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Water Industry Specification

SPECIFICATION FOR POLYETHYLENE SOCKET AND SPIGOT FITTINGS, SADDLES AND DRAWN BENDS FOR FUSION JOINTING FOR USE WITH COLD POTABLE WATER PE PRESSURE PIPES

FOREWORD

This specification has been prepared by the Water Research Centre (WRc) under the direction of the WAA Sewers and Water Mains Committee in consultation with the Water Industry and the British Plastics Federation to define the properties required for polyethylene joints and fittings in the nominal size range 20–1000.

In addition to the increase in the size range a number of amendments have been incorporated in this issue. The thermal stability test has been changed to a determination of the oxidation induction time. The requirements of the hydrostatic pressure tests at 80°C have been increased and a fatigue pressure test at 80°C included. It should also be noted that the range of spigot fittings of nominal size 20 to 63 are designed for use with socket fittings for fusion jointing manufactured to this specification or electrofusion couplers manufactured to WIS No. 4-32-06¶ and should not be used for butt fusion jointing.

Attention is drawn to the Manual for MDPE pipe systems for water supply, which has been prepared to offer guidance to the UK Water Industry on the practical design, installation and operation of PE water pipeline systems, and also to WIS No. 4-32-08 which specifies fusion jointing procedures.

The dimensions and pressure ratings of the pipes with which these fittings are to be used are based on BS 5556 and are given in BS 6572*, BS 6730 and WIS Nos. 4-32-02*, 4-32-03, 4-32-05 and 4-32-09¶. Fittings are designated by the nominal size of the pipe with which they are to be used.

Polyethylenes are manufactured by different processes and contain a range of, and varying quantities of, co-monomers which can result in substantially different basic properties, e.g. melt flow rate, density, creep resistance, etc. Materials known to be suitable for the manufacture of fittings to this specification may not be compatible for fusion jointing to pipes to BS 6572, BS 6730 and WIS Nos. 4-32-02, 4-32-03, 4-32-05 and 4-32-09 and the guidance of the manufacturer should be sought before fusion jointing dissimilar materials.

Compliance with this specification does not of itself confer immunity from legal obligations. This specification does not purport to include all the necessary provisions of a contract. Users of this specification are responsible for its correct application.

Purchasers are reminded that this specification requires that the manufacturer shall operate an acceptable quality system relating to the manufacture of pipe to this specification in compliance with BS 5750: Part 2 (EN 29002), which ensures that products claimed to comply with this specification consistently meet the required level of quality. Enquiries regarding the availability of third party certification should be addressed to WRc Swindon.

This specification calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

It has been assumed in the drafting of this specification that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Information contained in this specification is given in good faith but neither the Water Authorities Association nor the Water Research Centre can accept any responsibility for actions taken as a result.

* BS 6572 is equivalent to IGN No. 4-32-02 and is now regarded as the lead specification.
¶ in course of preparation.

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1. SCOPE

This document specifies the requirements for both blue and black pigmented polyethylene (PE) fittings for use in cold potable water services at pressures up to 12 bar (at 20°C) for sizes 20–63 and 10 bar for sizes 90–1000. The use of blue fittings shall be restricted to use underground or where protected from direct sunlight.

NOTE: Blue is the preferred colour for underground MDPE pipes for potable water use.

These fittings are designed for use with pipe manufactured to BS 6572, BS 6730 and WIS Nos. 4-32-02, 4-32-03 and 4-32-09* and fittings to WIS No. 4-32-06*. Particular attention is drawn to the additional hydrostatic design considerations given in WIS No. 4-32-03: Issue 3.

These fittings are jointed to the pipe by hot tool welding, by socket fusion and butt fusion. Spigot fittings for use with electrofusion couplers are included.

2. MATERIAL REQUIREMENTS

2.1 The base polymer shall be a single grade of polyethylene with a derived density in the range 931 to 944kg/m^3 at 23°C, when determined in accordance with BS 3412. This includes copolymers of ethylene and higher olefins, in which the higher olefin constituent does not exceed 10% by mass.

The base polymer shall be compounded with additives (antioxidants, pigment, carbon black, UV stabilisers, etc.) that are necessary for the manufacture, storage and use of fittings to this specification.

The base polymer and the compounds made therefrom shall conform to clauses 4, 5, 9 and 10 of BS 3412:1976 in respect of density, melt flow rate, colour variation, impurities and, where applicable, carbon black characterisation. Also, where carbon black is used, the compound supplier shall certify that the carbon black has an iodine absorption number of $\geq$ 110 when tested according to BS 5293: Part 10, a maximum toluene extract of 0.10% by mass when tested according to ISO 6209 and has a maximum extinction coefficient of 0.1 when tested according to Appendix C of BS 6730: 1986.

2.2 Black compound shall be Class W as defined in BS 3412 and conform to all relevant clauses of that standard except where otherwise stated by this specification. Antioxidants as listed in Table 2 of BS 3412:1976 (excluding 6,6′-diterbutyl-4,4′thiodi-m-cresol) shall be used provided that they comply with clauses 8.1 and 8.2 of BS

* In course of preparation.

3412:1976 and the final fitting produced satisfies this specification (4-32-04).

2.3 Blue compound shall be Class N as defined in BS 3412. Antioxidants as listed in Table 2 of BS 3412 (excluding 6,6'-diterbutyl-4,4'thiodi-m-cresol) shall be used provided that they comply with clauses 8.1 and 8.2 of BS 3412 and the final fitting produced satisfies this specification (4-32-04).

3. PHYSICAL REQUIREMENTS FOR FITTINGS

3.1 Additives

Additives shall be evenly distributed throughout the fitting. Compliance with clause 3.2 shall be accepted as indicating adequate dispersion of additives.

3.2 Colour

3.2.1 Blue fittings
Blue fittings shall have a colouration within the range of 18E51 and 18E53 of BS 4901. When tested across the fitting wall by the method described in BS 2782: Method 1106A, the pigment dispersion shall be equivalent in appearance to that shown in photomicrograph 1 or 2 of that standard.

3.2.2 Black fittings
When tested according to BS 2782: Method 823B, the carbon black dispersion shall be equivalent to photomicrograph 4 or less of that standard.

3.3 Dimensions and tolerances

Fittings shall conform to the dimensions and tolerances given in Tables 1, 2 and 3. Where applicable, outside diameters and wall thickness shall be measured by BS 2782: Method 1101A.

As dimensions may change after manufacture, procedures for measurement shall be generated accordingly. In case of dispute, fittings shall not be measured until 14 days after manufacture and subsequent conditioning at 23 ± 2°C for a minimum of 5 hours.

3.3.1 Socket fusion fittings.

3.3.1.1 Socket fusion fittings shall conform to the dimensions specified in Table 1 (see also Figure 1).

3.3.1.2 The thickness of the fitting at any point shall not be less than the minimum for the appropriate size and class of pipe.

3.3.1.3 The socket root diameter shall be measured at a point whose distance from the face of a fitting to the specified reference depth is as shown in Figure 1. The average diameter at the root shall be less than at the mouth.

Table 1 – Socket fusion fitting dimensions (mm)

Nom. pipe size	Pressure rating (bar)	Socket bore diameter measurements								Ref. depth	Min. bore	Pipe penetration depth into fitting
		Limits for average diameter on each fitting				Limits for individual diameter						
		Mouth (1)		Root (2)		Mouth (1)		Root (2)				
		max.	min.	max.	min.	max.	min.	max.	min.			
20	12	19.5	19.2	19.3	19.0	19.55	19.15	19.35	18.95	14.5	15.2	12 +2 −1
25	12	24.5	24.1	24.3	23.9	24.5	24.1	24.3	23.9	16.0	19.4	13 +2 −1
32	12	31.5	31.1	31.3	30.9	31.55	31.05	31.35	30.85	18.1	25.0	14.6+2 −1
50	12	49.45	48.95	49.2	48.7	49.5	48.9	49.25	48.65	23.5	39.4	21 +3 −1
63	12	62.5	62.0	62.1	61.6	62.55	61.95	62.15	61.55	27.4	49.8	24 +3 −1
90	10	89.9	89.3	88.5	87.9	90.1	89.1	88.7	87.7	33.0	71.6	29 +4 −1
125	10	125.0	124.4	123.2	122.6	125.2	124.2	123.4	122.4	40.0	99.6	35 +4 −1

NOTES

(1) The mouth is defined as the point of intersection between the extension of the bore and the face of the fitting. Where the fitting mouth radius does not permit the effective measurement of mouth diameter, mouth dimensions may be established by extrapolation from a measured diameter 5mm from fitting face and the measured root diameter.
(2) Root diameters are measured at the reference depth. The actual socket depth is greater than the reference depth.

Table 2 – Spigot fittings for use with socket fusion and electrofusion couplers – dimensions (mm)

Nominal pipe size	Mean outside diameter		Wall thickness 12 bar (SDR 11)	Minimum bore	Min spigot length
	minimum	maximum	minimum		L_1
20	20.0	20.3	2.3	14.8	37
25	25.0	25.3	2.3	19.8	40
32	32.0	32.3	3.0	25.2	44
50	50.0	50.4	4.6	39.6	55
63	63.0	63.4	5.8	50.0	63

NOTE: Fittings meeting the requirements of this specification and conforming to the dimensions in Table 2 are intended for use with socket fusion and electrofusion fittings and should not be used for butt fusion jointing.

Table 3 – Spigot fittings for butt fusion, socket fusion and electrofusion jointing – dimensions (mm)

Nominal pipe size	Mean outside diameter		Thickness of spigot of fitting				Minimum bore	Min spigot length
			10 bar (1)		6 bar (1)			
	minimum	maximum	minimum	maximum	minimum	maximum		L_1
90	90.0	90.6	8.2	9.2	–	–	67	79
125	125.0	125.6	11.4	12.7	7.1	8.0	93	87
180	180.0	181.2	16.4	18.2	10.2	11.4	135	105
250	250.0	251.5	22.7	25.2	14.2	15.8	189	130
315	315.0	316.8	28.6	31.7	17.9	19.8	239	150
355	355.0	357.1	32.3	35.7	20.1	22.3	269	(2)
400	400.0	402.3	36.4	40.2	22.7	25.2	304	(2)
450	450.0	452.6	41.0	45.3	25.6	28.4	343	(2)
500	500.0	502.9	45.5	50.3	28.3	31.3	380	(2)
560	560.0	563.2	50.8	56.1	31.7	35.1	425	(2)
630	630.0	633.7	57.2	63.1	35.7	39.5	478	(2)
710	710.0	714.0	–	–	40.2	44.4	539	(2)
800	800.0	804.6	–	–	45.3	50.0	608	(2)
900	900.0	905.0	–	–	50.9	56.2	684	(2)
1000	1000.0	1005.0	–	–	56.6	62.5	760	(2)

NOTE 1: See Appendix A of WIS No. 4-32-03 for additional hydrostatic design considerations.
NOTE 2: To be completed at a later date.

3.3.1.4 Socket fusion fittings may be used with pipe whose pressure rating is less than that of the fitting.

3.3.2 Spigot fittings for butt fusion jointing.

3.3.2.1 At its mouth a fitting shall have the same nominal wall thickness and mean diameter as the pipe to which it is to be joined, as specified in Table 3 (see also Figure 2).

3.3.2.2 The thickness of the body of the fitting at any point shall not be less than the minimum thickness of the pipe to which it is to be joined.

3.3.2.3 The minimum bore of the fitting, excluding any internal weld bead shall conform to the dimensions specified in Table 3.

3.3.2.4 The clamping length L_2 (shown in Figure 2) shall be not less than 500mm. This may be achieved by welding extension pipe lengths (pups) to the spigot ends of a fitting, thus the extension lengths and the weld are considered as part of the fitting for the purposes of this specification.

3.3.2.5 At no point around the circumference shall the mismatch of the outside surfaces of the pups and fitting in the immediate vicinity of the mating faces exceed the values specified in Table 4.

Table 4 – Mismatch of butt fusion joints

Nominal size range	Mismatch – maximum (mm)
90– 125	1
180– 250	2
315– 500	3
560– 710	4
800–1000	5

3.3.2.6 The out-of-roundness or ovality (the difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-section) of the end of the fitting or pupped end shall not be greater than:

Nominal size 90 up to and including nominal size 250:
0.02 x (nominal size)mm
Greater than nominal size 250:
0.03 x (nominal size)mm

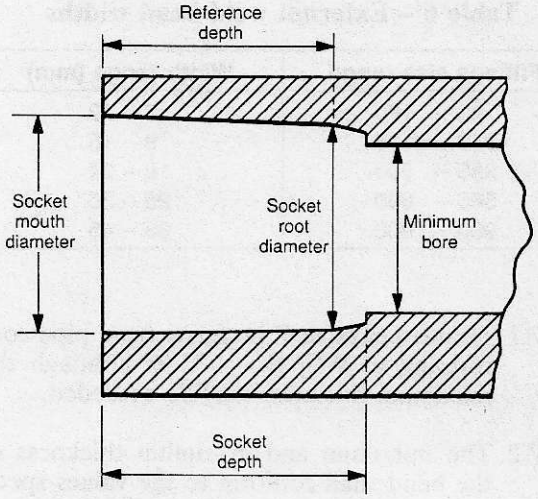

Figure 1 – Socket fusion fitting

3.3.3 Spigot fittings for electrofusion jointing.

3.3.3.1 At its mouth, a fitting shall have the same mean diameter and at least the same nominal wall thickness as the pipe to which it is to be jointed as specified in Tables 2 or 3 (see also Figure 2).

3.3.3.2 The thickness of the body of the fittings at any point shall not be less than the minimum thickness specified in Tables 2 or 3.

3.3.3.3 The minimum bore of the fitting shall not be less than that specified in Tables 2 or 3.

3.3.3.4 The dimensions of the spigot length L_1 (shown in Figure 2) shall be as specified in Tables 2 or 3.

Table 5 – Saddle fusion fitting – service connections

Pressure Pipe size	rating (bar)	Saddle fusion face radius (mm)	
		minimum	maximum
50	12	25.2	25.6
63	12	31.7	32.1
90	10	45.1	45.7
125	10	62.8	63.4
180	10	90.3	91.5
225	10	112.7	114.1
250	10	125.4	126.9
315	10	158.6	160.3

3.3.3.5 The out-of-roundness (or ovality) of the end of the fitting shall not be greater than that specified in 3.3.2.6.

3.3.4 Saddle fusion fittings.

3.3.4.1 The saddle fusion face shall be circular and shall conform to the dimensions in Table 5. The projected diameter (d) of the saddle shall be not less than 42mm (see also Figure 3).

3.3.4.2 The width of the saddle fusion face perpendicular to the axis of the off-take shall not be less than 12mm (see Figure 3).

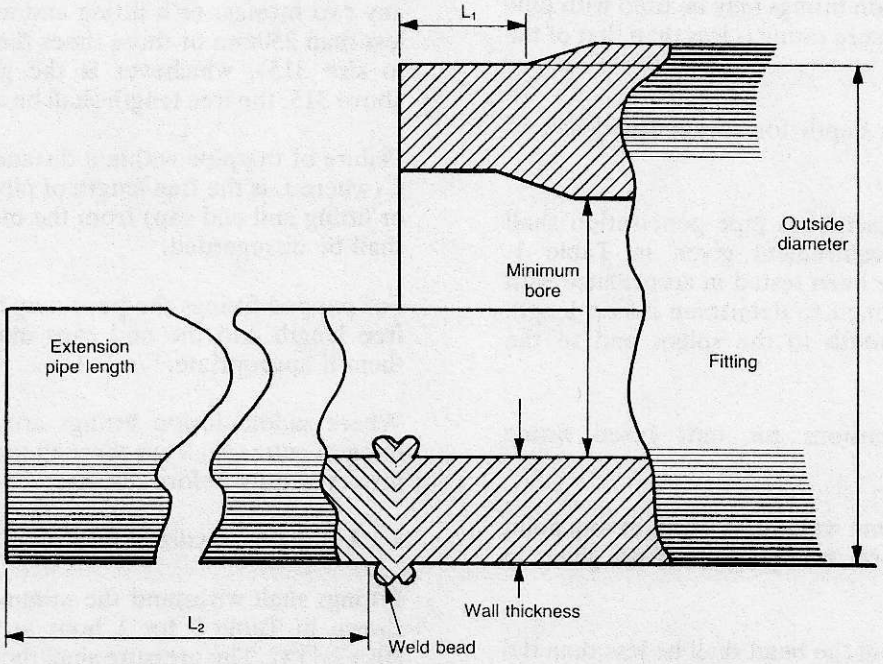

Figure 2 – Typical butt fusion fittings plus extension pipe lengths (pups) (location of dimensions)

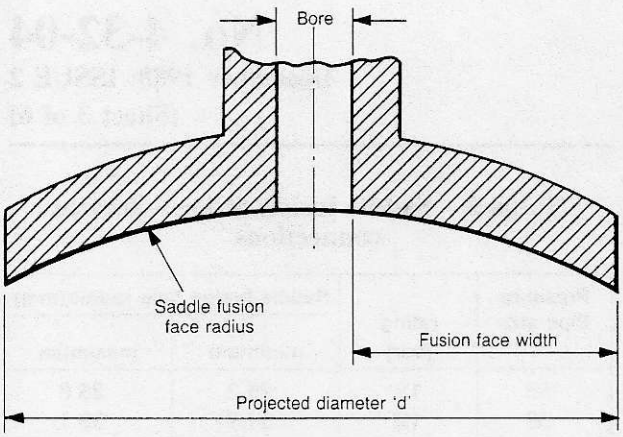

Figure 3 – Saddle fusion fitting

3.3.4.3 The outlet branch shall form a socket or spigot having dimensions conforming to Tables 1 or 2 respectively.

3.3.4.4 The bore of the fitting shall be not less than 16mm or 87.5% (whichever is the lesser) of the bore area of the service pipe which will be connected to it, calculated from the minimum nominal bore derived from Table 1 of BS 6572, BS 6730 or WIS No. 4-32-02.

3.3.4.5 The internal cutting device of saddle fusion fittings shall be corrosion resistant under the conditions for which they are designed, immune from dezincification and capable of cutting the main at air temperatures of -5°C and 30°C whilst it is under water pressure. The coupon shall be retained by the cutting device.

NOTE: Saddle fusion fittings may be used with pipe whose pressure rating is less than that of the fitting.

3.3.5 Penetration depth for socket fused assemblies.

For socket fused assemblies pipe penetration shall meet the depth requirement given in Table 1. Samples which have been tested in accordance with 4.1.2 shall be sectioned to determine fusion length from the socket mouth to the spigot end to the nearest mm.

3.3.6 Bead dimensions for butt fused fitting assemblies.

3.3.6.1 Total external weld bead width at any point shall conform to the dimensions given in Table 6.

The height of the bead shall be less than 0.6 x (measured external bead width) mm.

3.3.7 Drawn bends.

Table 6 – External weld bead widths

Fittings size range	Width range (mm)
90 – 180	7 – 12
250 – 315	9 – 15
355 – 500	10 – 24
560 – 800	25 – 35
900 – 1000	35 – 45

3.3.7.1 Drawn bends shall be made from pipe conforming to WIS No. 4-32-03 although the maximum thickness may be exceeded.

3.3.7.2 The minimum and maximum thickness of the bend shall conform to the values specified in Tables 2 or 3. The centre line radius shall not be less than 5 x outside diameter of the pipe. The leg length shall not be less than 500mm.

3.3.7.3 The tolerance on the nominal bend angle (in the same plane) shall not be greater than ±5°.

4. QUALITY CONTROL TEST REQUIREMENTS

4.1 Hydrostatic pressure tests

Tests shall be performed according to the method described in BS 4728 unless otherwise stated.

More than one fitting may be tested at a time. Pipe produced to BS 6572, BS 6730 and WIS Nos. 4-32-02 or 4-32-03 shall be used to connect the fittings to each other (using the manufacturer's published technique) and also end caps. End load bearing end closures of the type shown in Figure 1 of BS 4728 shall be used. There shall be a free length between any two fittings, or a fitting and an end cap, of not less than 250mm or three times the nominal size (up to size 315), whichever is the greater. For sizes above 315, the free length shall be a minimum of 1m.

Failure of the pipe within a distance of less than 0.1 L (where L is the free length of pipe between fittings or fitting and end cap) from the mouth of the fitting shall be disregarded.

For pupped fittings the pups may be included in the free length and the end caps may be attached to them if appropriate.

Where saddle fusion fittings are to be tested the integral cutter shall cut through the pipe wall and be retracted fully before testing.

4.1.1 1 hour hydrostatic strength test at 20°C

Fittings shall withstand the minimum hold pressure shown in Table 7 for 1 hour at a temperature of 20(+2-1)°C. The pressure shall then be raised so that failure occurs within 30 seconds. Compliance with the requirements of this test can be claimed if the pipe fails by yielding.

Table 7 – Test levels for hydrostatic strength at 20°C

Fitting rating (bar)	1 hour hold pressure (bar)
6 (SDR 17.6)	14.5
10 (SDR 11)	24.0
12 (SDR 11)	24.0

4.1.2 Hydrostatic pressure test at 80°C

Fittings rated at 10 bar or 12 bar shall withstand a pressure of 9.2 bar for 170 hours at 80(+2-1)°C. Fittings rated at 6 bar shall withstand a pressure of 5.5 bar for 170 hours at 80(+2-1)°C.

4.2 Stress relief test

Fittings excluding drawn bends shall be tested according to BS 2782: Method 1103A at 110(+2−1)°C for the times shown in Table 8. The fittings shall be sectioned after the test and on inspection shall show no cracking, opening of weld lines, cavities or blisters.

NOTE: Fittings may be tested without pupped ends.

Table 8 – Stress relief test times

Wall thickness (mm)	Test time (minutes)
Up to 8.6	120
8.6 to 28.2	240
Greater than 28.2	480

4.3 Freedom from defects

The internal and external surfaces shall be free from features such as cracks, holes, blisters, distortion, inclusions and dents which would impair the performance of the product in service.

5. TYPE TEST REQUIREMENTS

Type tests shall be applied to fittings from batches which have complied with clause 4.

5.1 Effect of materials on water quality

5.1.1 Non-metallic materials (in manufactured form) shall be tested to, and meet the requirements of BS 6920: Part 1.

NOTE to 5.1.1: 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.

(*WRc Byelaws Advisory Service, 660 Ajax Avenue, Slough SL1 4BG).

5.1.2 Pending the determination of suitable means of characterising the toxicity of leachates from materials in contact with potable water, materials (in manufactured form) shall be approved by the Department of the Environment Committee on Chemicals and Materials of Construction for use in Public Water Supply and Swimming Pools as being free from adverse health effects.

NOTE to 5.1.2: A list of approved chemicals and materials is available from the Technical Secretary of the above committee at Department of the Environment, Water Division, Romney House, 43 Marsham Street, London SW1P 3PY.

5.2 Hydrostatic pressure tests

Tests shall be carried out in accordance with the requirements of clause 4.1.

5.2.1 Long term hydrostatic strength at 20°C

Fittings rated at 10 bar or 12 bar shall withstand an internal pressure of 19.0 bar for a minimum of 10,000 hours at 20(+2−1)°C.

Fittings rated at 6 bar shall withstand an internal pressure of 11.4 bar for a minimum of 10,000 hours at 20(+2−1)°C.

On completion of the pressure test, the assembly shall be disconnected from the apparatus and the fitting sectioned. There shall be no visual evidence of stress cracking.

NOTE: Should failure occur in any pipe not constituting part of a fitting, a substitute assembly may be retested.

5.2.2 Hydrostatic pressure test at 80°C

Fittings rated at 10 bar or 12 bar shall withstand an internal pressure of 8.0 bar and fittings rated at 6 bar shall withstand an internal pressure of 4.8 bar at 80(+2-1)°C for 1,000 hours. On completion of the pressure test, the assembly shall be disconnected from the apparatus and the fitting sectioned. There shall be no visual evidence of stress cracking.

5.3 Fatigue test at 80°C

When tested in accordance with the method described in Appendix A, the assembly shall withstand 4×10^4 cycles without failure and the average number of cycles to failure of 5 samples shall not be less than 4.8×10^4.

5.4 Compatibility

Pipes manufactured to BS 6572, BS 6730, WIS Nos. 4-32-02 or 4-32-03 are considered to be compatible

for field use with fittings having the same base polymer and manufactured to 4-32-04. Pipes manufactured to BS 6572, BS 6730, WIS Nos. 4-32-02 or 4-32-03 are not considered to be compatible for use with another manufacturer's fitting conforming to WIS No. 4-32-04 but manufactured from a different base polymer unless fused assemblies of pipe and fitting comply with the requirements of clauses 5.2 and 5.3.

5.5 Oxidation induction time

The material in fitting form shall have an oxidation induction time (OIT) of at least 20 minutes when tested according to Appendix B.

6. CONTROL OF TEST CONDITIONS

6.1 Test conditions

Unless otherwise specified, test measurements shall be conducted at 23(+2-1)°C.

6.2 Specimen conditioning, during type testing, or in any case of disagreement

Specimens shall be conditioned prior to test by being kept at 23(+2-1)°C in air for not less than 12 hours for fittings of wall thickness up to and including 12.7mm or not less than 24 hours for fittings of wall thickness over 12.7mm, unless otherwise specified.

For hydrostatic tests involving liquid immersion the specimens shall be conditioned in the liquid at the test temperature for 24 hours or alternatively for one hour after the samples have attained 20 ±2°C or 80 ±2°C as appropriate. The conditioning time necessary to achieve those requirements for any particular size of fitting and test technique may be determined by prior experimentation, the results of which shall be available for inspection.

7. MARKING

7.1 Fittings manufactured to this specification shall be permanently marked as defined in 7.3. No method of marking shall prejudice the performance of the fitting when tested to the requirements of this specification. The marking shall give the following information:

7.1.1 The manufacturer's identification.

7.1.2 The number 4-32-04. (Alternatively, this may be applied by means of a suitable adhesive label). The marking on products produced to this specification of the number 4-32-04 may only be applied by manufacturers covered by a third party certification scheme acceptable to WRc.

7.1.3 Batch identification code.

7.1.4 The letters "PE" followed by polymer type identification (X or A)*.

* Definition of X and A to be agreed.

7.1.5 The nominal size and pressure rating in bar as given in Tables 1, 2 and 3.

NOTE: Whilst the pressure rating in bar is the preferred permanent mark, the SDR rating may be used as long as the pressure rating is appended to the fitting and clearly marked on the packaging.

7.2 Additional information shall be appended to the fitting by the manufacturer stating the fusion temperature and the time the fitting socket/faces should be held against the fusion tool.

7.3 The marking and information shall remain legible under normal handling and storage procedures.

7.4 Fittings of nominal size 63 and below shall have the information required by 7.1.4 and 7.1.5 clearly marked on their box or other packaging if not permanently marked on the fittings.

8. PROTECTION OF FITTINGS

8.1 Fittings shall be suitably packed to afford protection against damage.

8.2 Saddle fusion fittings complete with associated components shall be supplied in an individual package and any components that are lubricated shall be separately wrapped in the package to prevent contamination of fusion surfaces.

9. REFERENCES

This specification makes reference to the latest edition of the following documents, including all addenda and revisions:

BS 2782 Methods of testing plastics.
Part 0 Introduction.
Method 452B Determination of carbon black content of polyolefin compound.
Method 720A Determination of melt flow rate of thermoplastics.
Method 823B Methods for assessment of carbon black dispersion in polyethylene using a microscope.
Method 1101A Measurement of dimensions of pipes.
Method 1103A Stress relief test for injection moulded fittings: oven method.
Method 1106A Assessment of pigment dispersion in polyolefin pipes and fittings.

BS 3412 Polyethylene materials for moulding and extrusion.

BS 4728 Determination of the resistance to constant internal pressure of thermoplastics pipe.

BS 4901 Specification for plastics colours for building purposes.

BS 5293 Sampling and testing carbon black for use in the rubber industry.
Part 10 Method for determination of iodine adsorption number.

BS 5556 Specification for general requirements for dimensions and pressure ratings for pipes of thermoplastics materials (metric series).

BS 5750 Quality systems.
Part 2 Specification for production and installation.

BS 6572 Specification for blue polyethylene pipes up to nominal size 63 for below ground use for cold potable water.

BS 6730 Specification for black polyethylene pipes up to nominal size 63 for above ground use for cold potable water.

BS 6920 Suitability of non-metallic products for use in contact with potable water intended for human consumption with regard to their effect on the quality of the water.
Part 1 Specification.

WAA Sewers and Water Mains Committee Water Industry Specifications:

No. 4-32-02 Specification for polyethylene pressure pipe for cold potable water (underground use).

No. 4-32-03 Specification for blue polyethylene (PE) pressure pipe for cold potable water (nominal sizes 90 to 100 for underground or protected use).

No. 4-32-05 Specification for polyethylene (PE) sewer linings (non-pressure applications).

No. 4-32-06 Specification for polyethylene electrofusion couplers and fittings for cold potable water supply for nominal sizes up to and including 180.

No. 4-32-08 Specification for site fusion jointing of MDPE pipe and fittings.

No. 4-32-09 Specification for black polyethylene (PE) pressure pipes for sewage and above ground potable water (nominal sizes 90 to 1000).

EN 29002 (European Standard) Quality systems model for quality assurance in production and installation.

ISO 6209 Rubber compounding ingredients – Carbon black – Determination of solvent extractable material.

WRc/WAA Manual for MDPE pipe systems for water supply.

APPENDIX A – FATIGUE TEST AT 80°C

A.1 TEST EQUIPMENT

The equipment shall consist of a thermostatically controlled water bath maintained at 80(+2−1)°C, together with equipment that permits the application of a fatigue load using pneumatics or other suitable means, to produce a trapezoidal pressure change profile (see Figure 4).

Typical equipment is illustrated in Figure 6 and consists principally of compressed air supplied from line A, filtered (B) and then regulated (C) to the desired pressure. The filtered and regulated compressed air is then passed through a 5 way solenoid (D) which is controlled by a dual timer (E). The valve D cycles the compressed air between two lines (F and G) which supply the two samples (SF and SG). By using a symmetrical loading profile, the greatest use is made of the one supply of compressed air (line A) with the two samples out of phase, as shown schematically in Figure 5. Between the 5 way valve (D) and the two samples (SF and SG) there are two open 3 way solenoid valves (H and I on the two lines (F and G)) which are normally open. When one or both of the samples is detected as having failed, a current is supplied to either or both solenoid valves (H and I) to isolate the sample(s) from the compressed air.

Equipment in which a pressure point is connected to a single sample is also permitted.

A.2 TEST PIECES

For each size and type of fitting, 5 test pieces shall be evaluated.

Test pieces shall consist of fittings into which pipes have been jointed together with suitable end caps. The free length (L) of pipe between fitting and end cap shall be calculated from:

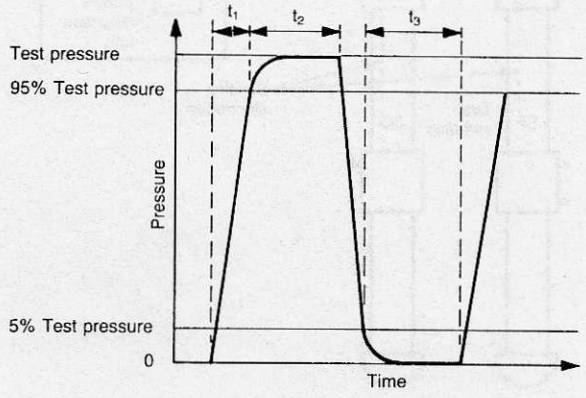

Figure 4 – Pressure loading profile

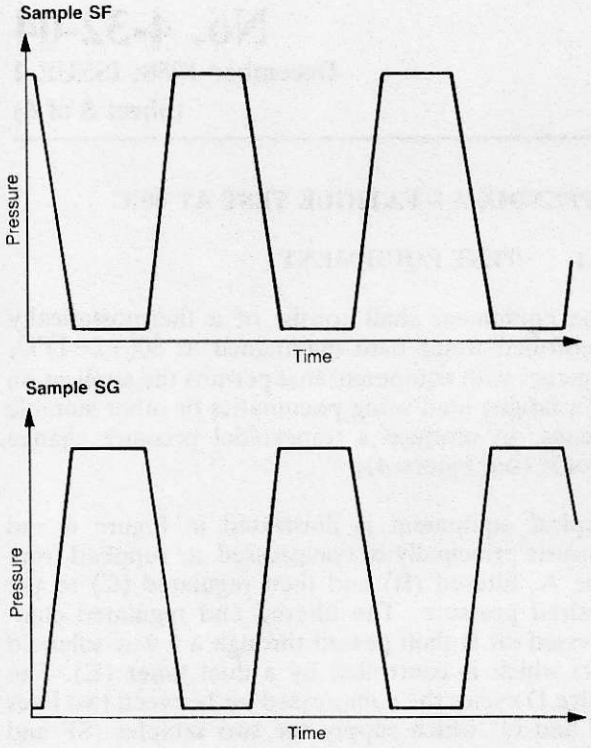

Figure 5 – Schematic presentation of internal pressure changes using one test point connected to two samples

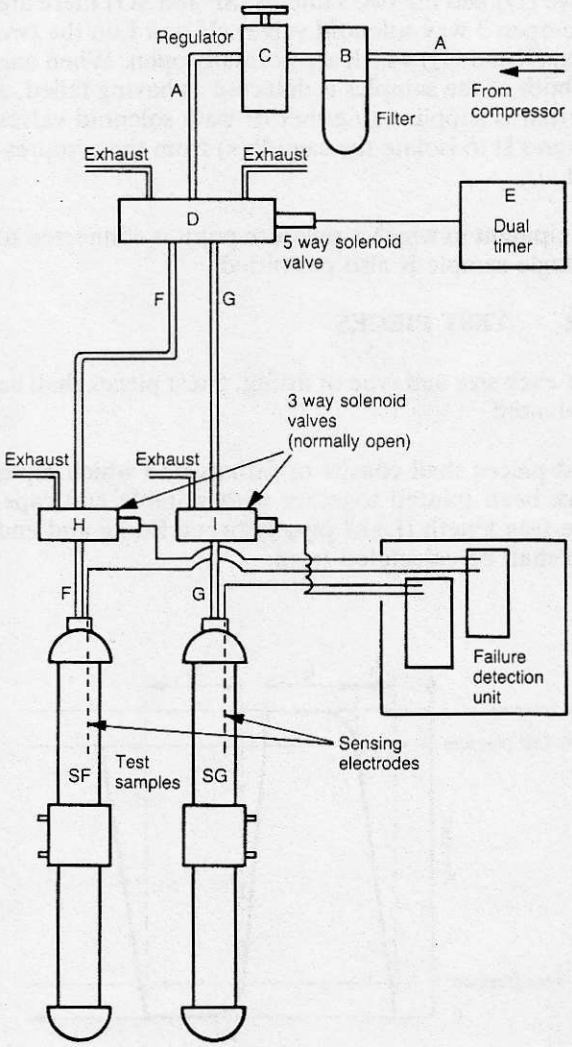

Figure 6 – Typical pneumatic equipment

L = 400 minimum or 3 x outside diameter of pipe up to and including nominal size 315 whichever is the greater. For sizes above 315, the free length shall be a minimum of 1m.

A.3 CONDITIONING

The assembly shall be conditioned for not less than 2 hours at a temperature of 80(+2−1)°C, before testing commences.

A.4 TEST METHOD

The sample shall be connected to the pressurising unit to produce the following pressure régime:

t_1 = 2 ±1.0 second
t_2 = 10 ±1.0 second
t_3 = 5 ±1.0 second

Where t_1 = time to raise the pressure from 0 bar to 95% of the test pressure (8 bar).

t_2 = time from when 95% of the test pressure has been reached to removal of the test pressure.

t_3 = time from when the pressure has decayed to 5% of the test pressure to the time when the pressure is raised.

NOTE 1: See Figure 4.

NOTE 2: The test pressure shall be reached and maintained during time t_2 at 8 ±0.2 bar for 10 or 12 bar (SDR 11) fittings and 4.8 bar for 6 bar (SDR17.6) fittings.

NOTE 3: The test pressure shall reduce to 0 bar gauge pressure during time t_3.

Failure of the pipe within a distance of less than 0.1 L from the mouth of the fitting shall be disregarded.

APPENDIX B – METHOD FOR THE DETERMINATION OF OXIDATION INDUCTION TIME

B.1 INTRODUCTION

This method measures the oxidative induction time of polyethylene in oxygen at elevated temperatures.

B.2 SCOPE

The method provides a means of measuring the oxidative thermal stability of polyethylene pipe and fittings material in oxygen at typical processing and welding temperatures. It may be used for measuring the stability of either raw materials or finished products, and may be taken as an indication of polymer or antioxidant performance.

The test temperature is 200°C which is suitable for adequately stabilised pipe and fittings materials.

The thermal stability measured by this method is dependent on specimen mass.

B.3 PRINCIPLE

The test measures the time during which the antioxidant present in the sample inhibits oxidation whilst the specimen is held isothermally at 200°C under a flow of oxygen.

The process of the oxidation is monitored by measuring the difference in temperature between the sample and reference compartments of a thermal analyser and recording this against time. The thermal stability is then derived from this record.

B.4 APPARATUS

The following apparatus is required:

B4.1 Differential scanning calorimeter (DSC) or differential thermal analyser (DTA) capable of:

(a) recording the difference in temperature or energy flow between sample and reference compartments against time.

(b) maintaining the test temperature within a ±0.25°C for the duration of the test.

(c) exposing the sample to a flow of oxygen equal to 50mLmin^{-1}.

(d) programming the specimen temperature over the range 150 to 250°C at a rate of 1°C.min^{-1} or less.

(e) continuously recording the specimen temperature with a resolution of 0.1°C. If this is not available then B4.2 applies.

B4.2 Temperature measuring apparatus, capable of continuously monitoring the specimen temperature with a resolution of 0.1°C.

A high impedance digital voltmeter with a resolution of 1μV has been found suitable when connected to the specimen thermocouple, and the associated cold junction, or cold junction compensator of the thermal analyser.

B4.3 Analytical balance, capable of weighing the test specimen to an accuracy of 0.1mg.

B4.4 Oxygen and high purity nitrogen supplies, able to be switched to give alternate flow. The change over must be made close to the DSC or DTA cell so that the atmosphere is completely changed within 1 minute of switch over.

B4.5 Gas flow measuring devices. Rotameters are suitable, but their calibration should be checked against a positive displacement device.

B4.6 High purity metal standards:
Indium
Tin.

B.5 PREPARATION OF TEST SPECIMENS

A cylindrical disc specimen of a specified weight, with a diameter just less than the inner diameter of the sample pans of the thermal analyser is required:

B5.1 Test specimens from pipe or fittings:

(a) Take two through wall cores from the top segment of the fitting as manufactured by using a core drill of suitable size (or equivalent method), ensuring that the sample is not overheated during this operation.

NOTE 1: The sides of the core should be lightly scraped to remove any contamination, etc.

NOTE 2: Any swarf which collects near the inner surface should be carefully lifted away.

(b) Using a scalpel, cut discs from the core sample of an approximate thickness to give a specimen weight of 5 ±0.5mg. Select the inner and outer surfaces as the minimum sample points which are to be tested individually.

(c) The specimens should be prepared for testing during the same day and should not be unduly handled or left in direct sunlight.

B.6 PROCEDURE

B6.1 Temperature calibration

Establish an oxygen flow of 50mLmin^{-1} over the specimen and reference compartments of the apparatus at a temperature of 10°C below the expected melting point of indium or tin. Heat 2mg specimens of indium or tin in a sealed aluminium pan, using an empty aluminium pan as reference, at a rate not exceeding 1°C min^{-1} until the melting endotherm is recorded. If the apparatus does not automatically do so, the indicated temperature should be marked on the chart at intervals in the region of the endotherm so that the melting point can be determined to a precision of ±0.1°C. Determine the melting points of both indium and tin.

The melting point of the metal is taken as the temperature given by the intercept of the extended baseline, and the extended tangent to the first slope of the endotherm (see Figure 7).

Adjust the apparatus so that the indicated melting points of indium and tin lie within 156.6 ±0.5°C and 231.9 ±0.5°C respectively.

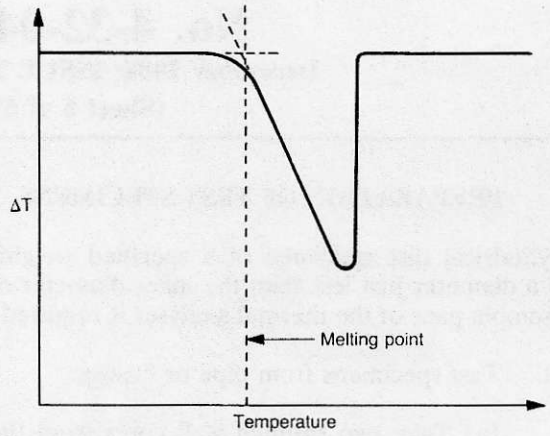

Figure 7 – Metal melting point

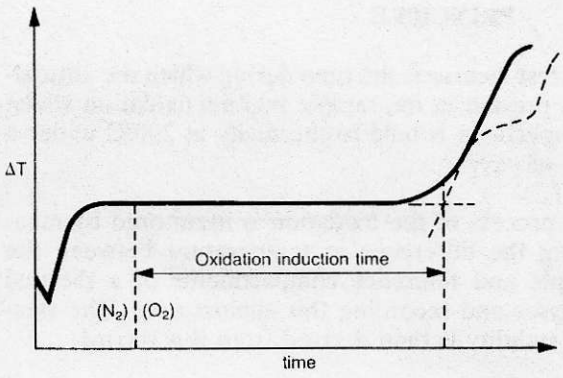

Figure 8 - Example of thermogram

NOTE 1: Unless tin of high purity is used, its melting point can vary considerably.

NOTE 2: In cases where the thermogram exhibits a knee in the trace the relevant maximum slope is that of the first part.

B6.2 Time calibration

Check that the pen moves along the abscissa at the selected rate using a stopwatch.

B6.3 Oxidation induction time measurement

Establish a nitrogen flow of 50mLmin^{-1} through the DSC or DTA cell. Check that when a switchover to oxygen is made the gas flow will continue at that rate and then revert to a nitrogen flow of 50mLmin^{-1}.

Introduce a 5 ±0.5mg cylindrical PE sample in an open aluminium pan and an empty aluminium reference pan into the cell. Specimens which contain the inner or outer surfaces of a pipe shall be placed in the sample pan with that surface uppermost. Set the instrument to run isothermally at 200 ±0.1°C raising the temperature at a rate of 20°Cmin^{-1}, and allow the temperature to stabilise. Make any minor corrections to the heater voltage to bring the specimen temperature to 200 ±0.1°C. Start to record the thermogram which is a plot of the temperature differential against time.

When steady conditions exist under nitrogen after 5 minutes, switch over to oxygen and mark this point on the thermogram. The cell should be purged within 1 minute of atmosphere changeover. Continue to run the thermogram until the oxidation exotherm has occurred, and has reached its maximum.

B.7 INTERPRETATION OF RESULTS

The oxidation induction time of the specimen is the time taken in minutes from the introduction of oxygen to the intercept of the extended baseline and the extended tangent drawn to the exotherm at the point of maximum slope (see Figure 8).

At least three oxidative induction time measurements, shall be made for each determination, two from the inner surface and one from the outer surface.

B.8 TEST REPORT

The report shall include the following information:

(a) Full identification of the product from which samples were taken.
(b) Sample weights.
(c) Individual oxidation induction times.
(d) Position of sample in pipe wall.
(e) Test temperature.
(f) The date of the test.