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Polyethylene pressure pipe with an aluminium barrier layer and associated fittings for potable water supply in contaminated land – Size 20 mm to 630 mm

bsi.

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Contents

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This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 34, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 28 February 2017. It was prepared by Subcommittee PRI/88/2, *Plastics piping for pressure applications*, under the authority of Technical Committee PRI/88, *Plastics piping systems*. A list of organizations represented on these committees can be obtained on request to their secretary.

Information about this document

This standard makes some reference to the suitability of pipework for conveying drinking water (potable water). The following regulations apply to the approval of substances and products used in the provision of public water supplies within the United Kingdom:

- WRAS. Regulation 31 of The Water Supply (Water Quality) Regulations 2000 (Statutory Instruments 2000 No 3184). England
- WRAS. Regulation 31 of The Water Supply (Water Quality) Regulations 2001 (Welsh Statutory Instruments 2001 No 3911(W.323). Wales
- SCOTLAND. Regulation 27 of The Water Supply (Water Quality) (Scotland) Regulations 2001
- NORTHERN IRELAND. Regulation 30 of The Water Supply (Water Quality) (Amendment) Regulations (Northern Ireland) 2009 (Statutory Rules of Northern Ireland 2009 No 246)
- Water Supply (Water Fittings) Regulations 1999, (England and Wales), the Water Byelaws 2000, (Scotland) and the current requirements for Northern Ireland apply.
- HSE. Health & Safety At Work Act 1974, and subsequent regulations.

This standard adopts the ISO classification of PE materials. PE100 is now used to describe HPPE grades. PE80 is now used to describe MDPE.

WARNING. This specification includes the use of substances and/or procedures that could 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.

The requirements contained in this standard are not necessarily indicative of all the performance requirements, or the suitability of pipework for the extreme service conditions, that are occasionally encountered in the UK. In such circumstances, users of this standard are advised to seek confirmation of suitability from the manufacturers of the pipework components.

It is recommended that sampling be carried out by the designated test laboratory. It has been assumed in the drafting of this specification that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Production certification/inspection/testing

Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Appropriate conformity attestation arrangements are described in BS EN ISO/IEC 17025. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Presentation conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb us "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with this British Standard cannot confer immunity from legal obligations.

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1 Scope

This British Standard specifies requirements for the materials, mechanical performance, dimensions, and effect on water quality of polyethylene pipes with an aluminium barrier layer, and associated fittings/joints for potable water supply installed in contaminated ground.

It is applicable to Type A and Type B pipes with nominal sizes up to and including 630 mm, with the following characteristics.

a) Type A: pipes where one or more polymer layers form a core pipe which is designed to bear the stresses associated with long term hydrostatic pressure, with the aluminium layer and outer polymer layer being barrier and protection layers respectively, and regarded as not bearing stresses arising from internal pressure.

b) Type B: pipes where one or more polymer layers and the aluminium layer bear the stresses associated with long term hydrostatic pressure.

*NOTE See **4.2** for pressure classes.*

This British Standard also covers the requirements for fittings and joints, manufactured by system manufacturers or others for use with one or more barrier pipe systems.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced documents (including any amendments) applies.

BS 5252, *Framework for colour co-ordination for building purposes*

BS 6920-2.2.1, *Suitability of non-metallic products in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 2 – Methods of test – Section 2.1 – Odour and flavour of water for hoses, composite pipes and tubes*

BS 6920-2.2.2, *Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water. Part 2 – Methods of test. Section 2.2 – Odour and flavour of water – Method of testing odours and flavours imparted to water by multi-layered hoses and pipes*

BS 8561, *Specification for mechanical fittings for use in the repair, connection and renovation of pressurized water supply pipelines – Requirements and test methods*

BS EN 805, *Water supply – Requirements for systems and components outside buildings*

BS EN 12106, *Plastics piping systems – Polyethylene (PE) pipes – Test method for the resistance to internal pressure after application of squeeze-off*

BS EN 12201-1, *Plastics piping systems for water supply – Polyethylene (PE) – Part 1: General*

BS EN 12201-2, *Plastics piping systems for water supply – Polyethylene (PE) – Part 2: Pipes*

BS EN 12201-3, *Plastics piping systems for water supply – Polyethylene (PE) – Part 3: Fittings*

BS EN ISO 3126, *Plastic piping systems – Plastics components – Determination of dimensions*

BS EN ISO 9080, *Plastics piping and ducting systems – Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

BS EN ISO 12162, *Thermoplastic materials for pipes and fittings for pressure applications – Classification and designation – Overall service (design) coefficient*

BS EN ISO 13479, *Polyolefin pipes for the conveyance of fluids – Determination of resistance to crack propagation – Test method for slow crack growth on notched pipes (notch test)*

BS ISO 1167, *Thermoplastics pipes for the conveyance of fluids - Resistance to internal pressure – test method*

BS ISO 4065, *Thermoplastic pipes – Universal wall thickness table*

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids – Nominal outside diameters and nominal pressures – Part 1: Metric series*

ISO 6259-1, *Thermoplastics pipes – determination of tensile properties and basic specifications – Part 1: General test method*

ISO 1043-1, *Plastics – Symbols and abbreviated terms – Basic polymers and their special characteristics*

ISO 6259-3, *Thermoplastics pipes – Determination of tensile properties and basic specifications – Part 3: Polyolefin pipes*

ISO 6964, *Polyolefin pipes and fittings – Determination of carbon black content*

ISO 11423-1, *Water quality – Determination of benzene and some derivatives – Part 1: Headspace chromatographic method*

ISO 11922-1, *Thermoplastics pipes for the transport of fluids – Dimensions and tolerances – Part 1: Metric series*

ISO 13953, *Polyethylene (PE) pipes and fittings – Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954, *Plastics pipes and fittings – Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 13955, *Plastics pipes and fittings – Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

ISO 17454, *Multilayer pipes – Test method for the adhesion of the different layers using a pulling rig*

ISO/TR 10837, *Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings*

Other publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[N1] WIS 4-32-11, Specification for thermoplastic end load resistant mechanical fittings for polyethylene pipes of nominal size ≤ 63mm

[N2] GREAT BRITAIN: DEPARTMENT OF THE ENVIRONMENT. Determination of Very Low Concentrations of Hydrocarbons and Halonogenated Hydrocarbons in Water 1984-5

3 Terms and definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS EN 805, ISO 1043-1 and the following apply.

3.1.1 barrier pipe
multi-layer pipe consisting of two polyethylene layers with an intervening aluminium barrier layer that together provide the necessary strength and resistance to permeation

3.1.2 barrier pipe system
compatible pipes and fittings used to convey or retain drinking water, for buried use in contaminated land

3.1.3 blank sample
reference sample of the test water taken for comparative analysis

3.1.4 butt fusion joint (using heated tool)
joint made by heating the planed ends of pipes or spigot end fittings (the surfaces of which match) by holding them against a flat heating plate until the PE material reaches fusion temperature, removing the heating plate quickly and pushing the two softened ends against one another under pressure to form a fusion joint

3.1.5 coiled pipe
pipe extruded in a multilayer coiled configuration with the layers strapped together to provide a stable unit without a supporting centre core

3.1.6 composite pipe
complete multi-layer barrier pipe construction

3.1.7 compound
homogeneous mixture of base polymer (PE) and additives

NOTE For example, anti-oxidants, pigments, carbon black, and UV-stabilizers.

[SOURCE: BS EN 12201:2011, **3.1.2.3**]

3.1.8 contaminants
substances which might permeate through the pipe wall and/or infiltrate joints and affect the quality of the conveyed water

NOTE In the case of polyethylene, the most aggressive substances that are likely to be found in contaminated ground are hydrocarbon fuels. For the purpose of this specification a standard fuel simulant, ASTM D471 Fuel C, is used as a model contaminant.

3.1.9 control piece
length of standard PE 80 or PE 100 pipe exposed to fuel during the permeation test

3.1.10 coupling
in-line connector supplied to connect one pipe to another, or pipework to equipment

3.1.11 core pipe
type A pipe without barrier layer and protective skin

3.1.12 design stress (σ_s)
allowable stress, in megapascals (MPa), for a given application, derived from the MRS by dividing it by the coefficient *C*

EXAMPLE

$$\sigma_s = \frac{MRS}{C}$$

3.1.13 drummed pipe
pipe extruded onto a rigid framed reel with a supporting centre core to which the pipe is anchored

3.1.14 electrofusion joint
joint between a PE electrofusion socket or saddle fitting and a pipe or a spigot end fitting

NOTE The electrofusion fittings are heated by the Joule effect of the heating element incorporated at their jointing surfaces, causing the material adjacent to them to melt and the pipe and fitting surfaces to fuse.

3.1.15 fusion compatibility
ability of two similar or dissimilar polyethylene materials to be fused together to form a joint

[SOURCE: BS EN 12201:2011, **3.1.5.5**]

3.1.16 joint
mechanism or design of components within a fitting, that facilitate or achieve connection between fittings and a pipe or between fittings

3.1.17 leachate water
water extracted from the test piece after exposure to the contaminant and to be assessed for trace amounts of permeated contaminants

3.1.18 lower confidence limit (σ_{LCL})
quantity, with the dimensions of stress, which represents the 97.5% lower confidence limited of the predicted hydrostatic strength at temperature Θ and time *T*

NOTE It is expressed in megapascals.

[SOURCE: BS EN 1555-1:2010, **3.1.3.1**]

3.1.19 maximum mean outside diameter ($d_{em,max}$)
maximum value for the mean outside diameter as specified for a given nominal size

3.1.20 maximum operating pressure (MOP)
maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use, taking into account the physical and the mechanical characteristics of the components of a piping system

NOTE It is calculated using the following equation:

$$MOP = \frac{20 \times MRS}{C \times (SDR - 1)}$$

3.1.21 maximum wall thickness (at any point) (e_{max})
maximum value for the wall thickness at any point around the circumference of a component, as specified

3.1.22 mean outside diameter (d_{em})
value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by π (= 3.142), rounded to the next greater 0.1 mm

3.1.23 minimum mean outside diameter ($d_{em,min}$)
minimum value for the mean outside diameter as specified for a given nominal size

3.1.24 minimum required strength (MRS)
value of σ_{LCL}, rounded down to the next smaller value of the R10 series or of the R20 series depending on the value of σ_{LCL}

NOTE R10 and R20 series are the Renard number series according to ISO 3 and ISO 497.

3.1.25 mean wall thickness (e_m)
arithmetical mean of a number of measurements of the wall thickness, regularly spaced around the circumference and in the same cross-section of a component, including the measured minimum and the measured maximum values of the wall thickness in that cross-section

3.1.26 mechanical joint
joint made by assembling a PE pipe with a fitting that generally includes a compression part to provide for pressure integrity and resistance to end loads, and a means of sealing to provide leaktightness

NOTE A support sleeve may be inserted into the pipe bore to provide a permanent support for the PE pipe to prevent creep in the pipe wall under radial compressive forces. The metallic part of this fitting can be assembled to a metallic pipe by screw threads, compression joints, welded or brazed flanges or by other means.

[SOURCE: BS EN 12201:2011, **3.1.5.4**]

3.1.27 melt-mass flow rate (MFR)
value relating to the viscosity of the molten material at a specified temperature and load, expressed in grams per 10 min (g/10 min)

3.1.28 minimum wall thickness (at any point) (e_{min})
minimum value for the wall thickness at any point around the circumference of a component, as specified

3.1.29 nominal outside diameter *(d_n)*
specified outside diameter, in millimetres, assigned to a nominal size (DN/OD)

3.1.30 nominal size, (DN/OD)
numerical designation of the size of a component, other than a component designated by thread size, which is a convenient round number, approximately equal to the manufacturing dimensions in millimetres (mm) and related to the outside diameter

[SOURCE: BS EN 12201:2011, **3.1.1.1**]

3.1.31 nominal size (D_n)
nominal size, related to the outside diameter

3.1.32 nominal wall thickness (*EN*)
numerical designation of the wall thickness of a component, which is a convenient round number, approximately equal to the manufacturing dimension in millimetres (mm)

NOTE For thermoplastics components, the value of the nominal wall thickness, EN, is identical to the specified minimum wall thickness at any point, e_{min}.

3.1.33 out-of-roundness (ovality)
expressed as either difference between the maximum and the minimum outside diameter in the same cross-section of a pipe or spigot, rounded off to the nearest 0.1mm for pipes, or this measurement as a percentage of the mean pipe diameter, d_{em}, for coils

3.1.34 outside diameter (at any point) *(d_e)*
value of the measurement of the outside diameter through its cross-section at any point of the pipe, rounded to the next greater 0.1 mm

3.1.35 overall service (design) coefficient or safety factor *(C)*
coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confident limit

3.1.36 own reprocessable material
material prepared from clean rejected unused pipes, fittings or valves, including trimmings from the production of pipes, fittings or valves, that will be reprocessed in a manufacturer's own plant after having been previously processed by the same manufacturer in the production of components

NOTE By, for example, injection-moulding or extrusion.

3.1.37 pipe batch
number of pipes, all of them of the same nominal outside diameter, wall thickness and marking, extruded from the same compound on the same machine.

NOTE The pipe batch is defined and identified by the pipe manufacturer.

3.1.38 reference piece
assembly of pipe and fittings not exposed to fuel during the permeation test

3.1.39 reference temperature
temperature for which the piping system is designed

NOTE It is used as the base for further calculation when designing a piping system or parts of a piping system for operating temperatures different from the reference temperature.

3.1.40 standard dimension ratio (SDR)
numerical designation of a pipe series, which is a convenient round number, approximately equal to the dimension ratio of the nominal outside diameter, d_n, and the nominal wall thickness, *EN*

3.1.41 technical data file
document containing the manufacturer's type test results, statements of conformity to this British Standard, product descriptions and definitions, compatibility information, applicable guidance and relevant supporting information

3.1.42 test panellist
individual, employed by the test house that carries out the water quality testing, who has demonstrated sensitivity to odours and flavours in water commonly associated with non-metallic materials

3.1.43 test piece
assembly of pipe, joints and fittings for permeation testing

3.1.44 test water
potable water to be used in assessing the resistance to permeability of the test piece

3.1.45 virgin material
material in a form such as granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessable or recyclable materials have been added

3.1.46 wall thickness (at any point) (*e*)
wall thickness at any point around the circumference of a component rounded to the next greater 0.1 mm

NOTE The symbol for the wall thickness of fittings and valve bodies at any point is E.

[SOURCE: BS EN 12201:2011, **3.1.1.9**]

3.1.47 wall thickness tolerance
permitted difference between the wall thickness at any point, *e,* and the nominal wall thickness, *EN*

NOTE $EN = e_{min}$.

3.2 Symbols
For the purposes of this British Standard, the following symbols apply.

C	overall service (design) coefficient
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
$d_{em,max}$	maximum mean outside diameter
$d_{em,min}$	minimum mean outside diameter
d_n	nominal outside diameter
e	wall thickness (at any point) of a pipe
e_m	mean wall thickness
e_{max}	maximum wall thickness (at any point)
e_{min}	minimum wall thickness (at any point)
EN	nominal wall thickness
σ_s	design stress
σ_{LCL}	lower confidence limit (MPa)

3.3 Abbreviations
For the purposes of this British Standard, the following abbreviations apply.

DN/OD	nominal size outside diameter related
LCL	lower confidence limit
MFR	melt mass-flow rate
MOP	maximum operating pressure
MRS	minimum required strength
PE	polyethylene
SDR	standard dimension ratio

4 Material classifications

4.1 PE material classification

4.1.1 The PE material shall meet the following long term strength and stress crack resistance requirements.

a) PE 100 shall have an MRS of 10 MPa at 50 years at 20 °C.

b) PE 80 shall have an MRS of 8 MPa at 50 years at 20 °C.

4.1.2 Both PE 80 and PE 100 materials shall meet the requirements of BS EN 12201-1.

4.1.3 The overall service (design) coefficient *C* shall be a minimum of 1.25 in accordance with BS EN ISO 12162.

NOTE 1 For Type A pipes, the design coefficient C should apply to the PE core pipe, less aluminium, adhesive and protection layers.

NOTE 2 For Type B pipes the design coefficient C should apply to the complete pipe including all layers.

4.2 Pipe pressure classification

For nominal sizes less than 63 mm, all pipes shall maintain a minimum wall thickness of 2.3 mm.

NOTE 1 For all nominal sizes 63 mm to 630 mm, preferred pressure ratings for different SDRs are given in Table 1.

NOTE 2 The SDR in each case should apply to the hydrostatic pressure bearing layers.

NOTE 3 See BS EN ISO 21003 for further guidance on multilayer pipes.

Table 1 **Pressure ratings for different PE core layer materials**

PE 80 core	PE 100 core
PN 12.5	PN 16
PN 8	PN 10

5 PE material properties (determined by materials supplier) in granule or pipe form

5.1 Materials

The physical and mechanical properties of the PE materials used shall meet the requirements of BS EN 12201-1.

Both PE 80 and PE 100 materials shall have long term stress crack resistance ≥1 000 h when tested in accordance with BS EN ISO 13479, at 80 °C.

NOTE Clean reprocessable material, generated by the pipe manufacturer's own production of pipes, may be reworked in the production of approved pipes provided it is derived from the same compound as that used in the manufacture of the approved pipes.

Other reprocessed material shall not be used.

5.2 Colour

5.2.1 The colour of the outer polyethylene layer for barrier pipes for potable water applications shall be light blue (for pipes with a PE80 core layer) within the range 18E51 to 18E53 in accordance with BS 5252.

5.2.2 The colour of PE100 pipes shall be dark blue for PE100, within the range 20D44 to 20D45, or 20E53 to 20E56 in accordance with BS 5252.

5.2.3 The pipes shall have identification stripes that indicate multilayer construction. The colour of the stripes shall be brown 06C37, 06C39, 08C37 or 08C39 in accordance with BS 5252.

5.2.4 The carbon black used in the PE layers shall have a primary particle size of 10 nm to 25 nm.

5.2.5 The carbon black content shall be 2% to 2.5% when measured in accordance with ISO 6964.

5.2.6 Pipes up to and including 180 mm nominal diameter shall have a minimum of four external longitudinal identification stripes equally spaced around the circumference.

5.2.7 Pipes above 180 mm nominal diameter shall have eight external longitudinal identification stripes equally spaced around the circumference.

6 Dimensions

6.1 Diameter and wall thickness

6.1.1 Type A pipes

Type A pipes shall have a PE core diameter in accordance with ISO 161-1. The outside diameter and wall thickness shall be in accordance with ISO 161-1 (diameters), BS ISO 4065 (universal wall thicknesses) and ISO 11922-1 (tolerances), for the nominal sizes and the SDRs specified in Table 2.

NOTE Type A pipes may have outside diameters of the composite pipe that differ from nominal diameters.

The appropriate information shall be supplied by the manufacturer in the technical data file.

Table 2 **Nominal sizes and SDRs** *(1 of 2)*

Nom. Size (mm)	Type A			Type B		
	Mean OD (mm)		Ovality (mm)	Mean OD (mm)		Ovality (mm)
	Min.	Max.		Min.	Max.	
20	21.30	22.58	1.20	-	-	-
25	26.20	27.78	1.20	25.00	25.30	1.20
32	33.30	34.78	1.30	32.00	32.30	1.30
40	41.30	42.75	1.40	-	-	-
50	51.30	52.75	1.40	-	-	-
63	64.30	67.75	1.50	63.00	63.40	1.50
75	77.00	79.75	1.60	-	-	-
90	92.00	94.10	1.80	90.00	90.60	1.80
110	112.00	114.00	2.20	110.00	110.70	2.20
125	127.00	129.90	2.50	125.00	125.80	2.50

Table 2 **Nominal sizes and SDRs** *(2 of 2)*

Nom. Size (mm)	Type A			Type B		
	Mean OD (mm)		Ovality (mm)	Mean OD (mm)		Ovality (mm)
	Min.	Max.		Min.	Max.	
140	142.20	145.70	2.80	-	-	-
160	162.00	166.10	3.20	-	-	-
180	182.00	187.30	3.60	180.00	181.10	3.60
200	202.00	209.40	4.00	-	-	-
225	227.00	234.80	4.50	-	-	-
250	252.00	260.00	5.00	-	-	-
280	282.00	290.40	9.80	-	-	-
315	317.00	325.80	12.10	-	-	-
355	357.00	366.40	13.50	-	-	-
400	402.00	411.80	15.00	-	-	-
450	452.00	465.80	16.60	-	-	-
500	502.00	516.40	18.50	-	-	-
560	562.00	577.20	20.60	-	-	-
630	632.00	648.00	23.10	-	-	-

6.1.2 Type B pipes

Type B pipes shall have overall wall thicknesses and diameters in accordance with ISO 161-1 (diameters), BS ISO 4065 (universal wall thicknesses) and ISO 11922-1 (tolerances), for the nominal sizes and the SDRs specified in Table 2.

6.1.3 Pipe outside diameter and wall thickness

NOTE A list of all pipe dimensions (Type A core and Type B composite) is given in Table 2.

The outside diameter shall be measured in accordance with BS EN ISO 3126, at a distance of at least one diameter from the end of the pipe. The wall thickness of any point around the circumference shall be measured in accordance with BS EN ISO 3126.

Where dimensions are measured at a temperature other than 23 °C, the results shall be correlated by calculation or experience to their value at 23 °C.

The mean outside diameter of the pipe at a distance from its end of $<0.1 \times d_{em}$, (where d_e is the diameter) shall not be less than 98% of the diameter measured at least one pipe diameter from the pipe end.

6.2 Compatible fittings and joints

All fittings and joints manufactured for one or more barrier pipe product(s), shall demonstrate dimensional and functional compatibility with that barrier pipe product by being tested in accordance with the requirements of BS 8561 for mains-sized pipes, and WIS 4-32-11 [N1] for service-sized pipes.

NOTE Table 2 gives the range of maximum and minimum pipe diameters and ovality of Type A pipes. Maximum and minimum diameters and ovality of an individual manufacturer's Type A pipes may be obtained from them.

6.3 Pipe ovality (out-of-roundness)

For Type A pipes, the core pipe geometric characteristics and tolerances shall conform to the requirements of BS EN 12201-2. For Type B pipes, the composite pipe geometric characteristics and tolerances shall conform to the requirements of BS EN 12201-2.

6.4 Length

Lengths of coiled or straight pipe and the tolerances thereon are not specified in this British Standard and shall be agreed between purchaser and manufacturer.

NOTE Standard straight pipe lengths are 6 m, 12 m, or 18 m. Other lengths should be agreed by negotiation between the manufacturer and purchaser.

6.5 Cut end tolerance

The ends of the pipe shall be cut cleanly and square to within the tolerance given in Table 3.

Table 3 **Cut end tolerances**

Nominal pipe diameter (mm)	Maximum tolerance (mm)
20	2
25	2
32	2
40	2
50	2
63	2
75	2
90	2
110	3
125	3
140	3
160	3
180[A)]	4

[A)] For sizes greater than 180 mm, details shall be provided by the pipe manufacturer in the technical data file.

6.6 Coil dimensions

6.6.1 Polyethylene pipes in the size range 75 mm to 180 mm, supplied as coils or on drums, shall be produced in accordance with Annex A.

NOTE Dimensions of coiled pipes 20mm to 63 mm are not specified.

6.6.2 After uncoiling, the ovality of any pipe section shall be less than 12% and 6% for SDR17 and SDR11 products respectively.

6.6.3 Coils are normally supplied in 25 m, 50 m, 100 m, and 150 m lengths dependent on diameter. Overall dimensions of coils or pipe on drums shall be as shown in Table 4.

Table 4 **Coil dimensions** *(1 of 2)*

Nominal pipe diameter (mm)	Minimum internal coil diameter (m)	
	SDR 11	SDR 17
20	0.6	-
25	0.6	-
32	0.7	-
40	1.0	-

Table 4 **Coil dimensions** *(2 of 2)*

Nominal pipe diameter (mm)	Minimum internal coil diameter (m)	
	SDR 11	SDR 17
50	1.0	-
63	1.3	-
75	1.5	2.2
90	1.8	2.5
110	2.0	2.5
125	2.5	2.5
140	2.5	2.5
160	2.5	2.5
180	3.0	3.0

NOTE For sizes greater than 180 mm, details shall be provided by the pipe manufacturer in the Technical data file.

6.7 Definition of operative pipe outside diameter

Specified outside diameters might vary from the standard nominal diameters because of the different construction/design types. Details shall be provided by the pipe manufacturer in a technical data file.

For Type A pipes, the diameter of the core pipe shall correspond to the nominal diameter.

For Type B pipes the outside diameter shall correspond to the nominal diameter.

7 Type tests

7.1 General requirements

The core layer of Type A barrier pipes shall conform to the requirements of BS EN 12201-2, as applicable.

NOTE 1 Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Appropriate conformity attestation arrangements are described in BS EN ISO/IEC 17025. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their requests to the relevant association.

For type tests, and unless otherwise stated in this standard, the smallest, largest, and one intermediate pipe size of each material classification in the manufacturer's size range shall be tested, with the exception of the requirements in **7.3** for which one size shall be tested and in **7.7**, for which the requirements are set out in Annex B.

The results of all the Type Tests in Clause **7** shall be provided by the pipe manufacturer in a technical data file in accordance with Annex C.

NOTE 2 The tests in this clause are designed to demonstrate that the pipe produced by the manufacturer has the same long term properties as the basic material compound. They are not required to be performed on each batch of pipe.

NOTE 3 Type tests and requirements are given in Table 5.

7.2 Appearance

When viewed without magnification, the internal and external surfaces of the pipe shall be smooth, clean and free from scoring, cavities and other surface defects.

7.3 Long-term hydrostatic pressure strength at 20 °C

7.3.1 Type A pipes

The core pipe shall conform to BS EN 12201-2.

7.3.2 Type B pipes

The long term pressure strength of the composite pipe (all layers) shall be determined at 20 °C using the specifications given in BS EN ISO 9080 by pressure regression testing. Pipes shall meet the appropriate pressure classification given in Table 1.

All layers of the composite pipe in Type B pipes are stress bearing, but only the outer PE layer can be affected by ground contamination. It shall therefore be demonstrated, by regression testing and using the guidance given in BS EN ISO 9080, that the inner PE layer and aluminium have sufficient hydrostatic pressure strength at 20 °C and at 50 years.

For both PE80 and PE100 based pipes, the pressure classification shall be the 97.5% LCL of the regression data.

7.4 Resistance to delamination of pipe layers

A delamination test shall be carried out in accordance with ISO 17454.

NOTE 1 Where the capacity of the tensile testing machine is insufficient to remove all of the circumferentially peeled layers in one continuous strip, the manufacturer may carry out a series of tests on adjacent strips so that the entire circumference is tested for delamination resistance.

NOTE 2 For Type A pipes, the outer protective PE and aluminium layers may be removed as one from the core pipe.

For Type B pipes, the complete pipe shall be tested and the calibration force determined accordingly.

A failure shall be recorded if any voids or localized disbonding of greater than 10% of the sample length are noted during sample testing. Otherwise, the measured and calculated forces shall be recorded in the technical data file. The manufacturer shall carry out quality control testing to demonstrate that the delamination resistance of the product is at least equal to that stated in the Technical data file.

7.5 Long term performance of pipe subjected to squeeze-off

7.5.1 When squeezed-off in accordance with BS EN 12106, the time to failure in a hydrostatic stress rupture test at 80 °C with stress levels of 4.6 MPa (PE 80) and 5.5 MPa (PE 100) shall be not less than 165 h.

NOTE Where the manufacturer states that the use of squeeze-off is not advised with their system, this test does not need to be undertaken.

7.5.2 The manufacturer shall detail in the technical data file, the method of squeeze-off and any protective measures and marking that are required.

7.6 Fusion welding of coiled pipe (sizes above 63 mm diameter)

7.6.1 The pipe manufacturer shall confirm that coiled pipes with the smallest coil radius can be satisfactorily re-rounded, in the technical data file.

*NOTE Where the manufacturer states in the technical data file that the pipe system is not suitable for fusion jointing in accordance with Clause **11**, this test does not need to be undertaken.*

7.6.2 Compliance with this requirement shall be demonstrated by a test using the manufacturer's largest coiled pipe size, in SDR 17. Both butt fusion and electrofusion joints shall be prepared and tested in accordance with ISO 13954.

7.7 Resistance to the permeation of contaminants

7.7.1 When tested in accordance with Annex B, the test piece shall be deemed satisfactory if the set of leachate samples taken from it meet the following criteria:

a) two or more test panellists detect no discernible odour in the diluted leachate samples when compared to the set taken from the blank/reference sample;

b) two or more test panellists detect no discernible flavour in the first 1:1 dilution of the diluted leachate samples when compared to the blank/reference sample, providing the third panellist does not detect a flavour in the second dilution; and

c) the concentration of dissolved hydrocarbons in the undiluted leachate sample is not greater than 100 μg/l.

7.7.2 The pipe, joints and fitting combinations shall not be suitable for use if any one of the following occur:

a) two or more panellists detect any discernible odour or flavour in the diluted leachate sample when compared to the blank/reference sample;

b) any panellist detects a flavour in the second dilution of the diluted leachate sample;

c) the concentration of dissolved hydrocarbons in the undiluted leachate sample is greater than 100 μg/l;

d) any of the control sample set passes the criteria set out in **7.7.1**a) and **7.7.1**b).

NOTE 1 A set of samples comprises three odour and flavour samples and one dissolved hydrocarbon sample.

NOTE 2 The set of reference samples should only be used when it is necessary to check whether the pipe and/or fitting is suspected of affecting the result.

Table 5 **Type tests and requirements** *(1 of 2)*

Characteristics	Clause	Requirements	Test Parameters		Test Method
			Parameters	Values	
Appearance	**7.2**	Internal and external surfaces of the pipe shall be smooth, clean and free from scoring, cavities and other surface defects which may affect pipe performance	Three pipe lengths	No defects	Visual inspection
Hydrostatic strength	**7.3**	Type A pipes: Classification in accordance with BS EN ISO 9080 shall be verified by the compound producer Type B pipes: Pressure requirement shall be verified by testing using the guidance in BS EN ISO 9080	At least 30 data points at each temperature and at least two temperatures to be tested. At least 18 data points at 20°C using compounds that meet the requirements of **4.1**	For PE80, the 97.5% LCL shall be greater than 8MPa For PE100, the 97.5% LCL shall be greater than 10 MPa	BS EN ISO 9080 and BS EN ISO 12162
Delamination of pipe layers	**7.4**	Type A pipes: the outer protective PE and aluminium layers may be removed. Type B pipes: the complete pipe shall be tested	Circumferential peeling of the PE and aluminium layers from the core pipe	<10% disbonding of the sample length	ISO 17454
Pipe subjected to squeeze-off	**7.5**	Where the manufacturer permits the use of squeeze-off	PE80:4.6 MPa PE100:5.5 MPa	=>165 h =>165 h	BS EN 12106

Table 5 **Type tests and requirements** *(2 of 2)*

Characteristics	Clause	Requirements	Test Parameters		Test Method
			Parameters	Values	
Fusion welding of coiled pipe	**7.6**	Where the manufacturer permits the use of fusion jointing	Crushing decohesion of an electrofusion joint for sizes less than 90mm	Less than or equal to 33% brittle failure	ISO 13955
			Decohesion of an electrofusion joint for sizes 90mm and greater	Less than or equal to 33% brittle failure	ISO 13954
			Butt fusion tensile test	Failure mode shall be ductile	ISO 13953
Resistance to permeation of contaminants	**7.7**	To demonstrate that pipes, joints and fittings can adequately resist the ingress of hydrocarbon contaminants	Odour and Flavour Hydrocarbon concentration	2 out of 3 panellists shall detect no odour or flavour <100μ g/l	Annex B of this British Standard

8 Batch release tests

8.1 General requirements

8.1.1 A quality plan shall be written, whereby details and results for each test specified in Clause **8** for each material composition are given, and shall be made available to the purchaser or their representative on request.

8.1.2 The manufacturer shall carry out the batch release tests, in **8.2** and **8.3** as appropriate, on representative pipe samples from each batch of pipe to be supplied.

NOTE A summary is tabulated in Table 6 for Type A pipes, and in Table 7 for Type B pipes.

8.1.3 A batch shall be defined in the manufacturer's quality plan.

Table 6 **Batch release tests: Type A pipes**

Characteristics	Clause	Requirements	Test Parameters		Test method
			Parameters	Value	
Appearance	**7.2**	Internal and external surfaces of the pipe shall be smooth, clean and free from scoring, cavities and other surface defects which may affect pipe performance.	One pipe length	No defects	Visual inspection
Tensile properties	**8.2.1**		Tensile strength Elongation	PE 80 ≥15MPa PE 100 ≥19MPa PE 80 ≥350% PE 100 ≥350%	ISO 6259 (Parts 1 and 3)
Oxidation induction time	**8.2.2**	Inner and outer layers	200 °C	≥20 mins.	ISO TR 10837
MFR change	**8.2.3**	For reprocessed materials	Inner layer	≤20% change from virgin compound range	BS EN ISO 1133
Short term 80 °C pipe stress crack test	**8.2.4**	Sizes ≤63 mm	Un-notched	≥165 h	BS ISO 1167
Short term 80 °C pipe stress crack test	**8.2.4**	Sizes >63 mm	Un-notched	≥165 h	BS EN 13479

Table 7 **Batch release tests: Type B pipes**

Characteristics	Clause	Requirements	Test Parameters		Test Method
			Parameters	Values	
Appearance	**7.2**	Internal and external surfaces of the pipe shall be smooth, clean and free from scoring, cavities and other surface defects which may affect pipe performance.	One pipe length	No defects	Visual inspection
Tensile properties	**8.3.1**	Ring test coinciding with the aluminium weld	50 mm/min.	PE80 ≥15 MPa PE100 ≥19 MPa	As detailed in **8.3.1**
Oxidation induction time	**8.3.2**	Inner and outer layers	200 °C	≥ 20 mins.	ISO TR 10837
MFR change	**8.3.3**	For reprocessed materials	Inner layer	≤20% change from virgin compound range	BS EN ISO 1133
Short term 80 °C pipe stress crack test	**8.3.4**	All sizes	Un-notched	≥165 h	BS ISO 1167

8.2 Batch release test requirements: Type A pipes

8.2.1 Tensile properties

NOTE To be tested on the core pipe only unless otherwise stated.

Tests shall be carried out in accordance with ISO 6259 (Parts 1 and 3) using the specified test speeds.

The value of yield stress (σ_y) and elongation at break shall be not less than the values given in Table 8.

Table 8 **Tensile properties**

Property	PE80	PE100
Tensile strength	≥ 15 MPa	≥ 19 MPa
Elongation	≥ 350%	≥ 350%

8.2.2 Oxidation induction time

The PE material forming the inner and outer layers shall meet a requirement of ≥20 min when tested at 200 °C according to ISO/TR 10837.

In the case of a dispute the reference temperature shall be 200 °C.

NOTE Tests may be carried out at 210 °C or higher providing there is a clear correlation to the results at 200 °C.

8.2.3 MFR change

NOTE This test is only required when reprocessed material is used.

The MFR of the PE material forming the core pipe shall not change on samples taken from the product by ≥20% from the range of the virgin compound supplied.

8.2.4 Short term 80 °C pipe stress crack resistance

For nominal sizes 25 mm to 63 mm, the pipe supplier shall carry out 80 °C/165 h control point hydrostatic pressure tests on un-notched core pipe in accordance with BS ISO 1167.

NOTE 1 Values for appropriate test pressures for different pipe SDRs and materials are given in Table 9.

For nominal sizes above 63 mm the pipe supplier shall carry out 80 °C/165 h control point tests on notched core pipe in accordance with BS EN ISO 13479.

NOTE 2 Values for appropriate test pressures for different pipe SDRs and materials are given in Table 9.

Table 9 **Test pressures for 80 °C stress crack resistance test (bar)**

SDR	Notched Pipe		Un-notched pipe	
	PE80	PE100	PE80	PE100
11	9.0	9.0	9.0	10.8
17	5.75	5.75	5.75	6.9

NOTE 1 One pipe specimen is deemed sufficient for this purpose.

NOTE 2 The batch may be released earlier by agreement with the purchaser, based on historical conformance with the test requirements.

8.3 Batch release test requirements: Type B pipes

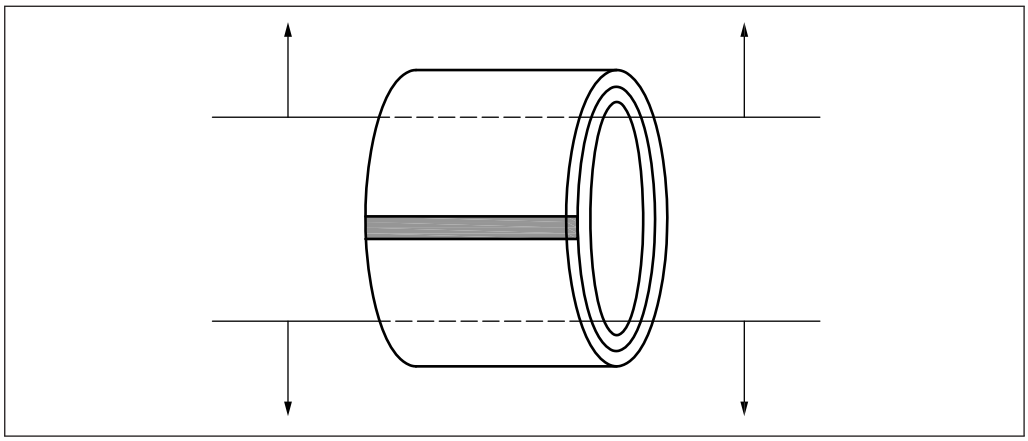
8.3.1 Tensile properties

Test shall be carried out on the composite pipe unless otherwise stated.

Tests shall be carried out on test samples mounted on two steel rods and mounted as shown in Figure 1, using a tensile testing machine at a crosshead speed of (50 ±2) mm/min.

The test samples shall be cut consecutively from the composite pipe so that the sides are parallel and at (90 ±2)° to the pipe axis. The length of each ring shall be (25 ±1) mm.

Figure 1 **Test sample mounted in two steel rods**



8.3.2 Oxidation induction time

The PE material forming the inner and outer layers shall meet a requirement of ≥20 mins when tested at 200 °C according to ISO TR 10837. In the case of dispute the reference temperature shall be 200 °C.

NOTE Tests may be carried out at 210 °C or higher providing there is a clear correlation to the results at 200 °C.

8.3.3 MFR change

NOTE This test is only required when reprocessed material is used.

The MFR of the PE material forming the inner layer shall not change on samples taken from the product by more than 20% from the range of the virgin compound supplied.

8.3.4 Short term 80 °C stress crack resistance

For nominal sizes 25 mm to 180 mm the un-notched pipe test on the composite pipe is sufficient. Values for appropriate test pressures for different pipe SDRs and materials shall be in accordance with Table 9.

9 Marking

9.1 Pipes

The marking of pipes shall be permanent and remain legible under normal handling, storage and installation procedures. The method of marking shall not prejudice the performance of the pipe when tested to the requirements of this standard. The marking shall show the following:

a) the manufacturer's identification, and system name;

b) the polymer classification (e.g. PE 80, or PE 100) together with a code identifying the basic raw material source;

c) the number of this standard (i.e. BS 8588:2017 [1)]) and pipe design type (Type A or Type B);

d) the nominal size;

e) continuous pressure rating at 20 °C (Either PN'X' or 'X' bar is acceptable). Values shall conform to those in Table 1 for all pipes that carry the full design stress;

f) the pipe composition: PE/Al/PE;

g) along one strip only, the manufacturing codes to identify the production line, date and production shift (or production time);

h) the word "WATER" shall appear 3 times per metre length of pipe; and

i) all coils of pipe >63 mm diameter shall have the lead and trailing ends clearly marked with the words "START" and "END" indicating which bands are to be first cut.

All pipes shall be marked at intervals not greater than 1 m along two strips on opposite sides of the pipe for nominal diameters 75 mm to 630 mm.

NOTE For diameters <75 mm marking along one strip only is sufficient.

The marking shall be printed in any contrasting colour and shall be easily distinguishable.

The height of characters shall be greater than 3 mm for nominal pipe sizes less than 125 mm and greater than 5 mm for sizes ≥125 mm.

9.2 Joints and fittings

9.2.1 Electrofusion

Electrofusion joints and fittings shall be marked in accordance with the requirements of BS EN 12201-3.

9.2.2 Mechanical

Mechanical joints and fittings shall be marked. Markings shall either be printed or formed directly on the fitting, or printed on a label attached to the fitting, or attached to the fitting packaging, in such a way that legibility is not affected by storage, weathering and handling. The size of the marking shall be such that the marking is legible without magnification.

Mechanical joints and fittings shall be labelled, using durable paper and waterproof ink, with the following information:

a) the manufacturer's identification;

b) the barrier pipe system/s it is suitable for use with;

c) the number of this standard, if only for use with PE barrier pipe;

d) the nominal size and SDR, if applicable; and

e) continuous pressure rating at 20 °C (either PN'X' or 'X' bar is acceptable).

[1)] Marking BS 8588:2017 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 solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

NOTE Where joints and fittings are supplied in individual polythene bags, it is acceptable to place a label within the sealed bag.

10 Supply of straight and coiled pipe

10.1 Supply of straight pipes

NOTE Whilst under the manufacturer's control, the pipes should be stacked/stored in such a way to minimize dimensional changes, scratches and the effect of weather. The pipe should also be protected from contamination.

Straight lengths of pipe shall be supplied in bundles that are constructed to minimize distortion of, or damage to, the pipes during transit or storage.

All pipe intended for potable water supply shall be provided with end closures to prevent ingress of contaminants. All swarf shall be removed before fitting end closures.

10.2 Supply of coils

Pipes shall be inspected by the manufacturer prior to delivery to ascertain whether the coiling has not caused excessive ovality that could compromise dimensions after delivery to site (see **7.6**).

For nominal sizes ≥63 mm, all coils shall be securely banded with tough tape, which cannot be removed except by cutting. The banding operations shall be in accordance with the procedures and values given in Annex A.

NOTE For smaller pipe sizes, coils may be supplied using shrink-fit, tough plastic film to hold the coil in place.

All pipe coils intended for potable water supply shall be provided with end closures to prevent ingress of contaminants. All swarf shall be removed before fitting end closures.

11 Requirements for joints

11.1 Details of any specific jointing requirements to be used with the pipe/joint/fitting, such as aluminium tape wrapping, shall be stated in the technical data file.

11.2 The pipe/fitting manufacturer shall state the following in the technical data file:

a) The pipes, joints and fittings used in the permeation tests detailed in **7.7**;

b) For pipes, the method of fusion jointing, whether butt fusion and/or electrofusion, tested against this standard (**6.2**)

c) For pipes, the joints and fittings demonstrated to be compatible in accordance with this standard.

11.3 Minimum required content of the manufacturer's technical data file shall be in accordance with Annex C.

11.4 Mechanical fittings for use with pipes of nominal size greater than 63 mm shall conform to the performance requirements of BS 8561.

11.5 Mechanical fittings for use with pipes of nominal diameter 20 mm to 63 mm shall conform to the performance requirements of WIS 4-32-11.

11.6 Barrier wrappings around joints and fittings are permitted for the purposes of providing additional chemical and permeation resistance. Where such wrappings are used on the fittings and joints that are used for permeation

testing in accordance with 7.7, an identical form and composition of wrapping shall be used on installed fittings and joints. The wrapping shall be installed in accordance with the fittings manufacturer's instructions.

11.7 Particular attention is drawn to the need to maintain corrosion or chemical resistance of any metallic components or plastics materials, including protective layers, under contaminated land conditions. Where direct contact might occur between metallic fittings, components or protective materials and the aluminium barrier layer, they shall be chosen to avoid galvanic corrosion.

Annex A (normative) Requirements for polyethylene barrier pipe, supplied as coils

*COMMENTARY ON **ANNEX A***

The requirements given in this annex apply to all polyethylene barrier pipe in the size range 75 mm to 180 mm supplied as coils or on drums. They include general requirements relating to quality and means of constraining the pipe, as coils or on drums, to permit the safe handling and controlled dispensing of the pipe.

The overall dimensions of coils and drums are also specified and requirements for marking included.

A.1 General requirements

A.1.1 The pipe, supplied as coils or on drums, shall conform to the requirements of Clause **6**, Clause **7** and Clause **8** determined in accordance with the quality plan (see **8.1.2**).

A.1.2 All pipe shall be constrained in a stable configuration in accordance with Figure A.1, by the use of straps or other means, that promote safe and controlled dispensing of the pipe. Any exposed ends of pipes on coils or drums shall be suitably protected from damage (e.g. by means of end caps or plugs). Restraining and dispensing methods shall not damage the pipe by causing kinking, scoring, etc. The requirements of Clause **7** of this specification shall apply.

A.1.3 The maximum external surface temperature of the pipe at the time of coiling shall not exceed 35 °C at a distance as near as practical to the centre axis of the coiling machine. The method of measurement (e.g. contact thermometer probe) shall be agreed between the manufacturer and purchaser.

A.1.4 Any open ends on coils or drums shall be plugged or covered.

A.2 Coiled pipe

Unless otherwise specified, coiled pipe shall be supplied in minimum lengths of 25 m and in multiples of 25 m thereafter.

The maximum external diameter of any coil shall be 4.0 m.

The maximum width of any coil shall be 1.0 m.

Coiled pipe shall be constrained in a stable configuration by strapping. The strapping shall permit the removal of one layer of the coil without the remainder of the coil being unwound. The strapping arrangement shall be such that individual layers are clearly discriminated and shall not be impaired by transport and handling.

The ends of the coil shall be straight for a distance of at least 2 pipe diameters excluding any anchorage holes.

NOTE If necessary, re-rounding/straightening tools may be used.

A.3 Drummed pipe

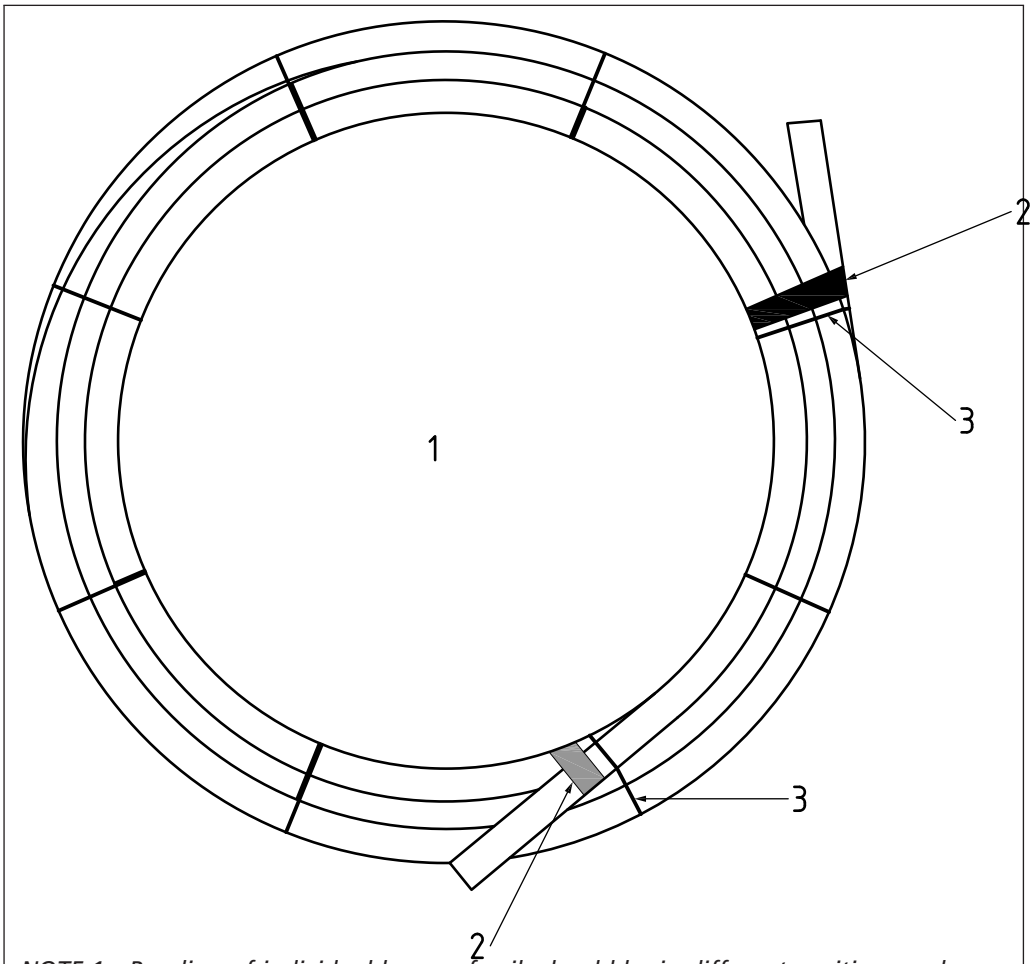
A.3.1 Drums shall be of such construction as to withstand normal site handling.

a) The core diameter of the drum shall be not less than 2.5 m.

b) The maximum diameter of any drum shall not exceed 4.0 m. The PE pipe shall not stand proud of the drum outer guardrail.

c) The maximum weight of the drum plus maximum length of PE pipe shall not exceed 2 500 kg. The pipe manufacturer shall declare the maximum length of pipe (for a given diameter and SDR rating) that is compatible with the weight and drum dimension criteria.

Figure A.1 **Pipe constraint**



NOTE 1 Banding of individual layers of coils should be in different positions and should be clearly staggered.

NOTE 2 Position of security banding should be not less than 2 pipe diameters, and no greater than 1 m from pipe lead and tail ends.

A.3.2 Where drums are supplied by the manufacturer for direct use from a low loader, the system shall incorporate a braking device and the weight limit specified in **A.3.1** does not apply.

A.4 Marking of coils and drums

Each coil and drum of pipe shall be clearly and indelibly labelled in accordance with Table A.1.

Table A.1 **Marking of coils and drums[A)]**

Legend	Mark or symbol examples
Weight of coil or drum	50 kg
Length	100 m
Nominal outside diameter, d_n and SDR	63 mm SDR11
Star and finish sequential number in metres	050-150

[A)] Drummed pipe shall not be banded, as both ends shall be secured to the drum.

For pipe sizes equal or greater than 90 mm, the label shall also carry the following warning: 'Before un-strapping, ensure that both pipe ends and coil/drum are firmly mechanically restrained'.

A label attached to the lead end of the pipe, or a directional arrow printed on the surface of the pipe shall be used to define which end of the coiled pipe should be dispensed first.

Annex B (normative) Method of assessing the resistance to permeability of specific contaminants

WARNING. This test requires the use of explosive substances and atmospheres.

B.1 Principle

A test rig assembly containing a fitting or joint, (the test piece), and a plain PE 80 or PE 100 pipe, (the control piece), are filled with potable water, and enclosed in the same environment, with synthetic petroleum fuel until the outer PE is saturated with fuel (60 days immersion).

NOTE A combination of liquid synthetic fuel and the saturated vapour is acceptable.

Upon saturation (at 60 days), the potable water is removed and replaced with fresh potable water.

Exposure of the test piece and control piece to the same petroleum environment is continued for a further 72 h, after which the water is carefully removed and tested for odour and flavour and dissolved hydrocarbons.

A blank sample of the test water (that has not been exposed to pipes) is also tested for odour and flavour and dissolved hydrocarbons.

Odour and flavour assessment is based upon the procedures set out in BS 6920-2.2.1 and BS 6920-2.2.2.

B.2 Reagents

B.2.1 Figure B.1 shows a typical test apparatus, which may be fabricated from a suitable sized steel tank and lid. Apparatus fabricated from steel tubes may also be used. The test apparatus shall be large enough to accommodate the test piece(s) and control piece(s). Sufficient space shall be provided within the tank or tube such that the test and control pieces do not touch adjacent samples. If a tee fitting or ferrule strap, or similar branched fitting is to be tested then space shall be provided for the branch. Orientation of the samples shall be such as to prevent the formation of air locks within the samples on filling, and effective drainage during sampling. If necessary a branch pipe may terminate outside the test tank with a test piece blanking end.

B.2.2 The test piece blanking ends shall have provision for extracting and replenishing the water, without the risk of contamination by the petroleum surrounding it.

B.2.3 The test water shall be chlorinated tap water and shall be freshly drawn from the same mains source for test, reference and control pieces and blank samples. For each filling the chlorine residual shall be measured using standard colorimetric equipment and the result recorded on the sample paperwork. The chlorine residual shall not exceed 0.5 mg/l.

B.2.4 The test fluid shall be a synthetic petroleum (gasoline) blend of 50% Toluene and 50% ISO-Octane.

NOTE This is equivalent to ASTM D471 fuel C, and is considered the most aggressive contaminant.

B.3 Preparation and preservation of test samples and test pieces

B.3.1 Test pieces shall comprise:

a) for couplings or fittings designed to joint PE to PE, two lengths of standard barrier pipe joined by a coupling or fitting at the midpoint;

b) for couplings or fittings designed to joint PE to threaded iron or to copper, a length of PE barrier pipe not less than 90% of the length of the test piece connected to a length of iron or copper pipe, as appropriate;

NOTE This test piece is also deemed to represent a ferrule connection to a metallic pipe.

c) for ferrule connections to a PE barrier pipe, the ferrule or tapping tee shall be connected and tapped to the barrier pipe length. The ferrule or tapping tee outlet shall be suitably blanked off.

B.3.2 All test pieces shall be jointed in accordance with the manufacturer's instructions, including the use of any protective tape where specified.

B.3.3 The test piece shall be the smallest diameter and the pipe SDR rating the highest (i.e. the thinnest wall thickness) of the size range in the manufacturer's product range.

B.3.4 Separate test pieces shall be submitted for each variation/combination of pipe construction, coupling/fitting type and material classification for which approval is sought.

NOTE Where fitting types are identical in materials of construction and joint design, e.g. for bends and straight connectors for PE to PE, only one fitting type needs to be tested.

B.3.5 Separate test pieces shall be tested for each variation of pipe construction, each coupling/fitting type and each material classification. Pipes from different manufacturers or from the same manufacturer but manufactured at a different location shall be deemed to be different pipe constructions and tested accordingly. Couplings/fittings from different manufacturers or from the same manufacturer but manufactured at a different location shall be deemed to be different types and shall be tested accordingly.

B.3.6 Where coupling/fitting types are identical in terms of materials used for construction and joint design, e.g. for bends and straight connectors for pipe to pipe, only one test piece of each type shall be tested.

NOTE 1 Examples of pipe construction types include the following:

a) Type A pipe, manufacturer A location x;

b) Type B pipe, manufacturer B location Y, etc.

NOTE 2 Examples of fitting types include the following:

a) straight couplings and reducers;

b) bends and elbows;

c) tees and branches;

d) threaded transition adaptors;

e) flanges and other fittings.

B.3.7 The external surface of each test piece exposed to the fuel shall be at least 1 m long and less than 2 m long.

B.3.8 The volume of water contained in the test piece ends (those parts of the test piece that are outside the test rig and not exposed to the fuel), shall be less than 10% of the total volume of the test piece.

B.3.9 The test piece shall be sealed at each end with stoppers suitable for use with potable water. Precautions shall be taken to ensure that the exposed sample ends are impermeable to fuel vapour that might have leaked from the seals at the tank boundary.

NOTE For example, if plain PE end caps are used, they may be wrapped with aluminium tape.

B.3.10 The test piece shall be sealed at both ends with stoppers made from a material that is suitable for contact with drinking water. Precautions shall be taken to ensure that the exposed ends of test pieces are impermeable to fuel vapour that might have leaked from the seals at the test tank boundary.

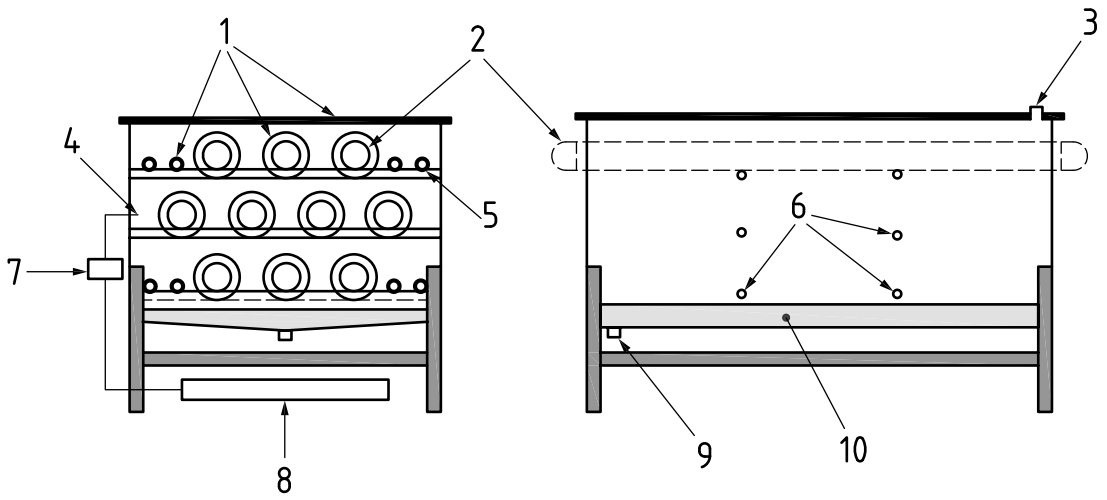
NOTE If plain PE end caps are used as the ends of the test pieces, they may be wrapped with aluminium tape.

B.4 Pre-treatment of the test piece

B.4.1 General

Assemble the test piece, fill with test water, seal both ends, and place the test piece in the test rig as shown in Figure B.1.

Figure B.1 **Typical test tank arrangement**



Key

1	Tank seals	6	Pipe supports
2	Test samples	7	Temperature controller
3	Fuel filler	8	Heater
4	Thermocouple	9	Fuel drain
5	Control samples	10	Liquid fuel

Sufficient test water shall be taken from a single source to provide for filling and refilling the test pieces, reference and control pieces and blanks, and for sample dilution water for odour and flavour testing. Storage shall be in appropriate containers that will not impart any additional odour or flavour to the water during storage and transit to the laboratory.

Add the synthetic petroleum fuel to the test rig to create a saturated vapour environment. Seal the inlet.

NOTE 1 A gas tight seal is recommended to eliminate the need to top up the fuel during the test period.

Ensure there is no leakage of fuel from the test rig end seals.

Leave the test piece exposed to the synthetic fuel for a period of (60^{+10}_{-2}) days and at a temperature of storage of (20 ±2) °C.

NOTE 2 This is to ensure that saturation of the outer layer of polyethylene has taken place.

NOTE 3 Attention is drawn to the regulatory requirements concerning health and safety, storage, handling and disposal of petroleum liquids.

B.4.2 Preparation of the leachate water

With the test piece remaining in situ within the test rig, remove the water from the test piece and refill with fresh test water, taking care to avoid any contamination.

Leave the test piece exposed to the fuel for a period of (72^{+6}_{-2}) h at (20 ±2) °C, then drain the water from the test piece into test containers that meet the requirements outlined in BS 6920-2.2.1:2000+A3:2014, **7.1**. The test laboratory shall supply or advise on the type of sample containers required. The containers shall be fitted with tamper proof stoppers and filled to the top. These samples are referred to as leachate samples. Three separate leachate samples, for odour and flavour analysis, shall be obtained in this manner.

A further leachate sample, for dissolved hydrocarbons, shall also be collected and placed in a suitable test container.

NOTE 1 Sample volumes required vary from test laboratory to test laboratory but the minimum quantities are likely to be:

- *500 ml per odour and flavour sample after applying the dilution factor (see Table B.1);*
- *500 ml, without dilution, per dissolved hydrocarbons sample for Method A analysis;*
- *50 ml, without dilution, per dissolved hydrocarbons sample for Method B analysis.*

NOTE 2 All samples may be taken from a single test piece. Where the volume of a single test piece is too small to provide the necessary amounts, it is permissible to use multiple test pieces, providing that all assemblies are exposed to the contaminant fluid at the same time.

In parallel with the permeation test, the same number of pipe assemblies shall be constructed to serve as reference pieces. These shall be assembled in accordance with **B.2** and shall be filled with the test water and subjected to the same exposure period and temperature environment but shall be stored in an environment completely free of fuel vapour. The reference pieces shall also be drained after the 60 day saturation period, refilled and sampled as for the test pieces outlined above.

Additionally, a plain piece of standard PE80 pipe shall be placed in the test rig as a control piece.

This shall be subjected to the same exposure regime as the test piece and drained, refilled and sampled as for the test piece.

Blank samples of the test water shall be collected for odour and flavour testing and one blank sample for dissolved hydrocarbons testing. The quantity of blank sample test water collected shall also be sufficient to provide enough water for all of the sample dilutions required in the flavour and odour testing. These samples shall be taken at the same time as the test, reference, and control pieces are refilled for sampling.

All samples shall be labelled with a unique identification code, the date and time they were collected and the purpose they were collected for.

NOTE 3 To avoid cross-contamination from the control water samples, which contain a high concentration of Fuel C, these should be collected last to avoid contamination of the sampling equipment and test environment. During transportation and storage every effort should be made to keep these samples separate from the other water samples to reduce the risk of cross contamination. The same precautions also apply to the handling of samples within the testing laboratory.

B.5 Procedure

The test laboratory shall assess the test and control piece leachate samples for odour and flavour in accordance with the procedure and dilution factors set out in BS 6920-2.2.1:2000+A3:2014, **2.2.1** and **2.2.2**. These factors are set out in Table B.1.

Test the odour and flavour leachate samples either:

a) within 24 h of them being collected or;

b) if the samples cannot be tested within this period, they shall be stored overnight in a refrigerator at a temperature of 4 °C and tested within 36 h of collection.

Samples shall be transported in insulated boxes with cooling blocks.

Analyze the dissolved hydrocarbon leachate samples taken from the test and control pieces, without dilution, using either:

1) Method A: a test method based upon the methodology outlined in the HMSO publication "Determination of Very Low Concentrations of Hydrocarbons and Halonogenated Hydrocarbons in Water 1984-5" [N3] using both the species and scan methods; or

2) Method B: a test method based upon the methodology set out in ISO 11423-1:1997.

Assess the test and control piece leachate samples against the blank sample.

NOTE Referral should be made to the reference leachate samples only when it is necessary to check whether the pipe and/or fitting is suspected of affecting the result.

Table B.1 **Dilution factors[A)]** *(1 of 2)*

OD	SDR	Bore	Area/m	volume/ m	area/L	Dilution
(mm)		(mm)	(mm^2)	(l)	(mm^2/l)	Factor
20	9	15.2	47601	0.180	244450	17.7
25	11	20.1	63146	0.317	199005	13.3
32	11	25.8	81053	0.523	155039	10.3
40	11	32.3	101473	0.819	123839	8.3
50	11	40.4	126920	1.282	99010	6.6
63	11	50.9	159907	2.035	78585	5.2
75	11	61.1	191951	2.932	65466	4.4
90	11	72.9	229022	4.174	54870	3.7
90	17	78.7	247243	4.865	50826	3.4
110	11	89.1	279916	6.235	44893	3.0
110	17	96.3	302535	7.284	41537	2.8
125	17	109.5	344004	9.417	36530	2.4
140	17	122.85	385945	11.853	32560	2.2
160	17	140.3	440765	15.460	28510	1.9

Table B.1 **Dilution factors**[A)] *(2 of 2)*

OD	SDR	Bore	Area/m	volume/ m	area/L	Dilution
180	17	158.0	496372	19.607	25316	1.7
200	17	175.5	551350	24.190	22792	1.5
225	17	197.3	619836	30.573	20274	1.4
250	17	219.6	689894	37.875	18215	1.2
280	17	245.9	772518	47.491	16267	1.1
315	17	276.6	868965	60.089	14461	1.0

[A)]Dilution factors for other pipe diameters and SDRs shall be calculated using the formula given in BS 6920-2.2.2:2000, **8.3**.

B.6 Expression of results

Results shall be provided in the form of a written test report. The minimum content of the test report shall be confirmation of the findings, for each test specimen, as follows:

a) the overall results expressed as Pass or Fail for odour and flavour and iso-octane, e.g. PASS;

b) the specific odour and flavour names, as reported by each panellist, e.g. solvent;

c) the level of iso-octane and toluene detected, expressed in microgram per litre, e.g. 172 μg/L; and

d) the limit of detection for hydrocarbons, e.g. 5 μg/L

B.7 Test report

The test report shall be produced for each type of test piece tested and shall include details of the following as a minimum:

a) identification of the manufacturer(s) and trade name(s) of the pipe and/or fitting under test;

b) the diameter and SDR of the pipe;

c) the material classification and construction of the pipe;

d) the production batch details of the pipe and/or fitting;

e) details of the construction and type of joint or fitting tested;

f) the test results;

g) reference to this standard and this annex;

h) name of the test laboratory.

Annex C (normative) Minimum required contents of the manufacturer's technical data file

NOTE 1 The technical data file should be in the manufacturer's preferred format and style.

NOTE 2 Guidance on the format of a technical file to characterise the performance of fittings can be found in DD ISO/TS 19911.

This British Standard contains specific requirements for the data that shall be made available in the manufacturer's technical data file and these are summarised in Table C.1.

Table C.1 **Requirements for the manufacturer's technical data file**

Clause number	Data to be made available
6.1.1	Dimensions for Type A pipes
6.2	Permeation test results – confirmation of compatible fittings and joints
6.5	Tolerance on squareness of cut of pipe ends for pipe sizes larger than 180mm, if applicable
6.6	Dimensions of coils for pipes larger that 180mm, if applicable
6.7	Definition of operative pipe outside diameter
7	All type test results
8.1.2	Definition of a pipe batch and/or a fitting batch
9.2	Marking of joints and fittings
11	A statement confirming compliance with Clause **11** of this British Standard

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM D471, *Standard test method for rubber property: Effect of liquids*

BS EN 1555-1:2010, *Plastics piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part 1: General*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration*

DD ISO/TS 19911, *Plastics pipes and fittings – Format of a technical file for characterizing PE spigot end fittings*

ISO 3, *Preferred numbers – Series of preferred numbers laboratories*

ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

Other publications

[1] WRAS. Regulation 31 of The Water Supply (Water Quality) Regulations 2000 (Statutory Instruments 2000 No 3184). England

[2] WRAS. Regulation 31 of The Water Supply (Water Quality) Regulations 2001 (Welsh Statutory Instruments 2001 No 3911(W.323). Wales

[3] SCOTLAND. Regulation 27 of The Water Supply (Water Quality) (Scotland) Regulations 2001

[4] NORTHERN IRELAND. Regulation 30 of The Water Supply (Water Quality) (Amendment) Regulations (Northern Ireland) 2009 (Statutory Rules of Northern Ireland 2009 No 246)

[5] Water Supply (Water Fittings) Regulations 1999, (England and Wales), the Water Byelaws 2000, (Scotland) and the current requirements for Northern Ireland apply.

[6] HSE. Health & Safety At Work Act 1974, and subsequent regulations.

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