



Specification for

Ductile iron pipes and fittings

Spécification des tuyaux et raccords en fonte ductile

Spezifikation für Rohre und Formstücke aus ductilem Gusseisen

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Foreword

This British Standard, prepared under the direction of the Iron and Steel Standards Committee, supersedes BS 4772 : 1971 which is now withdrawn. This revision is based on ISO 2531-1980 'Ductile iron pipes, fittings and accessories for pressure pipe-lines' published by the International Organization for Standardization (ISO).

Spigot and socket pipes in accordance with BS 78 : Part 1 and BS 1211 and fittings in accordance with BS 78 : Part 2 are not interchangeable with metric size units, and therefore the following optional methods of connecting metric size pipe with imperial size pipe are provided in this specification:

- (a) a double-socket change collar in accordance with table 25 of this standard; or
- (b) a spigot and socket change piece in accordance with table 26 with a standard metric size collar in accordance with table 24, where required; or
- (c) a double spigot change piece in accordance with table 27 with a standard metric size collar in accordance with table 24 and/or an imperial size collar, where required.

This British Standard provides for:

- (a) ductile iron pipe with flexible joints;
- (b) ductile iron pipe with flanges cast on or screwed-on;
- (c) ductile iron pipe with flanges welded-on;

(d) ductile iron fittings;

(e) cement mortar linings. (See appendix C.)

In view of the increase in use of cement mortar linings, these are included in this specification for the first time. The specification is based on ISO 4179-1980. The committee responsible for the preparation of this British Standard has taken note of the fact that standards for cement mortar/concrete linings other than ISO 4179-1980, are under consideration. If, at some future date, some degree of co-ordination becomes possible, this will be taken account of in a revision.

Flanges in this specification have been rationalized dimensionally to facilitate production. This does not affect their interchangeability with the corresponding flanges in BS 4504.

Detailed guidance on the use of these components in pipelines and pipe systems is provided in CP 2010 : Part 3.

NOTE 1. Pressures in this standard are given in bar (gauge):
1 bar = 10^5 N/m² = 100 kPa.

NOTE 2. Attention is drawn to the fact that it is claimed that the method of flanged attachment detailed in table 15 and described in 7.2.5 is the subject of British Patent no. 1443810, copies of which can be obtained from The Patent Office, 25 Southampton Buildings, London WC2. BSI takes no position as to the validity of the patent. The patent is endorsed 'Licence of Right' under Section 46 of the Patents Act 1977, which states:

'(3) Where such an entry is made in respect of a patent —

(a) any person shall, at any time after the entry is made, be entitled as of right to a licence under the patent on such terms as may be settled by agreement or, in default of agreement, by the comptroller on the application of the proprietor of the patent or the person requiring the licence.'

British Standard Specification for

Ductile iron pipes and fittings

1. Scope

1.1 This British Standard specifies requirements for ductile iron pipes produced by the following methods:

- (a) centrifugal casting in metal moulds;
- (b) centrifugal casting in sand moulds;
- (c) casting in sand moulds.

1.2 This standard also applies to ductile iron pipes and fittings having spigots and/or sockets for flexible joints or flanges and also to ductile iron pipes and fittings having other types of joint, the general dimensions of which, except those relating to the joints, are specified in this standard.

NOTE. Ductile iron pipes and fittings are not normally manufactured with spigots and sockets for lead caulked joints, except that imperial size ends of change fittings only may be specified with sockets of this type (6.6.2).

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Definitions

For the purposes of this British Standard the following definitions apply.

3.1 ductile iron. An iron used for pipes and fittings in which the graphite is present substantially in spheroidal form, instead of in flakes such as occur in grey iron.

3.2 pipe. A casting of uniform bore, straight in axis, having spigot, socket, flange or plain ends.

3.3 fitting. Any casting other than a pipe.

3.4 flexible joint. A connection between individual pipes and/or fittings that provides angular deflection or axial movement, or a combination of both, in service without impairing the efficiency of the connection.

3.5 push-in joint. A flexible joint in which an elastomeric gasket is located in the socket and the joint assembly is effected by entering the spigot through the gasket into the socket.

3.6 mechanical joint. A flexible joint in which an elastomeric gasket is located in the socket, sealing being obtained by applying pressure to the gasket by means of a gland bolted to the socket.

3.7 pressure rating. The maximum sustained operating pressure at which the pipe or fitting may be used.

NOTE. See CP 2010 : Part 3 with regard to surge pressure.

3.8 class designation. See 4.1 for the definition.

3.9 nominal size (DN). A numerical designation of size that is common to all components in a piping system. It is a convenient round number (in mm) for reference

manufacturing dimensions. The designation 'dn' has been used to denote nominal sizes of tees and tapers where these are less than 'DN'.

3.10 nominal pressure (PN). A numerical designation of pressure that is common to all components in a piping system. The values shown in this British Standard are aligned with those used for nominal pressure in related standards (e.g. BS 4504).

4. Class designations and calculation of standard wall thicknesses of pipes and fittings

4.1 The system of class designations used in this British Standard follows that established in ISO 2531.

Each designation shall comprise:

- (a) a prefix K.
- (b) a whole number (This is the selected coefficient inserted into the formula provided for the calculation of mean wall thickness (see 4.2).

4.2 Calculation of standard wall thickness of pipes and fittings

4.2.1 The standard wall thicknesses, e , of class K9 pipes up to and including DN 200 are calculated by the formula:

$$e = 5.8 + 0.003 D_N$$

4.2.2 Except for class K9 pipes up to and including DN 200, the standard wall thicknesses of pipes and fittings are calculated as a function of their nominal size by the formula:

$$e = K (0.5 + 0.001 D_N)$$

where

e is the standard wall thickness (in mm)

D_N is the nominal size (in mm)

K is the selected whole number coefficient (9, 12 and 14 being applicable to the classes designated K9, K12 and K14 respectively).

5. Pipes

5.1 Standard pipes with flexible joints shall be class K9 and shall conform to the dimensions given in table 13.

5.2 Standard pipes with screwed-on or cast-on flanges shall be class K12 and shall conform to the dimensions given in tables 14 and 16 respectively.

5.3 Standard pipes with welded-on flanges shall be class K9 and shall conform to the dimensions given in table 15.

5.4 The standard lengths of pipes are shown in tables 13 to 15. Where the purchaser specifies pipes of non-standard length (e.g. for make-up purposes), these pipes shall comply with the requirements of this British Standard except with regard to standard length.

5.5 The hydraulic pressure ratings and hydrostatic test pressures after installation for standard pipes shall be in accordance with appendix A. For further information relating to consideration of pressure ratings and field testing of pipelines, see CP 2010 : Part 3. The works proof tests shall be in accordance with clause 15.

5.6 Pipeline design considerations may justify or require the use of classes other than those detailed in tables 13, 14, 15 and 16. Provided that the thickness aligns with the system of class designation given in clause 4, that the pipes are marked appropriately in accordance with 8.1(c), and that they comply with all the other requirements of this specification, such pipes shall be deemed to comply with the requirements of this British Standard.

5.7 In the case of centrifugally cast pipes, increases or decreases in the thickness of the pipe wall (see 5.6) shall be obtained by variation of the internal diameter only.

6. Fittings

6.1 Standard fittings without branches, unless otherwise indicated, shall be class K12 and shall conform to the dimensions given in tables 17 to 20, 23 to 27, 29 to 33, 37 to 42 and 44.

6.2 Standard fittings with branches shall be class K14 and shall conform to the dimensions given in tables 21, 21A, 22, 22A, 43 and 43A.

6.3 The hydraulic pressure ratings and field hydrostatic test pressures for standard fittings shall be in accordance with appendix A. For further information relating to consideration of pressure ratings and field testing of pipelines, see CP 2010 : Part 3. The works proof tests shall be in accordance with clause 15.

6.4 Pipeline design considerations may justify or require the use of classes other than those detailed. Provided that the thickness aligns with the system of class designation shown in clause 4 and the fittings are marked in accordance with 8.1(c), such fittings shall be deemed to comply with the requirements of this British Standard.

6.5 Modifications to the thickness of the wall of fittings (see 6.4) may be obtained by modification of the external diameter (plugs, change pieces and flanged spigot pieces excepted) or of the internal diameter.

6.6 Change fittings

6.6.1 A range of change fittings, which shall conform to the dimensions given in tables 25 to 27, will enable metric size spigot and socket ductile iron pipes and fittings to be jointed to imperial size cast iron pipes and fittings having external diameters according to classes B, C and D of BS 1211.

NOTE. Unless adequately anchored, the use of change collars in accordance with table 25 is recommended only where the differential force due to internal pressure is insufficient to cause movement of the collar.

6.6.2 Change fittings are suitable for use with flexible joints at the metric size end and suitable for use with flexible joints or lead caulked joints as specified by the purchaser at the imperial size ends. Dimensional details of the lead caulked joint shall be in accordance with BS 78 : Part 2.

7. Types of joint

7.1 **Flexible joints.** Details of flexible joints, either of the 'push in' type or of the 'mechanical' type, are not included

in this British Standard since this could restrict their future development, but gasket and joint surfaces shall conform to the manufacturer's standard dimensions and tolerances.

As the manufacturing dimensions and tolerances of individual types of joint may differ, the manufacturer's guidance should be obtained with regard to interchangeability where pipes and fittings of differing design are to be jointed. Unless otherwise specified by the purchaser, the gasket shall be manufactured from elastomeric materials (a) complying with the requirements of BS 2494, and (b) compatible with the fluid to be conveyed. The gasket shall be of such size and shape that, when jointed in accordance with the manufacturer's instructions, it provides a positive seal within the manufacturer's range of maximum joint deflection and withdrawal under all combinations of joint and gasket dimensional tolerance, and in the range of pressures likely to occur in the pipeline including, where applicable, those below atmospheric pressure.

7.2 Flanged joints

7.2.1 Dimensional details of flanges designated PN 10, PN 16 and PN 25 are shown in tables 10, 11 and 12 respectively. The nominal pressure ratings for these flanges are applicable to the temperature range -10°C to 120°C ; the manufacturers should be consulted in connection with pressure and temperature conditions outside this range.

NOTE. Flanges in accordance with this British Standard are dimensionally compatible with the corresponding flanges that are in accordance with BS 4504.

7.2.2 The faces of the flanges of pipes shall be at right angles to, and concentric with, the axis of the bore. The faces of the flanges on fittings shall be at right angles to the directional axes. Flanges shall be faced over the jointing surface with a tool mark finish having a pitch of 1 ± 0.3 mm; serrations may be spiral or concentric.

7.2.3 Bolt holes shall normally be drilled using numerical control or multihead techniques or appropriate jigs to ensure accuracy of form and relative position. However, where particularly accurate machine moulding processes are used that produce results of equivalent functional quality, holes may be cored. The pitch circle diameter of the bolt holes shall be concentric with the bore. The bolt holes shall be located off the centre lines and, where there are two or more flanges, the bolt holes shall be aligned.

NOTE. If a purchaser requires non-standard location of bolt holes, the flange should be in accordance with this standard except for the bolt hole position.

7.2.4 Ductile iron pipes complying with the requirements of table 14, having ductile iron screwed-on flanges, shall be sealed at the threaded joint between the pipe and the flange by a suitable sealing compound. The standard sealing compound applied to the joint shall be suitable for use with raw and potable water up to a temperature of 100°C , natural and town gas, domestic sewage and industrial effluent treated so as to be acceptable for discharge into public sewers.

NOTE. For other duties, such as the carrying of industrial effluents or chemicals, the purchaser should specify the operating conditions to enable the manufacturer to provide a suitable sealing compound.

7.2.5 Ductile iron pipes with ductile iron welded-on flanges shall conform with respect to size, thickness and mass per metre of barrel to the requirements of table 15.

The pipe-to-flange weld attachment shall be of a design proven not to be the limiting factor in the integrity of the flanged pipe when subjected to excessive hydraulic pressures, bending moments and bolting loads.

A satisfactory design is illustrated above table 15 and the mass of flange and total mass refer to this design only. (See foreword.) The essential requirements of this particular design are as follows:

(a) The flange shall be an interference fit on the rounded and cleaned end of the pipe barrel (to ensure removal of material detrimental to the welding process) and attached to the pipe by a fillet weld made at the hub end of the flange. The welding shall be carried out by a proven mechanized factory welding process, e.g. metal inert gas (MIG) welding.

(b) The material used as a weld filler metal shall be selected to be compatible with the ductile iron base material.

(c) The jointing face of the flange, including the pipe end, shall be machined. If heat treatment is necessary, this shall be carried out before final machining.

NOTE 1. Welded-on flanges of different design are not precluded provided that they satisfy all necessary design and test criteria and are agreed between the purchaser and the supplier.

NOTE 2. Where this type of flange is laid underground, consideration should be given to additional external protection if the soil is aggressive.

7.3 Lead caulked joints. Details of imperial size lead caulked joints for use with change fittings are given in BS 78 : Part 2.

8. Marking

8.1 Each pipe and fitting shall be legibly and durably marked, at a convenient position, with the following:

(a) the manufacturer's name, initials or identification mark;

(b) the nominal size (e.g. 100);

(c) the class designation where this differs from standard (K9, K12 and K14);

(d) the number of this British Standard, i.e. BS 4772;

NOTE. Marking BS 4772 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

(e) the length of pipe with flexible joint where supplied to a non-standard length specified by the purchaser;

(f) where applicable, an indication that the pipe is suitable for cutting in the field (see 13.1.2);

(g) the last two digits of the year of manufacture;

(h) the angle of bends in degrees;

(i) the major axis of the spigot end of each pipe with flexible joint, DN 700 and larger, which shall be clearly marked by a short white line applied to the spigot by the manufacturer.

8.2 Where the manufacturer wishes to add indications that pipes and fittings are of ductile iron, these may be cast on, or painted on in red.

9. Quality and quality control

9.1 The metal used shall be such that the pipes and fittings are of ductile iron complying with the mechanical properties specified in table 1. The proof stress shall be measured only when specially agreed between the manufacturer and the purchaser.

NOTE. The proof stress should be measured under conditions that should be specified by the purchaser on his enquiry and order.

9.2 The manufacturer shall carry out tests to enable the quality of pipes and fittings to be controlled during manufacture in order to ensure continuing compliance with this British Standard and shall keep records of all such tests. Records of these tests shall be available for inspection by the purchaser or his representative (see clause 19). For routine quality control purposes, only the tensile strength and elongation shall be measured.

10. Heat treatment

10.1 Pipes centrifugally cast in unlined water-cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses; provided that the specified mechanical properties are satisfied, pipes cast under controlled cooling conditions need not be heat treated.

10.2 The manufacturer may supply fittings in the 'as cast' condition or alternatively subject them to heat treatment. Whichever method is employed, the representative test results shall comply with the minimum mechanical property requirements of table 1 and, in the case of heat treated fittings, the test pieces shall be subjected to the same heat treatment process.

11. Condition of pipes and fittings

11.1 Pipes and fittings shall be removed from the mould with every necessary precaution to avoid warping or shrinkage defects detrimental to their good quality.

Table 1. Mechanical properties

Nominal size DN	Type of casting	Tensile strength, min.	0.2 % proof stress, min.	Elongation, min.
80 to 1000 over 1000	Centrifugally cast pipes Centrifugally cast pipes	N/mm ² * 420 420	N/mm ² 300 300	% 10† 7
All sizes	Pipes not centrifugally cast, and fittings	420	300	5

*1 N/mm² = 1 MPa.

†7 % for pipes thicker than class K12. (See 5.6.)

11.2 Pipes and fittings shall be sound and free from surface or other defects detrimental to their functional quality.

11.3 Pipes and fittings having cracks and tears are specifically excluded from repair. However, it is permissible to repair minor surface imperfections by simple dressing.

It is permissible to rectify defects, other than cracks and tears, on the pipe body or on the jointing faces of pipes and fittings by a welding procedure which shall define the parameters for selection, preparation, rectification, welder approval, inspection and acceptance.

Before a manufacturer can be permitted to rectify defects in accordance with this standard, the procedure shall meet the requirements of a type test agreed with the purchaser or his representative.

11.4 The quality of the castings shall be such that they can be cut, drilled, tapped and machined. If the purchaser considers that the castings do not comply with this requirement, a hardness test shall be carried out as specified in clause 20.

12. Testing for straightness and uniformity

All pipes shall be tested for straightness and uniformity of thickness and external diameter.

The deviation of the pipe from the straight shall be not more than 0.00125 times the effective length of the pipe.

13. Tolerances on dimensions

13.1 External diameters of pipes and fittings

13.1.1 The tolerances for the external diameter, D_E , of the spigots of pipes, flanged spigot pieces, change pieces, and plugs, shall be not greater than those given in table 2 when measured circumferentially using a diameter tape.

13.1.2 The tolerance for the external diameter, D_E , of pipes shall apply to the full length of the barrel of pipes up to and including DN 300. For sizes DN 350 and larger, the tolerance shall apply to the full length of the barrel only in the cases where the pipes are intended for cutting in the field. Such pipes shall be supplied by special agreement between the purchaser and the manufacturer and shall be marked as being suitable for cutting in the field (see 8.1(f)).

NOTE 1. For information regarding the diameters of pipe barrels required to be cut in the field, either in existing pipelines or those not supplied by special agreement, see appendix D.

NOTE 2. The spigots of pipes cut in the field may require preparation in accordance with the manufacturer's recommendations prior to jointing.

NOTE 3. For all pipe sizes, a transition from the pipe barrel to the external socket profile is permissible. When it is required in the field to cut pipes close to the socket for jointing on the barrel, it may be necessary to reduce the external diameter by grinding.

13.1.3 No tolerance is specified in this standard for the external diameters of fittings (except for flanged spigot pieces, change pieces and plugs; see 13.1.1) or for pipes with flanges cast on.

13.1.4 Certain types of flexible joint will accept some degree of spigot ovality but the measured difference between the maximum and minimum axes of individual spigots shall not exceed the appropriate value in table 2. However, where the admissible spigot ovality applicable to such joints is smaller than that given in table 2, the values shall be detailed in the manufacturer's catalogue.

13.2 Tolerances on thickness. The tolerances on the wall thicknesses and flange thicknesses shall be in accordance with table 3.

13.3 Tolerances on length

13.3.1 The tolerances on the lengths of pipes shall be in accordance with table 4.

Table 2. Tolerances on the external diameters of the spigots of pipes and (where applicable) fittings

Nominal size DN	Tolerance on the external diameter of spigots and of plugs (D_E) (see 13.1.1 and 13.1.2)	Maximum ovality of spigots (D_E) (see 13.1.4)
	mm	mm
80 to 150	+1.0, -3.0	5
200 to 350	+1.0, -3.5	10
400 to 500	+1.0, -4.0	20
600 to 800	+1.0, -4.5	30
900 to 1000	+1.0, -5.0	40
1100 to 1200	+1.0, -6.0	50
1400	+1.0, -7.0	55
1600	+1.0, -8.0	65

Table 3. Tolerances on wall and flange thickness

Type of casting	Dimensions	Tolerance (in mm)
Centrifugally cast pipe	Wall thickness (e)	$-(1.3 + 0.001 D_N^*)$
	Flange thickness (b)	$\pm (1 + 0.05b)$
Pipes not centrifugally cast, and fittings	Wall thickness (e)	$-(2.3 + 0.001 D_N)$
	Flange thickness (b)	$\pm (1 + 0.05b)$

*For DN 80 to DN 100 class K9 ductile iron pipes only, the minimum wall thickness shall be 4.8 mm.

D_N is the nominal size in millimetres

b is the thickness of flange (exclusive of raised face) in millimetres

e is the thickness of wall in millimetres

Table 4. Tolerances on lengths of pipes

Type of casting	DN	Tolerance
Double plain-ended centrifugally cast pipes	All sizes	mm
Socket and spigot centrifugally cast pipes		± 30
Flanged pipes up to and including 2 m in length	All sizes	± 1.5
Flanged pipes over 2 m, but less than 3 m, in length	All sizes	± 2.5
Flanged pipes of 3 m and over in length	All sizes	± 3.0

13.3.2 The tolerances on the lengths of fittings shall be as specified in the applicable tables of this standard.

13.3.3 By agreement with the purchaser the manufacturer may supply pipes with flexible joints in order in lengths shorter than the standard length (see table 13).

13.3.4 Where the manufacturer cuts test rings from pipes for quality control purposes, 5 % of the total number of pipes on any one order are permitted to be shorter by up to 150 mm than the minimum length of standard length pipe. A further 5 % shall be permitted to be shorter than the minimum length of standard length pipes by up to 100 mm. Such pipes shall be accepted by the purchaser as being of standard length.

14. Tolerances on standard mass

14.1 The standard mass is dependent upon the design of the ends of pipes and fittings and shall be calculated on the nominal dimensions taking the density of ductile iron as 7050 kg/m³.

14.2 The masses shown in tables 13, 17 to 23, 31 and 32 are applicable to pipes and fittings with sockets for typical 'push-in' flexible joints the masses of which are in accordance with those given in table 5.

Table 5. Mass of sockets of typical 'push-in' flexible joints used for the calculation of the mass of standard pipes and fittings

Nominal size DN	Mass of sockets	
	Pipes	Fittings
	kg	kg
80	3.2	2.3
100	4.1	2.8
150	5.4	4.3
200	9.1	6.6
250	12.8	9.3
300	17.5	13.8
350	20.0	16.0
400	25.5	21.5
450	30.3	25.8
500	36.1	32.2
600	52.1	44.3
700	55.5	94
800	63.4	114
900	82.5	153
1000	120.0	188
1100	152.0	250
1200	190.0	290
1400	279.0	420
1600	375.0	560

14.3 The masses shown in tables 24, 25, 28 and 30 are applicable to fittings with sockets for typical 'mechanical' flexible joints as these types are not normally supplied with 'push-in' flexible joints; the masses of sockets for condensate receivers are shown in table 30.

14.4 Where the actual masses of sockets for flexible joints differ from those shown in tables 13, 17 to 25, 28 and 30 to 32, these shall be taken into account when applying the tolerances on standard mass given in table 6.

14.5 Each pipe DN 150 and over shall be weighed individually to ensure compliance within the tolerances specified in table 6.

14.6 Pipes below DN 150 and all fittings need not be weighed individually unless otherwise specified by the purchaser on his enquiry, or order.

Table 6. Tolerances on standard mass*

Nominal size DN	Type of casting	Lower limit of mass
80 to 200	Centrifugally cast pipes	-8 %
250 to 1600	Centrifugally cast pipes	-5 %
All sizes	Pipes not centrifugally cast	-8 %
All sizes	Standard fittings, excepting bends and fittings with branches	-8 %
All sizes	Standard bends and standard fittings with branches. Non-standard fittings	-12 %

*With respect to the masses shown in table 5. The upper limit of mass is not standardized.

15. Works proof tests

15.1 Before being coated, each pipe and fitting shall be hydrostatically tested by a proven means at the foundry to the satisfaction of the purchaser or his representative. The outside surface of the pipe or fitting shall be dry before testing.

The hydrostatic pressure shall be applied steadily and maintained for a period sufficient to facilitate adequate inspection but in no case shall this period be less than 15 s.

The internal pressure imposed on the pipe or fitting shall be measured by an accurate pressure gauge and means shall be provided for attaching the gauge of the purchaser or his representative. The pipes and fittings shall withstand the works hydrostatic test pressure specified in table 7 without showing signs of leakage, sweating or other failure of any kind.

NOTE 1. The hydrostatic test applied to fittings is a leak-tightness test only. The application of high hydrostatic pressure to fittings is precluded due to the risk of distortion resulting from the high restraining loads imposed on the fittings by standard test apparatus.

NOTE 2. Where specially agreed between the purchaser and the manufacturer, standard all-flanged fittings and pipes with cast-on flanges in sizes up to and including DN 1200 shall be works-hydrostatically tested to pressures up to, but not exceeding 16 bar, 25 bar and 30 bar (gauge) for items with PN 10, PN 16 and PN 25 flanges respectively.

15.2 Pipe with welded or screwed on flanges shall be tested to prove the leak-tightness of the joint between pipe and flange.

15.3 All standard pipes and fittings shall be capable of withstanding the field test pressures specified in appendix A.

15.4 Pipes and fittings supplied for pipelines to be used for the conveyance of gas shall be tested with air to a pressure of 3.5 bar (gauge) in addition to the hydrostatic test. While under air pressure, the fittings shall be totally immersed in water or, alternatively, coated with a suitable foaming agent in order to check for leakage.

16. Surface protection

16.1 Unless otherwise specified by the purchaser on his enquiry and/or order, all pipes and fittings shall be

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Table 7. Works hydrostatic proof test pressures and works leak-tightness test pressures

Nominal size DN	Works hydrostatic proof test pressures				Works hydrostatic leak-tightness test pressure for fittings and for pipes with cast-on flanges
	Pipes with flexible joints	Pipes with screwed or welded-on flanges			
		PN10 flange	PN16 flange	PN 25 flange	
	bar (gauge)	bar (gauge)	bar (gauge)	bar (gauge)	bar (gauge)
80 to 300	50	16	25	32‡	25*
350 to 600	40	16	25	32‡	16
700 to 800	32	16	25	32‡	10§
900 to 1000	32	16	25	25‡	10§
1100 to 1200	25‡	16	25	25‡	10§
1400 to 1600	25	—	—	—	2‡

*16 bar (gauge) for pipes and fittings with PN10 flanges and for condensate receivers in accordance with table 30.

‡Additionally tested with air at a pressure of 1 bar.

‡Where agreed between the purchaser and the manufacturer, the test pressure may be up to 40.0 bar for DN 80 to DN 800 pipes and up to 32 bar for DN 900 to DN 1200 pipes.

§Where agreed between the purchaser and the manufacturer, an air test at a pressure of 1 bar may be substituted.

coated internally and externally with, at the manufacturer's option, one of the materials specified in 16.3.

16.2 Coatings may be applied by dipping, brush, spray or roller.

16.3 No coating shall be applied to any casting unless its surfaces are clean, dry and free of rust. Standard coating materials are specified in:

- (a) BS 4147 type I grade C (Bitumen based hot applied)
- (b) BS 3416 type II (Bitumen based cold applied)

16.4 Where specified by the purchaser on the enquiry and/or order, pipes and fittings shall be cement mortar lined in accordance with appendix C and, unless otherwise specified, shall be coated externally with, at the manufacturer's option, one of the materials specified in 16.3.

17. Manufacturer's certificate

The manufacturer shall, on request, supply to the purchaser a signed certificate stating, at the purchaser's option, either:

- (a) that the pipes or fittings comply in all respects with the provisions of this British Standard; or
- (b) the results of all the specified tests.

18. Inspection

The inspector appointed by the purchaser and accredited by the manufacturer shall have access at all reasonable times to those parts of the works engaged in the manufacture and testing of the pipes and fittings he has ordered.

If at the time of placing the order the purchaser states that he wishes to carry out inspection during manufacture up to the point of despatch, the manufacturer shall be responsible for informing the purchaser or his agent in advance of the manufacturing date. If the purchaser, or his agent, is not present at the agreed time, the manufacturer shall be entitled to proceed with production and inspection and shall not be required to re-inspect. Records of the inspection shall be available for examination by the purchaser or his agent at a later date.

19. Purchaser's optional tensile test

19.1 Selection of bar test pieces

19.1.1 If it is stated on the enquiry and order that the purchaser or his agent wishes to witness tests on bar test pieces in respect of the pipes and fittings ordered, the bar test pieces may be selected by the purchaser or his representative during manufacture.

If the purchaser or his agent is not present at the agreed time of manufacture, the manufacturer shall be entitled to proceed with the selection of test pieces and testing. The results of the tests shall be recorded for examination by the purchaser at a later date, and the test pieces shall be retained for a minimum of fourteen days.

19.1.2 The manufacturer shall prepare the necessary bar test pieces and supply the labour and appliances for such testing as may be carried out on his premises in accordance with this British Standard.

19.1.3 For the purpose of selecting and approving the bar test pieces, the pipes and fittings ordered shall be divided into batches as given in table 8.

Table 8. Batching of bar test pieces

Pipes and fittings	Size	Batch
Pipes centrifugally cast	DN 80 to DN 300	100 pipes
	DN 350 to DN 600	50 pipes
	DN 700 to DN 1200	25 pipes
	DN 1400 to DN 1600	10 pipes
Pipes not centrifugally cast, and fittings	All sizes	4 tonnes

Any pipes remaining after dividing into batches, as specified, shall be considered as a batch and, where the total order is less than the appropriate batch size, the order shall be considered as a batch. The batch may contain pipes of any size within the groups specified above.

19.1.4 One bar test piece shall be taken from each batch and, if the batch contains pipes of more than one size

the bar test piece selected shall be regarded as being representative of all the pipes in the batch, irrespective of size.

19.1.5 Bar test pieces representative of pipes not centrifugally cast, and fittings, may be taken from a sample cast separately but they shall be cast from the same iron as that used for the manufacture of the castings they represent and, where applicable, the bar test pieces shall have been subjected to the same heat treatment. Alternatively, bar test pieces may be taken from a sample cast integrally with the pipe or fitting at the manufacturer's option.

19.2 Dimensions of bar test pieces

19.2.1 Bar test pieces taken from centrifugally cast pipes shall be cut from the spigot end and, when prepared for testing, shall be representative of the metal at approximately mid-thickness. The axis of the bar test piece shall be parallel to the axis of the pipe from which it was taken. Each bar test piece shall include a cylindrical part having a gauge length of 3.54 or 5.0 times its diameter and having a diameter as shown in table 9(a).

19.2.2 Where the sample is cast separately, its dimensions shall comply with the requirements of BS 2789. Where a sample is integrally cast, it shall conform to the dimensions given in table 9(b).

19.3 Method of test. The method of testing shall be in accordance with that normally used for quality control

purposes by the manufacturer, unless otherwise agreed between the manufacturer and the purchaser.

19.4 Results of tensile test. Each bar test piece selected in accordance with 19.1 shall be tested, and the test results shall be deemed satisfactory if they comply with the mechanical properties specified in table 1.

19.5 Retests. If a bar test piece representing any batch fails the tensile test, two further tests shall be carried out on bar test pieces selected by the purchaser, or his representative, from two other pipes of the same batch. If either of these additional bar test pieces fails the tensile test, the batch represented shall be deemed not to comply with the requirements of this British Standard.

20. Hardness test

20.1 If the purchaser considers that the quality of the castings does not comply with the requirements of 11.4, hardness tests shall be carried out on the castings after slight grinding.

20.2 The tests shall be in accordance with the requirements of BS 240 : Part 1 except that the period of application shall be 15 ± 1 s.

20.3 The results of the hardness tests shall not exceed 230 HB in the case of centrifugally cast pipes, and 250 HB in the case of all other castings. If the surface hardness of the castings exceeds these values, the castings shall be deemed not to comply with the requirements of this British Standard.

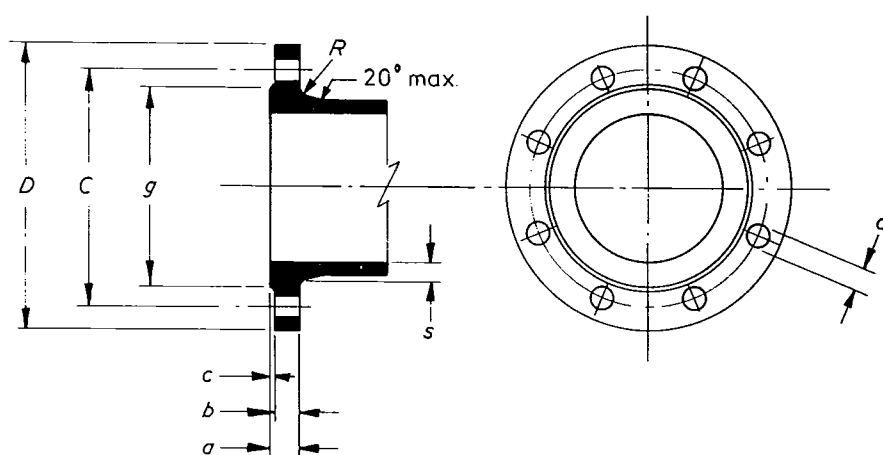
Table 9(a) Bar test piece diameter

Thickness of pipe	Diameter of bar test piece
mm	mm
Less than 6	2.5
6 and above but below 8	3.5
8 and above but below 12	5.0
12 and above	6.0

Table 9(b) Dimensions of integrally cast test samples

Description of castings represented	Dimensions		
	Length	Width	Thickness
Pipes not centrifugally cast and fittings, having a wall thickness of up to and including 12.5 mm	55 to 75	45 to 65	12.5
Pipes not centrifugally cast and fittings, having a wall thickness of over 12.5 mm	55 to 75	45 to 65	16

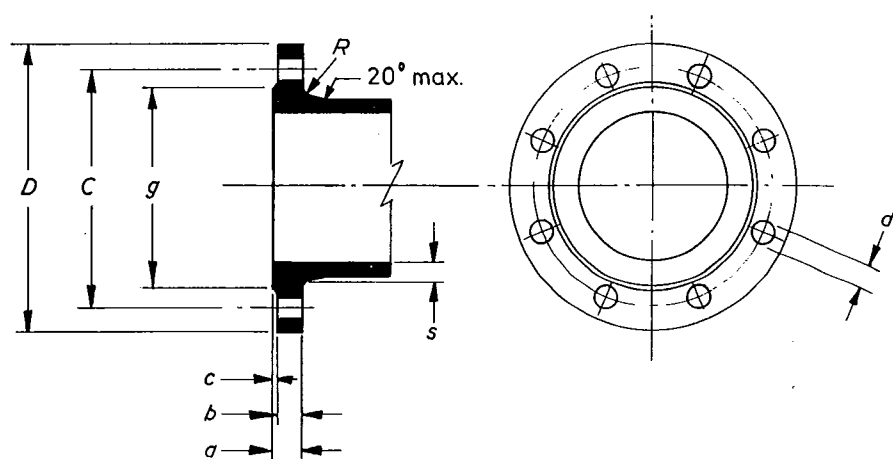
Table 10. Standard flanges, type PN 10



Nominal size DN	D	Pitch circle diameter C	g	a	b	c	Bolt holes		s	R	Mass
							Number	d			
	mm	mm	mm	mm	mm	mm		mm	mm	mm	kg
80	200	160	132	19.0	16.0	3	8	19	15.0	6	2.9
100	220	180	156	19.0	16.0	3	8	19	15.0	6	3.3
150	285	240	211	19.0	16.0	3	8	23	15.0	8	4.9
200	340	295	266	20.0	17.0	3	8	23	16.0	8	6.8
250	400	350	319	22.0	19.0	3	12	23	17.5	10	9.6
300	455	400	370	24.5	20.5	4	12	23	19.5	10	12.8
350	505	460	429	24.5	20.5	4	16	23	19.5	10	14.1
400	565	515	480	24.5	20.5	4	16	28	19.5	10	16.3
450	615	565	530	25.5	21.5	4	20	28	20.5	12	18.1
500	670	620	582	26.5	22.5	4	20	28	21.0	12	21.8
600	780	725	682	30.0	25.0	5	20	31	24.0	12	30.8
700	895	840	794	32.5	27.5	5	24	31	23.0	12	42.0
800	1015	950	901	35.0	30.0	5	24	34	24.5	12	57.0
900	1115	1050	1001	37.5	32.5	5	28	34	26.5	12	65.0
1000	1230	1160	1112	40.0	35.0	5	28	37	28.0	12	88.0
1100	1340	1270	1218	42.5	37.5	5	32	37	30.0	12	105.0
1200	1455	1380	1328	45.0	40.0	5	32	40	31.5	12	134.0
1400	1675	1590	1530	46.0	41	5	36	43	32.0	12	148.0
1600	1915	1820	1750	49.0	44	5	40	49	34.5	12	206.0

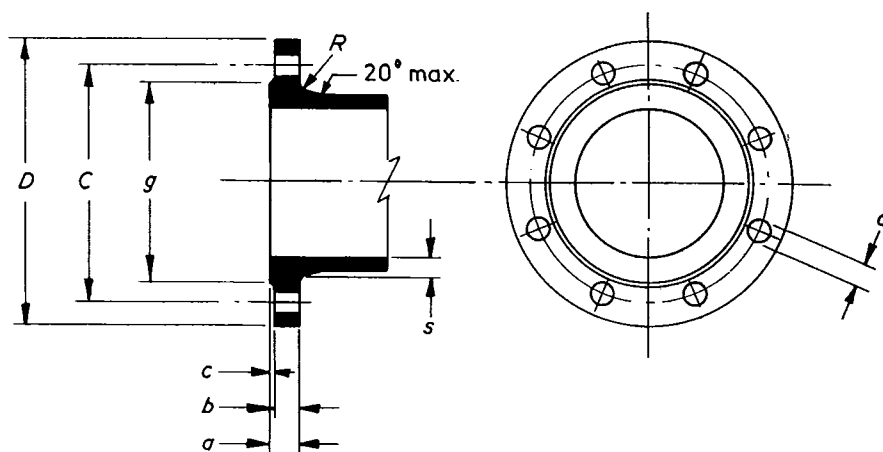
BS 4772 : 1980

Table 11. Standard flanges, type PN 16



Nominal size DN	D	Pitch circle diameter C	g	a	b	c	Bolt holes		s	R	Mass
							Number	d			
	mm	mm	mm	mm	mm	mm		mm	mm	mm	kg
80	200	160	132	19.0	16.0	3	8	19	15.0	6	2.9
100	220	180	156	19.0	16.0	3	8	19	15.0	6	3.3
150	285	240	211	19.0	16.0	3	8	23	15.0	8	4.9
200	340	295	266	20.0	17.0	3	12	23	16.0	8	6.6
250	400	355	319	22.0	19.0	3	12	28	17.5	10	9.2
300	455	410	370	24.5	20.5	4	12	28	19.5	10	12.4
350	520	470	429	26.5	22.5	4	16	28	21.0	10	17.2
400	580	525	480	28.0	24.0	4	16	31	22.5	10	21.9
450	640	585	548	30.0	26.0	4	20	31	24.0	12	26.7
500	715	650	609	31.5	27.5	4	20	34	25.0	12	37.0
600	840	770	720	36.0	31.0	5	20	37	29.0	12	57.3
700	910	840	794	39.5	34.5	5	24	37	27.5	12	57.0
800	1025	950	901	43.0	38.0	5	24	40	30.0	12	72.0
900	1125	1050	1001	46.5	41.5	5	28	40	32.5	12	90.0
1000	1255	1170	1112	50.0	45.0	5	28	43	35.0	12	122.0
1100	1355	1270	1218	53.5	48.5	5	32	43	37.5	12	141.0
1200	1485	1390	1328	57.0	52.0	5	32	49	40.0	12	189.0
1400	1685	1590	1530	60.0	55	5	36	49	42.0	12	216.0
1600	1930	1820	1750	65.0	60	5	40	56	45.5	12	308.0

Table 12. Standard flanges, type PN 25



Nominal size DN	D	Pitch circle diameter C	g	a	b	c	Bolt holes		s	R	Mass
							Number	d			
	mm	mm	mm	mm	mm	mm		mm	mm	mm	kg
80	200	160	132	19.0	16.0	3	8	19	15	6	2.9
100	235	190	156	19.0	16.0	3	8	23	15	6	3.8
150	300	250	211	20.0	17.0	3	8	28	16	8	5.9
200	360	310	274	22.0	19.0	3	12	28	17.5	8	8.7
250	425	370	330	24.5	21.5	3	12	31	19.5	10	13.1
300	485	430	389	27.5	23.5	4	16	31	22.0	10	18.0
350	555	490	448	30.0	26.0	4	16	34	24.0	10	25.5
400	620	550	503	32.0	28.0	4	16	37	25.5	10	33.2
450	670	600	548	34.5	30.5	4	20	37	27.5	12	42.2
500	730	660	609	36.5	32.5	4	20	37	29.0	12	48.7
600	845	770	720	42.0	37.0	5	20	40	33.5	12	71.5
700	960	875	820	46.5	41.5	5	24	43	32.5	12	89.0
800	1085	990	928	51.0	46.0	5	24	49	35.5	12	122.0
900	1185	1090	1028	55.5	50.5	5	28	49	39.0	12	146.0
1000	1320	1210	1140	60.0	55.0	5	28	56	42.0	12	194.0
1100	1420	1310	1240	64.5	59.5	5	32	56	45.0	12	224.0
1200	1530	1420	1350	69.0	64.0	5	32	56	48.5	12	271.0