

Specification for

**Polyethylene fusion
fittings with integral
heating element(s) for
use with polyethylene
pipes for the
conveyance of gaseous
fuels**

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics Standards Policy Committee (PLM/-) to Technical Committee PLM/9, upon which the following bodies were represented:

- British Board of Agrément
- British Gas plc
- British Plastics Federation
- British Plumbing Fittings Manufacturers' Association
- British Valve and Actuator Manufacturers' Association
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Construction Industries Directorate)
- Department of the Environment (Property Services Agency)
- Department of Transport
- Electricity Supply Industry in England and Wales
- Engineering Equipment and Materials Users' Association
- Health and Safety Executive
- Institute of Building Control
- Institution of Civil Engineers
- Institution of Gas Engineers
- Institution of Production Engineers
- Institution of Water and Environmental Management
- National Association of Plumbing, Heating and Mechanical Services Contractors
- Plastics and Rubber Institute
- Plastics Land Drainage Manufacturers' Association
- Royal Institute of Public Health and Hygiene
- Society of British Gas Industries
- Society of British Water Industries
- Water Companies Association
- Water Research Centre
- Water Services Association of England and Wales

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Institute of Plumbing
- Ministry of Agriculture, Fisheries and Food
- Standards Association of Australia

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

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Foreword

This British Standard has been prepared under the direction of the Plastics Standards Policy Committee.

It introduces a specification for fittings made substantially of polyethylene (PE) but incorporating integral heating element(s) to enable fusion jointing with pipes made with compatible grades of polyethylene and intended for use in the conveyance and distribution of natural and manufactured gaseous fuels.

The nominal sizes of the fittings covered by this British Standard are 16 mm to 500 mm where these sizes indicate compatibility of fit with PE pipes of the corresponding size (and nominal outside diameter) in accordance with BS 7281. The fittings are intended for use under the same range of operating conditions.

The requirements for the electrical components and systems are based upon the design philosophy that the fusion time shall be dependent upon the type and size of the fitting and independent of the grade of PE from which the pipe or fitting is made.

This specification is based chiefly upon experience with use of such fittings to convey natural gas as available in the UK. Fittings complying with this specification are considered to be suitable for the conveyance of landfill gas and liquefied petroleum gas provided that the gas composition and the operating conditions are such that the fuel remains at all times in the gaseous state. If other constituents are present and/or condensation of the fuel may affect the performance of the fitting, the maximum allowable working pressure should be carefully evaluated with reference to clause 4 and the note to that clause. Any additional potentially harmful effects to personnel if exposed to the pipework contents, particularly in the case of landfill gases, should be taken into account.

The requirements of this British Standard for protection from weathering of the fitting are intended to ensure that the fitting will be satisfactory after storage and handling in accordance with recommended practices prior to installation; it is assumed that in service the fitting will be buried or otherwise protected from weathering.

Attention is drawn to CP 312-1, which gives general guidance on storage, handling and installation of plastics pipework, and to CP 312-3, which includes such guidance specific to polyethylene pipework for pressure applications.

Attention is also drawn to codes of practice IGE/TD/3 [1] and IGE/TD/4 [2], published by the Institution of Gas Engineers¹⁾, which contain detailed guidance on the use of polyethylene piping systems in the gas industry.

In the preparation of this British Standard, attention has been given to the work of Technical Committee 138 of the International Organization for Standardization (ISO), but the requirements of the available draft standard were not considered to be sufficiently stringent for UK application. Attention has also been given to the work aimed at international standardization of methods of extrapolation of data for assessing long-term performance; in the absence as yet of a public ISO document for cross reference, those aspects of the method relevant to this standard have been summarized or reproduced in Appendix A of BS 7281:1990.

Attention is drawn to the provisions of the Health and Safety at Work etc. Act, 1974 and the need to take appropriate precautions to ensure the safety of personnel when carrying out the methods of test required by this standard.

Product certification. Users of this British Standard are advised to consider the desirability of third party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS 5750.

¹⁾ Available from the Institution of Gas Engineers, 17 Grosvenor Crescent, London SW1X 2B.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

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 50, 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.

1 Scope

This British Standard specifies requirements for fusion fittings made substantially of polyethylene (PE) and incorporating integral heating element(s), where the shape and composition of the fitting is suitable for jointing with PE pipe complying with BS 7281 up to and including nominal outside diameter 500 mm and for conveying the following natural and manufactured fuels in the gaseous state (see note 1):

- a) natural gas (see BS 1179);
- b) landfill gas (see 2.5);
- c) liquefied petroleum gas (LPG) (including butane and propane; see BS 1179).

Such fittings are intended for use at operating temperatures between 20 °C and + 40 °C and at pressures up to and including 8 bar²⁾, depending upon the material class, the pipe pressure classification and the application (see clause 4 of this standard and clause 4 of BS 7281:1990, including the note).

This British Standard is applicable to fittings intended for applications in which the fitting is buried or otherwise protected from weathering.

It gives requirements for materials, design characteristics, dimensions, marking, assembly conditions, electrical connections, power requirements, fusion cycle controls, physical properties and hydraulic performance for individual or assembled fittings, as applicable.

Methods of test piece preparation and assembly and/or testing are given in Appendix A to Appendix R.

Guidance on quality control testing and recommendations for sampling and testing are given in Appendix S and Appendix T respectively.

NOTE 1 Other gases may have a deleterious effect on the fitting and further testing and evaluation may be necessary.

NOTE 2 The titles of BSI and ISO standards publications referred to in this standard are listed on the inside back cover. References to publications other than BSI and ISO are identified in the text by numbers in square brackets and are listed in Appendix U.

2 Definitions

For the purposes of this British Standard, the definitions given in BS 1179 and BS 1755-1 apply, together with the following.

2.1

branch saddle

a lateral fitting which uses ancillary cutters for drilling the hole in the main

2.2

elbow

a curved cylinder enabling a change of direction with a maximum centreline radius of one times nominal bore

2.3

flange adaptor

a spigot fitting used with a seal/gasket and backing ring(s) for making a mechanical joint in a PE piping system

2.4

inner cold zone

for a socket, the distance between the inner end of the fusion coil and the pipe penetration stop of a socket fitting

2.5

landfill gas³⁾

gas, consisting essentially of a mixture of methane and carbon dioxide, extracted during and/or following landfill operations

2.6

masterbatch³⁾

a well-dispersed mixture of a polymer and high percentages of one or more component(s) (colorants and/or other additives) in known proportions for use in blending in appropriate amounts with the basic polymer in the preparation of a compound

2.7

spigot fitting

a fitting terminating with a cylindrical end stub, the dimensions of which comply with those of the corresponding pipe

2.8

standard dimension ratio (SDR)⁴⁾

for a pipe or equivalent hollow right cylinder of circular cross section, the ratio of the specified minimum outside diameter to the specified minimum wall thickness

2.9

tapping tee

a lateral fitting that contains an integral cutter which remains in the body of the fitting after installation

²⁾ 1 bar = 10⁵ N/m² = 0.1 MPa.

³⁾ Definition consistent with BS 7281:1990.

⁴⁾ Definition consistent with BS 5556:1978.

3 Materials

3.1 Basic materials

3.1.1 The base polymer shall be designated in accordance with BS 3412:1976 (as amended by Amendment Nos 1 and 2) as comprising a type A or type D polymer intended for moulding. It shall be in accordance with clauses 4, 5 and 9 of that standard in respect of the acceptable variation in density (see 3.1.2), melt flow rate (MFR) (see 3.1.3) and colour and of the presence of impurities.

3.1.2 When determined in accordance with ISO 1872-1:1986, the conventional density at 23 °C of the base polymer shall be greater than 930 kg/m³ and not more than 960 kg/m³ and shall be classified and coded in accordance with Table 2 of ISO 1872-1:1986, i.e. as having a code of 33, 40, 45, 50 or 57.

NOTE In accordance with ISO 1872-1:1986, the manufacturer states which cell will designate the material. If subsequent individual values lie on, or either side of, the cell limit because of manufacturing tolerances (see 3.1.1), the designation is not affected. The code is applicable accordingly.

3.1.3 Subject to permissible deviations consistent with 4.3, when determined in accordance with ISO 1872-1 the MFR of the base polymer shall correspond to a nominal value which shall be declared by the fitting manufacturer.

NOTE The effective permissible deviations for the MFR of the base polymer are partly dependent upon the effect on the MFR of the production process for the fitting and should be agreed between the fitting manufacturer and the material supplier.

3.2 Additives

3.2.1 General. The base polymer shall include, or be blended with, only such additives (see, for example, 4.1.3 concerning fusibility, 4.2.2 for pigment and 4.4 for anti-oxidants) as are necessary to produce a compound for the manufacture, storage and use of fittings in accordance with this standard.

3.2.2 Masterbatch. If the compound is produced from masterbatch and natural material, the masterbatch shall be based upon the natural polymer with which it is to be mixed.

3.3 Reworked material

If reworked PE material is used, it shall be clean, derived from fittings produced in accordance with this standard, which are free from any previously reworked PE material, and shall be reground under the supervision of the same manufacturer. Fittings comprising reworked PE material shall be identifiable as such through reference to the date of manufacture [see 8.1 f)].

3.4 Compounded material

The compounded material shall be free from visible water.

3.5 Heating elements

The following material properties of the integral heating elements shall be declared by the fitting manufacturer:

- the permissible range of the temperature coefficient of resistance per Kelvin;
- the permissible range of resistance per unit length (in Ω/m).

NOTE The composition or surface treatment of exposed electrical connections for heater elements is required to be corrosion-resistant (see 4.7).

4 General requirements for fittings

4.1 Design

4.1.1 Classification. The fitting shall be classified with reference to the class of pipe in accordance with BS 7281:1990 as a function of the material type and SDR (see 2.8) of the pipe with which it is to be used, as shown in Table 1.

Table 1 — Classification of fittings

Material class of pipe in accordance with BS 7281:1990	Pressure rating at 20 °C		
	Standard dimension ratio of the corresponding pipe		
	SDR 11	SDR 17.6	SDR 26
	bar	bar	bar
A	4	2.5	1.5
B	5.5	3	2
C	7	4	2.5
D	8	4.5	3

NOTE The pressure ratings given in Table 1 are the maximum allowable working pressures that may be sustained for not less than 50 years at a temperature of 20 °C, based on the following calculation.

$$p_w = 20M/F_s (R - 1)$$

where

p_w is the maximum allowable working pressure (internal, gauge) (in bar);

M is the minimum required strength for the applicable material class in accordance with 3.3.3 and Table 1 of BS 7281:1990 (in MPa);

F_s is a design factor, for which a nominal value of 3 has been assumed for pipes in accordance with BS 7281;

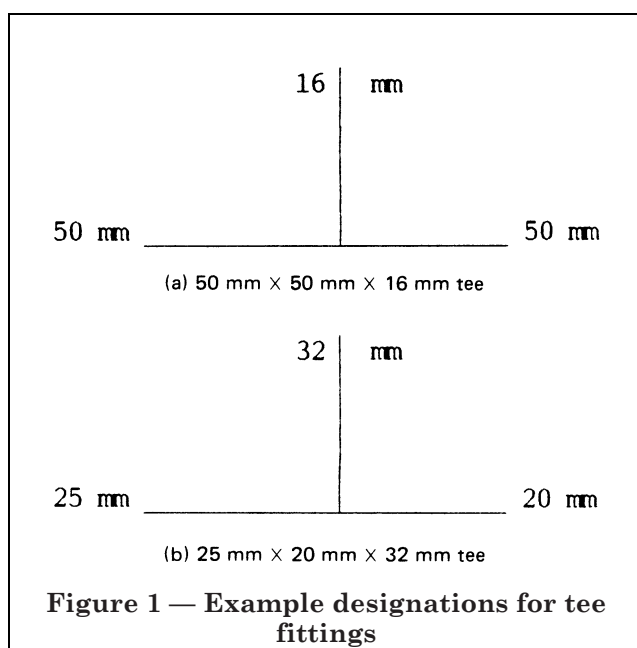
R is the applicable SDR for the corresponding pipe in accordance with BS 7281.

The maximum allowable working pressure for a piping system depends on the design factor, which is also governed by many factors other than the material used for the pipe or fitting, such as jointing techniques, fitting systems, risk of rapid crack propagation failure [3], operating temperatures and the consequences of a failure. Hence a nominal design factor of 3 may not be suitable for all applications and the final design factor for a system should be determined by a designer taking into consideration all the relevant factors. For such purposes, attention is drawn to the guidance given in IGE/TD/3 [1] and IGE/TD/4 [2].

4.1.2 Nominal size and designation of fittings. The nominal size of a fitting or of each individual connection thereon shall be designated by the nominal size of the pipe(s) with which it is to be used (see BS 7281). The method of designating the fitting shall be as follows, depending on the type of fitting.

a) *Straight fittings and bends.* For fittings having two unequal ends, the larger end is given first, e.g. 20 × 16.

b) *Tee fittings.* Tee fittings are designated first by the ends on the run, i.e. two ends in the same straight line with, if applicable, the larger of the two being specified first and then by the remaining end, as shown, for example, in Figure 1.



4.1.3 Fusion jointing. The fitting shall be capable of being jointed in accordance with the following conditions.

a) For each size and type of fitting produced by a manufacturer, the fusion time at a given voltage shall be selected (see 5.9 and associated tables, as applicable) and declared by the fitting manufacturer. It shall be the same for all pipes to be jointed to that fitting irrespective of the pipe SDR and material, where the pipes comply with BS 7281:1990.

NOTE The combination of the fitting design and the selection of the fusion time and voltage is also subject to constraints imposed in respect of other electrical considerations and of cooling times (see 5.9).

b) A given type and size of fitting shall be capable of being jointed in accordance with Appendix A with any corresponding pipe in accordance with a), using the applicable fusion time and voltage at – 5 °C and + 23 °C to produce jointed assemblies that comply with clause 7.

c) A permanent and obvious means of indicating that the joint has been subjected to the fusion cycle shall be provided on the external surface of the fitting, e.g. a fusion indicator.

d) With the exception of fusion indicators [see c)], melt from the fusion operation shall not exude outside the confines of the fitting or into the inner cold zone(s) of the fitting.

e) The fusion process shall not induce any of the following effects:

- 1) pipe collapse or internal creasing of the bore;
- 2) voids in the fusion interface that would prevent compliance of the joint with this standard.

f) When assembled subject to cooling and reheating in accordance with pattern 4 of Table A.2, a joint subjected to a single cooling and reheating cycle shall not deteriorate to an extent that would prevent compliance with the production tolerance on the nominal resistance of the heating element in accordance with 5.9.1, the minimum long-term strength of the joint in accordance with 7.4 or the stress crack resistance of the joint in accordance with 7.5.

4.1.4 Means of handling. For fittings of socket sizes of 250 mm or greater, means shall be provided to facilitate gripping of the fitting for handling purposes.

NOTE Examples of means of handling that have been found to be suitable include tough removable cardboard or film covers with associated straps or handles.

4.2 Appearance

4.2.1 Surface appearance. When viewed without magnification, the internal and external surfaces of the fitting shall be free from cracks, voids, blisters, distortion, dents, inclusions or any other such features to an extent that would prevent the fitting from complying with this standard.

4.2.2 Pigmentation. The colour of the fitting shall be yellow within the range 10 E 50, 10 E 53, 10 E 55 and 08 E 53 of BS 5252:1976. When tested in accordance with BS 2782:Method 1106A using test pieces which represent all levels of the thickness of the fitting wall, the pigment dispersion shall be at least as uniform in appearance as that shown in photomicrograph 2 of Figure 1 of BS 2782:Method 1106A:1983, i.e. appearances similar to or less homogeneous than those shown in photomicrographs 3 to 6 of that figure shall be unacceptable.

4.3 Melt flow rate (MFR)

When tested in accordance with ISO 1872-1, using test material representative of the full wall thickness of the thinnest parallel-faced wall section of the fitting, the MFR of material from the fitting shall meet the following conditions:

- a) the MFR shall not differ by more than $\pm 30\%$ from the nominal value declared in accordance with 3.1.3;
- b) the MFR shall not differ by more than $\pm 20\%$ from the actual MFR of the base material used for the production of that fitting.

4.4 Oxidation induction time

When tested in accordance with Appendix D of BS 7281:1990, using test pieces representative of the inner surface, outer surface and mid-wall regions of the fitting, the oxidation induction time shall be not less than 20 min.

4.5 Conditioning and test conditions

Test pieces shall be conditioned in accordance with Appendix B, as appropriate to both the purpose of the test and the references to that appendix in other clauses of this British Standard. For type test purposes or in case of dispute, measurements of physical properties, including dimensions, and the preparation of jointed test piece assemblies shall not be undertaken within 14 days of the manufacture of the fitting or within 7 days of the manufacture of the pipe.

Unless otherwise specified in this standard, tests and measurements shall be conducted at a temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

NOTE The conditioning periods and conditions given in Appendix B are considered appropriate to the thermal conductivity and non-hygroscopic nature of the material and the need for some data for quality control purposes to be obtained with the minimum of delay.

4.6 Dimensions

When determined in accordance with Appendix C the following conditions shall be met:

- a) the minimum wall thickness between the mid-points of the fusion zones shall be not less than that appropriate to the internal diameter of the fitting cross section to give the equivalent SDR as that of the pipe in accordance with BS 7281 for which the fitting is intended;
- b) the minimum bore diameter at any point between sockets in a fitting, excluding penetration stops, shall be $1.0075d_e$ (in mm) (see note);
- c) the minimum bore diameter for any cross section including pipe penetration stops adjacent to a socket shall be not less than the maximum bore diameter of the pipe in accordance with BS 7281 for which the socket is intended.

NOTE Other dimensional requirements are given in respect of particular types of fittings or connections. Some dimensions are specified as a function of d_e , where d_e corresponds to the nominal size and hence the minimum mean outside diameter, in millimetres, of the pipe which the fitting or connection is intended to fit.

4.7 Exposed metal components

Where exposed metal components are used, there shall be no evidence of corrosion of the component(s) after the fitting has been immersed for 7 days at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in an aqueous sodium chloride solution, 30 g/L, and then removed from the solution and examined for evidence of rust spots.

NOTE This clause is aligned with test conditions given in BS 4576-1:1989.

4.8 Elastomeric seals

If elastomeric rings are used in joints, they shall comply with the requirements of BS 2494 for joint rings for gas applications.

5 Individual types of fittings or connections

5.1 Sockets

NOTE See 4.5 and 4.6.

5.1.1 The socket shall have a lead-in at least 5 mm long to ease assembly, as shown in Figure 2. The dimensions of socket fittings or connections shall comply with the limits given in Table 2 and indicated in Figure 2, where

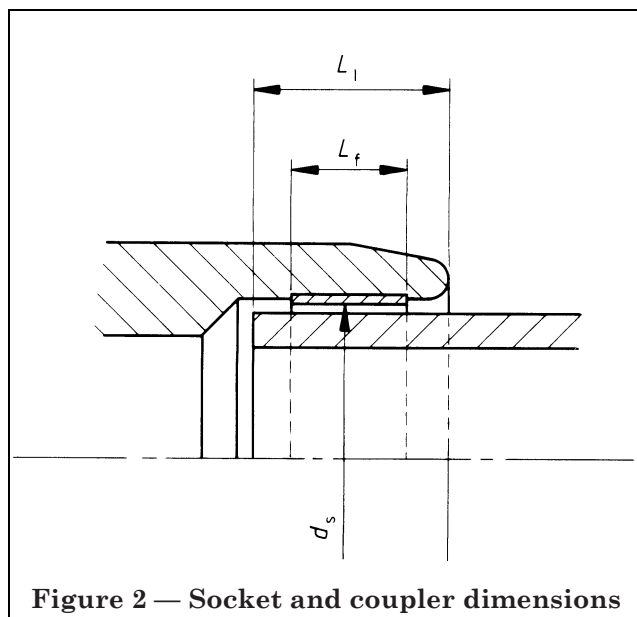
d_s is the average internal diameter of the socket measured over the fusion length, L_f ;

L_f is the nominal fusion length and comprises the length of the integral heating element from the first regular section of the element to the end of the regular section, on one side of the fitting, when measured from outside edge to outside edge of the wire;

L_1 is the depth of the penetration of the pipe or the male end of a spigot fitting.

5.1.2 When measured in accordance with Appendix C, the ovality within the bore of a socket shall be not greater than $0.015d_e$.

5.1.3 The minimum bore diameter at any point in a socket, excluding penetration stops, shall be $1.0075d_e$.



5.2 Couplers

5.2.1 General. Straight couplers shall incorporate a means of preventing pipe penetration beyond the socket. The means shall not prevent use of couplers with longitudinally restrained pipes in a repair situation, i.e. it shall be possible to slide the coupler onto one pipe end far enough to allow the pipe ends to be aligned and the movement of the coupler reversed until it overlaps both pipe ends in position to be jointed.

NOTE See 4.5 and 4.6.

Table 2 — Socket and coupler dimensions

Pipe size (d_o)	Measured over nominal fusion length, L_f				Nominal fusion length, L_f	Nominal overall length of couplers, L_c
	Limits for average internal diameter on each fitting, d_s		Depth of penetration of the pipe or spigot end, L_1			
	max.	min.	max.	min.	min.	max.
(mm)	mm	mm	mm	mm	mm	mm
16	16.6	16.4	41	27	15	82
20	20.6	20.4	41	28	16	82
25	25.6	25.4	41	30.5	18	82
32	32.9	32.5	41	31.5	18	82
40	41.0	40.6	49	32	18	98
50	51.1	50.7	50	35	20	100
55	56.1	55.7	59	36.5	21	118
63	64.1	63.7	59	39	23	118
75	76.3	75.9	62.5	42.5	25	125
90	91.5	91.1	77.5	47	28	155
110	111.6	111.1	82	53	32	164
125	126.7	126.2	85.5	57	35	171
140	141.7	141.2	92	57	38	184
160	162.1	161.4	98	67	42	196
180	182.1	181.5	105	69	46	210

5.2.2 Sizes up to and including 180 mm

5.2.2.1 The maximum overall length, L_c , shall comply with the limit specified in Table 2.

5.2.2.2 The length of each inner cold zone shall be not less than $0.1d_e + 5$ mm for sizes up to and including 125 mm and $0.1d_e$ for larger sizes.

5.2.3 Sizes over 180 mm

5.2.3.1 The maximum overall length, L_c , shall be $0.66d_e + 90$ mm (see Figure 2).

5.2.3.2 The minimum average internal diameter, d_s , shall be greater than the maximum mean outside diameter specified in BS 7281 for the corresponding size of pipe.

The maximum average internal diameter of the nominal fusion lengths of the coupler shall be such that when the coupler is assembled and tested in accordance with Appendix D, using pipes subject to a mutual axial angular deflection of not less than 1.5° , the following conditions are satisfied:

- a) the maximum force required to position the coupler shall not exceed 500 N;
- b) the heating element(s) shall not be dislodged;
- c) the fused assembly shall comply with the peel test failure mode requirements of 7.2.2.

The manufacturing tolerances on the mean internal diameter of the coupler shall be declared by the manufacturer.

5.2.3.3 Each nominal fusion length, L_f (see Figure 2), shall be greater than 50 mm.

5.2.3.4 The length of each inner cold zone shall be not less than $0.1d_e$ (in mm).

5.3 Reducers

5.3.1 General

NOTE See 4.5 and 4.6.

5.3.1.1 There shall be no sudden step changes of internal diameter.

5.3.1.2 Reducers shall incorporate a means of preventing pipe penetration beyond the smaller socket during installation.

5.3.2 Sizes with a major diameter up to and including 180 mm

5.3.2.1 The minimum average internal diameter, d_s , and minimum nominal fusion length(s) shall comply with the limits specified in Table 2 and indicated in Figure 2 if applicable and otherwise the minimum average internal diameter at any point shall comply with 4.6, where d_e is that of the smaller pipe with which the reducer is to be used.

5.3.2.2 The maximum overall length shall comply with the applicable limit specified in Table 3.

5.3.2.3 The length of the inner cold zone for each socket shall be not less than $0.1d_e + 5$ mm for sizes up to and including 125 mm and for larger sizes shall be not less than $0.1d_e$.

5.3.3 Sizes with major diameters over 180 mm

5.3.3.1 The maximum overall length shall comply with the applicable limit specified in Table 3.

Table 3 — Overall length of reducers

Major diameter	Maximum length	Major diameter	Maximum length
mm	mm	mm	mm
32	105	200	245
50	105	225	260
55	120	250	280
63	120	280	300
75	140	315	320
90	180		
125	215		
140	215		
180	280		

5.3.3.2 The minimum average internal diameter, d_s , shall comply with the relevant limit specified in Table 2, if applicable, or shall be greater than the maximum outside diameter specified for the corresponding pipe in accordance with BS 7281.

The manufacturing tolerances on the average internal diameters of the reducer shall be declared by the manufacturer.

5.3.3.3 The nominal fusion lengths shall comply with the relevant limit(s) given in Table 2, if applicable, or shall be greater than 50 mm.

5.3.3.4 The length of the inner cold zone for each socket shall be not less than $0.1d_e$.

5.4 In-line electrofusion tees and associated spigots

NOTE See 4.5 and 4.6.

5.4.1 The minimum average internal diameter, d_s , and the minimum nominal fusion lengths shall comply with the limits specified in Table 2 and indicated in Figure 2 if applicable and otherwise the minimum average internal diameter at any point shall comply with 4.5, where d_e shall be the diameter of the smaller pipe.

5.4.2 The outlet spigot length shall comply with the applicable limit specified in Table 4. Over the minimum spigot length, the dimensions of the fitting shall comply with the requirements for the corresponding size of pipe in accordance with BS 7281.

5.4.3 The maximum overall length of the in-line electrofusion portion of the fitting shall be $2d_e + 90$ mm.

5.4.4 The length of the inner cold zones for each socket shall be $0.1 d_e + 5$ mm for sizes up to and including 125 mm and for larger sizes shall be not less than $0.1 d_e$ (in mm).

5.4.5 The fitting shall incorporate a permanent means of controlling pipe penetration within the socket, such as to prevent obstruction of the tee outlet, as shown in Figure 3.

5.4.6 The pressure loss across the fitting shall be less than 1.5 times the velocity head, when measured between the main pipe and the branch outlet with the main extension blanked off and determined in accordance with Appendix E using a nominal line pressure of 25 mbar at flow velocities of 1.5 m/s, 3 m/s, 5 m/s and 7.5 m/s.

5.4.7 The orientation of the terminal shrouds (see 5.9.3) shall be as shown in Figure 4.

5.5 Elbows

NOTE See 4.5 and 4.6.

5.5.1 The maximum overall length of the intersection of the fitting centre line to the mouth of the socket shall be $d_e + 45$ mm.

5.5.2 The length of the inner cold zone for each socket shall be $0.1 d_e + 5$ mm for sizes up to 125 mm and for larger sizes shall be not less than $0.1 d_e$ (in mm).

Table 4 — Dimensions of spigot connections

Pipe/fitting size	Tubular length, L_2	Pipe/fitting size	Tubular length, L_2
	min. ^a		min. ^a
(mm)	mm	mm	mm
16	46	125	87
20	46	140	92
25	46	160	98
		180	105
32	46	200	112
50	49	250	130
55	55	280	140
63	63	315	150
75	70	355	165
90	79	400	180
110	82	500	212

^a Actual spigot lengths should take account of couplers and use of installation tools, e.g. scrapers and pipe clamps.

5.5.3 The fitting shall incorporate a means of preventing pipe penetration beyond the socket, as indicated in Figure 3.

5.5.4 For fittings of sizes up to and including 180 mm, the pressure loss across the fitting, when determined in accordance with Appendix E using a nominal line pressure of 25 mbar at flow velocities of 1.5 m/s, 3 m/s, 5 m/s and 7.5 m/s, shall comply with the applicable limit as follows:

- a) for 45° elbows, the pressure loss shall be less than 0.5 times the velocity head;
- b) for 90° elbows, the pressure loss shall be less than 1.0 times the velocity head.

5.5.5 The orientation of the terminal shrouds (see 5.9.3) shall be as shown in Figure 4.

5.6 Tapping tees

5.6.1 All fittings shall be capable of installation by using a force generated from above and on the centreline of the tapping tee stack, where the force applied to the fitting shall be in the range 1 000 N to 1 500 N.

5.6.2 Tapping tee outlets shall be spigot type. The outside diameter shall be either 32 mm $^{+0.3}_{-0}$ mm

over a minimum spigot length of 46 mm

or 63 mm $^{+0.4}_{-0}$ mm over a minimum spigot

length of 70 mm. The spigot wall thickness shall comply with the limits given in Table 3 of BS 7281:1990 as applicable for the size and SDR of the corresponding outlet pipe.

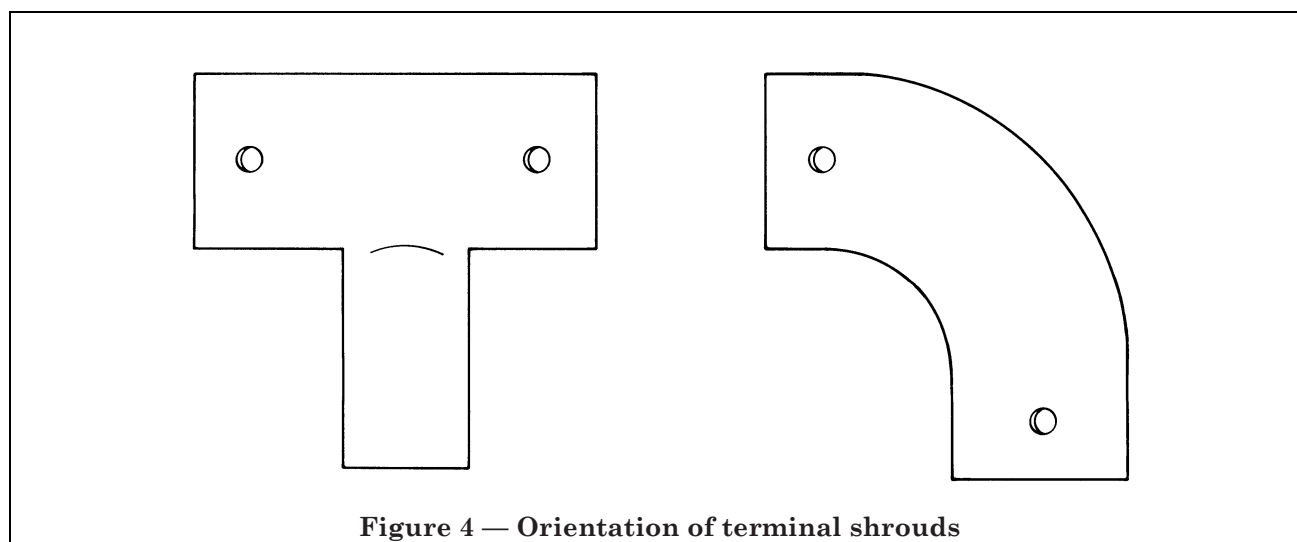
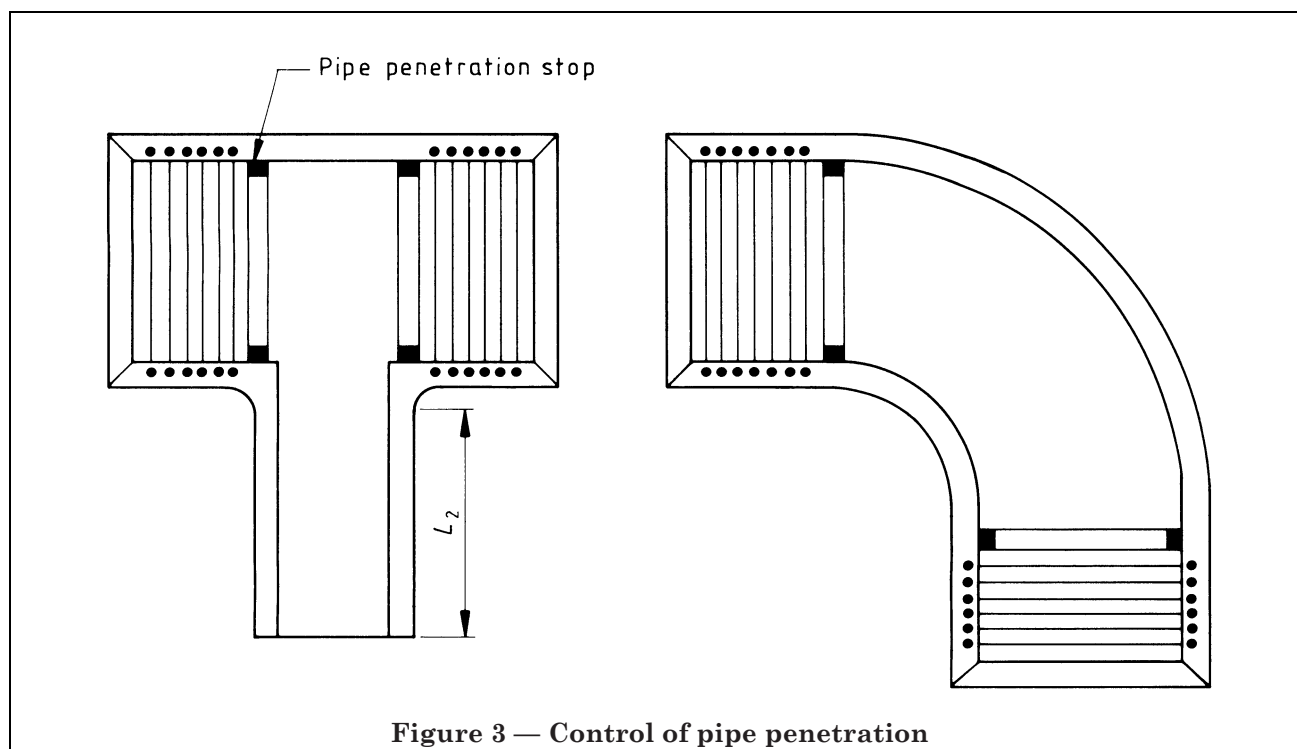
5.6.3 The minimum wall thickness at any point of the fitting shall comply with the limit given in Table 3 of BS 7281:1990 as applicable for the size and SDR of the corresponding outlet pipe.

5.6.4 The tapping tee cap design shall incorporate means for the easy removal and replacement of the cap from an above-ground position. It shall be capable of passing all tests required of the fittings without additional fastenings or constraints when tightened with a torque of 4 N m. It shall not fail by cracking when a torque of 15 N m is applied.

5.6.5 If an “O” ring is used as a seal, it shall remain in position when the cap is removed and replaced.

5.6.6 Tapping tees shall provide a means of cutting through the pressurized main pipe and allowing gas to flow into the outlet pipe without allowing uncontrolled leakage of gas to atmosphere to occur.

The cutting device shall be capable of cutting the pressurized pipe over the range of temperatures -5°C to 23°C without producing any swarf and so that the coupon is retained by the cutting device. For pipe sizes up to 180 mm, SDR 17.6, the operating torque applied at 5 turns/min shall not exceed 45 N m. For larger pipe sizes, torque values shall be declared by the manufacturer.



The integral cutter shall have a socket key recess of minimum depth 16 mm. The cutter shall be operated by a 12 mm hexagonal key having a cross section in accordance with BS 4168-9:1983 when $s = 12$. The key shall not include a thread follower.

NOTE 1 The length of the key is not restricted to the limits given in BS 4168-9.

NOTE 2 The key specified corresponds to a 12 mm AF key.

5.6.7 The fitting shall have the integral heating element clear of the path of the cutter. The fusion sealing width, i.e. the distance between the inner and outer turns, at any point of the fusion face shall be not less than 15 mm. The maximum saddle base dimension, along the main, for tapping tees of 32 mm outlet shall be 120 mm and for a 63 mm outlet shall be 200 mm.

5.6.8 The design of the tapping tee shall include provision for pressure testing of the connected service pipe and the fusion interface between the pipe and fitting without removal of the cutter prior to tapping the main.

5.6.9 When tested in accordance with Appendix F at a working pressure of $25 \text{ mbar} \pm 1 \text{ mbar}$ with the applicable flow rate given in Table 5, the pressure drop for the appropriate gas shall not exceed the value given in Table 5.

Table 5 — Pressure drop through saddle connections

Fitting outlet size	Flow rate of methane ^a	Pressure drop across fitting ^b as service pipe velocity heads
mm	m ³ /h	
32	4.3	4
63	18	4
^a Corrected to standard temperature and pressure. ^b Including electrofusion fitting fused to spigot outlet.		

5.7 Branch saddles

5.7.1 For spigot outlet sizes up to and including 63 mm, the fitting shall be capable of installation by using a force generated from above and on the centreline of the branch saddle spigot, where the force applied to the fitting shall be in the range 1 000 N to 1 500 N. For outlet sizes greater than 63 mm, other methods of loading shall be permissible provided that the resultant joint complies with clause 7.

5.7.2 For 90 mm nominal size and above, branch saddle outlets shall be either spigotted or flanged. Branch saddle outlets smaller than 90 mm shall be spigotted. A spigotted outlet shall have a minimum length, L_2 , complying with the applicable limit given in Table 4. The length of a flanged outlet, when measured from the face of the stub flange to the crown of the main, shall comply with the applicable limit given in Table 6.

5.7.3 Any butt-fused assembly shall have both the internal and external beads removed.

5.7.4 The flanged portion on branch saddles shall comply with 7.6.

Table 6 — Dimension from stub flange face to crown of the main

Flanged fitting	Shut-off method	Dimension	
		min.	max.
mm		mm	mm
90 off 125	Valve	230	254
90 off 125	Squeeze	1 255	1 275
125 off 180	Valve	204	228
125 off 180	Squeeze	1 255	1 275

5.8 In-line electrofusion flange adaptors

The electrofusion portion of the flange adaptor shall match the dimensional characteristics of a straight coupler of half length (see 5.2). The flanged portion on branch saddles shall comply with 7.6.

5.9 Electrical

5.9.1 For each size and type of fitting, the manufacturer shall declare the nominal resistance of the heating element and specify the production tolerance and limits for that resistance.

When joints are made using the two extremes respectively of the tolerance band for assembly and inspection in accordance with Appendix G, the following conditions shall be met:

- a) the sectioned test assembly shall show no signs of collapse of the pipe or of creasing of the pipe bore;
- b) sections from the joint shall comply with 7.2 as applicable.

5.9.2 The maximum power requirement for socket fittings up to and including 180 mm and for all saddles shall be 2 kW at 40 V r.m.s. and the fitting voltage supply shall be 39 V r.m.s. to 40 V r.m.s. Except in the case of socket fittings with a major diameter of up to 250 mm, which may be fused at 40 V r.m.s. provided that the power requirement does not exceed 2 kW, the maximum power requirement for socket fittings above 180 mm major diameter(s) shall be 4 kW at 80 V r.m.s. and the fitting voltage supply shall be 78 V r.m.s. to 80 V r.m.s.

The fitting fusion time shall be selected by the manufacturer from Table 7 or Table 8 as appropriate and declared [see 4.1.3 a)]. When selecting the fusion time, consideration of joint cooling time before handling is necessary such that the following conditions shall be met:

- a) when determined in accordance with Appendix H, the maximum cooling time for fittings up to and including 180 mm size shall not exceed 20 min;

b) for sizes above 180 mm, the maximum jointing time (i.e. fusion plus cooling time) shall be declared by the manufacturer.

5.9.3 All fittings shall have mechanically shrouded male electrical terminals (see note 1). Fitting terminals and shrouds shall comply with the dimensions given in Figure 5(a) to Figure 5(c), where Figure 5(a) is applicable to connections unrelated to the fusion time to be used and Figure 5(b) and Figure 5(c) are applicable to connections in which the angular displacement of the inner key with respect to the outer slot is indicative of fusion times given in Table 7 or Table 8 as appropriate (see note 2).

The terminal pins shall have an upper limit for surface roughness of R_a 0.8 μm when determined in accordance with BS 1134-1. If hollow terminal pins are used, the hole at the top of the pin shall be less than 1 mm in diameter.

NOTE 1 Consideration should be given to the design of the shroud with respect to impact damage.

NOTE 2 The relative angular positions of the key and the slot are not restricted by this standard and should therefore be agreed between the purchaser and the supplier as necessary.

5.9.4 For fittings having two sockets of sizes up to and including 355 mm, the circuit connections shall be such that both sides of socket fittings shall be fused in one operation.

5.9.5 The heating elements shall be designed to prevent short circuiting or local overheating during the fusion operation. Any protective coatings applied to the heating element shall not prevent compliance of the joint with clause 7.

5.9.6 The heating element wire shall not be disturbed during assembly in accordance with Appendix A.

5.9.7 The indicators [see 4.1.3 c)] shall not operate if any wire becomes open circuit during the first 50 % of the fusion cycle in accordance with Appendix A.

Table 7 — Fusion times for 40 V systems

Fusion time					
s	s	s	s	s	s
20	32	46	85	160	300
22	34	50	90	180	360
24	36	55	110	200	400
26	40	60	120	220	440
28	42	70	130	240	500
30	44	80	140	260	600

Table 8 — Fusion times for 80 V systems

Fusion time					
s	s	s	s	s	s
200	320	440	560	680	800
220	340	460	580	700	820
240	360	480	600	720	840
260	380	500	620	740	860
280	400	520	640	760	880
300	420	540	660	780	900

6 Long-term dimensional stability of individual fittings

6.1 Couplers and other forms of socket fittings

After storage for 12 months at $30\text{ }^{\circ}\text{C} \pm 20\text{ }^{\circ}\text{C}$, the fitting shall comply with either a) or b) as follows:

- the fitting shall remain within all applicable dimensional limits of this standard (see note);
- the fitting shall comply with the following conditions:

- the average internal diameter shall comply with the applicable limit;
- the fitting shall be capable of assembly by hand and jointing to pipe at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in accordance with Appendix A;
- fittings jointed in accordance with 2) shall comply with 7.5.

NOTE Specified or declared limits apply. See, for example, 5.2.2.

6.2 Tapping tees and branch saddles

After storage for 12 months at $30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, the fitting shall comply with either a) or b) as follows:

- the fitting shall remain within all applicable dimensional limits of the standard;
- the fitting shall be capable of assembly and jointing to pipe at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and the resulting joint shall comply with 7.5.

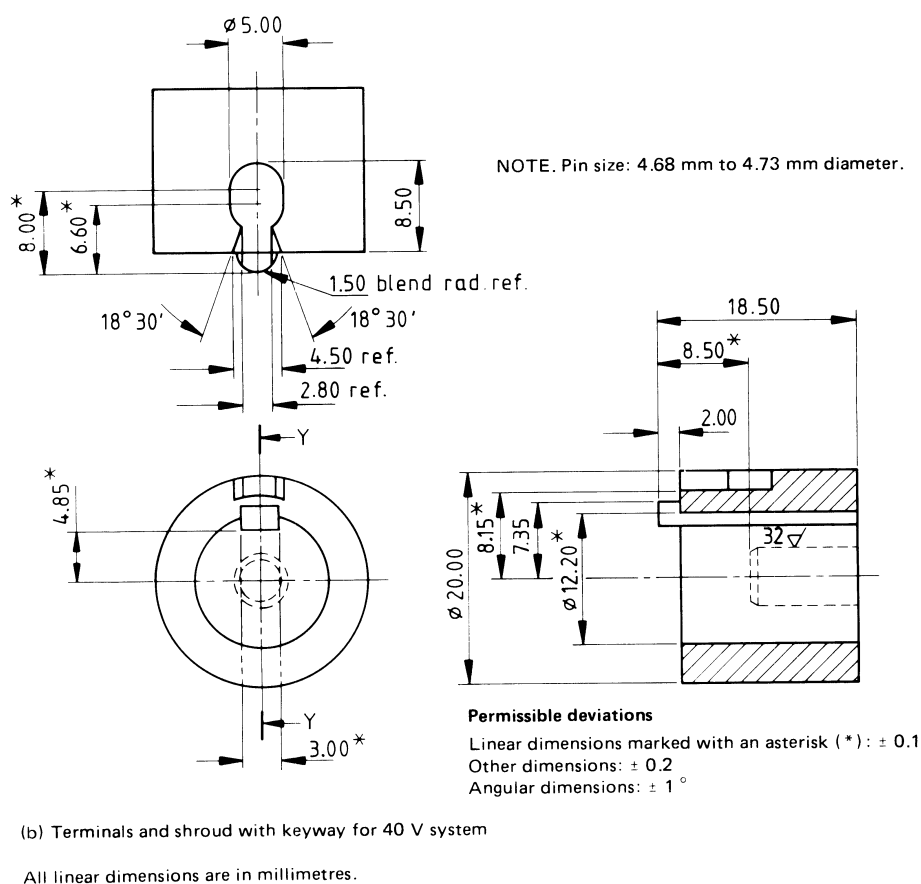
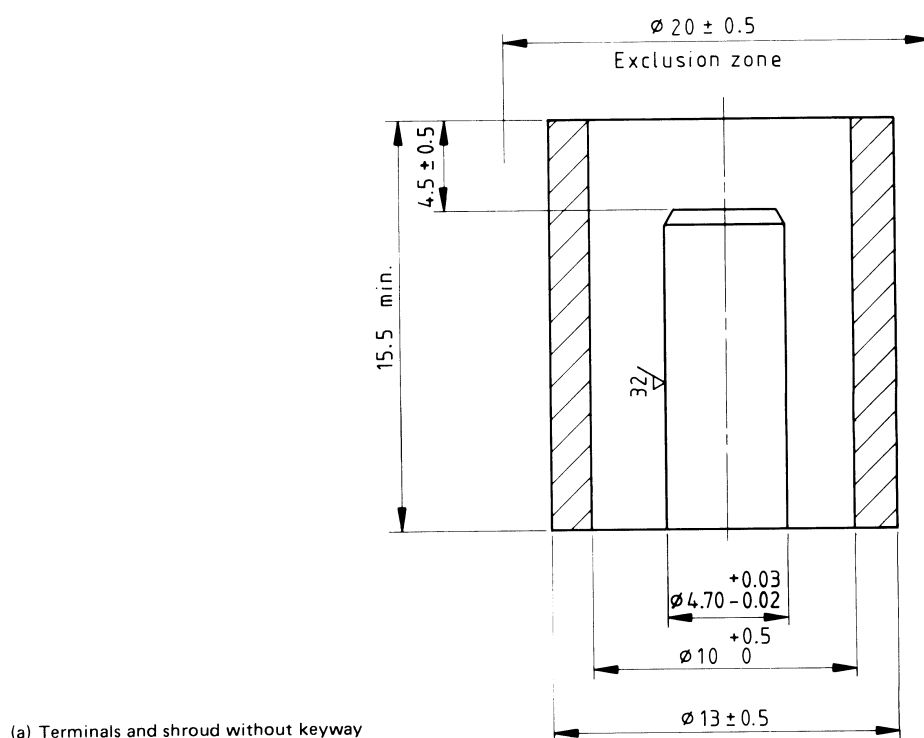
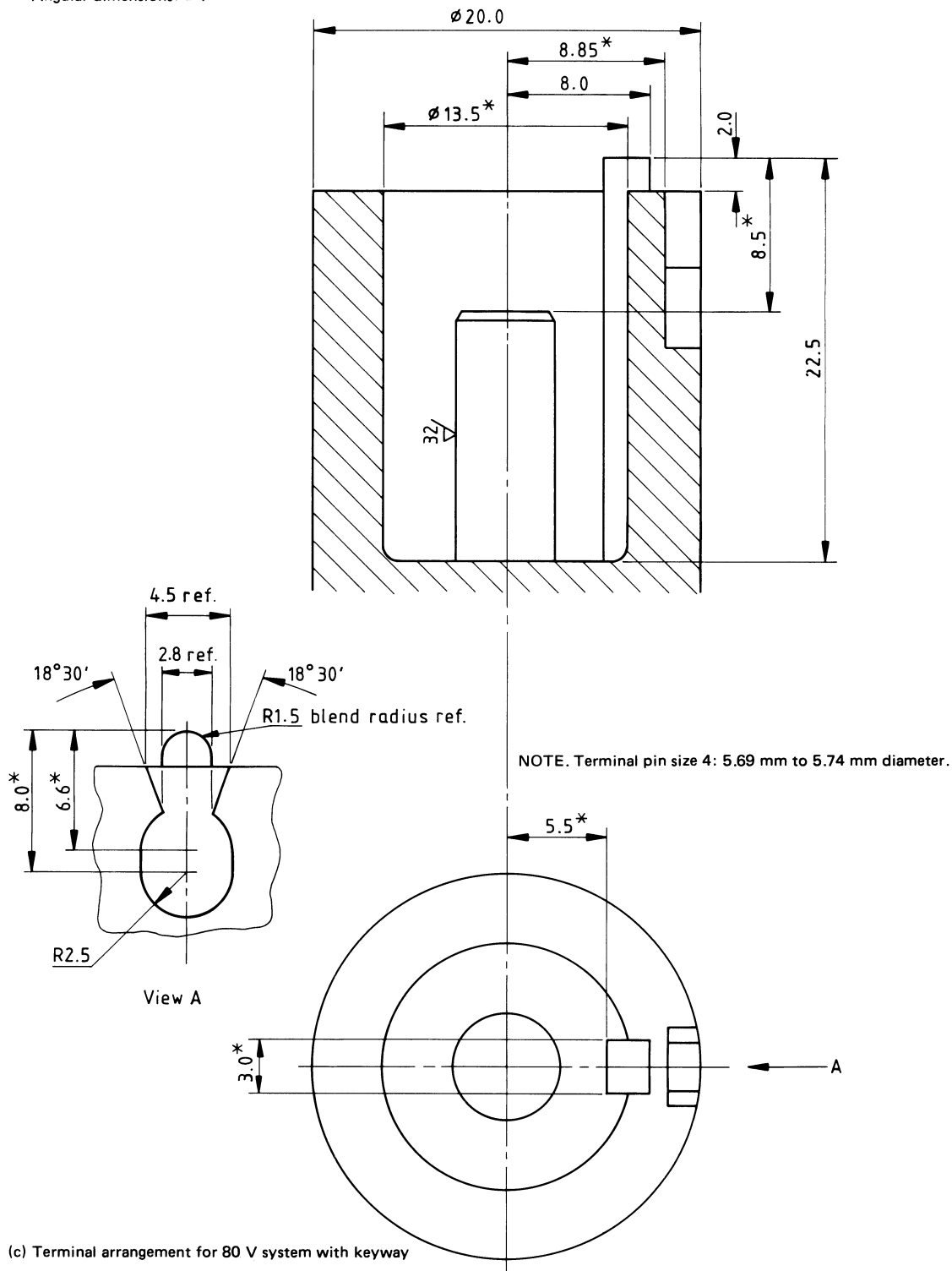


Figure 5 — Terminals and shrouds

Permissible deviationsLinear dimensions marked with an asterisk (*): ± 0.1 Other linear dimensions: ± 0.2 Angular dimensions: $\pm 1^\circ$ 

All linear dimensions are in millimetres.

Figure 5 — Terminals and shrouds (concluded)