 - Locomotive and Allied Manufacturers' Association of Great Britain
 - Machine Tool Trades Association
 - Ministry of Labour (Factory Inspectorate)
 - Ministry of Power
 - Ministry of Public Buildings and Works
 - *Ministry of Transport
 - National Coal Board
 - *National Physical Laboratory (D.S.I.R.)
 - Radio Industry Council
 - War Office
- The Government departments and scientific and 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 standard:
- British Bolt, Nut, Screw and Rivet Federation
 - British Valve Manufacturers' Association
 - Copper Development Association
 - Institute of Welding
 - Lloyd's Register of Shipping
 - National Association of Drop Forgers and Stampers
 - North East Coast Institution of Engineers and Shipbuilders
 - Oil Companies Materials Association
 - Water-tube Boilermakers' Association
 - Individual Manufacturers

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BRITISH STANDARD SPECIFICATION FOR FLANGES AND BOLTING FOR PIPES, VALVES AND FITTINGS

FOREWORD

This revised standard has been prepared under the authority of the Mechanical Engineering Industry Standards Committee and supersedes B.S. 10, Part 1, 1947; B.S. 10, Part 2, 1926; B.S. 10, Part 3, 1929; B.S. 10, Part 4, 1931 and B.S. 10, Part 5, 1932.

The number of tables has been reduced by the omission of Tables B, C, L, M and P included in the previous edition. The increase in pressure ratings at lower temperatures for Tables D and E has made Tables B and C redundant; Tables L, M and P have found little application.

Additions have been made to the standard to conform to the requirements of current practice. The size ranges for Tables D, E, K, R and T have been extended. Thicknesses for cast iron flanges have been added to Table H. Dimensional requirements for steel boss type flanges have been included in Tables A, D, E, F, H and J. Dimensions for welding neck flanges have also been included for all tables except Table A.

Some of the sizes of flanges specified in the previous edition of B.S. 10 have been deleted and other sizes have been introduced in this revised standard. The dimensions of flanges to Table A, Sizes 54 in, 60 in, 66 in, and 72 in, have been completely revised to meet the requirements of the principal users.

Pressure ratings for each table of flanges have been calculated to enable values to be scheduled for a number of temperatures, from 0°F (−17.8°C) upwards, superseding the ratings given in Clause 8, Part 5 of B.S. 10, 1932. Pressure ratings for flanges of carbon steel and cast iron have been increased at the lower temperatures; for flanges of copper alloy the temperature-pressure ratings are based on B.S. 2060* and flange thicknesses for certain sizes have been reduced in agreement with current practice. The pressures referred to in this standard are gauge pressures.

It should be noted that, apart from cast iron flanges, the hydraulic test pressure applied to a flange joint is limited to one-and-a-half times the highest rated pressure of the flange (see Clause 8).

Flange materials for all tables are now specified and this standard has been extended to cover flanges of certain alloy steels.

* B.S. 2060. 'Copper alloy globe valves for general purposes'

Review of tables. B.S. 10 flanges have been in use since 1904 and have been developed continuously to meet increasing pressure and temperature requirements. At the time of this revision, flange joints with carbon steel pipe flanges for high temperatures and pressures to the British Standard tables have been in service throughout the world for periods equal to the economic life of primary plant. The trend towards the use of ever higher temperatures in thermal cycles, together with the need to conserve resources, necessitated a revision of design theory. Research into the design of flange joints under the auspices of the Institution of Mechanical Engineers made it possible to calculate the effects of high temperatures. The results of this research have been applied in this revision of B.S. 10.

Experience has indicated that where temperatures of 800°F (427°C) and higher have to be withstood, an estimate of the effect of creep becomes essential so that the condition of a joint at any given time, after initial tightening, can be predicted. This has been made possible by methods of analysis developed for application to the British Standard type of flange, and examination of the resulting proportions of these flanges has shown that a complete rationalization of the tables can be obtained by an increase in the thickness of the flange in certain sizes. Apart from Table A sizes 54 to 72 inch, the other basic dimensions, i.e., the flange diameter, bolt circle diameter and the number and sizes of the bolts have not been altered except in the case of Table E where the bolt diameter has been increased from 1 inch to 1 ½ inch for the 24 inch size flange.

The type of steel flange for which calculations have been made is essentially a flat annular ring, homogeneous with the pipe, having a raised jointing face of prescribed diameter and with the gasket substantially covering the full area of the jointing face. The thicknesses of boss and welding neck flanges and of integral flanges – cast or forged – on valves, have not yet been evaluated theoretically. As an interim measure the thicknesses for boss and welding neck flanges are the same as for plain flanges and the existing thicknesses of integral flanges on valves, which have been used for many years, are given in the tables.

Development of analysis. It has been established that the critical stress in a steel plain flange is the circumferential stress.

In calculating the external loads on the flange allowance has been made for the effect of the adjacent pipe which is usually subjected to plastic deformation.

At temperatures where no creep occurs elastic conditions prevail in the flange plate throughout the lifetime of the joint and the elastic theory has been used for these conditions.

Where temperatures are such as to produce creep and consequently plastic conditions in all parts of the joint the initial stresses relax and the stress distribution is changing throughout its lifetime. In this case the criterion for tightness of the joint has to be satisfied under initial tightening conditions (cold), under operating conditions at the end of its life and at all intermediate times.

To solve completely the problems set by these requirements, the relaxed stresses in the component parts of the joint in service should be known. For carbon steel these stresses were obtained from tests on 8 in bore—Table T flanges; for alloy steel they have been derived from existing designs which have been proved to be reliable in service over many years.

As far as present knowledge of creep and relaxation properties allows, the temperatures applicable at corresponding pressures (Temperature—pressure applicability) for steel flanges have been ascertained on the basis of ensuring a tight joint for a period of 100 000 hours of continuous service under stable conditions without retightening.

NOTE 1. When metric equivalents of the pipe dimensions in this standard are required, reference should be made to the corresponding values in ISO recommendations R64* and R65† as appropriate. When it is required to convert the figures in this standard from British units into metric units it is recommended that the conversion factors and the table of conversion contained in B.S. 350, 'Conversion factors and tables', be used. Attention is also drawn to B.S. 2856, 'Precise conversion of inch and metric sizes on engineering drawings'.

NOTE 2. In place of the customary, but incorrect, use of the pound as a unit of force, the unit called 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.

SPECIFICATION

SCOPE

1. This standard provides for a series of carbon steel, alloy steel, cast iron and copper alloy flanges, and also appropriate bolts and nuts, for use with pipes, valves and fittings containing steam, oil, compressed air or water within the following ranges of temperature and pressure:

Temperature: — 328°F (— 200°C) up to and including 975°F (524°C) *As altered Apr. 1966*
(for low temperature applications refer to Clause 9).

Pressure: Up to and including 2800 lbf/in².

The use of flanges complying with this standard for temperatures below 0°F (—17.8°C) shall be agreed between purchaser and manufacturer.

These flanges may also be used on pipes, valves and fittings carrying other fluids for which the same requirements for safety and joint tightness are appropriate.

The applicability relationship between temperature and pressure for the above materials is specified for each table of flanges in Tables 3, 4, 5 and 6.

The types of gasket, and gasket materials, and the surface finish of the jointing face are matters for agreement between the purchaser and the manufacturer. When a raised jointing face is specified the outside diameter of the gasket should extend at least to the outside diameter of the raised face. For steel flanges when a raised jointing face is not specified, the gasket should be within the bolt holes.

* ISO R64, 'Steel tubes: outside diameters'.

† ISO R65, 'Steel tubes suitable for screwing in accordance with ISO Recommendation R'.

DESIGN TEMPERATURE AND PRESSURE

2. The design temperature and pressure shall be stated by the purchaser except where the flange table is specified. Where there is an appropriate application standard it is the responsibility of the purchaser to ensure that the design temperature and pressure stated comply with the requirements of that standard. The temperature-pressure ratings given in Tables 3 to 6 inclusive are design temperatures and pressures. The pressure ratings, with the exception of those in the second column in Table 5 are applicable to installations subject to moderate shock such as may occur in an efficiently designed and operated boiler feed main. Where a system may be subject to more severe shock, it is the responsibility of the purchaser to make a suitable allowance when stating the design pressure or the flange table.

DESIGNATION

3. The flange sizes shall be designated by the nominal bores of their respective pipes as given in the first and last column of each table.

FLANGE DIMENSIONS

4. The dimensions of the flanges to this standard shall conform to those specified in the appropriate tables and Figs. 3, 4, 5, 6 and 7.

As
altered
Jan.
1963

The thicknesses and diameters of flanges specified in this standard are minima except that the thickness (T) of cast iron flanges of pipes and fittings to B.S. 2035* and B.S. 78, part 1†, shall be subject to limits of $\pm (0.05T + 0.03)$ in.

a. *Raised jointing faces for steel flanges only.* (see Figs. 3, 4, 5 and 6).

(i) *Tables A, D, E and F.* Raised jointing faces are not specified because it is not customary to use them on these flanges. If a raised jointing face is required on a steel flange, the diameter shall be $\frac{1}{4}$ in less than the diameter of the inscribed circle touching the bolt holes.

(ii) *Tables H, J, and K.* Raised jointing faces are specified in these tables and are recommended only for steel flanges.

(iii) *Tables R, S and T.* Raised jointing faces as specified in these tables shall be used.

b. *Flange thicknesses.* (Figs. 3, 4, 5, 6 and 7).

The thickness (T) specified in the tables includes a raised jointing face having a height not exceeding $\frac{1}{16}$ in. Where there is no raised face, T is the thickness of the flange.

If the height of the raised jointing face is more than $\frac{1}{16}$ in, the thickness (T) shall be increased by an equivalent amount.

* B.S. 2035, 'Cast iron flanged pipes and flanged fittings'.

† B.S. 78, 'Cast iron spigot and socket pipes (vertically cast) and spigot and socket fittings', Part 1, 'Pipes'.

The backs of integrally cast steel flanges shall be machined. This machining may be either by spot-facing at the bolt holes or by back-facing at the option of the manufacturer (see Fig. 5). The backs of other flanges may be left unmachined at the option of the manufacturer unless otherwise specified by the purchaser.

After machining, the thickness of the flange shall not be less than the thickness specified.

c. Flange drilling. Unless otherwise specified by the purchaser all bolt holes shall be drilled, shall be equally spaced on the bolt pitch circle diameter, and in the case of integral flanges the bolt holes shall be drilled off centres. As altered
Apr. 1966

For $\frac{1}{2}$ inch and $\frac{5}{8}$ inch bolts, the diameters of the holes shall be $\frac{1}{16}$ inch larger than the diameters of the bolts, except that for cast iron flanges with $\frac{5}{8}$ inch bolts the holes may be $\frac{1}{8}$ inch larger than the diameters of the bolts. For $\frac{3}{4}$ inch bolts and larger, the diameter of the holes shall not be more than $\frac{1}{8}$ inch larger than the diameters of the bolts in all cases.

FLANGE MATERIALS

5. Flanges shall be made of the following materials, as appropriate:

(i) Steel flanges either forged, stamped or plate shall be made of materials complying with the minimum requirements of the following. Alternative materials may be used providing that the mechanical properties at operating temperature are not inferior to those given in the specifications referred to below. As altered
Apr. 1966

Flange table	TEMPERATURE	
	0°F to 750°F inc. — 17.8°C to 399°C inc.	over 750°F to 900°F inc. over 399°C to 482°C inc.
A to J inclusive	B.S. 1501-151 Grade 23A* B.S. 1503-161 Grade A†	B.S. 1501-151 Grade 23B* B.S. 1503-161 Grade B†
K to T inclusive	B.S. 1501-151 Grade 26A* B.S. 1503-161 Grade B†	B.S. 1501-151 Grade 26B* B.S. 1503-161 Grade B†

(ii) Steel of the following minimum requirements may be used for flanges in Tables A to H inclusive for temperatures from 0°F (— 17.8°C) to 500°F (260°C).

Analysis:

Carbon	0.26 per cent maximum
Sulphur	0.06 per cent maximum
Phosphorus	0.06 per cent maximum

* B.S. 1501, 'Steels for fired and unfired pressure vessels. Plates'.

† B.S. 1503, 'Steels for use in the chemical, petroleum and allied industries. Forgings'.

Tensile strength: 22 tonf/in² minimum.

Elongation: Percentage elongation on gauge length of $5.65\sqrt{S_0}$ not less than 600 divided by the tensile strength (tonf/in₂) of the test piece.

b. Cast carbon steel to B.S. 592—Grade A, in B.S. 3100* or B.S. 1504—161, Grade A.†.

c. Forged carbon-molybdenum steel to B.S. 1503–240, Grade A.†.

d. Cast carbon-molybdenum steel to B.S. 1398 in B.S. 3100* or B.S. 1504–240†.

e. Forged chromium molybdenum steel to B.S. 1503–620† or B.S. 3604‡.

f. Cast chromium molybdenum steel to B.S. 1504–621†.

g. Grey cast iron having mechanical properties at least equivalent to the following (see Table 5):

*As altered
Jan.,
1963*

TABLE	TEMPERATURE			
	°F	0 to 250	0 to 375	up to 430
	°C	— 17.8 to 121.1	— 17.8 to 190.6	— 17.8 to 221
A, D and E	B.S. 1452, Grade 12§ B.S. 2035	B.S. 1452, Grade 12§	B.S. 1452, Grade 12§	B.S. 1452, Grade 14§
F and H	B.S. 1452, Grade 12§	B.S. 1452, Grade 12§	B.S. 1452, Grade 12§	B.S. 1452, Grade 14§

* B.S. 3100, 'Steel castings for general engineering purposes'.

† B.S. 1501–6, 'Steels for use in the chemical, petroleum and allied industries'.

‡ B.S. 3604, 'Steel pipes for pressure purposes—low and medium alloy'.

§ B.S. 1452, 'Grey iron castings'.

|| B.S. 2035, 'Cast iron flanged pipes and flanged fittings'.

h. Malleable cast iron to B.S. 309* or B.S. 310†.

j. Copper alloys having mechanical properties at least equivalent to those specified in B.S. 1400-LG2-C, or B.S. 1400-LG3-C‡.

NOTE. Other grades of alloy steels, cast iron and copper alloys having superior properties are available for which the temperature-pressure ratings have not yet been evaluated. Spheroidal or nodular cast iron to B.S. 2789§ may be used at temperatures not exceeding 650°F (343.3°C)

Flanges shall be free from laminations and surface defects.

Where welding neck flanges are made from wrought steel the direction of the fibres of the material in the neck shall be parallel to the longitudinal axis of the flange.

If the purchaser requires certificates of the process, chemical analysis of the specified elements and physical properties of the materials, this shall be stated on the order.

When the purchaser requires the individual flange he has ordered to be marked to identify the materials used, the system of marking to be employed shall be the subject of agreement between the purchaser and the manufacturer.

BOLTS AND NUTS

6. *a. Application.* Bolts, stud-bolts and nuts shall comply with the minimum requirements, corresponding to the various flange tables and temperature limits, specified in Table 1.

b. Dimensions, finish and materials. Hexagon headed bolts with hexagon nuts or stud-bolts with hexagon nuts shall be used, the dimensions and finish of which shall comply with the requirements of Table 2. The materials specified in Table 2 are typical and materials to other specifications, having similar or superior properties, may be used by agreement between the purchaser and the manufacturer.

Free cutting steel shall not be used for design temperatures exceeding 450°F (232.2°C).

For design temperatures up to and including 500°F (260°C) steels for bolts, stud-bolts and nuts shall contain not more than 0.060 per cent of sulphur or phosphorus and for design temperatures over 500°F (260°C) shall contain not more than 0.050 per cent of sulphur or phosphorus.

The minimum yield stresses specified for alloy steels apply to the material in the hardened and tempered condition.

Alloy steels shall have creep relaxation properties and impact properties adequate for the design temperature and shall be agreed between the purchaser and the manufacturer.

* B.S. 309, 'Whiteheart malleable iron castings'.

† B.S. 310, 'Blackheart malleable iron castings'.

‡ B.S. 1400, 'Schedule of copper alloy ingots and copper and copper alloy castings'.

§ B.S. 2789, 'Iron castings with spheroidal or nodular graphite'.

*As
altered
Jan.,
1963*

c. Nuts. Nuts may be made from steel to the same specification as that used for the bolts or stud-bolts to which they are fitted but, for design temperatures over 550°F (287.8°C), it is recommended that nuts should be made from a material having a lower tensile strength than that for the bolts, provided that it is suitable for the design temperature.

d. Stud-bolts. Stud-bolts for design temperatures not exceeding 750°F (399°C) shall be:

*As
altered
Apr.
1966*

(i) screwed each end and plain in centre.

or (ii) screwed full length,

For design temperatures above 750°F (399°C) and not exceeding 900°F (482°C) stud-bolts shall be:

(iii) screwed each end and shaped in accordance with Fig. 1,

or (iv) screwed full length.

For design temperatures above 900°F (482°C):

(v) screwed each end and shaped in accordance with Fig. 1.

e. Washers. Washers, where used, shall be of steel and shall be:

(i) For bolts or stud-bolts references I, II or III (see Table 2)—to B.S. 3410*.

or (ii) For bolts or stud-bolts references IV, V or VI (see Table 2)— to B.S. 3410, Part 1*, except that for design temperatures above 900°F (482°C), the steel shall be to B.S. 970 En 2E, 3A or 4†, unless otherwise agreed between purchaser and manufacturer.

The use of washers may necessitate the partial removal of the radius or fillet at the back of the flange by spot-facing or back-facing. Washers shall not be fitted where this would result in the removal of the radius or fillet to an extent greater than that indicated in Fig. 5 for integrally cast or forged steel flanges.

NOTE. For references III to VI inclusive (see Table 2) it is desirable to mark the nuts, bolts and stud-bolts to identify the materials used. When the purchaser requires this to be done, the system of marking to be employed should be the subject of agreement between the purchaser and the manufacturer.

ATTACHMENT OF FLANGES

7. *a.* The method of securing flanges (other than integral flanges) to pipes and fittings supplied complete by manufacturers shall be in accordance with the appropriate application standard. Where there is no appropriate application standard, the methods of attachment shall be the subject of agreement between

* B.S. 3410, 'Metal washers for general engineering purposes'.

† B.S. 970, 'Wrought steels in the form of bars, billets and forgings, up to 6 in ruling section, for automobile and general engineering purposes. En series'.

the purchaser and the manufacturer, but the methods shown in the following British Standards should be regarded as minimum requirements:

B.S. 806. Ferrous pipes and piping installations for and in connection with land boilers.

B.S. 1306. Part 1. Non-ferrous pipes and piping installations for and in connection with land boilers.

b. If flanges are to be supplied loose, they shall, unless otherwise specifically called for by the purchaser, be prepared for attachment to pipes as follows:

Steel flanges:

- (i) Boss flanges, sizes 6 in and smaller – screwed in accordance with B.S. 21, 'Pipe threads'.
- (ii) Boss flanges, sizes 7 in to 12 in machined in the bore to slip over the outside diameter of the pipe or fitting; suitable for welding.
- (iii) Plain flanges $\frac{1}{2}$ in thick and thicker – machined in the bore; suitable for welding-on to form one of the types in the appropriate application standard as required by the purchaser. The purchaser shall specify the type of preparation required.
- (iv) Welding neck flanges – machined in the bore to a diameter to be specified by the purchaser, and suitably bevelled for welding to pipes or fittings.

Copper alloy flanges: Machined in the bore to slip over the outside diameter of the pipe or fitting; suitable for fusion welding (where applicable), bronze welding to B.S. 1724* or brazing to B.S. 1723.†

HYDRAULIC TESTING OF FLANGE JOINTS

8. This standard does not specify the hydraulic test pressures for flanged pipes or components, details of which should be obtained from the appropriate standards which specify test pressures for pipes or components but in any case, the test pressure to be applied to the joint shall not exceed one-and-a-half times the highest rated pressures for steel and copper alloy flanges, and twice the highest rated pressures for cast iron flanges.

Where flanged assemblies are not covered by any standard specifying test pressures but incorporate flanges complying with this standard, or where any assembly is to be used for duties of a special nature, the test pressure shall be agreed between the purchaser and the manufacturer.

* B.S. 1724, 'Bronze welding by gas'.

† B.S. 1723, 'Brazing'.

TABLE 1. APPLICATION OF BOLTS AND STUD-BOLTS (See Figs. 2a and 2b)

Flange tables	Design temperature not exceeding	Reference for bolts or stud-bolts (see Table 2, Column 1)	Type	Flange tables	Design temperature not exceeding	Reference for bolts or stud-bolts (see Table 2, Column 1)	Type
A & D	450°F (232.2°C)	I	Bolt	H, J & K	750°F (399°C) 900°F (482°C) 975°F (524°C)	III V VI	Bolt or stud-bolt Stud-bolt
D, E & F	500°F (260°C) 750°F (399°C) 800°F (427°C)	II III V	Bolt or stud-bolt Bolt or stud-bolt Stud-bolt	R, S & T	750°F (399°C) 900°F (482°C) 975°F (524°C)	IV V VI	Bolt or stud-bolt Stud-bolt Stud-bolt

As altered
Jan.,
1965

TABLE 2. MATERIALS, DIMENSIONS AND FINISH OF BOLTS, STUD-BOLTS AND NUTS

Ref.	Materials	Typical material specifications		Screw threads (B.S. 84* or B.S. 1580†)	Specifications for dimensions (except screw threads) and finish	
		Bolts and stud-bolts	Nuts		Bolts and nuts, and nuts for stud-bolts	Stud-bolts
I	Carbon steel	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Min. tensile strength 26 tonf/in²	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Min. tensile strength 26 tonf/in²	B.S.W. or UNC	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Black all over	—
II	Carbon steel	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Min. tensile strength 28 tonf/in² Not more than 0.060 per cent sulphur or phosphorus	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Min. tensile strength 28 tonf/in² Not more than 0.060 per cent sulphur or phosphorus	B.S.W. or UNC	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Black all over	
III	Carbon steel	Tensile strength 35/40 tonf/in² Min. yield stress 18 tonf/in² Min. elongation 20 per cent on 2 in gauge length For design temperatures not exceeding 500°F (260°C) not more than 0.060 per cent sulphur or phosphorus. For design temperatures over 500°F (260°C) not more than 0.050 per cent sulphur or phosphorus.	Tensile strength 32/38 tonf/in² Min. yield stress 16 tonf/in² Min. elongation 20 per cent on 2 in gauge length Alternatively, Tensile strength 35/40 tonf/in² Min. yield stress 18 tonf/in² Min. elongation 20 per cent on 2 in gauge length In each case, for design temperature not exceeding 500°F (260°C) not more than 0.060 per cent sulphur or phosphorus. For design temperatures over 500°F (260°C) not more than 0.050 per cent sulphur or phosphorus.	B.S.W. or B.S.F. or UNC 8 UN (sizes over 1 inch)	B.S. 916‡ or B.S. 1769§ or B.S. 2708 Black all over	Shaped as Fig. 1 or screwed full length or screwed each

IV	Carbon steel	B.S. 1083, Grade R $\frac{1}{2}$; or B.S. 1768, Grade S**. Not more than 0.050 per cent sulphur or phosphorus.	0.050 per cent sulphur or phosphorus	B.S.W. or B.S.F. or UNC or 8 UN (sizes over 1 in)	B.S. 916 $\frac{1}{2}$ or B.S. 1769 $\frac{1}{2}$ or B.S. 2708 $\frac{1}{2}$ Alternatively, B.S. 1083 $\frac{1}{2}$ B.S. 1768**	With heads and nuts machined on bearing face.	end and plain in centre.
V	Alloy steel	B.S. 970 $\frac{1}{2}$ †† En 20B(T), hardened and tempered. Min. yield stress 44 tonf/in ^{2}	Carbon-molybdenum to B.S. 1506-240 $\frac{1}{2}$ † Alternatively, B.S. 970 $\frac{1}{2}$ †† En 20B(T) hardened and tempered. Alternatively, for design temperatures not exceeding 850°F (454°C) carbon steel. Tensile strength 35/40 tonf/in ^{2} Min. yield stress 18 tonf/in ^{2} Min. elongation 20 per cent on 2 in gauge length Not more than 0.050 per cent sulphur or phosphorus.	B.S.F. or UNC (sizes 1 in and below) 8 UN (sizes over 1 in)	(Nuts only) B.S. 916 $\frac{1}{2}$ or B.S. 1769 $\frac{1}{2}$ or B.S. 2708 $\frac{1}{2}$ Alternatively, B.S. 1083 $\frac{1}{2}$ or B.S. 1768**	Machined on bearing face	Shaped as Fig. 1 except as stated in Clause 6d.
VI	Alloy steel	Chromium molybdenum or chromium molybdenum vanadium steel with creep relaxation and impact properties adequate for the design temperature which shall be agreed between the purchaser and the manufacturer. For design temperatures not exceeding 950°F, carbon-molybdenum nuts to B.S. 1506-240 $\frac{1}{2}$ †† may be used.		B.S.F. or UNC (sizes 1 in and below) 8 UN (sizes over 1 in)	(Nuts only) B.S. 916 $\frac{1}{2}$ or B.S. 1769 $\frac{1}{2}$ or B.S. 2708 $\frac{1}{2}$ Alternatively, B.S. 1083 $\frac{1}{2}$ B.S. 1768**	Machined on bearing face	

* B.S. 84, 'Parallel screw threads of Whitworth form'.

† B.S. 1580, 'Unified screw threads'.

‡ B.S. 916, 'Black bolts, screws and nuts'.

§ B.S. 1769, 'Unified black hexagon bolts, screws and nuts (UNC and UNF threads) - normal series'.

|| B.S. 2708, 'Unified black square and hexagon bolts, screws and nuts'.

¶ B.S. 1083, 'Precision hexagon bolts, screws and nuts'.

** B.S. 1768, 'Unified precision hexagon bolts, screws and nuts (UNC and UNF threads) - normal series'.

†† B.S. 970, 'Wrought steels in the form of bars, billets and forgings, up to 6 in ruling section, for automobile and general engineering purposes. En series'.

‡‡ B.S. 1501-6, 'Steels for use in the chemical, petroleum and allied industries'.

NOTE. For sizes above 1 in (Ref. III, IV, V & VI), 8 UN threads to B.S. 1580 are specified.

TABLE 3. TEMPERATURE - PRESSURE RATINGS
(See Clauses

TABLE	TEMPERATURE							
	°F	0 to 250	0 to 450	500	550	600	650	700
	°C	-17.8 to 121.1	-17.8 to 232.2	260.0	287.8	315.6	343.3	371.1
PRESSURE								
A		50†	25*					
D			100	95	85	80	70	65
E			200	185	170	155	140	130
F			300	280	255	235	215	195
H			500	465	430	395	355	320
J			700	650	600	550	500	450
K			900	835	770	705	645	580
R			1 200	1 115	1 030	945	855	770
S			1 800	1 670	1 545	1 415	1 285	1 155
T			2 800	2 600	2 400	2 200	2 000	1 800

Intermediate values above 450°F (232.2°C) may be obtained by linear interpolation.

* This rating applies to temperatures above 250°F (121.1°C) up to and including 450°F (232.2°C) and does not apply to flange sizes above 36 in.

TABLE 4. TEMPERATURE - PRESSURE RATINGS
(See Clauses 5c,

TABLE	TEMPERATURE								
	°F	0 to 450	500	550	600	650	700	750	800
	°C	-17.8 to 232.2	260.0	287.8	315.6	343.3	371.1	399	427
PRESSURE									
H		500	470	445	415	390	360	335	305
J		700	660	620	585	545	505	465	430
K		900	850	800	750	700	650	600	550
R		1 200	1 135	1 065	1 000	935	865	800	735
S		1 800	1 700	1 600	1 500	1 400	1 300	1 200	1 100
T		2 800	2 645	2 490	2 335	2 180	2 020	1 865	1 710

Intermediate values may be obtained by linear interpolation.