British Standard

BRITISH STANDARD

BS 534:1990

Specification for

Steel pipes, joints and specials for water and sewage

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Piping Systems Components Standards Policy Committee (PSE/-) to Technical Committee PSE/8, upon which the following bodies were represented:

Adhesive Tape Manufacturers' Association
British Compressed Air Society
British Gas plc
British Malleable Tube Fittings Association
British Steel Industry
British Valve and Actuator Manufacturers' Association
British Welded Steel Tube Association
Food and Drink Federation
Institution of Civil Engineers
Institution of Gas Engineers
Institution of Water and Environmental Management
Mechanical Handling Engineers' Association
Stainless Steel Fabricators' Association of Great Britain
TI (Group Services) Ltd.
Water Companies' Association
Water Research Centre
Water Services' Association of England and Wales
Wrought Fitting Makers' Association

This British Standard, having been prepared under the direction of the Piping Systems Components Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 August 1990

First published 1934
Second edition December 1966
Third edition February 1981
Fourth edition August 1990

The following BSI references relate to the work on this standard:
Committee reference PSE/8
Draft for comment 88/73158 DC

ISBN 0 580 188175

Amendments issued since publication

Amd. No.	Date	Comments

Contents

Foreword

This British Standard has been prepared under the direction of the Piping Systems Components Standards Policy Committee and supersedes BS 534:1981 which is withdrawn.

Pipe outside diameters have been aligned with ISO 4200 published by the International Organization for Standardization.

Requirements for external and internal protections given in section 5 will be replaced in due course by protection requirements given in new British Standards.

Reference is made to the need for non-metallic products which will come into contact with potable water to comply with BS 6920-1.

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 to iv, 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.

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Section 1. General

1 Scope

This standard specifies requirements for seamless and welded carbon steel pipes and specials and for joints in respect of the pipe end preparation, in sizes 60.3 mm to 2 235 mm outside diameter, for the conveyance of water and sewage. It includes external and internal protection against the corrosive action of the surrounding medium and conveyed fluid.

NOTE 1 This standard does not apply to those steel tubes and tubulars with screwed and socketed joints, which are covered by the requirements of BS 1387.

NOTE 2 For recommendations on the basis of design and service limitations, reference should be made to CP 2010-2.

NOTE 3 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Information to be supplied by the purchaser

2.1 The purchaser is to provide to the supplier the information given in Appendix A to enable products to be supplied in accordance with this standard.

2.2 A number of options are permitted by this standard as given in Appendix B.

Both the definitive requirements specified throughout this standard and the options selected by the purchaser shall be satisfied by the manufacturer before a claim of compliance with this standard can be made and verified. In the event that the purchaser does not indicate his requirements at the time of enquiry and order the manufacturer shall select the option where appropriate.

3 Definitions

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

3.1
pipe

a straight conduit for fluid, of circular cross section, with plain or prepared ends

3.2
fitting

a component fitted to a pipe for jointing, connecting or changing the direction or bore of a pipe

3.3
special

a fitting made from manipulated or fabricated pipe, i.e. bend, gusseted bend, tee, collar

3.4
working pressure

the maximum sustained operating pressure at which the pipe, fitting or special is intended to be used

3.5
random lengths

normal manufacturing lengths falling within a specified range

3.6
cut lengths

pipes cut to a specified length on which only a small tolerance is allowed

3.7
effective length

the actual length that a pipe contributes when correctly assembled in a run of piping. This dimension excludes the additional length contributed by a slip-on type coupling when this is used

3.8
glass tissue

a uniformly porous mat, of minimum mass 40 g/m^2, made of glass monofilaments in random arrangement bonded with a thermosetting resin

3.9
reinforced glass tissue

glass tissue with the addition of strands of glass yarn to give additional longitudinal tensile strength, the whole being bonded with a thermosetting resin

3.10
woven glass cloth

a loom-state fabric, of minimum mass 120 g/m^2, made of low alkali glass, complying with BS 3396-1 and uniformly woven from continuous filament yarn to form a porous cloth with selvedges well made, substantially straight and even, or a lock woven square mesh lacquer bonded fabric

3.11
composite glass fibre fabric

a reinforcement consisting of glass lock welded fabric and glass fibre combined

NOTE This reinforcement may be impregnated uniformly with a suitable bitumen or coal tar derived material.

3.12
lining

a durable material applied to the internal surface of steel pipes and fittings to protect the metal from corrosion, erosion or chemical attack

3.13
coating

a durable material applied to the external surface of steel pipes and fittings to protect the metal

3.14
closing length

the final length of pipe which effectively completes or closes the system and which is normally cut to length on site

4 Designation of size

4.1 Pipes

Pipes shall be designated by their outside diameters (in mm).

4.2 Specials

4.2.1 Bends shall be designated by their outside diameter (in mm) and the angle of the bend.

4.2.2 Tees shall be designated as follows.

a) A tee with no reductions shall be designated by its common size.

b) A tee reducing only on the branch shall be designated by two sizes, the size of the main being given first.

c) A tee reducing on the branch and the main or only on the main shall be designated by three sizes, the larger size of the main followed by the smaller size of the main followed by the size of the branch.

4.2.3 Collars shall be designated by the outside diameter (in mm) of the pipes for which they are intended.

5 Materials

5.1 Pipes

Pipes shall comply with BS 3601.

NOTE 1 It is essential that the grade and method of manufacture required is stated in the enquiry and order (see item b) of Appendix A).
NOTE 2 The purchaser has options permitted under BS 3601.

5.2 Specials

The main bodies of specials shall comply with BS 3601.

NOTE 1 It is essential that the grade and method of manufacture is stated in the enquiry and order (see item b) of Appendix A).
NOTE 2 Unless otherwise specified by the purchaser branches of tees may be made of other grades of weldable steel, provided the completed fittings are at least as strong as required for the main bodies. The purchaser should state in the enquiry and order if the material for branches of tees should be identical to that used for the main bodies (see item a) of Appendix B).

6 Effect of non-metallic products on water quality

When used under the conditions for which they are designated, non-metallic products in contact with or likely to come into contact with potable water shall comply with BS 6920-1:1988.

NOTE 1 Non-metallic products for installation and use in the United Kingdom which are verified and listed under the UK Water Fittings Byelaws Scheme are deemed to satisfy the requirements of this clause. Details of the Scheme are obtainable from the Water Research Centre Byelaws Advisory Service, 660 Ajax Avenue, Slough SL1 4BG.

Non-metallic products approved by the Department of the Environment Committee on Chemicals and Materials of Construction for use in Public Water Supply and Swimming Pools are considered free from adverse health effects for the purposes of compliance with this clause.

NOTE 2 A list of approved chemicals and materials and details of the approvals scheme is available from the Secretary of the Committee at the Department of the Environment, Water Division, Romney House, 43 Marsham Street, London SW1P 3PY.

7 Marking

7.1 Each pipe and special shall be legibly marked by stencilling or other indelible marking in accordance with **7.2**.

7.2 The marking shall consist of the following in the sequence indicated:

a) the manufacturer's name or identification mark;

b) the number and date of this British Standard, i.e. BS 534:1990[1)];

c) the designation of size;

d) the material designation as given in BS 3601, e.g. ERW 430;

e) when a test certificate is supplied, the purchaser's order number or other appropriate mark to identify the pipes with the test certificate.

Alternatively, for tubes that are bundled, the information given in a), b), c) and e) shall be either stamped on one or more metal or other durable tags, or printed on banding clips or straps, which shall be securely attached to each bundle.

Not more than one steel grade shall be included in any one bundle.

NOTE Additional markings may be used provided they do not conflict with the requirements of **7.2**.

[1)] Marking BS 534:1990 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

7.3 The quality of the paint or ink applied shall be such that it shall have a life of at least 1 year in unheated storage under cover.

The dried film shall not contain more than 0.025 % (*m/m*) of each of the following metals:

lead, tin, copper, zinc.

NOTE For certain applications limits may be required on the levels of sulphur and halogens in the paint. These limits should be subject to agreement between the supplier and the purchaser.

8 Manufacturer's and test certificates

8.1 Manufacturer's certificate

When a manufacturer's certificate is supplied it shall state that the pipes, joints and specials, as appropriate, comply in all respects with the requirements of this standard.

NOTE If a manufacturer's certificate is required this should be stated by the purchaser in the enquiry and order (see item b) of Appendix B).

8.2 Test certificates

When a test certificate is supplied it shall contain a statement by the manufacturer confirming that the pipes, joints and specials, as appropriate, have been tested in accordance with this standard.

NOTE If a test certificate is required this should be stated by the purchaser in the enquiry and order (see item c) of Appendix B).

Section 2. Pipes

9 Sizes, masses per unit length and test pressures of pipes

9.1 Outside diameters and thicknesses shall be selected from Table 1 of BS 3600:1976. The thicknesses selected shall be not less than the minimum nominal thicknesses given in Table 1.

NOTE It is essential that outside diameters and thicknesses are stated in the enquiry and order (see item c) of Appendix A).

9.2 Pipes ordered for cutting into closing lengths at site shall be supplied sized throughout their lengths to the same dimensions as the spigot ends.

NOTE It is essential that when pipes are required for cutting into closing lengths at site this is stated in the enquiry and order (see item d) of Appendix A).

10 Length

Pipes shall be supplied in either:

a) random lengths; or

b) cut lengths.

Where cut length is specified, the maximum variation in length shall be + 6, – 0 mm for lengths up to and including 6 m. For every 3 m increase in length above 6 m, the plus tolerance shall increase by 1.5 mm to a maximum of 12.5 mm.

NOTE It is essential that the enquiry and order states whether random lengths or cut lengths are required (see item e) of Appendix A) together with the following information:

a) for random lengths, the length range required and the total quantity in metres (see item f) of Appendix A);

b) for cut lengths, the exact length and the total number of lengths required (see item g) of Appendix A).

Unless otherwise specified by the purchaser random lengths will be supplied.

Table 1 — Minimum nominal thickness, mass per metre length and hydraulic test pressure for steel pipes

Outside diameter	Minimum nominal thickness	Mass per metre length (plain end)	Hydraulic test pressure (steel 430)
mm	mm	kg	bar[a]
60.3	2.9	4.11	70
76.1	3.2	5.75	70
88.9	3.2	6.76	70
114.3	3.6	9.83	70
139.7	3.6	12.1	70
168.3	3.6	14.6	70
193.7[b]	4.0	18.7	70
219.1	4.0	21.2	70
244.5[b]	4.0	23.7	70
273	4.0	26.5	64
323.9	4.0	31.6	54
355.6	4.5	39.0	56
406.4	4.5	44.6	49
457	5.0	55.7	48
508	5.0	62.0	43
559	6.3	85.9	50
610	6.3	93.8	45
660	6.3	102	42
711	6.3	109	39
762	6.3	117	36
813	7.1	141	38
864	7.1	150	36
914	7.1	159	34
1 016	7.1	177	31
1 219	8.0	239	29
1 422	8.8	307	27
1 626	10.0	399	27
1 829	11.0	493	26
2 032	12.5	623	27
2 235	14.2	778	28

NOTE 1 The nominal thicknesses given in this table are the minimum considered suitable for general use under normal conditions (see **9.1**).

NOTE 2 Seamless pipes are available in sizes up to 508 mm o.d.

NOTE 3 The calculated masses per unit length have been based on BS 3600 and apply to pipes with plain ends or ends bevelled for butt welding, and are included for information only. Allowance should be made for other end conditions depending on the type of joint.

NOTE 4 Where pipes are protected, it is essential that allowance is made for the mass of the protection.

NOTE 5 The hydrostatic test pressures are works inspection test pressures in accordance with BS 3601. They are not intended as a basis for pipeline design and do not necessarily have any direct relationship to working pressures; they are included for information only.

[a] 1 bar = 10^5 N/m^2 = 100 kPa.

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

Section 3. Joints

11 Types of joints

The pipe ends shall be prepared, as appropriate, for one of the following types of joints:

a) butt-welded joints;

b) sleeve joints for welding;

c) slip-on type couplings;

d) flange joints;

e) screwed and coupled joints.

NOTE 1 Other types of joints made to proprietary designs are available but are not covered by this standard.

NOTE 2 It is essential that the type of joint is stated in the enquiry and order (see item h) of Appendix A).

NOTE 3 Illustrations showing the basic design principle for the more common types of joints appropriate to this standard are given in Figure 1 to Figure 4. The actual details of the joints may differ from one manufacturer to another.

12 Butt-welded joints

12.1 End preparation

Pipes of thickness less than 5.0 mm shall be cut square.

NOTE 1 Pipes of thickness 5.0 mm and greater will be supplied with ends bevelled, as shown in Figure 1, unless otherwise specified in the enquiry and order.

NOTE 2 If a butt-welded end preparation, other than that shown in Figure 1, is required the details should be stated in the enquiry and order (see item d) of Appendix B).

12.2 End tolerances

The tolerance on the outside diameter for a distance of 100 mm from the end of the pipe shall be as given in Table 2. For pipes of 508 mm to 2 235 mm o.d., the tolerance shall be checked by measuring the circumference.

NOTE In general, butt-welded joints are not suitable for lined pipes in sizes 610 mm o.d. and smaller. Where these sizes are required to be lined, consideration should be given to mechanical joints or other forms of joints designed to avoid damage to the lining.

13 Sleeve joints for welding

13.1 General

Sleeve joints for welding shall comply with **13.2** or **13.3** or **13.4**.

13.2 Type 1 joints

For type 1 joints (see Figure 2) the pipes shall be supplied with spigot end parallel and sleeve end either parallel or with the diameter tapered to approximately 0.8 mm per 25 mm length of sleeve. The minimum length of sleeve shall be 75 mm.

The sleeve shall be sized to ensure that the spigot will enter the sleeve freely and be engaged by the socket when fully home.

13.3 Type 2 joints

For type 2 joints (see Figure 2) the pipes shall be supplied with the spigot end and the sleeve end parallel. The collar forming the sleeve shall be fabricated with not more than one longitudinal weld and shall be welded externally and internally to the sleeve pipe. The minimum sleeve length shall be $(150 + 2t)$ mm, where t is the thickness of the sleeve, to ensure an adequate space between the spigot end and the internal collar weld to effect the inside joint weld, if required.

The sleeve shall be sized to ensure that the spigot will enter the sleeve freely and be engaged by the socket when fully home.

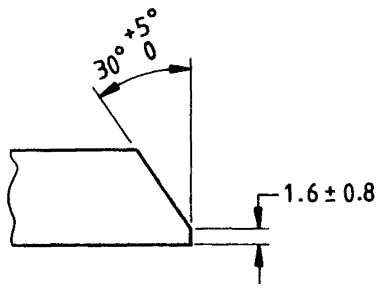
13.4 Type 3 joints

For type 3 joints (see Figure 2) the pipe shall be supplied with the contact surfaces of the spigot end and sleeve end formed to the same spherical radius. The spherical radius shall be not less than half the outside diameter of the pipe. When fitted together the mean penetration of each spigot into the sleeve shall be not less than four times the pipe thickness (see note 4).

NOTE 1 The joints shown in Figure 2 may differ in detail from one manufacturer to another provided the dimensions identified are maintained.

Table 2 — End tolerances

Outside diameter	Tolerance
mm	mm
60.3 to 273	+ 1.6 – 0.4
323.9 to 2 235	+ 2.4 – 0.8



Linear dimension is in millimetres

Figure 1 — Butt-welded joint preparation

NOTE 2 On sizes smaller than 711 mm o.d., the joint should be welded on the outside only. On sizes 711 mm o.d. and larger, welding may be either inside, or outside, or both inside and outside.

NOTE 3 In general, sleeve welded joints are not suitable for lined pipes in sizes 610 mm o.d. and smaller. Where these sizes are required to be lined, consideration should be given to mechanical joints or other forms of joints designed to avoid damage to the lining.
NOTE 4 These types of sleeve joint may be used to accommodate small changes in pipe line direction provided the spigot and the sleeve are engaged around the whole circumference and the mean penetrated is not less than four times the pipe thickness.

13.5 Individual sleeve joints

When individual sleeve joints are required to be pressure tested after welding, each sleeve shall be provided with a nominal size ¼ tapped hole complying with BS 21 fitted with a matching plug. The tapped holes shall be within the end 30 mm of the sleeves and be clear of any possible shop or field welding runs.

NOTE The purchaser should state any requirements for pressure testing of sleeved joints on the enquiry and order (see item e) of Appendix B).

13.6 Sleeve welded joints

13.6.1 For type 1 joints the pipes shall be supplied with spigot end parallel and sleeve end either parallel or tapered to approximately 0.8 mm on diameter per 25 mm length of sleeve. The minimum length of sleeve shall be 75 mm (see Figure 2).

The sleeve shall be sized to ensure that the spigot will enter the sleeve freely and be engaged by the socket when fully home.

13.6.2 For type 2 joints the pipes shall be supplied with the spigot end and sleeve end parallel. The collar forming the sleeve shall be fabricated with not more than one longitudinal weld and shall be welded externally and internally to the sleeve pipe (see Figure 2). The minimum sleeve length shall be $(150 + 2t)$ mm, where t is the thickness of the sleeve, to ensure an adequate space between the spigot end and the internal collar weld to effect the inside joint weld if required.

The sleeve shall be sized to ensure that the spigot will enter the sleeve freely and be engaged by the socket when fully home.

13.6.3 For type 3 joints the pipes shall be supplied with the contact surfaces of the spigot end and sleeve end formed to the same spherical radius. The spherical radius shall be not less than half the outside diameter of the barrel of the pipe. When fitted together the penetration of each spigot into the sleeve shall be not less than four times the pipe thickness.

14 Slip-on type couplings

14.1 Slip-on type couplings for use with plain end pipe shall be of the general form shown in Figure 3.

14.2 The lengths of the coupling sleeves shall be as given in Table 3.

NOTE The details of the joints shown in Figure 3 may differ from one manufacturer to another provided the dimensions identified are maintained.

14.3 The pipe ends for length L shall be within the tolerances on outside diameter as specified in Table 4 when checked by measuring the circumference and shall permit the passage of a ring gauge which has a bore 1.6 mm larger than the maximum permissible diameter of the pipe.

14.4 Surface irregularities such as peaks, flats or depressions shall blend smoothly into the surface of the pipe and their height or depth shall not exceed 0.25 mm.

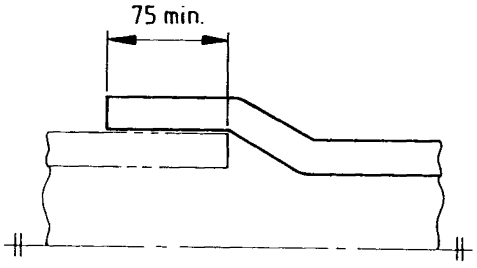
Table 3 — Lengths of slip-on type coupling sleeves

Pipe size o.d.	Sleeve length s	
mm	mm	
60.3	80	Tolerance on sleeve length ± 3 mm
76.1 to 323.9	100	
355.6 to 914	150	
1 016 to 1 829	178	
2 032 and 2 235	254	

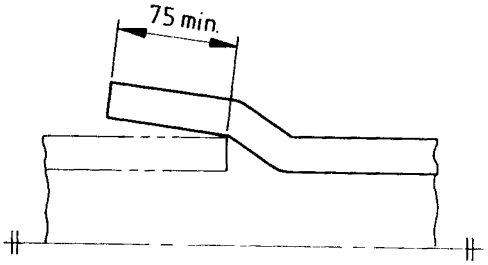
NOTE 1 Other sleeve lengths may be used for special service conditions but are not covered by this standard.
NOTE 2 Coupling sleeves with a form of centre register may be specified by the purchaser.

Table 4 — Tolerances on outside diameter on length L

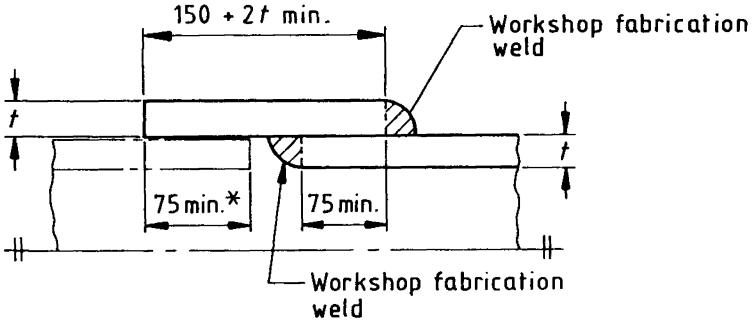
Pipe size o.d.	Tolerance on o.d. for length L
mm	mm
60.3 to 114.3	± 0.8 for 100
139.7 to 323.9	+ 1.6, – 0.8 for 100
355.6 to 1 219	± 1.6 for 150
1 422	+ 1.6, – 3 for 150
1 626 to 1 829	± 3 for 150
2 032 to 2 235	± 3 for 200



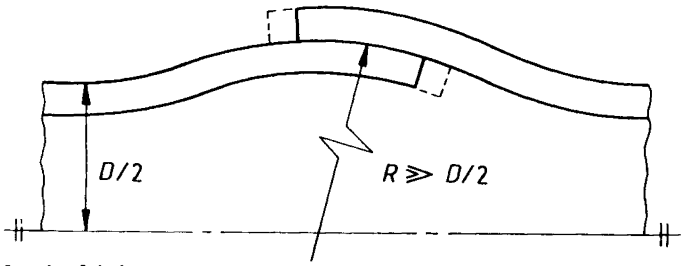
Type 1 (parallel sleeve)



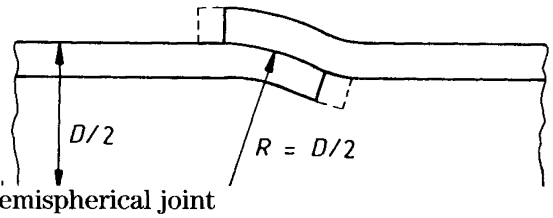
Type 1 (taper sleeve; taper approximately 0.8 mm on diameter for each 25 mm on length of socket)



*For guidance
Type 2 (collar sleeve)



Spherical joint
($R > \frac{D}{2}$ where D is the outside diameter)



Hemispherical joint
($R = \frac{D}{2}$ where D is the outside diameter)
Type 3 (surfaced sleeve)

All dimensions are in millimetres

Figure 2 — Sleeve welded joints

14.5 Pipes ordered for cutting and subsequent jointing on site shall be supplied to the tolerances specified in Table 4 throughout their length.

15 Flange joints

15.1 Flange joints shall have flanges in accordance with BS 10, BS 4504-3.1 or BS 1560-3.1, as appropriate to the design conditions.

NOTE It is essential that the type of flange required is stated in the enquiry and order (see item i) in Appendix A).

15.2 Where pipes are supplied with flanges welded on, the welding shall be carried out in accordance with BS 2633 or BS 2971.

16 Threaded and coupled joints

Where bitumen lined pipes are required with threaded and coupled joints, the thread for sizes up to 139.7 mm o.d. shall be in accordance with BS 21 but shall have a taper thread on both the pipe and the coupling. Sizes 168.3 mm o.d. to 323.9 mm o.d. shall be threaded in accordance with API[2] standard 5B. The couplers shall be recessed in the centre to take the lining (see Figure 4). The dimensions of the recess for pipe of 60.3 mm o.d. to 139.7 mm o.d. shall be as given in Table 5 and for pipes of 168.3 mm o.d. to 323.9 mm o.d. the dimensions of the recess shall be as given in Table 6.

Table 5 — Coupler recess dimensions: taper threading to BS 21

Pipe size o.d.	Diameter	
	A	*B*
mm	mm	mm
60.3	60	30
76.1	75	35
88.9	9O	35
114.3	115	40
139.7	140	40

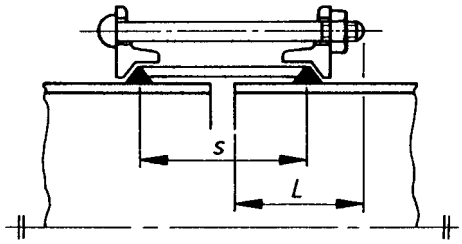


Figure 3 — Slip-on type couplings

Table 6 — Coupler recess dimensions: taper threading to API standard 5B

Pipe size o.d.	Diameter	
	A	*B*
mm	mm	mm
168.3	170	35
219.1	220	35
273	275	40
323.9	325	40

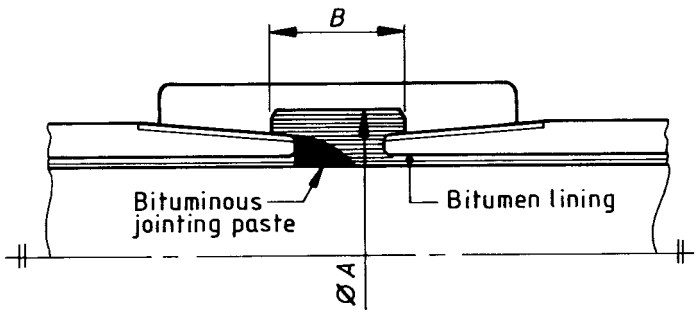


Figure 4 — Threaded and coupled joints recessed for bitumen lining

[2] American Petroleum Institute.

Section 4. Specials

17 Fabrication

Where specials are fabricated by welding, the preparation and welding shall be carried out in accordance with BS 2633 or BS 2971. The ends of specials shall be prepared to match those of the pipes to which they are to be joined.

18 Testing

Specials shall be manipulated or fabricated by welding from pipes which have been hydraulically tested before coating, in accordance with BS 3601. All welds which have not previously been hydrostatically tested shall be tested before coating by the application of a non-destructive test to ensure equivalent leak-tightness.

NOTE 1 Acceptable leak-tightness test procedures are dye penetrant, oil, magnetic particle, ultrasonic, eddy current and radiography.

Specials shall be capable of withstanding a hydraulic test pressure of one-and-a-haft times the maximum working pressure.

NOTE 2 It is essential that the maximum working pressure is stated in the enquiry and order (see item l) of Appendix A).
NOTE 3 The purchaser should state in the enquiry and order whether a hydraulic test is required prior to delivery (see item h) of Appendix B).

19 Tolerances

The tolerances on specials shall be as follows.

a) *Bends*

1) Tolerance on angle between the end faces shall be ± 1°. The end faces shall be at right angles to the axis of the bend.

2) Tolerance on leg length, for gusseted bends only, i.e. L_1 in Figure 7; L_2 in Figure 8; L_3 in Figure 9, shall be:

i) for pipe diameters not exceeding 219.1 mm o.d.: ± 35 mm

ii) for pipe diameters over 219.1 mm o.d.: ± 70 mm.

3) Where fixed leg length is specified, the tolerance on leg length shall be ± 6 mm.

b) *Tees*

1) Tolerance on angle of branch relative to axis of barrel shall be ± 1°.

Barrel and branch end faces shall be at right angles to axis of barrel and branch respectively.

2) Tolerance on dimensions *C, D, E* and *F* (see Figure 10, Figure 11 and Figure 12) shall be ± 6 mm.

NOTE The above tolerances for a) and b) are suitable for general pipeline work but closer tolerances may be necessary for particular applications.

20 Even curvature manipulated bends

20.1 The dimensions of even curvature bends formed by manipulation for pipes of 60.3 mm to 323.9 mm o.d. shall be as given in Table 7 (see Figure 5 and Figure 6).

NOTE 1 The minimum thicknesses shown are those appropriate to bends of the radii specified.
NOTE 2 Bends are commonly specified in sizes of 11 $^1/_4$°, 22 $^1/_2$°, 45° and 90° but they may be of any angle as required by the purchaser.

20.2 The bending radius R for sizes over 323.9 mm o.d. up to 610 mm o.d. shall be not less than five times the outside diameter of the pipe.

20.3 The lengths of straight S specified in Table 7 shall be the minima applicable to bends with slip-on type couplings and bends prepared for butt welding. The lengths of straight S may be modified to suit other types of joint but shall be not less than 1.5 times the nominal pipe size.

NOTE For sleeve joints and the like, the joint length is additional to the length of straight specified.

20.4 When bitumen lining is required on sizes over 168.3 mm o.d., the tube length in the bend shall be reduced to 1 800 mm or gusseted.

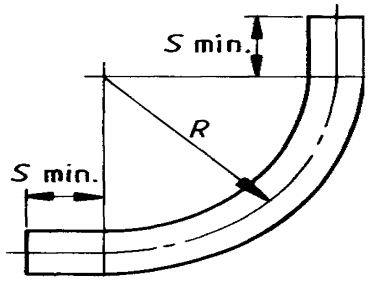


Figure 5 — Even curvature bend of 90°

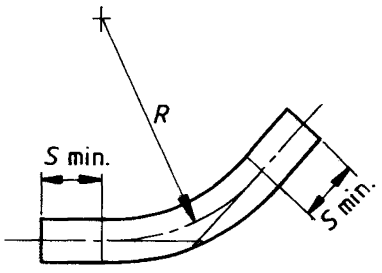


Figure 6 — Even curvature bend less than 90°

Table 7 — Dimensions of even curvature bends: sizes 60.3 mm to 323.9 mm o.d. inclusive

Pipe		Bend	
Outside diameter	**Minimum thickness**	*R*	*S* min.
mm	mm	mm	mm
60.3	3.6	250	150
76.1	3.6	325	150
88.9	4.0	400	150
114.3	4.5	500	150
139.7	4.5	625	190
168.3	4.5	750	225
193.7[a]	5.0	875	265
219.1	5.0	1 000	300
244.5[a]	5.9	1 125	340
273	5.9	1 250	375
323.9	7.1	1 500	450

[a] The use of these sizes should be avoided whenever possible.

21 Gusseted bends

Dimensions of normal gusseted bends shall be as given in Table 8 (see Figure 7, Figure 8 and Figure 9).

NOTE 1 Bends with different dimensions may be required, e.g. where pipelines require to be brushed or pigged or where anchor blocks are necessary; these are deemed to comply with the requirements of this standard providing they meet all other requirements. In such cases, the details should be specified by the purchaser (see item i) of Appendix B).

NOTE 2 When special bends are required the details should be specified by the purchaser in the enquiry and order (see item i) of Appendix B).

22 Tees

Dimensions of normal tees shall be as given in Table 9 (see Figure 10, Figure 11 and Figure 12).

NOTE 1 Tees with different leg length dimensions may be required, e.g. where anchor blocks are necessary; these are deemed to comply providing that they meet all other requirements. In such cases the details should be specified by the purchaser (see item j) of Appendix B).

NOTE 2 When tees with special dimensions are required, the details should be specified by the purchaser in the enquiry and order (see item j) of Appendix B).

NOTE 3 Figure 12 applies to tees as shown in Figure 10 and Figure 11 but with flanged branch. Where tees are flanged on the barrel, the centre to face dimension *C* applies.

23 Welding collars

23.1 Welding collars for use with cut pipes shall be as shown in Figure 13.

23.2 The inside diameters of the collars shall be such that they can be fitted over a cut pipe.

NOTE The inside diameters of collars should be not greater than 6 mm above the pipe outside diameter to facilitate effective welding.

23.3 Collars shall be at least equal in thickness to the adjoining pipes. The minimum length of collars shall be 250 mm.

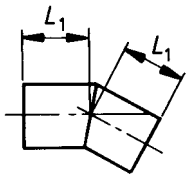


Figure 7 — Gusseted bend type 1, not more than 30°

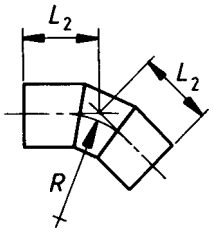


Figure 8 — Gusseted bend type 2, over 30° up to 60°

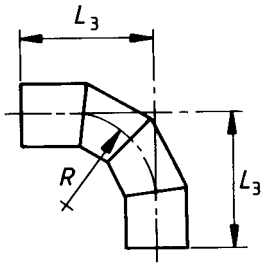


Figure 9 — Gusseted bend type 3, over 60° up to 90°

Table 8 — Dimensions of gusseted bends: pipe sizes 114.3 mm to 2 235 mm o.d. inclusive

Pipe size o.d.	Type 1	Type 2				Type 3	
	Not more than 30°	Over 30° to 45°		Over 45° to 60°		Over 60° to 90°	
	L_1	R	L_2	R	L_2	R	L_3
mm	mm	mm	mm	mm	mm	mm	mm
114.3	175	150	200	150	250	150	300
139.7	200	200	250	200	250	200	350
168.3	225	225	300	225	300	225	400
193.7[a]	275	275	300	275	300	275	400
219.1	300	300	350	300	400	300	500
244.5[a]	300	350	350	350	400	350	550
273	375	375	450	375	500	375	650
323.9	375	450	450	450	500	450	700
355.6	450	525	550	525	600	525	800
406.4	450	600	600	600	600	600	850
457	450	675	600	450	600	450	850
508	450	750	600	500	600	500	850
559	450	825	650	550	600	550	850
610	550	900	750	600	750	600	1 000
660	550	975	750	650	750	650	1 000
711	550	1 050	800	700	750	700	1 100
762	600	1 125	850	750	850	750	1 100
813	600	1 200	850	800	850	800	1 200
864	600	1 275	850	850	850	850	1 200
914	600	1 350	900	900	900	900	1 300
1 016	750	1 500	1 100	1 000	1 100	1 000	1 500
1 219	850	1 800	1 200	1 200	1 200	1 200	1 700
1 422	850	2 100	1 300	1 400	1 300	1 400	1 900
1 626	900	2 400	1 400	1 600	1 400	1 600	2 100
1 829	900	2 700	1 500	1 800	1 500	1 800	2 200
2 032	1 000	3 000	1 600	2 000	1 600	2 000	2 500
2 235	1 000	3 300	1 700	2 200	1 700	2 200	2 600

[a] The use of these sizes should be avoided whenever possible.

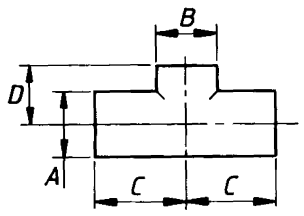


Figure 10 — Plain end tee for slip-on type coupling and butt-welded joint

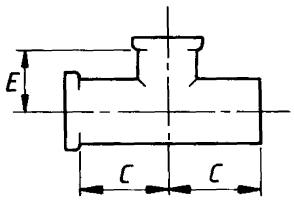


Figure 11 — Sleeve joint tee for welding

Table 9 — Dimensions of tees: pipe sizes 60.3 mm to 2 235 mm o.d. inclusive

Barrel		Branch			
Outside diameter *A*	*C*	**Outside diameter** *B*	*D*	*E*	*F*
			0.5*A* plus		
mm	mm	mm	mm	mm	mm
60.3	240	60.3	200	100	100
76.1	240	76.1	200	100	100
88.9	250	88.9	200	100	110
114.3	270	114.3	200	100	130
139.7	280	139.7	200	110	140
168.3	290	168.3	200	110	140
193.7[a]	300	193.7[a]	200	110	150
219.1	370	219.1	250	110	150
244.5[a]	380	224.5[a]	250	130	160
273	410	273	250	130	160
323.9	450	323.9	250	130	180
355.6	530	355.6	300	150	200
406.4	600	406.4	300	150	230
457 to 711	1.5*B* but with a minimum of 0.5*A*	457 to 711	300	230	300
762 to 914		762 to 914	380	300	300
1 016 to 2 235		1 016 to 2 235	380	380	380

NOTE 1 Dimensions *C, D, E* and *F* should be rounded to the nearest 10 mm.
NOTE 2 The effective length of the barrel of tees with sleeve joint for welding equals 2*C*.
NOTE 3 Any branch of equal or smaller diameter may be matched with any barrel size.

[a] The use of these sizes should be avoided whenever possible.

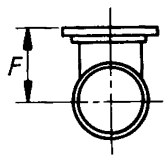
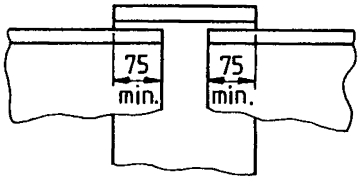


Figure 12 — Tee with flanged branch



Dimension is in millimetres

Figure 13 — Welding collar

Section 5. Protection against corrosion

NOTE 1 This section specifies methods of protecting pipes and specials against corrosion. It covers external protection by bitumen, coal tar based and plastics materials, and internal protection by bitumen, concrete and cement mortar.
NOTE 2 This section will be replaced in due course by separate British Standards covering protection which will incorporate other types of protective coating materials.
NOTE 3 It is permissible for other surface protection systems to be applied in which cases it is necessary for an agreement between the purchaser and the manufacturer to be reached. However, such systems do not form part of this standard.
NOTE 4 It is essential that whether the pipes and specials are to be protected against corrosion, whether the protection is to be external, internal or both, and the type or types of protection required are stated in the enquiry and order (see item k) of Appendix A).
NOTE 5 It is essential that where pipes are for use in or to be transported through an extreme climate, this is stated in the enquiry and order (see item m) of Appendix A) and the manufacturer should take this into account in the choice of material.

24 Surface preparation

24.1 General

The surfaces to be protected shall be clean and free from scale, loose rust, oil, grease or other foreign matter. Surface preparations for other than cement mortar or concrete linings shall be effected by one of the following methods:

a) acid pickling;

b) abrasive, mechanical or flame descaling.

24.2 Acid pickling

Where surface preparation is by acid pickling, the pipes and specials shall be immersed in an acid solution until all the scale has been removed, washed in clean water and the surface suitably inhibited.

24.3 Abrasive descaling

Where surface preparation is by abrasive descaling, the surface finish shall be at least to second quality in accordance with BS 4232.

NOTE If a first quality surface finish is required, this should be specified by the purchaser and the manufacturer (see item l) of Appendix B).

25 Coatings and linings

25.1 Bitumen

Coatings are applied hot or cold and, where bitumen coatings are applied by dipping, the pipes and specials shall be immersed in a bath of molten bitumen until they attain the temperature of the bath. They shall be drained after the removal from the bath and, where necessary for the purposes of jointing, any excess coating shall be removed from the ends. Where coatings are applied by spray or brush, the application shall be such as to provide a smooth continuous coating.

NOTE These bitumen coatings may not be suitable for extended service.

26 External protection

26.1 Priming

Before the application of bitumen or coal tar external protection, pipes and specials shall be primed with a compatible priming coat. Materials and methods complying with BS 4147 or BS 4164 shall be used as appropriate.

26.2 Bitumen sheathing

The materials shall consist of natural or blown petroleum bitumen mixed with an inert filler, i.e. type 2 or type 3 in accordance with BS 4147. The pipes and specials shall be covered with a layer of sheathing material, applied as a hot coating or mastic to provide a seamless, consolidated and smooth layer having a minimum thickness as given in Table 10.

26.3 Reinforced bitumen sheathing

Reinforced sheathing shall be bitumen complying with **26.2** with the addition of an overlapping spiral wrapping of woven glass cloth firmly embedded into the sheathing.

26.4 Bitumen enamel wrapping (filled bitumen with glass tissue)

The pipes shall be covered with a layer of bitumen containing a mineral filler applied hot, i.e. type 2 in accordance with BS 4147, and an inner wrapping of glass tissue and an outer wrapping of bitumen impregnated reinforced glass tissue, the inner wrapping being embedded in the bitumen. For pipes the glass tissue wrappings shall be wound spirally with an overlap. For specials the glass tissue wrapping shall be wound spirally or circumferentially with an overlap. There shall be not less than 1 mm of enamel between the pipe surface and the inner wrapping and also between the inner and outer wrapping. The protection shall have a minimum thickness of 3 mm.

26.5 Reinforced bitumen enamel wrapping

Reinforced wrapping shall be bitumen enamel wrapping complying with **26.4** except that the outer wrapping shall be of composite glass fibre fabric.

Table 10 — Thickness of bitumen sheathing material

Pipe outside diameter	Minimum thickness
mm	mm
88.9 to 168.3	3
193.7 to 323.9	4.5
355.6 to 2 235	6

26.6 Coal tar enamel wrapping (filled coal tar with glass tissue)

The pipes and specials shall be covered with a layer of type 2 filled coal tar in accordance with BS 4164 and an inner wrapping of glass tissue and an outer wrapping of coal tar impregnated reinforced glass tissue, the inner wrapping being embedded in the coal tar. For pipes the glass tissue wrappings shall be wound spirally on the pipe with an overlap. For specials the glass tissue wrapping shall be wound spirally or circumferentially with an overlap. There shall be not less than 1 mm of enamel between the pipe surface and the inner wrapping and also between the inner and outer wrappings. The protection shall have a minimum thickness of 3 mm.

26.7 Non-stick and reflective finish

For bitumen or coal tar coated pipes a non-stick and reflective coating shall be applied to the finished external protection.

26.8 Plastics cladding

Pipes shall be covered with an even layer of hot melt adhesive undercoat with a minimum thickness of 0.1 mm. The undercoat shall consist of a non-setting, pressure sensitive adhesive based on a blend of elastomer resin and fluxing oil. Immediately after the application of this undercoat, a seamless sheath of medium/high density polyethylene shall be continuously applied and shrunk on to the pipe to provide a smooth outer sheath, free from pin holes and cracks. The thickness of the polyethylene shall be in accordance with Table 11.

The minimum thickness of polyethylene shall be the thickness as given in Table 11 minus 12.5 %.

Table 11 — Thickness of polyethylene

Outside diameter of pipe	Polyethylene thickness
mm	mm
60.3	0.6
76.1 to 114.3	0.9
139.7 to 457	1.3

27 Internal protection

27.1 Priming

Before internal bitumen protection is applied, pipes and specials shall be primed with a compatible priming coat. Materials and methods complying with BS 4147 shall be used.

27.2 Bitumen lining of pipes

27.2.1 The materials shall consist of a uniform blend of natural or blown bitumen mixed with an inert filler to produce a homogeneous composition of type 2 in accordance with BS 4147.

27.2.2 The lining material, in a hot fluid condition, shall be applied centrifugally to straight lengths of pipe to give a smooth continuous lining, having a minimum thickness as given in Table 12.

27.3 Bitumen lining of specials

The lining material and the finished lining shall comply with the corresponding requirements of clause **27.2** for straight pipes.

NOTE In view of the variety of methods adopted for the lining of specials, this standard does not specify the procedure to be followed.

28 Tests on applied external and internal protections

28.1 "Holiday" test

All pipes shall be checked for continuity of the applied protection in accordance with Appendix C using a "Holiday" detection unit. Discontinuities and pinholes indicated by the test shall be made good.

28.2 Adhesion test

When an adhesion test is carried out it shall comprise one of the following methods. The manufacturer shall select the first test method.

a) *The ring test.* A ring 75 mm wide shall be cut cold from one end of finished pipes. The ring shall be flattened at a temperature between 10 °C and 20 °C to 50 % of the original diameter. The lining and/or coating shall not part from the metal under this test.

b) *The strip test.* Using a tool with a thin sharp blade, two cuts approximately 50 mm apart shall be made through the protection to the metal pipe. Sudden impact which would cause untimely separation shall be avoided. The blade shall be worked under the protection and an attempt made to peel it from the metal. The adhesion shall be considered satisfactory if removal of the protection causes cohesive failure and the protection does not peel cleanly from the primer or the pipe surface.

The tests shall be performed when the protection has been allowed to cure at a temperature not less than 10 °C or more than 35 °C for a minimum of 48 h after application.

Table 12 — Thickness of bitumen lining material

Outside diameter of pipe	Minimum thickness
mm	mm
60.3 to 323.9	1.5
355.6 to 610	3
660 to 914	4.5
1 016 to 2 235	6

NOTE When an adhesion test is required, this should be stated by the purchaser in the enquiry and order (see item m) of Appendix B).

28.3 Repairs

Any defective coatings and linings shall be made good using compatible materials.

29 Concrete lining and cement mortar lining of pipes

29.1 Concrete lining

29.1.1 The lining shall be concrete made from Portland cement complying with BS 12 or from sulphate-resisting Portland cement complying with BS 4027 and fine aggregate complying with Table 5 of BS 882:1983, grading zones 1, 2 or 3, except that the maximum size of aggregate shall not exceed one-third the thickness of the lining.

NOTE 1 Unless the purchaser states in the enquiry and order his requirement for sulphate-resisting Portland cement (see item n) of Appendix B), the manufacturer has the option of supplying pipes lined with either Portland cement or sulphate-resisting Portland cement.

NOTE 2 The use of additives or any other admixture is not covered by this standard. Such use is not permitted unless specifically agreed in detail with the purchaser.

The minimum cement content shall be 330 kg/m^3 and the maximum water:cement ratio shall not exceed 0.46 : 1.

29.1.2 The water used in the preparation of the concrete shall be neither deleterious to concrete nor deleterious to the water that the pipe is eventually intended to convey. (See clause **6**.)

29.1.3 The concrete lining in contact with potable water shall not discolour the water, impart any objectionable taste or odour or release any toxic substances into the water or support any microbial growth. (See clause **6**.)

29.1.4 The concrete shall give, upon testing, the compressive strength and density specified in **29.5**.

29.1.5 The pipe shall be charged in a single operation and spun at a suitable speed to achieve a minimum rate of radial acceleration of 250 m/s^2 (25 g_n) until the uniform thickness of concrete lining given in Table 13 has been attained over the whole of the inner surface with the exception of stop backs for jointing.

The spinning of the pipe shall continue until surplus water has been dispersed and the greatest possible density of lining obtained. Any damage caused to the lining by the removal of the end rings shall immediately be made good by hand before the lining is set. No more than 1 h shall elapse between the removal of the lined pipe from the lining machine and the commencement of the approved curing procedure.

29.1.6 After being lined, the pipes shall be marked with the date of lining and stored undisturbed for 21 days for maturing, during which time they shall be protected from frost. Means shall be employed to prevent the lining from drying too rapidly, particularly during the 48 h period after the lining operation. The lining shall be kept damp by spraying with water or by other means, e.g. by closing the pipe with end caps until curing is complete.

29.1.7 The surface of the lining shall be smooth and free from irregularities.

Fine surface crazing, hair cracks, or cracks up to 0.25 mm in width in saturated linings and not over 300 mm in length shall not be a cause for rejection.

Cracks over 0.25 mm in width in saturated linings, and cracks over 300 mm in length or other defective linings shall be made good using compatible materials.

29.1.8 No pipe shall be despatched until at least 21 days have elapsed since the date of lining.

Table 13 — Thickness of concrete lining

Outside diameter of pipe or special	Minimum thickness[a] of concrete	Tolerance
mm	mm	mm
Up to and including 168.3	6	+ 3, – 0
193.7 to 323.9	10	+ 3, – 0
355.6 to 610	13	+ 3, – 0
660 to 1 219	19	+ 6, – 0
1 422 to 2 235	25	+ 6, – 0

[a] Thicker linings may be specified.

29.2 Concrete lining of specials

29.2.1 When it is practicable to do so, specials shall be made from cut lengths of mature lined straight pipes.

NOTE See **28.2.3** for situations where it is impracticable to do so.

The lining shall be cut back from the end or ends to be bevelled and welded, for a sufficient distance to ensure that any of the concrete which is intended to remain as part of the lining shall not suffer damage by the cutting or welding process. The lining shall be made good by rendering by hand.

29.2.2 Hand rendering of specials shall consist of freshly mixed concrete of a mixture equivalent to that of the lining being repaired, and shall be thoroughly compacted and finished to a smooth surface of the correct form.

29.2.3 Specials other than those made from cut lengths of mature lined straight pipes shall be lined by hand rendering as specified in **30.2.2**. The rendering of specials of 323.9 mm o.d. and above shall be reinforced with expanded metal or equivalent, securely attached to the inner surface.

29.2.4 Curing shall comply with **29.1.6**.

29.3 Centrifugally applied cement mortar lining

29.3.1 The lining shall be cement mortar made from Portland cement complying with BS 12 or from sulphate-resisting Portland cement complying with BS 4027 and specially graded washed silica sand complying with grading zone 4 in Table 5 of BS 882:1983.

NOTE 1 Unless the purchaser states in the enquiry and order his requirement for sulphate-resisting Portland cement (see item n) of Appendix B), the manufacturer has the option of supplying pipes lined with either Portland cement or sulphate-resisting Portland cement.

NOTE 2 The use of additives or any other admixture is not covered by this standard. Such use is not permitted unless specifically agreed in detail with the purchaser.

The cement mortar shall have a minimum cement content of 1 000 kg/m^3 and a water:cement ratio of between 0.30 : 1 and 0.45 : 1 by mass.

29.3.2 The water for mixing shall comply with **29.1.2**. (See clause **6**.)

29.3.3 The lining in contact with potable water shall comply with the requirements of **29.1.3**. (See clause **6**.)

29.3.4 The cement mortar lining shall be carried out by one of the following methods.

a) Centrifugally spraying and subsequent rotation to achieve smoothing.

b) Centrifugally spraying and simultaneously smoothing by trowelling.

The spray operation shall be such that a continuous feed of freshly mixed mortar shall be evenly applied to the whole bore of the pipe in a single pass in one continuous operation. Where smoothing by rotating is utilized, the duration and speed of rotation shall be kept to a minimum to prevent separation of the constituents of the mortar.

NOTE Vibration can be applied to further shorten the duration of rotation.

29.3.5 The curing process shall comply with **29.1.6**.

29.3.6 The surface of the lining shall be smooth and free from irregularities.

Fine surface crazing, hair cracks or cracks up to 0.25 mm wide in saturated linings and not over 300 mm in length shall not be a cause for rejection.

Cracks over 0.25 mm in width in saturated linings, cracks over 300 mm in length or other defective linings shall be made good using compatible materials.

29.3.7 Formed ends of linings, when specified by the purchaser in the enquiry and order, shall be made after the spraying and smoothing processes unless formed by the insertion of removable formers or end rings.

29.3.8 Lining thicknesses shall be not less than the minimum thicknesses given in Table 14.

29.3.9 Hand finishing of the end of the bore of the pipe, for not more than 100 mm, shall be permitted to rectify the thinning of linings.

29.3.10 Fittings and specials shall be centrifugally spray lined to the same requirements as straight pipes or, if this is precluded by their shape, be hand finished and cured so as to achieve comparable results.

29.4 Spun cement mortar lining

The lining materials, thicknesses and tests shall comply with the requirements for centrifugally applied cement mortar lining as specified in **29.3**. The method of application and the curing of the linings shall comply with the requirements for spun concrete linings as specified in **29.1**.

29.5 Tests on concrete and cement mortar used for lining

Test blocks of the same material as used for the pipe lining shall be made in 100 mm or 150 mm cube moulds and subjected to cube crushing tests. Each block shall be removed from its mould as soon as practicable and cured under conditions of temperature and humidity identical with those in which the lining of the pipe is cured.

Table 14 — Thickness of cement mortar lining

Outside diameter of pipe or special	Minimum thickness[a] of cement mortar	Tolerance
mm	mm	mm
Up to and including 323.9	6	+ 2, – 0
355.6 to 610	7	+ 2, – 0
660 to 1 219	9	+ 2, – 0
1 422 to 2 235	12	+ 3, – 0

[a] Thicker linings may be specified.

The cube strength of the test cube shall be not less than 31 N/mm^2 after 28 days of curing or 17 N/mm^2 after 7 days of curing. The density of the test cube shall be not less than 2 300 kg/m^3 in the case of concrete and 2 100 kg/m^3 in the case of cement mortar.

30 Stop back of protection at ends

30.1 Pipes and specials supplied with concrete or cement mortar linings which are to be joined together by internal welding shall have the lining stopped back at the ends a distance sufficient to permit welding of the joints without damage to the lining.

30.2 Pipes and specials supplied with bitumen, coal tar or plastic coatings and linings shall have the external protection stopped back a distance sufficient to permit assembly of the joint. The internal protection shall extend to the pipe end.

Pipes and specials to be joined together by welding shall have the external and internal protection stopped back at the ends as follows.

a) *Butt welded joints*. 75 mm from the ends of the pipes to be welded.

b) *Sleeve welded joints*. For sleeve and spigot sleeve length plus 75 mm.

In all cases, priming shall extend to the ends of the pipes.

31 Completion of protections at joints

31.1 External protection

When material is supplied to make good the joints, or to repair minor damage of sheathed or wrapped pipes and specials, the material supplied shall be compatible with the factory coating.

NOTE The purchaser should state in the enquiry and order his requirement for material to be supplied (see item p) of Appendix B). A sufficient quantity of primer, bitumen based or coal tar based composition, and glass tissue cloth where appropriate, should be supplied with each consignment to cover the joints after laying and to repair minor damage.

31.2 Internal protection

When material is supplied to make good the joints, or to repair minor damage of bitumen lined pipes or specials, the material supplied shall be compatible with the factory coating.

NOTE The purchaser should state in the enquiry and order his requirement for material to be supplied (see item p) of Appendix B). A sufficient quantity of lining material should be supplied with each consignment to ensure continuity of the internal protection at joints and to repair minor damage.

32 Protection of coated and lined pipes against damage in storage, transport and handling

32.1 Coated pipes and specials shall be protected against damage in storage, transport and handling, e.g. by using straw or wood wool pads.

32.2 The ends of all lined pipes and specials shall be sealed to exclude foreign matter during transit and storage.

NOTE Suitable protection may be in the form of plugs, discs or plastic sheeting.

Appendix A Essential information to be supplied by the purchaser in the enquiry and order

The purchaser should supply the following information in the enquiry and order.

a) The number of this British Standard, i.e. BS 534.

b) The method of manufacture of the pipe or special and the grade of steel required (see **5.1** and **5.2**).

c) The dimensions of the pipe or special, i.e. outside diameter and thickness of pipe required (see **9.1**).

d) Whether pipes are for cutting into closing lengths at site (see **9.2**).

e) Whether random or cut lengths are required (see clause **10**).

f) For random lengths the length range, and the quantity in metres required (see clause **10**).

g) For cut lengths the finished length and the total number of lengths required (see clause **10**).

h) Type of joint required (see clause **11**).

i) Type of flange required (see **15.1**).

j) Types of specials required (see section 4).

k) Corrosion protection requirements (see section 5).

l) Maximum working pressure (see clause **18**).

m) Whether pipes or specials are for use in or to be transported through an extreme climate (see note 5 to section 5).

Appendix B Purchaser options

This standard lists certain options and a number of options are specified in BS 3601 (see **2.2** of BS 3601:1987). The purchaser should state in the enquiry and order whether the following are required but if no such statement is made supply is at the option of the manufacturer.

a) Whether branches of tees are to be made of the same material as the main bodies.

b) Whether a manufacturer's certificate is required (see clause **8**).

c) Whether a test certificate is required (see **8.2**).

d) Preparation of pipe ends required for butt-welding if different from the preparation specified in clause **12**.

e) Whether individual sleeve joints are required to be pressure tested after welding (see **13.5**).

f) Whether pipes are required for cutting into closing lengths (see **13.6** and **9.2**).

g) Variation from steel specified in this standard for nozzles and branches (see **5.2**).

h) Whether hydraulic testing of specials is required at the manufacturer's works (see clause **18**).

i) Details of variations of gussetted bends from tabulated values (see clause **21**).

j) Details of variations of dimensions for tees (see clause **22**).

k) Requirements for protection materials other than specified in this standard (see notes to section 5).

l) Whether first quality abrasive descaling is required (see **24.3**).

m) Whether an adhesion test is required (see **28.2**).

n) Whether sulphate-resisting Portland cement lining is required.

o) The number of cube crushing tests required (see **29.5**).

p) Whether material for completing the internal and external protection of joints at site is required (see **31.1** and **31.2**).

Appendix C Electrical test for continuity

C.1 Principle

Possible faults in the protection are examined for using a high tension scanning electrode.

C.2 Equipment

C.2.1 *Variable voltage detector (Holiday detector)*

C.2.2 *Scanning electrode,* in the form of a metallic brush or a jointed spiral spring or conductive rubber.

C.3 Procedure

Ensure that the pipe protection is free from surface moisture. Connect the metal substrate, if possible, to earth.

Check at the time of testing that the spark length from the apparatus is 10 mm or twice the minimum specified thickness of the coating, whichever is the greater.

Place the electrode in contact with the surface to be tested. Operate the electrode with a continuous movement at the rate recommended by the manufacturer of the equipment. In the absence of such recommendations, operate the electrode at a rate of approximately 0.2 m/s.

When the brush passes over a fault, a spark will be produced between the electrode and the pipe.

Locate the fault.

Publications referred to

BS 10, *Specification for flanges and bolting for pipes, valves and fittings (obsolescent).*

BS 12, *Specification for Portland cements.*

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).*

BS 882, *Specification for aggregates from natural sources for concrete.*

BS 1387, *Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.*

BS 1560, *Circular flanges for pipes, valves and fittings (Class designated).*

BS 1560-3.1, *Specification for steel flanges.*

BS 2633, *Specification for Class I arc welding of ferritic steel pipework for carrying fluids.*

BS 2971, *Specification for Class II arc welding of carbon steel pipework for carrying fluids.*

BS 3396, *Woven glass fibre fabrics for plastics reinforcement.*

BS 3396-1, *Specification for loom-state fabrics.*

BS 3600, *Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes.*

BS 3601, *Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes.*

BS 4027, *Specification for sulphate-resisting Portland cement.*

BS 4147, *Specification for bitumen-based hot-applied coating materials for protecting iron and steel, including suitable primers where required.*

BS 4164, *Specification for coal-tar-based hot-applied coating materials for protecting iron and steel, including a suitable primer.*

BS 4232, *Specification for surface finish of blast-cleaned steel for painting.*

BS 4504, *Circular flanges for pipes, valves and fittings (PN designated).*

BS 4504-3.1, *Specification for steel flanges.*

BS 4772, *Specification for ductile iron pipes and fittings.*

BS 6920, *Suitability of non-metallic products for use in contact with water intended for human comsumption with regard to their effect on the quality of the water.*

BS 6920-1, *Specification.*

BS 8010, *Code of practice for pipelines.*

BS 8010-2, *Pipelines on land: design, construction and installation.*

ISO 4200, *Plain end steel tubes, welded and seamless: General tables of dimensions and masses per unit length.*

API 5B, *Specification for threading, gauging and thread inspection of casing, tubing and line pipe threads*[3)].

[3)] Available from BSI Sales Department, Linford Wood, Milton Keynes MK14 6LE.

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