

SPECIFICATION FOR POLYETHYLENE PIPES AND FITTINGS

1. General

1.1 The polyethylene (PE) pipes and fittings to be supplied under this Contract shall conform to the requirements of the following standards in every respect where appropriate:

- BS EN 12201-1
- BS EN 12201-2
- BS EN 12201-3

Unless otherwise specified, the requirements of this Appendix shall take precedence over the above standards.

1.2 PE pipes and fittings to be supplied under this Contract shall meet the colour requirements for the application listed in **Table 22.09-1**.

Table 22.09-1

Application	Colour	BS 4901 Colour	RAL Code
Potable water pipes installed below ground	Blue	20E53-20E56	5005
Potable water fittings installed below ground	Blue	20E53-20E56	5005
Non-potable water pipes installed below ground	Blue	20E53-20E56	5005
Non-potable water fittings installed below ground	Blue	20E53-20E56	5005
All pipes & fittings installed above ground (exposed)	Black	00E53	9011

1.3 The Engineer may order purple colour pipes for the application listed in **Table 22.09-1A**. The Contractor is deemed to have made due allowance in the Contract for the supply of such pipes irrespective of the quantities of such pipes ordered.

Table 22.09-1A

Application	Colour	BS 4901 Colour	RAL Code
Non-potable water pipes installed below ground	Purple	04D44-04D45	4004

1.4 The size of PE pipes and fittings shall be designated by the nominal size (DN/OD) in millimetres which corresponds to a nominal outside diameter (d_n).

1.5 For the purpose of connecting to pipes of other materials or connecting non-PE fittings, which are of the same nominal size, the equivalent sizes in DN in **Table 22.09-2** shall be used.

Table 22.09-2

Nominal Size (DN/OD) / Nominal Outside Diameter (d _n)	Equivalent Size in DN
20	15
25	20
32	25
50	40
63	50
90	80
125	100
180	150
250	200
315	250
355	300
450	350
500	400
560	450
630	500
710	600
800	700

- 1.6 All non-metallic components in contact with potable water, including but not limited to PE compounds, sealing rings, gasket materials, O-rings, etc., shall comply with the requirements of BS 6920.

2. **Definitions**

- 2.1 The definitions in Clause 3 of BS EN 12201-1 and those listed below shall apply to this Appendix.
- 2.1.1 Base compound shall be a compound as defined in BS EN 12201-1 Clause 3.1.2.3, but without the addition of pigments.
- 2.1.2 Product batch for pipes and fittings shall be as defined in PD CEN/TS 12201-7 Clause 3.16. The pipes and fittings in each product batch shall be of a single size. The total length of pipes in a product batch shall not exceed 9,999 metres.
- 2.1.3 Compounder is a third party that specialises in mixing and blending compounds and specifically does not manufacture pipes or fittings.
- 2.1.4 Material producer, as described in Clause 4.2 of BS EN 12201-1, is the compound manufacturer, not the pipe manufacturer.
- 2.1.5 An injection-moulded fitting is a fitting produced by injecting PE compound under pressure into a mould in the shape of a finished fitting. It shall have an external moulded surface finish (except that the surface of the spigot(s) of the fitting may be machined) and a visible injection mould filling gate point, and shall not contain any butt weld joints. A

fitting produced by butt welding a moulded fitting spigot to another pipe or fitting spigot shall be regarded as a fabricated fitting in accordance with Clause 5.5.7 of this Appendix.

- 2.1.6 Fitting body is a specific shape formed by machining from a solid or hollow extruded PE bar.

3. PE Compound

- 3.1 PE100 compounds shall be used for the manufacture of pipes and fittings supplied under this Contract. The compounds shall have a minimum required strength of 10MPa when classified in accordance with BS EN ISO 9080 and shall conform to BS EN 12201-1, and the following additional requirements:
- 3.1.1 All compounds shall be virgin materials from the material producer and shall be delivered ready for extrusion or moulding in a pre-compounded and pre-coloured state. No recycled, own reprocessed and own reprocessible materials shall be used in the manufacture of any pipe or fitting.
- 3.1.2 Compounds delivered to the pipe or fittings manufacturer shall not be altered by blending or mixing with any other compound, pigment or additive before or during extrusion or moulding.
- 3.1.3 Multiple compounds when used in the manufacture of a single product (such as pipes with co-extruded layers) shall have the same brand name on their data sheets or use the same base compound to ensure compatibility.
- 3.1.4 Blue and black compounds shall meet the requirements of BS EN 12201-1 Tables 1 and 2, and the additional requirements in Clauses 1.2, 3.2 to 3.7, 3.9 and 3.10 of this Appendix.
- 3.1.5 Purple compounds required in Table 22.09-1A which are not covered under Clause 4.3 of BS EN 12201-1 shall be pre-compounded using base compound and pigments with the following requirements:
- 3.1.5.1 Base compound shall meet the requirements of BS EN 12201-1 Tables 1 and 2, together with Clauses 3.2, 3.6, 3.9 and 3.10 of this Appendix.
- 3.1.5.2 A compounder shall undertake pigmentation of the base compound to purple colour as specified in Table 22.09-1. The purple compound shall be tested by an independent laboratory meeting the requirements of PS Clause 22.10(3)(b) and shall comply with the type test requirements of Annex 1 together with Clauses 3.2, 3.5, 3.8 and 3.10 of this Appendix. Compounds having successfully completed such type testing shall be regarded as a certified compound, complying with BS EN 12201-1.

- 3.1.5.3 Changes to the certified compound as defined in PD CEN/TS 12201-7 Annex A, Clause A.2 shall require re-evaluation in accordance with PD CEN/TS 12201-7 Annex A, Clause A.3. Notwithstanding this, if changes are required under Clause A.3.1, then only testing in accordance with Annex 1 of this Appendix shall be required. If the un-pigmented compound has changed, type tests demonstrating compliance with Clause 3.1.6.1 above shall be submitted.
- 3.2 The compound in the form of granules used for the manufacture of pipes and fittings under this Contract shall have physical characteristics conforming to the requirements given in Table 1 of BS EN 12201-1 and the following additional requirements:
- 3.2.1 Melt mass-flow rate (MFR) for the compound used for the manufacture of pipes and fabricated fittings, when tested in the form of granules in accordance with BS EN ISO1133 Condition T at 190°C under a nominal 5 kg load, shall be ≥ 0.20 g/10 minutes and ≤ 0.40 g/10 minutes.
- 3.2.2 MFR for the compound used for the manufacture of injection-moulded fittings, when tested in the form of granules in accordance with BS EN ISO1133 Condition T at 190°C under a nominal 5 kg load, shall be ≥ 0.20 g/10 minutes and ≤ 0.58 g/10 minutes.
- 3.2.3 Density of the compound, when tested in the form of granules in accordance with BS EN ISO 1183-1 and BS EN ISO 1183-2, shall be ≥ 947 kg/m³.
- 3.2.4 Oxygen induction time (OIT) of the compound, when tested in the form of granules in accordance with BS EN ISO 11357-6 at 200°C, shall be ≥ 40 minutes, or when tested in the form of granules in accordance with BS EN ISO 11357-6 at 210°C, shall be ≥ 20 minutes.
- 3.3 The compound used for the manufacture of pipes under this Contract shall have characteristics conforming to the requirements given in Table 2 of BS EN 12201-1 and the following additional requirements:
- 3.3.1 Hydrostatic strength of the compound, when tested in the form of pipe in accordance with BS EN ISO 1167-1 and BS EN ISO 1167-2 at 20°C and 12.0 MPa hoop stress, shall conform to the requirement that no failure shall occur during the test period of 200 hours.
- 3.3.2 Slow crack growth resistance of the compound shall conform to one of the following requirements:
- 3.3.2.1 Slow crack growth resistance, when tested in the form of pipe using the notched pipe test at 80°C in accordance with EN ISO 13479, shall conform to the requirement that no failure shall occur during the test period of 8760 hours.
- 3.3.2.2 Slow crack growth resistance, when tested using the full-notch creep test (FNCT) in accordance with PAS 1075:2009-04 Annex A1 at 4 MPa tensile stress applied while immersed in a 2% Arkopal N-100 solution at 80°C, shall conform to the

requirement that no failure shall occur in any of the six samples during the test period of 8760 hours as specified in Table 1a, No. 1 of PAS 1075:2009-04.

Notwithstanding the above, in case one or more of the six samples have failed in a ductile mode in less than 8760 hours, but all three samples from the same compound have passed the point loading tests given in Table 1a, test No.2. of PAS 1075:2009-04, the compound shall be considered to have met the requirements of this clause.

The laboratory performing such testing shall be accredited in accordance with ISO/IEC 17025 and their scope of accreditation shall include testing to PAS1075: 2009-04 and BS EN 12814-3.

- 3.4 The compound used for the manufacture of fittings under this Contract shall have characteristics conforming to the requirements given in Table 2 of BS EN 12201-1 and the following additional requirements:
 - 3.4.1 Hydrostatic strength of the compound, when tested in the form of pipes in accordance with BS EN ISO 1167-1 and BS EN ISO 1167-2 at 20°C and 12.0 MPa hoop stress, shall conform to the requirement that no failure shall occur during the test period of 200 hours.
 - 3.4.2 Slow crack growth resistance of the compound, when tested in the form of pipe using the notched pipe test at 80°C in accordance with BS EN ISO 13479, shall conform to the requirement that no failure shall occur during the test period of 1000 hours.
- 3.5 Compounds with different brands or model numbers used for the manufacture of pipes and fittings under this Contract shall be fusible to each other and shall be demonstrated by type testing in accordance with the applicable joining method given below:
 - 3.5.1 For pipes and fittings jointed using electrofusion, a decohesive resistance test shall be carried out in accordance with the requirement given in Table 4 of BS EN 12201-3.
 - 3.5.2 For pipes and fittings jointed using butt fusion, a tensile strength test shall be carried out in accordance with the requirement given in Table 4 of BS EN 12201-3.
- 3.6 The compound manufacturer shall be listed as a member company of the PE100+ Association (<http://www.pe100plus.com>) at the date when the compounds were manufactured.
- 3.7 The compound manufacturer of compounds other than purple coloured compound shall engage an independent laboratory complying with PS Clause 22.10(3)(b) to carry out type testing of compounds in accordance with the requirements given in Table 3 of PD CEN/TS 12201-7 and the additional requirements specified in Clauses 3.2, 3.3 and 3.4 of this Appendix.

- 3.8 The compounder of purple coloured compound shall engage an independent laboratory complying with PS Clause 22.10(3)(b) to carry out type testing of the compound in accordance with Annex 1 of this Appendix and submit the type test report together with copies of the base compound certificate of analysis and the compounder's certificate of analysis. The compounder's certificate of analysis shall list all additives used and the percentage of each additive in the pigmented compound by mass.
- 3.9 The compound manufacturer shall engage an independent laboratory complying with PS Clause 22.10(3)(b) to carry out process verification testing of compounds in accordance with the requirements of Table 11 of PD CEN/TS 12201-7, with the exception that the resistance to slow crack growth shall be tested as specified in Clauses 3.3 and 3.4 of this Appendix. For purple compounds, only process verification testing of the base compound shall be required.
- 3.10 The compound manufacturer shall carry out batch release testing of compounds in accordance with the requirements of Clause 9.2 of this Appendix.

4. **PE Pipes**

- 4.1 PE pipes shall conform to BS EN 12201-2 and the requirements stipulated in Clause 4 of this Appendix, and shall be manufactured from compounds complying with Clause 3 of this Appendix.
- 4.2 Pipes shall have a nominal pressure rating (PN) and standard dimension ratio (SDR) as shown in **Table 22.09-3** and BS EN 12201-2, Table 2.

Table 22.09-3

	PN (Bar)	SDR
Pipes installed below ground	PN 16.0	SDR 11
Pipes installed above ground in an exposed condition*	PN 20.0	SDR 9

* Installed in a condition where the pipe surface temperature may exceed 40°C

- 4.3 The nominal outside diameter (d_n) of pipes, including the minimum and maximum mean outside diameters, shall be in accordance with BS EN 12201-2 Table 1 and shall be measured using a circumference tape on a sample conditioned at 23°C. If diameters are measured in an unconditioned state, adjustment for temperature can be made using the following formula:

$$\text{Increase / decrease in diameter over } d_n \text{ in mm} = \frac{(t_{ext} + t_{int} - 46)}{2} \times \frac{0.09 \times OD \text{ mm}}{1000}$$

where t_{int} = Internal surface temperature in °C, t_{ext} = External surface temperature in °C, both at the point of measurement.

- 4.4 The wall thickness of pipes at any point shall not fall below e_{min} as specified in BS EN 12201-2 Table 2, appropriate to the DN/OD and SDR, and the mean wall

thickness e_m shall not exceed the maximum specified thickness e_{max} as specified in BS EN 12201-2 Table 2.

- 4.5 The maximum out-of-roundness of pipes shall be in accordance with BS EN 12201-2 Table 1 for sizes DN/OD \leq 250 mm and shall not exceed the tolerances for grade M as stated in BS ISO 11922-1 Table 2 for sizes DN/OD $>$ 250 mm.
- 4.5.1 Pipes that are not within the tolerance for grade M as stated in BS ISO 11922-1 Table 2 shall be re-rounded using a hydraulic re-rounding device approved by the Engineer before electrofusion. Re-rounding equipment shall be used directly adjacent to each side of the coupler being welded and shall remain in place throughout the fusion process until the cooling time has elapsed.
- 4.5.2 Pipe re-rounding shall be mandatory on pipes with DN/OD $>$ 450mm when conducting electrofusion welding regardless of circular dimensions.
- 4.6 The colour of PE pipes shall be in accordance with **Table 22.09-1** or **Table 22.09-1A** where appropriate. For co-extruded pipes, the colour requirement in Table 22.09-1 shall apply to the outer layer only. Stripes on the pipe surface shall not be accepted.
- 4.7 Pipes with co-extruded layers shall only be used in nominal sizes DN/OD \geq 90 mm and shall be in accordance with BS EN 12201-2 Annex B and the following additional requirements:
- 4.7.1 Batch release testing of pipes with co-extruded layers shall meet the requirements of Clause 9.4 of this Appendix. MFR testing shall be conducted and reported separately on each colour used in co-extruded pipes.
- 4.7.2 Outer co-extruded layer shall be even around the entire circumference, the thickness of the outer co-extruded layer shall be $(10 \pm 1.5)\%$ of the nominal wall thickness at any point when the pipe is cut & inspected.
- 4.8 Length of pipes shall be nominally 6.0 m or 12.0m $+50 / -250$ mm supplied in straight lengths. Pipes with DN/OD \leq 63mm (excluding black pipes) may be supplied in 50 m or 100 m coils. No reduction in the specified length stated above shall be allowed unless prior approval is obtained from the Engineer.
- 4.9 The pipes supplied under this Contract shall have mechanical characteristics conforming to the requirements given in Table 3 of BS EN 12201-2 and the following additional requirements:
- 4.9.1 Hydrostatic strength, when tested in accordance with BS EN ISO 1167-1 and BS EN ISO 1167-2 at 20°C and 12.0MPa hoop stress, shall conform to the requirement that no failures shall occur during the test period of 200 hours.
- 4.9.2 Slow crack growth resistance shall conform to one of the following requirements:

4.9.2.1 Slow crack growth resistance, when tested using the notched pipe test at 80°C in accordance with BS EN ISO 13479, shall conform to the requirement that no failures shall occur during the test period of 3300 hours.

4.9.2.2 Slow crack growth resistance shall be tested in accordance with Table 3, No.1 of PAS 1075:2009-04. The samples shall be tested using a two-notch creep test (2NCT) at 4 MPa tensile stress applied while immersed in an Arkopal N-100 2% solution at 80°C. No failures shall occur in less than 3300 hours.

Pipe test samples shall be taken from the smallest and largest DN/OD SDR 11 pipes supplied by the supplier and a sample of DN/OD 125 SDR 11 pipe.

Three test specimens from each sample shall be prepared in accordance with the requirements of PAS 1075:2009-04 Annex A1 with the following amendments:

Test specimen shall be prepared with the width in accordance with BS EN 12814-3 Table 2 - Dimensions of type 1 specimens, "for flat assemblies", dimension *b*.

In accordance with the requirements of PAS 1075:2009-04 Annex A2, test specimens shall be cut from the pipe wall parallel to the pipe axis and shall be notched on TWO sides perpendicular to the pipe axis in the same plane, on the machined sides of the specimen in order to keep the inside and outside pipe surface intact.

4.10 The pipe manufacturer shall engage an independent laboratory complying with the requirements of PS Clause 22.10(3)(b) to carry out type testing of pipes in accordance with the requirements given in Table 4 of PD CEN/TS 12201-7 and the additional requirements specified in Clause 4.9 of this Appendix, except that no type testing shall be required for black PE pipes of SDR 9.

4.11 The pipe manufacturer shall engage an independent laboratory complying with the requirements of PS Clause 22.10(3)(b) to carry out process verification testing of pipes in accordance with the requirements given in Table 12 of PD CEN/TS 12201-7.

4.12 The pipe manufacturer shall carry out batch release testing of pipes in accordance with the requirements of Clause 9.4 of this Appendix.

5. Fittings for PE pipes

5.1 Fittings for PE pipes shall conform to BS EN 12201-3 and the requirements stipulated in Clause 5 of this Appendix, and shall be manufactured from compounds complying with Clause 3 of this Appendix.

- 5.2 The PN rating of all fittings shall be the same as, or higher than the nominal pressure rating of the connecting pipes. The fittings shall be supplied with complete set of accessories including insert, liners, joint rings, flange gaskets, studs, bolts and nuts, etc. as appropriate.
- 5.3 The colour of PE fittings shall be in accordance with **Table 22.09-1** except for fittings with nominal outside diameter $d_n > 315$ mm where the Engineer may consider the acceptance of black fittings.
- 5.4 Welds on fabricated fittings shall be undertaken using only butt fusion in accordance with BS ISO 21307 and internal weld beads shall be removed, while external weld beads shall not be removed at the factory. Extrusion welding, also known as freehand, contact, speed tip, hot air or stick welding shall not be permitted in the fabrication of any PE fittings. Extrusion welding shall not be used to reinforce butt fusion welds or to repair gouges, damage or any other defect. Evidence of any extrusion welding in a fitting may constitute rejection of the entire batch of fittings.
- 5.5 Spigot End Fittings
- 5.5.1 All spigot end fittings with sizes nominal outside diameter $d_n \leq 315$ mm shall be injection-moulded unless approved by the Engineer, except that black coloured fittings for above ground installation may be fabricated. Injection-moulded spigot end fittings with $d_n > 315$ mm may be used subject to the approval by the Engineer.
- 5.5.2 The minimum internal diameter of any fabricated fitting shall not be less than dimension D_2 given in BS EN 12201-3 Table 3, Figure 2.
- 5.5.3 Spigot end dimensions of fabricated fittings shall be in accordance with BS EN 12201-3 Table 3, specifically 'Grade B' and out-of-roundness for 'electrofusion and butt fusion' shall apply to all fittings supplied.
- 5.5.4 Bends with $d_n > 315$ mm shall be manufactured from pipe segments complying with Clause 4 of this Appendix with the nominal bend radius $r \geq 2.5 \times d_n$ and mitre angle $\leq 7.5^\circ$.
- 5.5.4.1 Segmented bends with a nominal angle $\leq 15^\circ$ shall have a single mitre;
- 5.5.4.2 Segmented bends with a nominal angle $> 15^\circ$ but $\leq 30^\circ$ shall have a minimum of two mitres;
- 5.5.4.3 Segmented bends with a nominal angle $> 30^\circ$ but $\leq 45^\circ$ shall have a minimum of three mitres;
- 5.5.4.4 Segmented bends with a nominal angle $> 45^\circ$ but $\leq 60^\circ$ shall have a minimum of four mitres;
- 5.5.4.5 Segmented bends with a nominal angle $> 60^\circ$ but $\leq 75^\circ$ shall have a minimum of five mitres.
- 5.5.4.6 Segmented bends with a nominal angle $> 75^\circ$ but $\leq 90^\circ$ shall have a minimum of six mitres.

- 5.5.5 Swept bends shall comply with BS EN 12201-3 Annex B. Specifically the wall thickness at any point on the outer radius of a swept bend, when measured by ultrasonic thickness measurement in accordance with BS EN 14127, shall be \geq minimum wall thickness given in BS EN 12201-2 Table 2. Swept bends shall be type tested in accordance with PD CEN/TS 12201-7 Annex B table B.1.
- 5.5.6 Segmented tees fabricated out of pipe segments in accordance with BS EN 12201-3 Annex B.5 shall not be permitted. Fabricated tees shall be formed in accordance with Clause 5.5.7 of this Appendix.
- 5.5.7 Other fabricated fittings, not covered under BS EN 12201-3 Annex B and not already defined under Clause 5.5 of this Appendix, shall meet the following requirements:
- 5.5.7.1 Fabricated fittings may be formed by butt welding together the spigot ends of pipes and/or fittings or by butt welding the spigot ends of pipes or fittings to a spigot end on a fitting body.
 - 5.5.7.2 The fitting body shall be machined from a single homogeneous extruded piece of PE and the dimensions of the fitting body shall be sufficient to achieve a pressure rating equivalent to the pipes it is connecting to. The forming of the fitting body by hot wrapping PE on a mandrel or die shall not be permitted.
 - 5.5.7.3 The addition of reinforcement to the fitting by sleeve, shrink fitting or welding together of components to achieve the pressure rating shall not be permitted.
 - 5.5.7.4 All pipes and fittings used for fabrication shall comply with clauses 4 and 5 of this appendix respectively and shall have a nominal pressure rating not less than that of the connecting pipes.
 - 5.5.7.5 Butt welding shall be in accordance with Clause 5.4 of this Appendix.
 - 5.5.7.6 Notwithstanding Clause 5.5.4 of this Appendix, butt welds shall only be perpendicular to the axis of either the fitting offtake or the fitting main way. Angled butt welds or side fusion butt welds shall not be permitted in the fabrication of any fittings under this Contract.
 - 5.5.7.7 Each fabricated fitting shall be type tested in accordance with PD CEN/TS 12201-7 Annex B Table B.2.
 - 5.5.7.8 The Contractor shall specifically demonstrate how the dimensions of the fitting body have been calculated to achieve the pressure rating. Drawings and calculations shall be submitted to the Engineer for approval.
- 5.6 Electrofusion Socket Fittings
- 5.6.1 Electrofusion socket fittings, including couplers, reducers, tees, caps and elbows, shall comply with BS EN 12201-3.

- 5.6.2 All electrofusion socket fittings with sizes DN/OD ≤ 315 mm shall be injection-moulded. Butt welds and fabrication shall not be permitted in any electrofusion socket fittings.
- 5.6.3 Fitting terminals and shrouds of electrofusion socket fittings shall comply with BS EN 12201-3 Annex C Figure C.1. Other designs of the fitting terminals will only be considered if the Contractor can demonstrate that appropriate lead adaptors are readily available such that electrofusion of their fittings can be conducted using commonly available electrofusion control units in the market.
- 5.6.4 Fusion zone length for electrofusion socket 'L₂' as shown in BS EN 12201-3: Figure 1 is the distance between the first and last adjacent coils perpendicular to the fitting axis embedded at each end of the fusion zone. When measured, the fusion zone length shall comply with **Table 22.09-4**, where L_{2, min} is given in BS EN 12201-3 Table 1.

Table 22.09-4

Nominal diameter of the fitting d _n (mm)	Minimum fusion zone length for electrofusion socket (mm)
≤ 355	$\geq 1.8 \times L_{2, \min}$
> 355	$\geq 1.6 \times L_{2, \min}$

- 5.6.5 Outer cold zone length 'L₃' as shown in BS EN 12201-3: Figure 1, shall comply with the dimensions stated in **Table 22.09-5**:

Table 22.09-5

Nominal diameter of the fitting d _n (mm)	Minimum outer cold zone length 'L ₃ ' (mm)
≤ 50	≥ 10.0
63 – 90	≥ 15.0
125 – 180	≥ 20.0
250 – 355	≥ 25.0
450 – 630	≥ 30.0
700 – 800	≥ 40.0

- 5.6.6 Internal diameter of the fusion zone in electrofusion socket fittings shall comply with the dimensions stated in **Table 22.09-6**. It shall be measured in accordance with BS EN ISO 3126 on a coupler pre-conditioned to 23°C, as described in BS EN 12201-3 Clauses 6.1 and 6.2.1.

Table 22.09-6

Nominal size of electrofusion socket DN/OD (mm)	Maximum Internal diameter D ₁ (mm)
≤ 125	$\leq d_n + 1.0$
$> 125 - \leq 250$	$\leq d_n + 1.8$
$> 250 - \leq 355$	$\leq d_n + 2.3$
$> 355 - \leq 710$	$\leq d_n + 3.0$
> 710	$\leq d_n + 3.8$

- 5.6.7 Fusion and pre-heat parameters shall be stored on permanent waterproof barcode stickers applied to each fitting during manufacture. The barcode format shall be in accordance with 2/5 Interleaved ANSI format.
- 5.6.8 Electrofusion socket fittings shall not require more than 48 volts to achieve a successful fusion weld.
- 5.6.9 Electrofusion socket fittings shall be capable of being welded by electrofusion control units complying with BS ISO 12176-2 and all electrofusion control units shall include a bar code scanner / reader to read the fusion parameters from each electrofusion fitting.
- 5.6.10 Injection-moulded electrofusion socket fitting bodies with DN/OD \geq 250 mm shall be machined in the bore to meet the tolerances given in **Table 22.09-6** of this Appendix.
- 5.6.11 Electrofusion heating coils in the fusion zone shall be mechanically ploughed into the coupler body. The fusion coils shall be visible across the whole fusion zone. The coils shall be evenly spaced and securely embedded in the fitting and shall not become dislodged even in the case of an interference fit between the pipe and the coupler.
- 5.6.12 Pre-heating shall be mandatory on couplers DN/OD \geq 250 mm prior to commencement of the welding cycle. Pre-heating shall be executed by scanning a pre-heat barcode attached to each fitting. The pre-heat soak time and voltage shall heat the fitting and pipe but not allow fusion to commence. The preheat shall be recorded by the electrofusion control unit.
- 5.6.13 The Contractor shall provide the design of electrofusion socket fittings which are not injection moulded and have DN/OD $>$ 315 mm to demonstrate that expansion of the fitting body will be prevented during the fusion cycle. Such design shall be applied directly above the fusion zones and have a width \geq the width of each fusion zone. The design shall be applied during the manufacturing process and shall form a permanent part of the electrofusion socket.
- 5.6.14 Electrofusion socket fittings shall be a single homogeneous piece of PE after fusing where the wall thickness of the fused socket shall not be less than the wall thickness of the connecting pipe. The addition of any external reinforcement by sleeve, shrink fitting, ploughing or any other reinforcement method shall not be considered as part of the minimum required thickness of the socket in accordance with BS EN 12201-3 Clause 6.2.2.
- 5.7 Compression Joint Fittings
- 5.7.1 Compression joint fittings for connecting to PE pipes DN/OD \leq 63mm shall be of the socket type with a plastic body, plastic grip rings and rubber sealing rings and shall conform to the requirements of BS ISO 17885. An independent laboratory meeting the requirements of PS

Clause 22.10(3)(b) shall issue a type test report demonstrating the fitting is a full-end-load resistant joint, resistant to pull-out at 23° C according to BS ISO 17885 Clause 9.3.3.3.

- 5.7.2 The fittings shall be supplied together with liners or inserts to be installed inside pipe ends for PE pipes with SDR11. Liners or inserts are not required to be installed inside the pipe ends for PE pipes with SDR 9.
- 5.7.3 Threads incorporated into compression joint fittings shall be compatible with pipes and fittings threaded to BS EN 10226-1 (taper external threads and parallel internal threads).
- 5.7.4 Ferrous and non-ferrous metallic components shall not be used on compression fittings.
- 5.7.5 Compression joint fittings shall be black in colour and manufactured from an appropriate engineering plastic material which provides long term UV resistance. The colour requirement in Table 22.09-1 is not applicable to compression joint fittings.

5.8 Fusion Transition Fittings

- 5.8.1 Fusion transition fittings for connecting to PE pipes DN/OD \leq 63 mm shall have an electrofusion or spigot end and a threaded end DN \leq 50 mm, and shall conform to the requirements of BS EN 12201-3 Annex E. An independent laboratory meeting the requirements of PS Clause 22.10(3)(b) shall issue a type test report demonstrating compliance with the requirements of BS EN 12201-3 Annex E.
- 5.8.2 Threaded ends in contact with sea water shall comply with BS EN 1982 grade CC491K / CuSn₅Zn₅Pb₅-C or an alternative approved material which shall not give rise to galvanic corrosion between the transition fittings and copper alloy gate valves.
- 5.8.3 Threaded ends in contact with potable water shall be lead free copper alloy complying with either BS EN 12163 or BS EN 12168 grade CW724R / CuZn₂₁Si₃P, or shall be a dezincification resistant copper alloy complying with BS EN 12165 grade CW 602N or grade CW 303G. Alternative dezincification copper alloys may be approved by the Engineer.
- 5.8.4 Threads where incorporated into fusion transition fittings shall be compatible with pipes and fittings threaded to BS EN 10226-1 (taper external threads and parallel internal threads).

5.9 Mechanical Transition Fittings

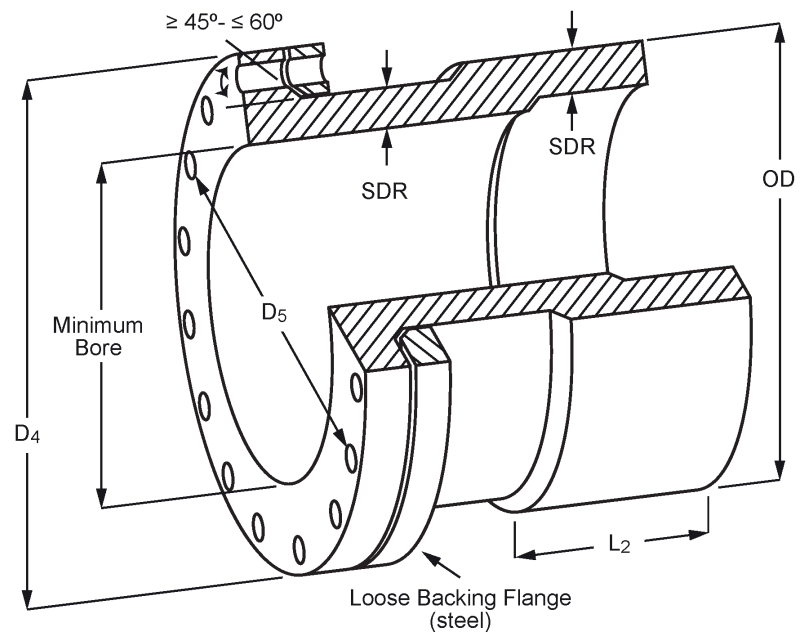
- 5.9.1 Mechanical transition fittings for connecting to PE pipes DN/OD \geq 90 mm shall be of the socket type with a ductile iron body, non-ferrous grip rings and rubber sealing rings and shall conform to the requirements of WIS 4-24-01 Type 1. An independent laboratory meeting the requirements of PS Clause 22.10(3)(b) shall issue a type test report

demonstrating the fitting is a full-end-load resistant joint conforming to WIS 4-24-10 Type 1.

- 5.9.2 Ferrous metallic components, excluding fasteners, on mechanical fittings shall be completely encapsulated with Fusion Bonded Epoxy (FBE) or equivalent with a minimum dry film thickness of 300µm. The coating material shall meet the performance requirements of WIS 4-52-01/02. Specifically, the coating test requirements of WIS 4-52-01 Appendix D shall apply. No ferrous surface shall be exposed.
 - 5.9.3 Material used in the gripping mechanism shall not be a ferrous material.
 - 5.9.4 Sealing rings shall be a moulded elastomer complying with BS EN 681-1, and shall comply with the requirements of BS 6920.
 - 5.9.5 Fasteners for applying compression to the PE pipes or fittings shall be stainless steel bolts and nuts complying with BS EN ISO 3506-1&2, steel Grade A4 and property Class 80. Washers shall be Grade 1.4401 in the softened condition complying with BS EN 10029, BS EN 10048, BS EN 10051 + A1, BS EN 10095 and BS EN ISO 9445. Bolts, nuts and washers shall be insulated from electrochemically dissimilar metal by non-metallic washers and sleeves.
 - 5.9.6 Flanges on mechanical fittings shall conform to BS EN 1092-2 PN16, Figure 6 type 16 or 21 and dimensions shall be in accordance with Table 9 'DI'.
- 5.10 Flanged fittings
- 5.10.1 Flange adaptors shall comply with the following requirements:
 - 5.10.1.1 DN of the flange adaptor connection shall align with the PE pipe DN/OD as given in **Table 22.09-2** of this Appendix.
 - 5.10.1.2 For $DN/OD \leq 180$ mm, the flange adaptor head OD, 'D4' as shown in ISO 9624 Figure 2, shall be as given in ISO 9624 Table 3. The flange adaptor shank OD, 'D5' as shown in ISO 9624 Figure 2, shall be as given in ISO 9624 Table 3, with the exception that the flange adaptor shank OD shall be 185mm for DN/OD 180mm.
 - 5.10.1.3 For $DN/OD \geq 250$ mm, the flange adaptor head OD, 'D4' as shown in ISO 9624 Figure 2, shall be as given in BS EN 1092-1 Table 13, dimension 'D'. The flange adaptor shank OD, 'D5' as shown in ISO 9624 Figure 2, shall be the diameter of bolt circle 'K' as given in BS EN 1092-1, Table 13, less 1 x diameter of bolt hole 'L'. The transition between the flange shank D5 and the spigot shall be a taper $\geq 45^\circ$ and $\leq 60^\circ$ to the flange adaptor axis. The flange adaptor may be fabricated by butt welding the spigot ends of fittings in accordance with Clause 5.4 of this Appendix.

- 5.10.1.4 For $DN/OD \geq 450$ mm, the Contractor shall submit to the Engineer for approval the design of the flange adaptor. Such flange adaptor may have an integrated reducing section as indicated in **Figure 22.09-1** of this Appendix. The design shown in **Figure 22.09-1** is typical only. Clearance between the fastener heads and the flange adaptor body shall be sufficient to enable the use of a socket wrench with diameter $\geq 2 \times$ bolt diameter to fit over the hex head to tighten or loosen the fasteners.

Figure 22.09-1 – Typical flange adaptor with integrated reducing section



- 5.10.1.5 Thickness of flange adaptor head shall be $\geq 1.2 \times$ the minimum wall thickness of the fusion end E1 in BS EN 12201-3 Figure 2.
- 5.10.1.6 SDR of the flange adaptor, when measured at any point using $OD / \text{wall thickness}$, shall not be less than the SDR of the connecting pipe.
- 5.10.1.7 Minimum bore dimension of the flange adaptor as given in BS EN 12201-3 Table 3 (for electrofusion and butt fusion) shall not apply to any reducing section of the flange adaptor at the flange end in sizes $DN/OD \geq 355$ mm. The minimum bore of a flange adaptor $DN/OD \geq 355$ mm and $DN/OD < 800$ mm at any point shall be $\geq 0.90 \times DN$ of the connecting flange as given in **Table 22.09-2** of this Appendix.

5.10.1.8 Spigot dimensions shall be as given in BS EN 12201-3 Table 3 (for electrofusion and butt fusion).

5.10.1.9 Overall length of the flange adaptor shall be sufficient that all bolts can be installed and removed from the completed assembly after the PE flange adaptor has been fused with a coupler and is bolted to the mating flange connection.

5.10.1.10 Clause 5.5.1 of this Appendix may not apply to flange adaptors DN/OD ≥ 250 mm.

5.10.2 Loose backing flanges for flange adaptors shall be rated PN16 unless stated otherwise. The bolted flange DN size shall align with the pipe DN/OD as indicated in **Table 22.09-2** of this Appendix. The loose backing flanges shall have dimensions conforming to **Table 22.09-7** of this Appendix and shall comply with either of the following requirements:

5.10.2.1 Steel loose backing flanges shall be manufactured in accordance with BS EN 1092-1 Figure 8, Type 01 and Table 13 except for the bore diameter 'B₁' which shall comply with Table 22.09-7 of this Appendix. The thickness of the flange shall be in accordance with BS EN 1092-1 Table 13 'C₁'.

- The loose backing flange shall be completely encapsulated with a Fusion Bonded Epoxy (FBE) coating meeting the requirements of WIS 4-52-01 and shall have a minimum spot thickness of $\geq 300\mu\text{m}$. After coating no ferrous surface shall be exposed. The coating performance shall comply with the requirements of WIS 4-52-02.
- For size \geq DN 250 mm, the loose backing flanges shall have a taper matching the taper of the flange adaptor as given in Clause 5.10.1.3 of this Appendix and as indicated in Figure 22.09-1.

5.10.2.2 Ductile iron loose backing flanges shall be manufactured in accordance with BS EN 1092-2 Table 9 and shall be type A, flat faced as shown in Figure 2 of BS EN 1092-2. Dimensions shall be in accordance with a type 05 flange specified in BS EN 1092-2.

- The loose backing flange shall be completely encapsulated by injection moulding with a fiber reinforced polypropylene, and no ferrous surface shall be exposed. The polypropylene material used for encapsulation shall meet or exceed the following requirements:
 - Impact resistance of the coating material when tested in accordance with BS EN ISO 179-1, shall not be $< 20\text{kJ/m}^2$.

- Tensile modulus of the coating material when tested in accordance with BS EN ISO 527-2, shall not be < 5000MPa.
- Dimensions given in **Table 22.09-7** of this Appendix and in BS EN 1092-2 Table 9 shall be inclusive of polypropylene encapsulation. Notwithstanding this, the thickness of the uncoated ductile iron ring when measured on the circumference, shall not be less than the thickness as given in BS EN 1092-2 Table 9, Flange thickness, DI, 'C', type 05.
- For size \geq DN 200 mm, loose backing flanges shall have a taper matching the taper of the flange adaptor as given in Clause 5.10.1.3 of this Appendix and as indicated in Figure 22.09-1.
- Type testing of each size of ductile Iron loose backing flange fitted to its matching flange adaptor shall be undertaken in accordance with the requirements of BS EN 12201-3 Table 4, Hydrostatic strength at 80° C, 1000 hours. No leaking of the joint shall occur. An independent laboratory meeting the requirements of PS Clause 22.10(3)(b) shall issue such type test certificates.

Table 22.09-7 – Dimensions of loose backing flanges

DN (mm)	Nominal Size OD / d_n (mm)	Minimum flange outside diameter D (mm)	Maximum flange bore (B₁) or internal diameter (mm)
50	63	165	78
80	90	200	108
100	125	220	135
150	180	285	188
200	250	340	253
250	315	405	318
300	355	460	358
350	450	520	413
400	500	580	461
450	560	640	519
500	630	715	579
600	710	840	693
700	800	910	766

5.10.2.3 Stainless steel bolts and nuts shall comply with BS EN ISO 3506-1&2, steel Grade A4 and property Class 80. Washers shall be Grade 1.4401 in the softened condition complying with BS EN 10029, BS EN 10048, BS EN 10051 + A1, BS EN 10095 and BS EN ISO 9445. Bolts, nuts and washers shall be insulated from electrochemically dissimilar metal by non-metallic washers and sleeves.

- 5.10.2.4 Gasket materials, O-rings and seals shall be Type WA, Hardness Category '70' elastomeric joint rings complying to BS EN 681-1 and BS 6920 where used with potable water.
- 5.10.3 Where puddle flanges are to be supplied under the Contract, the Contractor shall submit the design of puddle flanges to the Engineer for approval.
- 5.11 The fittings supplied under this Contract shall have mechanical properties conforming to the requirements give in Table 4 of BS EN 12201-3.
- 5.12 The fittings manufacturer shall engage an independent laboratory complying with the requirements of PS Clause 22.10(3)(b) to carry out type testing of fittings in accordance with the requirements given in Table 5 of PD CEN/TS 12201-7, except that no type testing shall be required for black PE fittings of SDR 9.
- 5.13 The fittings manufacturer shall engage an independent laboratory complying with the requirements of PS Clause 22.10(3)(b) to carry out process verification testing of fittings in accordance with the requirements given in Table 12 of PD CEN/TS 12201-7.
- 5.14 The fittings manufacturer shall carry out batch release testing of fittings in accordance with the requirements of Clause 9.5 of this Appendix.

6. Marking and Traceability Barcodes

- 6.1 Each PE pipe shall be marked at the time of manufacture by direct printing onto the pipe surface, repeating at one metre intervals continually along the length of the pipe. Marking shall be in accordance with BS EN 12201-2 Clause 11 and the following additional information:
- 6.1.1 Manufacturer's information described in BS EN 12201-2 Table 6 shall comprise of a unique production batch number of six digits and other additional manufacturer's information such as the production site. A change in production, as defined in PD CEN/TS 12201-7 Clause 3.16, shall constitute a change in the batch number.
- 6.1.2 Date of manufacture in the format of YY/MM/DD.
- 6.1.3 Traceability barcode with human readable numbers representing the barcode data printed beneath it.

The marking shall be in Arial font in accordance with **Table 22.09-8**,

Table 22.09-8

Pipe DN/OD	Text height	Marking repeating each metre of pipe	Bar codes repeating each meter of pipe	WSD Logo quantity and height
< 75 mm	≥ 5mm	1 line of text	Not required	4 per meter of pipe at ≥ text height

75 – 225	≥ 8mm	2 lines of text @ 120° radial separation	2 bar codes @ 120° radial separation	8 per meter of pipe ≥ 1.3x text height
250 – 800	≥ 12mm	2 lines of text @ 120° radial separation	2 bar codes @ 120° radial separation	8 per meter of pipe ≥ 1.3x text height

- 6.2 Unique traceability barcodes shall be provided on each meter of PE pipe and shall comply with the following requirements:
- 6.2.1 The barcode shall be of type “Code 128 Type C”, have a length of 40 digits coded according to BS ISO 12176-4 and have a human readable representation immediately below the barcode with the following requirements:
- 6.2.2 Digits 10 to 15 of the barcode shall be used to record the production batch number of six digits as specified in Clause 6.1.1 of this Appendix;
- 6.2.3 Digits 27 to 32 of the barcode shall be used to record the manufacturing date in the format (YY/MM/DD);
- 6.2.4 Digits 33 to 36 of the barcode shall be used to record the sequential meterage of the pipe as it was manufactured in the batch (0001m – 9999m). For each new batch number, the meterage shall commence at 0001m. No batch shall be longer than 9999 meters;
- 6.2.5 Digits 37 to 40 of the barcode shall be used to record the pipe length at delivery in metres, rounded to the nearest full metre (6m = 0006).
- 6.3 Marking elements on injection moulded PE fittings, including the manufacturers name or symbol, nominal outside diameter(s) of fitting d_n , material and designation, SDR and the manufacturers information, shall be moulded directly into the fitting surface during the manufacturing process in accordance with BS EN 12201-3 Clause 11. For fabricated fittings, marking shall be by either direct printing or permanent waterproof sticker, applied to each fitting during manufacture in accordance with BS EN 12201-3 clause 11.
- 6.4 A traceability barcode shall be provided on each PE fitting and shall comply with the following requirements:
- 6.4.1 The barcode shall be of type “Code 128 Type C”, have a length of 26 digits coded according to BS ISO 12176-4 and have a human readable representation immediately below the barcode.
- 6.4.2 Traceability barcodes shall be stored on a permanent waterproof barcode sticker applied to each fitting during manufacture. Fittings DN/OD ≤ 63 may have the sticker applied to the individual bag the fitting is supplied in.
- 6.5 Barcodes on pipes and fittings shall be capable of being read by a barcode reader, scanner or smartphone and being converted into digits that match the human

readable numbers. Manual recording of the barcode using the human readable format shall not be allowed unless permitted by the Engineer.

- 6.6 Barcodes on pipes and fittings shall comply with the following requirements:
 - 6.6.1 A minimum of five of the traceability barcodes printed directly onto the surface of each length of pipe shall be readable in accordance with Clause 6.5 of this Appendix.
 - 6.6.2 A minimum of one traceability barcode applied to each fitting shall be readable in accordance with Clause 6.5 of this Appendix.
- 6.7 The marking on pipes shall be durable in accordance with Clause 11.1.1 of BS EN 12201-2 and shall not be able to be rubbed off by hand.

7. Packaging of Fittings

- 7.1 Each fitting (including electrofusion fittings) shall be delivered from the manufacturer inside an individually sealed PE bag. The bag shall remain sealed until the time of installation and fusing.
- 7.2 Accessories such as bolts, nuts, washers, inserts, compression rings, gaskets and other items necessary for the completion of a joint shall be provided in complete sets, each sealed inside an individual PE bag or equivalent packaging. Any other form of delivery for the fittings shall be subject to the agreement of the Engineer.

8. Samples and Submissions after Acceptance of Tender

- 8.1 The pipe materials related submissions specified in PS Clause 22.10(4) shall include, but not limited to, the information stipulated in Clauses 8.1.1 to 8.1.12 below:
 - 8.1.1 Contact details including name and address of:
 - 8.1.1.1 Compound material producer (including compound brand names and compound origin)
 - 8.1.1.2 Pipe manufacturer and location of pipe extrusion facility
 - 8.1.1.3 Fittings manufacturer(s) and location(s) of fitting manufacturing facilities
 - 8.1.1.4 Local agent or representative
 - 8.1.2 ISO 9001 quality assurance certification issued by an independent body meeting the requirements of PS Clause 22.10(3)(b) for:
 - 8.1.2.1 Pipe manufacturer
 - 8.1.2.2 Fitting manufacturer(s)

- 8.1.3 Product Certification for BS EN 12201-2, covering the sizes and SDR required in this Contract for the pipe manufacturer.
- 8.1.4 Technical data sheets from the compound material producer.
- 8.1.5 Pipe manufacturer's technical data sheet or brochure for the proposed pipes.
- 8.1.6 Fitting manufacturer's technical data sheet or brochure for the proposed fittings.
- 8.1.7 Water potability certification to BS6920 shall be issued by Water Research Centre of the UK or an equivalent organisation for each proposed PE compound and for one pipe sample and one fitting sample (regardless of type or size) manufactured using that compound, and for all non-metallic components of the PE pipes and fittings which are exposed to potable water, as mentioned in Clause 1.6 of this Appendix. The test certificate shall have an issue date no more than 60 months prior to the date of submission.
- 8.1.8 Chlorine water resistance certification as specified in Japanese Industrial Standard (JIS) K6762 Annex 3 shall be undertaken by an independent laboratory meeting the requirements of PS Clause 22.10(3)(b) on each compound used in the manufacture of pipes or fittings for potable water. The test certificate shall have an issue date no more than 60 months prior to the date of submission.
- 8.1.9 Compound type test reports required in Clauses 3.7 and 3.8 of this Appendix shall be supplied by the material producer(s) for the same grade(s) proposed in the submission.
- 8.1.10 Type test reports for pipes and fittings required in Clauses 4 to 5 of this Appendix.
- 8.1.11 Process verification test reports for compounds, pipes and fittings required in Clauses 3.9, 4.11 and 5.13 of this Appendix.
- 8.1.12 Fusion compatibility test reports for pipes and fittings required in Clause 3.5 of this Appendix.
- 8.2 Type test reports for pipes and fittings required in Clauses 4 and 5 of this Appendix shall have an issue date no more than 36 months prior to the date of submission unless they are accompanied by an up-to-date process verification report. The type test shall be conducted on pipes or fittings using the compounds proposed in Clause 8.1.1.1 above.
- 8.3 Type test reports for pipes and fittings required in Clauses 4 to 5 of this Appendix shall include photographs of each size of pipe and size and type of fitting being type tested to demonstrate the following:

- 8.3.1 The free length of the pipe welded to the pipe or fitting undergoing type testing shall comply with the requirements of Clause 4.6 of BS EN ISO 1167-4.
- 8.3.2 The human readable number below the barcode shall be legible to enable identification from the photograph of each pipe being type tested.
- 8.3.3 The marking elements on the fitting showing information required under Clause 6.3 of this Appendix shall be legible to enable identification from the photograph of each fitting being type tested.
- 8.4 If instructed by the Engineer, samples for each of the PE pipes and fittings to be supplied shall be submitted within 28 days from the date of instruction.

9. Manufacturer's Documentation before Delivery

- 9.1 The documents listed in Clauses 9.2 to 9.6 below shall be provided in English in a legible format for consideration by the Independent Inspection Body (IIB) as stipulated in PS Clause 22.10(5) for each batch of pipes and fittings to be delivered.
- 9.2 For each batch of compound supplied, batch release test (BRT) reports shall be provided to demonstrate compliance with PD CEN/TS 12201-7 Table 7 and the following requirements below with the exception that OIT value shall comply with Clause 3.2.4 of this Appendix:
- Batch number
 - Brand name and grade
 - Name and address of pipe or fitting manufacturer to whom the compound was shipped
 - Quantity of compound supplied under each batch certificate
 - Date when the compound was dispatched or tested
- 9.3 For each product batch of pipes supplied, batch inspection reports showing the following information in a tabular format shall be provided:
- Product batch number.
 - Product name of the compound(s) used to manufacture the pipes as described in the PE 100+ Association web site.
 - Identification of each pipe using the sequential starting meterage taken from the first complete barcode printed on each pipe (refer Clause 6.2.4 of this Appendix).
 - The compound batch number(s) of the compound(s) used for the manufacture of each pipe.
 - Geometrical characteristics for each pipe as described in BS EN 12201-2 Clause 6.
- 9.4 For each product batch of pipes supplied, batch release test (BRT) reports shall be provided to demonstrate compliance with PD CEN/TS 12201-7 Table 8 with

the exception that the OIT value shall comply with Clause 3.2.4 of this Appendix.

9.5 For each product batch of fittings supplied, including injection-moulded and fabricated fittings, batch release test (BRT) reports shall be provided to demonstrate compliance with PD CEN/TS 12201-7 Table 9 and the following additional requirements:

9.5.1 Change of MFR shall be no more than $\pm 20\%$ from the value given in the material producer's BRTs as stated in BS EN 12201-3 Table 7.

9.5.2 OIT shall comply with Clause 3.2.4 of this Appendix.

9.6 The following information shall be provided by the pipe or fittings manufacturer for each product batch (pricing information may be redacted) for desktop audit:

- Material producer's invoice showing invoice date
- Material producer's packing list showing delivery date
- Address and contact details of the material producer
- Quantity of compound supplied to the pipe or fittings manufacturer
- Material producer's batch number(s) on the invoice/packing list shall match with the compound's batch number(s) on the pipe batch inspection reports.

The pipe manufacturer shall demonstrate using the batch inspection reports that the quantity of compound used in the manufacture of the pipes being inspected is less than the quantity of compound indicated in the invoice/packing list.

The Engineer reserves the right to contact the material producer directly to confirm the details of the compound supplied to the pipe or fittings manufacturer and may send the material producer samples from the site to confirm that the material supplied matches the submission.

10. **Transport, handling and storage**

10.1 General

Pipes and fittings shall not be dropped, indented, crushed or impacted. Pipes and fittings shall not be stored or transported where they are exposed to heat sources exceeding 70°C. PE pipes and fittings shall not be exposed to lubricating or hydraulic oils, petrol or any other hydrocarbon source.

Pipes with scores or scratches to a depth of $\geq 10\%$ of the wall thickness on the outside of the pipe shall be rejected and cut out or not used in pressure applications. Pipes with any visible scoring on the inside of the pipe shall be rejected.

10.2 Lifting and Handling

PE pipes and fittings shall not be subjected to rough handling during loading, unloading or installation. For lifting of PE pipes by crane, only webbing slings shall be used. Under no circumstances should chains, wire ropes and hooks be used to handle PE pipes.

10.3 Storage and Transport

Pipes of colours other than black shall be protected from direct sunlight during storage if they are to be stored outside for more than 6 months.

Pipes shall not be stored directly on the ground or the bed of a truck, horizontal supports with bearing width of at least 75mm at spacing of not more than 1.5m shall be used between the pipe and any surface it is stored on.

Pipes shall be stacked and transported by pyramid stacking the pipes together. Full length contact shall be provided between stacked pipes. Larger pipes shall be stored at the bottom of the stack.

Pipes may be placed inside each other for transport or storage provided distortion does not occur. When being transported or stored, pipes shall not be restrained in a manner likely to result in damage or distortion to the pipes. Electrofusion fittings shall be stored under cover in cartons and kept in dry conditions. All PE fittings shall be kept sealed in their factory packaging until use.

11. **Sampling and Testing of PE Pipes and Fittings Delivered to Site**

11.1 For each product batch of pipes delivered to site, one random sample of pipe shall be selected by the Engineer for further testing with the following requirements:

11.1.1 Slow crack growth resistance

The slow crack growth resistance of the pipe sample shall conform to the following requirement:

A correlated (2NCT) creep test performed under ACT test conditions where three specimens from one sample shall be tested in accordance with PAS 1075:2009-04 Table 4, No.1 and shall conform to the requirement that no failure shall occur during the test period of 160 hours. In addition to PS Clause 22.10(3)(b), the laboratory performing such ACT testing shall be accredited in accordance with ISO/IEC 17025 and their scope of accreditation shall include testing to PAS1075: 2009-04 and BS EN 12814-3: 2014. In case the result of ACT test does not comply with the specified requirement for the test, the Contractor may arrange for the Engineer to select another sample from the same batch for retesting by the same laboratory using the test method stated in Clause 4.9.2.1 of this Appendix. If the result of the retest using the method stated in Clause 4.9.2.1 of this Appendix complies with the specified requirement for the test, then the requirement for slow crack growth resistance under this Clause is deemed to be satisfied.

11.1.2 Pigment dispersion (for purple pipes only)

The test shall conform to the requirement in BS EN 12201-1 Table 1.

- 11.2 For the fittings delivered to site, the fittings shall be grouped into three groups as given in **Table 22.09-10**, and one random sample shall be selected by the Engineer from each fitting group for further testing with the following requirements:

11.2.1 Slow crack growth resistance

Test samples shall be taken from the spigot in first preference or alternatively from the fitting body, and slow crack growth resistance, when tested using the two notch creep test in accordance with EN 12814-3 at 4 MPa tensile stress applied while immersed in a 2% Arkopal N-100 solution at 80°C, shall conform to the requirement that no failure shall occur during the test period of 1000 hours.

11.2.2 Oxygen induction time (for moulded fittings only)

The oxygen induction time shall conform to the requirement of Clause 3.2.4 of this Appendix

11.2.3 Butt weld non-destructive Test (fabricated fittings only)

Where the fabricated fitting containing one or more butt welds, excluding bends fabricated in accordance with Clause 5.5.4 of this Appendix, is supplied under this Contract, all external weld beads on each fabricated fitting shall be removed where practicable and the bead non-destructively tested in accordance with PS Clause 22.16(2).

11.2.4 Swept bend wall thickness

Where swept bends are supplied under this Contract, the minimum thickness at any point on the bend (specifically the outer radius) shall be determined using non-destructive ultrasonic thickness measuring equipment in accordance with BS EN 14127:2011 at a rate of one randomly selected fitting per batch.

Table 22.09-10 – Groups of Fittings

<u>Fitting group</u>	<u>Fitting Type</u>	<u>Format of the fitting to be sent for site testing</u>
(a)	Electrofusion socket fittings	One complete EF socket fitting
(b)	Injection-moulded spigot end fittings	For sizes < OD 250 one complete spigot end fitting For sizes ≥ OD 250 a spigot cut from the fitting ^(Note 1)
(c)	Fabricated spigot fittings	For sizes < OD 250 one complete fabricated fitting

		For sizes \geq OD 250 a spigot cut from the fitting ^(Note 1)
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Note 1: The spigot shall be cut from the fitting under witness of the Engineer who shall write the human readable 26 digits from the fitting bar code sticker onto the spigot and place his signature and name on the spigot before it is sent for testing.

- 11.3 Tests shall be carried out by an independent laboratory meeting the requirements of PS Clause 22.10(3)(b) and approved by the Engineer.
- 11.4 The selected samples of pipes $>$ DN/OD 75 and all fitting sizes sent for testing shall include a complete barcode with the human readable number below the barcode to enable identification of the pipes or fittings being tested as given in Clause 6.2 and 6.4 of this Appendix respectively.
- 11.5 Reports for testing of pipes and fittings required in Clauses 11.1 and 11.2 of this Appendix shall include photographs of each sample being tested. For pipe sizes $>$ DN/OD 75 and all fitting sizes, the human readable number below the barcode shall be legible to enable identification from the photograph in the report of each sample being tested.
- 11.6 Steel backing ring testing shall comprise one random sample selected by the Engineer for each size and shall be tested according to the following requirements:
- | <u>Test</u> | <u>Complying with</u> |
|---------------------------|----------------------------------|
| Coating thickness testing | Clause 5.10.2.1 of this Appendix |
| Coating adhesion testing | WIS 4-52-01 Appendix D |
- 11.7 Test reports shall be sent directly from the laboratory to the Engineer.
- 11.8 If the result of any one or both tests stated in Clauses 11.1.1 and 11.1.2 of this Appendix does not comply with the specified requirements for the test, one additional sample from the same product batch and one sample from each of the other product batches of pipes shall be selected by the Engineer, and additional tests for both slow crack growth and pigment dispersion (for purple pipes only) shall be carried out on the selected samples. A product batch shall be considered as not complying with the specified requirements if the result of any additional test on that product batch does not comply with such requirements.
- 11.9 If the result of any one or both tests stated in Clause 11.2.1 and 11.2.2 of this Appendix for any fitting group does not comply with the specified requirements for the test, one additional sample from every product batch of fittings shall be selected by the Engineer, and additional tests for both slow crack growth and oxygen induction time shall be carried out on the selected samples. All product batches shall be considered as complying with the specified requirements if the results of all additional tests comply with such requirements. A product batch shall be considered as not complying with the specified requirements if the result of any additional test on the sample from that product batch does not comply with such requirements.

- 11.10 If the result of the butt weld non-destructive test stated in Clause 11.2.3 of this Appendix on a particular fabricated fitting does not comply with the specified requirements for the test, that fabricated fitting shall be considered as a non-compliant product.
- 11.11 If the result of the wall thickness test stated in Clause 11.2.4 of this Appendix on a particular swept bend does not comply with the specified requirements, that swept bend shall be considered as a non-compliant product. Subsequent to this failure, all swept bends from each batch shall be tested in accordance with Clause 11.2.4 of this Appendix and any swept bend which does not comply with the specified requirements shall be considered as a non-compliant product.
- 11.12 If the result of any test stated in Clause 11.6 of this Appendix does not comply with the specified requirements for the test, one additional sample from the same batch size and one sample from each size of backing ring from all other batches shall be selected by the Engineer, and additional tests for all the tests specified in Clause 11.6 of this Appendix shall be carried out on the selected samples. The batch shall be considered as not complying with the specified requirements if the result of any additional test on that batch size does not comply with such requirements.
- 11.13 If a batch of pipes or fittings is considered as non-compliant with the specified requirements as stated in Clauses 11.8 and 11.9 of this Appendix, the whole product batch including all the delivered and undelivered pipes or fittings is considered as non-compliant products. For any non-compliant product or product batch stated in Clause 11.8 to 11.12 of this Appendix, the Contractor shall propose corrective actions for the approval of the Engineer, including details of the identification and disposal or return to the supplier of the condemned product or product batches, or details of the replacement of the non-compliant product. The non-compliant product or product batch shall not be sold, supplied or used in any other WSD contracts.
- 11.14 All costs and expenses incurred in connection with the testing and inspection stated in Clause 11 of this Appendix including delivery costs, additional tests and removal of non-compliant pipes and fittings, shall be deemed to have been included in the rates given in the Bill of Quantities and the Contractor shall not be entitled to any additional payment in fulfilling these requirements.

Type Test Requirements for Purple Compound

Type testing requirements shall be undertaken using purple compound and pipe samples made only from purple compound, except for cohesive strength test (see note g below) and shall comply with the following table. An independent laboratory meeting the requirements of PS Clause 22.10(3)(b) shall issue such type test certificates.

Characteristic	Test Requirement Reference	Sampling procedure – PD CEN/TS 12201-7
Compound density	BS EN 12201-1 Clause 4.4.1	3 samples / compound
Oxidation induction time (thermal stability) (OIT)	BS EN 12201-1 Clause 4.4.1	3 samples / compound
Melt mass-flow rate (MFR)	BS EN 12201-1 Clause 4.4.1	3 samples / compound
Volatile content	BS EN 12201-1 Clause 4.4.1	1 sample / compound
Water content ^a	BS EN 12201-1 Clause 4.4.1	1 sample / compound
Pigment colour	Clauses 1.2 and 1.3 of this Appendix	1 pipe sample / visual comparison
Pigment dispersion ^b	BS EN 12201-1 Clause 4.4.1	1 sample / compound
Resistance to weathering ^c	BS EN 12201-1 Clause 4.4.2	Once / compound
Determination of the failure mode in a tensile test on a butt fusion weld (DN/OD 110 SDR 11)	BS EN 12201-1 Clause 4.5.1	3 samples / compound
	BS EN 12201-1 Clause 4.5.2	3 samples / compound
Cohesive strength of electrofusion saddle fittings	BS EN 12201-3 Clause 7.3, and BS EN 12201--5:2011, Clause 4.2.3.1	1 sample of a $d_n \geq 32$ mm electrofusion saddle fused to a purple pipe with DN/OD 125 mm & SDR 11
Hydrostatic strength performance at 20°C	BS EN 12201-2 Clause 7.2	Pipe - See footnotes ^d
Hydrostatic strength performance at 80°C	BS EN 12201-2 Clause 7.2	Pipe - See footnotes ^e
Resistance to slow crack growth (DN/OD 110 SDR 11)	FNCT test ≥ 8760 hours (or equivalent ACT correlated result ≥ 320 hours) ^f , refer to PAS 1075-4:2009-04, Table 2, test No.1	3 samples / compound

^a Only applicable if the requirement for volatile content is not conformed to. In case of dispute the requirement for water content shall apply.

^b Only applicable for non-black compound.

^c Three pieces for elongation at break / three pieces for hydrostatic strength / one sample for decohesion of an electrofusion joint.

^d Check two stress levels at 20 °C: 12 MPa / 200 hrs and 11.1 MPa / 2500 hrs. Test three test pieces at each stress level on size group 1 pipe in accordance with PD CEN/TS 12201-7:2014, A.2.4.1. The times shall be exceeded without failure.

^e Check two stress levels at 80 °C: 5.4 MPa / 165 hrs and 4.9 MPa / 2500 hrs. Test three test pieces at each stress level on size group 1 pipe in accordance with PD CEN/TS 12201-7:2014, A.2.4.1. The times shall be exceeded without failure.

^f Testing laboratory shall be accredited in accordance with ISO/IEC 17025 and their scope of accreditation shall include testing to PAS1075: 2009-04 and BS EN 12814-3: 2014

^g Cohesive strength testing may be conducted on co-extruded pipes.