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POLYETHYLENE PRESSURE PIPE SYSTEMS WITH AN ALUMINIUM BARRIER LAYER FOR POTABLE WATER SUPPLY IN CONTAMINATED LAND – SIZE 25mm to 630mm

FOREWORD

This document is the specification for polyethylene pressure pipes with an aluminium barrier layer for potable water supply in contaminated land, together with associated joints and fittings.

It has been prepared by the BPF Plastic Pipes Group in conjunction with the UK Water Industry's Standards Board in consultation with the Water Industry and manufacturers.

It should be noted that this document adopts the ISO classification of PE materials. PE100 is now used to describe HPPE grades. PE80 is now used to describe MDPE.

Compliance with this specification does not 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. Reference to a European Standard, British Standard, Water Industry Specification or any other specification applies equally to any equivalent specification.

This specification includes 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. Neither the BPF Plastic Pipes Group, nor Water UK can accept any responsibility for actions taken by others as a result.

CONTENTS

1. SCOPE

1.1 This standard specifies the materials and physical / mechanical performance for barrier piping systems of Polyethylene pipes (PE) with an Aluminium (Al) barrier layer for potable water supply in contaminated land together with associated fittings and joints in nominal sizes up to and including 630mm. In the construction of the pipes, the inner and outer polyethylene layers are bonded to the aluminium.

1.2 Two types of pipe construction / design are covered by this specification:

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 non stress bearing.

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

NOTE: See clause 3.2 for pressure classes.

1.3 The specification also covers the requirements for fittings and joints manufactured by system manufacturers or others for use with one or more barrier pipe systems. Such fittings and joints shall comply with the performance requirements for fittings, joints and jointing specified within this standard and other relevant existing standards. Barrier pipe manufacturers may, in the Technical Data file, list fittings and joints recommended for use with their system.

1.4 This standard details requirements for materials, dimensions, effect on water quality and marking as well as physical and mechanical properties.

2. TERMS AND DEFINITIONS, SYMBOLS, AND ABBREVIATIONS

2.1 Terms and definitions

For the purposes of this Water Industry Specification, the terms defined within ISO 1043-1:1997 apply, together with the symbols d_e, e, e_{min} and e_{max} in BS EN 12201 and ISO 11922-1:1997.

2.1.2 Geometrical definitions

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

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.

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.

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.

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

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.

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

nominal size DN/OD
nominal size, related to the outside diameter.

nominal size DN
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 dimension in millimetres (mm).

nominal wall thickness (e_n)
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, e_n, is identical to the specified minimum wall thickness at any point, e_{min}.

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 0.1 mm for pipes, or, this measurement as a percentage of the mean pipe diameter d_{em}, for coils.

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.

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, e_n.

tolerance
permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value.

wall thickness (at any point) (*e*)
wall thickness at any point around the circumference of a component.

wall thickness tolerance
permitted difference between the wall thickness at any point, *e*, and the nominal wall thickness, e_n. Note $e_n = e_{min}$.

2.1.2 Material definitions

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

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

composite pipe
refers to the complete multi-layer barrier pipe construction.

compound
homogenous mixture of base polymer (PE) and additives, i.e. anti-oxidants, pigments, UV-stabilisers and others, at a dosage level necessary for the processing and use of components conforming to the requirements of this standard.

contaminants
substances which may permeate through and affect the properties of polyethylene pipes. 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.

control piece
length of standard PE80 or PE100 pipe exposed to fuel during the permeation test.

core pipe
Refers to the PE pipe without barrier layer and protective skin.

drummed pipe
Pipe extruded onto a rigid framed reel with a supporting centre core to which the pipe is anchored. The pipe shall be dispensed from a trailer or low loader.

leachate water
water extracted from the Test Piece after exposure to the contaminant and to be assessed for trace amounts of permeated contaminants.

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 plant after having been previously processed by the same manufacturer in the production of components by, for example injection-moulding or extrusion.

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

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

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

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

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.

2.1.3 Definitions related to material characteristics

lower confidence limit (σ_{LCL})
quantity, with the dimensions of stress in megapascals (MPa), which can be considered as a property of the material, and represents the 97.5 % lower predicted limit of the mean long term strength at 20°C for 50 years with internal water pressure.

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.

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.

design stress (σ_s)
allowable stress, in megapascals (MPa), for a given application. It is derived from the MRS by dividing it by the coefficient *C, i.e.:*

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

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).

2.1.4 Definitions related to service conditions

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

NOTE: It is calculated using the following equation:

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

reference temperature
temperature for which the piping system is designed. 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.

2.1.5 Definitions related to joints

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.

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

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

fusion compatibility
ability of two similar or dissimilar polyethylene materials to be fused together to form a joint which conforms to the performance requirements of this standard.

2.1.6 Mandatory and non-mandatory requirements

2.1.6.1 shall
indicates a mandatory requirement.

2.1.6.2 should
indicates best practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment shall be completed to show that the alternative method delivers the same, or better, level of protection.

2.2 Symbols

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)
e_n	: nominal wall thickness
σ_s	: design stress
σ_{LCL}	: lower confidence limit (MPa)

2.3 Abbreviations

DN	: nominal size
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

3. MATERIAL CLASSIFICATIONS

3.1 PE Material Classification

3.3.1 The PE material shall meet the appropriate long term strength and stress crack resistance properties as specified below.

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.

3.1.2 Both PE 80 and PE 100 materials shall meet the requirements of BS EN 12201-1, and in addition, shall have long term stress crack resistance in accordance with Note d) of the UK National Annex of BS EN 12201-2, i.e. $\geq$1000 hours.

NOTE: In line with CEN and ISO recommendations, the Overall Service (Design) Coefficient C should be a minimum of 1.25 in accordance with BS EN ISO 12162.

For Type A pipes, the Design Coefficient C should apply to the PE core pipe, less aluminium, adhesive and protection layers.

For Type B pipes the Design Coefficient C should apply to the complete pipe including all layers.

3.2 Pipe Pressure Classification

3.2.1 For nominal sizes less than 63 mm, all pipes shall be supplied as SDR 11 and shall maintain a minimum wall thickness of 2.3 mm.

3.2.2 For nominal sizes 63 mm to 630 mm, the minimum pressure ratings for different SDR's are given in Table 1. Pipes may be supplied in other SDR ratings provided a minimum Overall Service (Design) Coefficient of 1.25 is maintained.

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

For Type A pipes, this will be the core pipe.

For Type B pipes this will be the complete pipe including all layers.

Table 1 - Pressure ratings for different PE materials

SDR	PE 80	PE 100
11	PN 12.5	PN 16
17	PN 8	PN 10

3.3 Aluminium Specification

3.3.1 The aluminium foil used in the construction of the composite pipe shall consist of at least 90% aluminium and shall have a minimum thickness of 100 µm.

3.3.2 The aluminium layer within the pipe shall be in the form of a tube which is created by either welding or an overlap bonded seam.

3.3.3 The weld line / overlap seam, depending on the type of construction shall be as specified in the Technical Data File supplied by the pipe manufacturer.

4. PE MATERIAL PROPERTIES (DETERMINED BY MATERIALS SUPPLIER) IN GRANULE OR PIPE FORM

4.1 Materials

The physical and mechanical properties of the PE materials used shall meet the requirements of BS EN 12201-1, including the text of the UK National Annex.

4.2 Colour

4.2.1 The colour of the outer polyethylene layer for aluminium barrier pipes for potable water applications shall be light blue for PE80 within the range 18E51 to 18E53 of BS 5252 or dark blue for PE100 within the range 20D44 to 20D45 or 20E53 to 20E56. The colour of the stripes shall be brown 06C37, 06C39, 08C37 or 08C39 in accordance with BS 5252.

4.2.2 The use of a blue, black or natural polyethylene inner layer is permitted. The carbon black used shall have a primary particle size of 10 nm to 25 nm.

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

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

5. WATER QUALITY REQUIREMENTS - IN "AS MANUFACTURED" FORM

5.1 Water Quality Approval

5.1.1 It is the responsibility of the manufacturer to ensure that any pipe or fitting supplied for potable/raw water transmission has approval in accordance with the requirements of the Water Supply (Water Quality) Regulations, Regulation 31 (England and Wales), Regulation 27 (Scotland) and Regulation 30 (Northern Ireland). Changes shall not be made to any approved compound or material unless they have been approved under the above Regulations.

5.1.2 All products in contact with, or likely to come into contact with, water for public supply shall be introduced in compliance with the requirements of Regulation 31 of the Water Supply (Water Quality) Regulations 2000, the Water Supply (Water Quality) Regulations 2001 for Wales, Regulation 27 of the Water Supply (Water Quality) (Scotland) Regulations 2001 or Regulation 30 of the Water Supply Regulations (Northern Ireland) 2007, as appropriate.

5.1.3 Whenever the Regulations change, it is the manufacturer's responsibility to ensure conformity with any new requirements.

5.1.4 Approval in accordance with the Regulations is mandatory. This applies only to products used by water companies in the treatment and distribution of public water supplies. It does not apply to use of fixtures and fittings on consumers' premises, where approval under the Water Supply (Water Fittings) Regulations (1999) or Scottish Water Byelaws (2004) in Scotland is required.

5.2 Rework

Clean reprocessable material, generated by the 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.

6. DIMENSIONS

6.1 Diameter and wall thickness

6.1.1 Type A pipes

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

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.

6.1.2 Type B pipes

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

6.1.3 Pipe outside diameter and wall thickness

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

The outside diameter shall be measured according to 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 according to BS EN ISO 3126, or by an alternative method of at least equivalent accuracy.

Measurements of all dimensions shall be related to reference dimensions at 23ºC $\pm$ 2ºC.

The mean outside diameter of the pipe at a distance from its end of < 0.1 × 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

Fittings and joints tested by a manufacturer for use with his barrier pipe system shall be listed in the Technical Data file together with the details of all tests carried out.

Fittings and joints manufactured by others for use with one or more pipe manufacturer's barrier pipe system, but not tested by the pipe manufacturer, shall demonstrate dimensional compatibility with that system and include full details of all tests carried out, including permeation tests, in the Technical Data File for that product.

6.3 Pipe ovality (out-of-roundness)

The ovality of straight pipes up to and including nominal size 180 mm shall not exceed the values given in Table 2.

NOTE: Ovality is defined as the maximum individual pipe diameter minus the minimum individual pipe diameter.

6.4 Length

Standard straight pipe lengths are 6 m, 12 m or 18 m. Other lengths should be agreed by negotiation.

Table 2 - Dimensions

Nom Size mm	Mean O.D. (mm)		Ovality (mm as extruded)	Wall Thickness (mm)			
				SDR 11		SDR 17	
	Min	Max	Max	Min	Max	Min	Max
25	25.0	25.3	1.2	2.3	2.7		
32	32.0	32.3	1.3	3.0	3.4		
40	40.0	40.4	1.4	3.7	4.2		
50	50.0	50.4	1.4	4.6	5.2		
63	63.0	63.4	1.5	5.8	6.5	3.8	4.3
75	75.0	75.5	1.6	6.8	7.6	4.5	5.1
90	90.0	90.6	1.8	8.2	9.2	5.4	6.1
110	110.0	110.7	2.2	10.0	11.1	6.6	7.4
125	125.0	125.8	2.5	11.4	12.7	7.4	8.3
140	140.0	140.9	2.8	12.7	14.1	8.3	9.3
160	160.0	161.0	3.2	14.6	16.2	9.5	10.6
180	180.0	181.1	3.6	16.4	18.2	10.7	11.9

NOTE 1: For Type A pipes the dimensions shall relate to the core PE pipe. For Type B pipes the dimensions shall relate to the composite pipe

NOTE 2: For other diameters and SDR's not covered in Table 2, these shall meet the requirements of BS EN 12201-2

NOTE 3: For sizes greater than 180mm, details shall be provided by the pipe manufacturer in a Technical Data File

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6.5 Cut end tolerance

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

Table 3 - Cut End Tolerances

Nominal Pipe Diameter (mm)	Maximum tolerance (mm)
25	2
32	2
40	2
50	2
63	2
75	2
90	2
110	3
125	3
140	3
160	3
180	4

NOTE: 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 the requirements of Appendix A of this specification.

6.6.2 After uncoiling, the ovality (see clause 6.3 Note) of any pipe section shall be less than 12% and 6% for SDR17 and SDR11 product 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

Nominal Pipe Diameter (mm)	Minimum Internal Coil Diameter (m)	
	SDR 11	SDR 17
25	0.6	-
32	0.7	-
40	1.0	-
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 may 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

7.1.1 This specification is primarily concerned with the performance aspects of the barrier system employed. Where a manufacturer already has BSI Kitemark approval (or bona fide equivalent) of the core pipe against WIS 4-32-17 or BS EN 12201 then the parts of this specification common to WIS 4-32-17 or BS EN 12201 shall be deemed to have been satisfied.

7.1.2 For Type Tests, and unless otherwise stated in the referring text or Appendices, 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 of Clause 7.3 for which one size shall be tested at a range of different temperatures and Clause 7.7 for which the requirements are set out in Appendix B.

The tests in this section 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.

7.1.3 Type testing requirements are summarized 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 which may affect pipe performance.

7.3 Long-term hydrostatic pressure strength at 20°C

7.3.1 Type A pipes

As the core pipe is the only stress bearing layer, and cannot be affected by ground contamination (protection is given by the aluminium), regression data generated by the material supplier to determine the MRS classification of the material at 20°C in accordance with ISO/TR 9080 and BS EN ISO 12162 shall be deemed to comply with this requirement for Type A pipes.

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 guidance given in ISO/TR 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 ISO/TR 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

7.4.1 A delamination test shall be carried out according to the method of ISO17454. 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.

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 should be tested and the calibration force determined accordingly.

A failure shall be recorded if any voids or areas of disbonding 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, he 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 not be less than 165 h. for a pipe squeezed off in accordance with BS EN 12106.

NOTE: Where the manufacturer states that the use of squeeze off is not advised with his 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 Using standard industry equipment, the pipe manufacturer shall demonstrate that coiled pipe can be satisfactorily re-rounded to allow jointing by both butt fusion and electrofusion, where these techniques are employed in the pipe system. The pipe section for testing shall be cut from the part of the coil with the smallest radius.

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 WIS 4-32-08, and shall satisfy the acceptance criteria outlined in WIS 4-32-08.

7.7 Resistance to the Permeation of Contaminants

7.7.1 When tested in accordance with the test method detailed in Appendix B of this Specification, the Test Piece shall be deemed satisfactory if the set (see Note 1) of Leachate samples taken from it meet the following criteria:

a) Two or more panellists detect no discernable odour in the diluted Leachate samples when compared to the set taken from the Blank/Reference sample;

b) Two or more panellists detect no discernable 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 discernable odour or flavour in the diluted leachate sample when compared to the blank/reference sample; or

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

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

d) Any of the control sample set passes the criteria set out in 7.7.1(a) and 7.7.1(b) above.

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

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

Table 5 - Type Testing requirements

Characteristics	Requirements	Test Parameters		Test method
		Parameters	Values	
Section 7.2 Appearance	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
Section 7.3 Hydrostatic strength at 20°C	Type A pipes Classification in accordance with ISO/TR 9080:1992 shall be certified by the compound producer Type B pipes Pressure requirement shall be verified by testing using the guidance of ISO/TR 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 resins that meet the requirements of Clause 3.1	For PE80, the 97.5% LCL shall be greater than 8MPa For PE100, the 97.5% LCL shall be greater than 10MPa	ISO/TR 9080 and BS EN ISO 12162
Section 7.4 Delamination of pipe layers	Type A pipes, the outer protective PE and aluminium layers may be removed. Type B pipes, the complete pipe is to be tested	Circumferential peeling of the PE and aluminium layers from the core pipe	<10% disbonding of the sample length	ISO 17454
Section 7.5 Pipe subjected to squeeze-off	Where the manufacturer permits the use of squeeze-off	PE80 4.6 MPa PE100 5.5 MPa	=>165 hours =>165 hours	BS EN 12106
Section 7.6 Fusion welding of coiled pipe	Where the manufacturer permits the use of fusion jointing	Electrofusion peel test Butt fusion tensile test	$K_1c > 1.7$ kJm$^{3/2}$ failure mode shall be ductile	WIS 4-32-08 WIS 4-32-08
Section 7.7 Resistance to permeation of contaminants	To demonstrate that pipes, joints and fitting combinations can adequately resist the ingress of hydrocarbon contaminants	Odour and Flavour Hydrocarbon concentration	2 out of 3 panellists must detect no odour or flavour <100ug/l	Appendix B of this specification

8. BATCH RELEASE TESTS

8.1 General Requirements

8.1.1 The manufacturer shall operate a Quality Management System conforming to BS EN ISO 9001: 2000. This shall include a Quality Plan whereby details and results for each test specified in Clause 7 for each material composition shall be made available to the purchaser or his 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. A summary of which is tabulated in Table 8 for Type A pipes and in Table 9 for Type B pipes. A batch shall be defined in the manufacturers' Quality Plan.

8.2 Batch Release Test Requirements: Type A pipes

Tests for Type A pipes are summarised in Table 8.

8.2.1 Tensile Properties

Tested on the core pipe only unless otherwise stated

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

The value of yield stress (σ_y) and elongation at break shall not be less than the values given in Table 6.

Table 6 - Tensile properties

Property	PE 80	PE 100
Tensile Strength	$\geq$ 15 MPa	$\geq$ 19 MPa
Elongation	$\geq$ 350%	$\geq$ 350%

8.2.2 Oxidation Induction Time

The PE material forming the inner and outer layers shall meet a requirement of $\geq$ 20 minutes when tested at 200°C according to ISO TR 10837. Tests may be carried out at 210°C or higher providing there is a clear correlation to the results at 200°C. In the case of dispute the reference temperature shall be 200°C.

8.2.3 MFR Change

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 more than 20% from the range of the virgin compound supplied.

8.2.4 Short Term 80°C Notched 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 ISO 1167. Values for appropriate test pressures for different pipe SDRs and materials are given in Table 7.

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. Values for appropriate test pressures for different pipe SDRs and materials are given in Table 7.

Table 7 - Test Pressures for 80°C Stress Crack Resistance Test (bar)

SDR	Notched Pipe		Un-notched pipe	
	PE 80	PE 100	PE 80	PE 100
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

Tests for Type B pipes are summarised in Table 9.

8.3.1 Tensile Properties

Tested 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 2, using a tensile testing machine at a crosshead speed of (50 $\pm$ 2) mm/min.

The test samples shall be cut consecutively from the composite pipe so that the sides are parallel and a $(90+2)^{o}$ to the pipe axis. The length of each ring shall be (25 $\pm$ 1) mm.

The test samples shall be mounted on two steel rods as shown in Figure 1.

Table 8 - Batch release tests: Type A pipes

Characteristics	Requirements	Test Parameters		Test method
		Parameters	Values	
Section 7.2 Appearance	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 lengths	No defects	Visual inspection
Section 8.2.1 Tensile properties		Tensile strength Elongation	PE80 =>15MPa PE100 =>19MPa PE80 =>350% PE100 =>350%	ISO 6259 (Parts 1 & 3)
Section 8.2.2 Oxidation induction time	Inner and outer layers	200°C	=> 20 mins.	ISO TR 10837
Section 8.2.3 MFR change	For reprocessed materials	Inner layer	Less than 20% change from virgin compound range	BS EN ISO 1133
Section 8.2.4 Short term 80°C Notched pipe stress crack test	Sizes 25mm to 63mm pipes Sizes >63mm	Un-notched Notched test	=>165 hours =>165 hours	ISO 1167 BS EN ISO 13479

Table 9 - Batch release tests: Type B pipes

Characteristics	Requirements	Test Parameters		Test method
		Parameters	Values	
Section 7.2 Appearance	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 lengths	No defects	Visual inspection
Section 8.3.1 Tensile properties	Ring test coinciding with the aluminium weld	50mm /min.	PE80 =>15MPa PE100 =>19MPa	As detailed in section 8.3.1
Section 8.3.2 Oxidation induction time	Inner and outer layers	200°C	=> 20 mins.	ISO TR 10837
Section 8.3.3 MFR change	For reprocessed materials	Inner layer	Less than 20% change from virgin compound range	BS EN ISO 1133
Section 8.3.4 Short term 80°C pipe stress crack test	All sizes	Un-notched	=>165 hours	ISO 1167

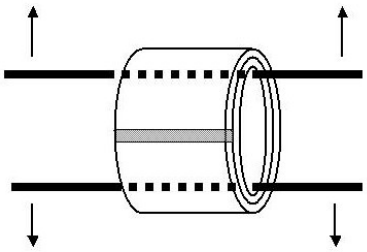

Figure 1

8.3.2 Oxidation Induction Time

The PE material forming the inner and outer layers shall meet a requirement of ≥ 20 minutes when tested at 200°C according to ISO TR 10837. Tests may be carried out at 210°C or higher providing there is a clear correlation to the results at 200°C. In the case of dispute the reference temperature shall be 200°C.

8.3.3 MFR Change

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 are given in Table 7.

Table 10 - Pipe Manufacturer's Tests

TEST	Type Test	BRT	Clause
Dimensions	/	/	6
Appearance	/	/	7.2
OIT See Note 1	/	/	8.2.2 8.3.2
Tensile yield stress Apparent tensile strength Type B only)	/	/	8.2.1 8.3.1
Elongation (Type A only)	/	/	8.2.1
MFR Change See Note	/	/	8.2.3 8.3.3
Long term MRS 20°C (Cross checks)	/		7.3
Short term Stress Crack Resistance		/	8.2.4 8.3.4
Delamination of Pipe Layers	/		7.4
Stress Rupture Resistance at 80°C on pipe subjected to squeeze off	/		7.5
Welding of coiled pipe	/		7.6
Permeation Resistance	/		7.7
Water Quality	/		5.1
Note : Only when reprocessed material used			

9 MARKING

Pipes

9.1.1 The marking of pipe shall be permanent and remain legible under normal handling, storage and installation procedures. No method of marking shall prejudice the performance of the pipe when tested to the requirements of this specification. 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 Specification 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.

9.1.2 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. 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.

9.1.3 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.

Joints and Fittings

9.2.1 Electrofusion

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

Where the fittings or joints are of non standard dimensions they shall be labelled to that effect and state for which barrier pipe system they are designed.

9.2.2 Mechanical

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 approved for use with;

c) The number of this Specification 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).

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

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

Straight lengths of pipe shall be supplied in bundles that are constructed to minimise 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 ensure that the coiling has not caused excessive ovality that could compromise dimensions after delivery to site (see Clause 6.6).

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

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 JOINTING REQUIREMENTS

11.1 The pipe manufacturer shall state in the Technical Data File which jointing systems, e.g. mechanical, butt or electrofusion, may be used with the pipe system, together with any system specific requirements, such as aluminium tape wrapping.

The pipe manufacturer shall also state which joints and fittings were used in the permeation tests detailed in Clause 7.7.

Joints and fittings shall fully conform with the Instructions for Use documents that form the basis of the barrier pipe approval under Regulation 31 (or 27 for Scotland or 30 for Northern Ireland).

11.2 All manufacturers of joints and fittings intended for use with PE barrier pipes shall provide a Technical Data File stating the PE barrier pipe system/s that the joints and fittings are approved for use with, together with any specific installation requirements. The Technical Data file shall also state details of the tests carried out to ensure dimensional compatibility with the barrier pipe system/s.

11.3 All jointing systems and fittings shall be fully compliant with the requirements of this Clause 11 and Clauses 7.7 and 9.2 of this Specification.

11.4 Fusion jointing systems shall comply with the performance requirements of WIS 4-32-08 and BS EN 12201-3 as appropriate

11.5 Mechanical fittings for use with pipes of nominal size greater than 63 mm shall comply with the performance requirements of WIS 4-24-01.

11.6 Mechanical fittings for use with pipes of nominal diameter 25 mm to 63 mm shall comply with the performance requirements of WIS 4-32-11.

11.7 All joints and fittings shall be approved in accordance with Regulation 31(4)(b) of the Water Supply (Water Quality) Regulations, 2000 in England and Wales (or 27 for Scotland or 30 for Northern Ireland).

11.8 Manufacturer's recommended barrier wrappings around joints and fittings may be used for the purposes of providing additional chemical and permeation resistance, provided that these are identical in form and composition with those tested with in accordance with Clause 7.7 and are installed in accordance with the manufacturer's instructions.

11.9 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 may occur between metallic fittings, components or protective materials and the aluminium barrier layer, they shall be chosen to avoid galvanic corrosion.

11.10 If a type of fitting is employed that is unsuitable for use with conventional unprotected PE pipe, by virtue of dimensions or otherwise, it shall be clearly marked or labelled as such.

12. REFERENCES

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

British Standards

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.
BS 6920-2.2.2	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 2.2 – Odour and Flavour of water for hoses, composite pipes and tubes.
BS EN ISO 3126	Plastic piping systems. Plastics components – Determination of dimensions.
BS EN ISO 9001	Quality Management Systems – Requirements.
BS EN 12106	Plastics piping systems - Polyethylene (PE) pipes - Test method for the resistance to internal pressure after application of squeeze-off

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 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 1133	Plastic – Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics
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

International Standards

ISO 3	Preferred numbers -- Series of preferred numbers
ISO 161-1	Methods of testing plastics. Thermoplastics pipes, fittings and valves. Thermoplastics pipes for the conveyance of fluids. Nominal outside diameters and nominal pressures. Metric series
ISO 497	Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers
ISO 6259	Thermoplastics pipes - determination of tensile properties and basic specifications - Part 1: General test method
ISO 6259	Thermoplastics pipes - Determination of tensile properties and basic specifications - Part 3: Polyolefin pipes
ISO 11423-1	Water Quality – Determination of Benzene and some derivatives. Part 1, Headspace Chromatographic Method
ISO 11922	Thermoplastics pipes for the transport of fluids – Dimensions and tolerances - Part 1 : Metric series
ISO 13949	Method for the assessment of the degree of pigment dispersion in polyolefin pipes, fittings and compounds
ISO 17454	Multilayer pipes – Test method for the adhesion of the different layers using a pulling rig.
ISO TR 9080	Thermoplastics pipes for the transport of fluids – Methods of extrapolation of hydrostatic stress rupture data to determine the long term hydrostatic strength of thermoplastics pipe materials
ISO TR 10837	Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings

Water Industry Specifications

WIS 4-32-08	Specification for site fusion jointing of PE80 and PE100
WIS 4-24-01	Specification for mechanical fittings and joints including flanges for polyethylene pipes for the conveyance of cold potable water for the size range 90-1000 mm nominal diameter.
WIS 4-32-11	Specification for thermoplastic end load resistant mechanical fittings for polyethylene pipes of nominal size ≤63mm
WIS 4-32-17 (Now withdrawn)	Polyethylene pressure pipes for pressurised water supply and sewerage duties
IGN 4-32-18	The choice of pressure ratings of polyethylene pipes for water supply and sewerage duties
ASTM D471	Standard Test Method for Rubber Property: Effect of Liquids

APPENDIX A REQUIREMENTS FOR POLYETHYLENE PIPE, SUPPLIED AS COILS OR ON DRUMS

A.1 SCOPE

These requirements apply to all polyethylene barrier pipe in the size range 75 mm to 180 mm supplied as coils or on drums. These 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.2 GENERAL REQUIREMENTS

A.2.1 The pipe, as coils or on drums, shall conform to the requirements of Sections 5-7 of this specification determined in accordance with the Quality Plan (see 8.1.2).

A.2.2 All pipe shall be constrained in a stable configuration which permits the safe and controlled dispensing of the pipe. Restraining and dispensing methods shall not damage the pipe e.g. kinking, scoring, etc. The requirements of clause 7 of this specification shall also apply.

A.2.3 The maximum external surface temperature of the pipe at the time of coiling shall not exceed 35°C (measured using an agreed method, e.g. contact thermometer probe) at a distance as near as practical to the centre axis of the coiling machine.

A.2.4 Any open ends on coils or drums shall be plugged or covered.

A.3 COILED PIPE

Unless otherwise specified, coiled pipe shall be supplied in minimum lengths of 25 m and 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 ensure 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. If necessary, re-rounding/straightening tools may be used.

A.4 DRUMMED PIPE

A.4.1 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 2500 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.

A.4.2 Where drums are supplied by the manufacturer for direct use from a low loader, the weight limits of A.4.1 shall not apply and the system shall incorporate a braking device.

A.5 MARKING

Pipes shall be marked in accordance with clause 9 of this specification. In addition each coil above size 63 mm, and each drum shall be clearly and indelibly labelled with the following:

Nominal weight of coiled pipe or nominal weight of loaded drum, in kilograms, as applicable;

Requirements for safe handling and pipe dispensing.

APPENDIX B
METHOD OF ASSESSING THE RESISTANCE TO PERMEABILITY OF SPECIFIC CONTAMINANTS

B.1 PRINCIPLE

A test pipe assembly containing a fitting or joint, the Test Piece, is filled with potable water and immersed in an environment of synthetic petroleum fuel until the outer PE is saturated with fuel (60 days immersion). A combination of liquid synthetic fuel and the saturated vapour is acceptable.

Upon saturation, the potable water is removed and replaced with fresh potable water.

Exposure of the Test Piece to the petroleum environment is continued for a further 72 hours after which the water is carefully removed and tested for odour and flavour and dissolved hydrocarbons.

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

The concentration of dissolved hydrocarbons is determined using either of the methods set out in Clause B.4.3 below.

Reference Pieces, Control Pieces and Blank Samples shall be included as part of the test.

B.2 APPARATUS

B.2.1 Figure B1 shows a typical test apparatus, which may be fabricated from a suitable sized steel tube, flanged at both ends.

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.

B2.3 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 TEST PIECES

B3.1 Test Pieces shall comprise:

a) For couplings or fittings designed to joint PE to PE, two standard lengths of 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. 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. The ferrule or tapping tee shall be open as if to permit supply.

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. 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 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.3.6 The volume of water contained in the Test Piece ends (those parts of the Test Piece 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.3.7 The Test Piece shall be sealed at each end with suitable stoppers known not to impart odour or flavour into water.

B.4 TEST METHOD

B.4.1 Pre-Treatment of the Test Piece

Assemble the Test Piece, fill with test water, seal both ends, and place the test piece in the test rig as shown in Figure B1.

Add the synthetic petroleum fuel to the test rig to create a saturated vapour environment. Seal the inlet. 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)^{o}C This is to ensure that saturation of the outer layer of polyethylene has taken place.

NOTE: Practitioners should familiarise themselves with the regulatory requirements concerning Health and Safety, Storage, Handling and Disposal of Petroleum Liquids.

B.4.2 Preparation of 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) hours at (20 +/- 2)^{o}C, then drain the water from the Test Piece into test containers that meet the requirements outlined in clause 7.1 of BS 6920 – Part 2.2.1. 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. 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 B1 below.
- 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: 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 Clause B.3 above 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.

Finally, 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.

It is recommended that sampling be carried out by the designated test laboratory. If sampling is carried out by the pipe supplier then this shall be witnessed by an independent party and the samples placed in tamper-proof bottles prior to being analysed.

B.4.3 Test Requirements

All samples, including those from the Reference Pieces, Control Pieces and the Blanks, shall be tested by a laboratory holding UKAS (ISO 17025)

accreditation for testing in accordance with BS 6920 - Parts 2.2.1 and 2.2.2 (Odour and Flavour assessment) and BS EN ISO 9001 or equivalent for the selected dissolved hydrocarbon test method.

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 BS 6920 – Parts 2.2.1 and 2.2.2. These factors are set out in Table B.1 below.

Odour and Flavour leachate samples shall be tested either within 24 hours of being collected or, if the samples cannot be tested within this period, they shall be stored overnight in a refrigerator at a temperature of 4^{o}C and tested within 36 hours of collection. Samples shall be transported in insulated boxes with cooling blocks.

The test laboratory shall analyse the dissolved hydrocarbon leachate samples taken from the Test and Control pieces, without dilution, using either:

a) 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" using both the species and scan methods; or

b) Method B: a test method based upon the methodology set out in ISO 11423-1: 1997 - Water Quality - Determination of Benzene and some derivatives, Part 1, Headspace Chromatographic Method.

Test and Control Piece leachate samples shall be assessed against the Blank Sample. 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.

B.5 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 Appendix;
h) Name of the test laboratory.

Table B1 - Dilution Factors

OD (mm)	SDR	Bore (mm)	Area/m (mm2)	vol/m (L)	area/L (mm2/L)	Dilution Factor
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
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

NOTE: Dilution factors for other pipe diameters and SDRs shall be calculated using the formula given in Clause 8.3 of BS 6920-2.2.2 :2000

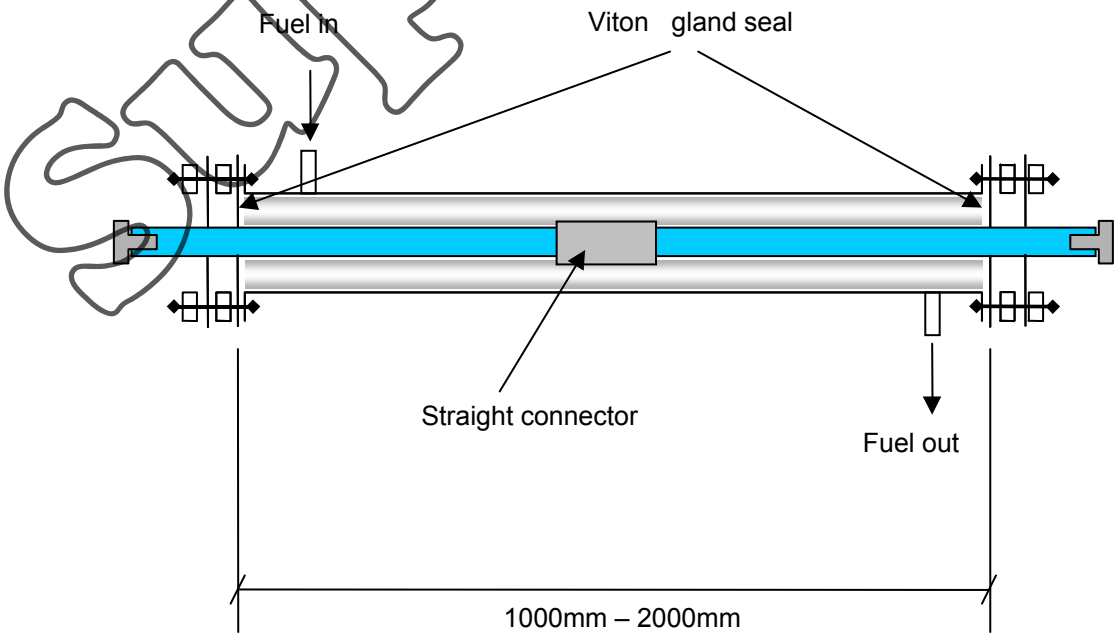

Figure B1 - A Typical Test Rig Assembly