

**SPECIFICATION FOR POLYETHYLENE PIPES AND FITTINGS**  
**FOR WASTE WATER PRESSURE RISING MAINS & GRAVITY DRAINAGE**

**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
- BS EN 12666-1

PE pipes shall conform to the requirements of BS EN 12201-2. PE fittings for pressure applications (> 0.5bar), including electrofusion socket fittings for both pressure and non-pressure applications, shall comply with BS EN 12201-3. Other fittings for non-pressure applications shall comply with either BS EN 12201-3 or BS EN 12666-1.

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 5A-1**

**Table 5A-1**

<b>Application</b>	<b>Colour</b>	<b>BS 4901 Colour</b>	<b>RAL Code</b>
Pipe and fittings installed above & below ground	Black	00E53	9011
Stripe colour for sewer pipes	Red brown	06C39	8012
Stripe colour for Stormwater pipes	Fern green	12D45	6025
Inner CCTV colour layer for pipes	Orange	08E55	2003

1.3 Not used.

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 5A-2** shall be used.

**Table 5A-2**

<b>Nominal Size (DN/OD) / Nominal Outside Diameter (<math>d_n</math>)</b>	<b>Equivalent Size in DN / ID</b>
110	100
160	150
225	200
250	225

<b>Nominal Size (DN/OD) / Nominal Outside Diameter (d<sub>n</sub>)</b>	<b>Equivalent Size in DN / ID</b>
280	250
355	300
400	375
450	400
500	450
560	500
630	525
710	600
800	675
900	825
1000	900
1200	1050
1400	1200
1600	1350
1800	1650
2000	1800

1.6 not used.

## 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 reprocessable 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 Black compounds shall meet the requirements of BS EN 12201-1 Tables 1 and 2, Orange compounds shall meet the requirements of BS EN 1555-1, Tables 1 and 2. Black and Orange compounds shall meet the additional requirements in Clauses 1.2, 3.2 to 3.7, 3.9 and 3.10 of this Appendix. BS EN 12201-1 Table 2, Effect on water quality, is not required.
- 3.1.5 Red brown and fern green striping compounds required in **Table 5A-1** 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 red brown or fern green colour as specified in **Table 5A-1**
- 3.1.5.3 Not used
- 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:

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- 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  $\geq 0.20$  g/10 minutes and  $\leq 0.40$  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  $\geq 0.20$  g/10 minutes and  $\leq 0.58$  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  $\geq 947$  kg/m<sup>3</sup>.
- 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  $\geq 40$  minutes, or when tested in the form of granules in accordance with BS EN ISO 11357-6 at 210°C, shall be  $\geq 20$  minutes.
- 3.3 Black and orange compounds 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 for black and Table 2 of BS EN 1555-1 for orange 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.

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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 manufacturer of compounds other than for red brown and fern green coloured stripe 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 red brown and fern green coloured stripe compound shall submit 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 red brown and fern green coloured compound, 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 For pressure applications the nominal pressure (PN) rating of pipes shall be as stated in the schedule of quantities but shall not be < PN8. For non-pressure applications, the initial ring stiffness (SN) rating of pipes shall be as stated in the schedule of quantities but shall not be < SN12. Pipes shall be selected in accordance with **Table 5A-2** for nominal size and BS EN 12201-2, Table 2 for PN ratings or BS EN 12201-2 Annex D, Table D.1 for SN ratings.

- 4.2.1 PE pressure pipe and fittings installed above ground shall be de-rated according to **Table 5A-3** after considering the mean pipe temperature (average of the maximum expected inside & outside surface temperatures of the pipe when in service), as a guide;

Non-exposed application: Pipe and fittings installed above ground not exposed to direct sunlight (approximate mean pipe  $t^{\circ} \leq 35^{\circ}\text{C}$ )

Exposed application: Pipe and fittings installed above ground and exposed to direct sunlight (approximate mean pipe  $t^{\circ} \leq 55^{\circ}\text{C}$ )

**Table 5A-3**

<b>PN used for buried pipe</b>	<b>De-rated PN (Bar) used for non-exposed pipe</b>	<b>De-rated PN to be used for exposed pipe</b>
$\leq$ PN 10	$\leq$ PN 12.5	$\leq$ PN 16
$\leq$ PN 12.5	$\leq$ PN 16	$\leq$ PN 20
$\leq$ PN 16	$\leq$ PN 20	$\leq$ PN 25

Where a combination of different PN ratings are used in the same pipeline to accommodate temperature de-rating or for any other reason, the internal transition from the thicker wall section pipe to the thinner pipe shall be tapered  $\leq 45^{\circ}$  when jointing by either electrofusion or butt-welding.

- 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  $23^{\circ}\text{C}$ . 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 black. The colour of pipe stripes and CCTV inner layer shall be in accordance with **Table 5A-1**.
- 4.7 Pipes DN/OD  $\leq$ 800 and larger sizes if required by the engineer, shall have in internal co-extruded Orange colour layer to assist CCTV inspection 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 The inner co-extruded layer shall be even around the entire circumference, the thickness of the inner co-extruded layer shall be  $(15 \pm 1.5)$  % of the nominal wall thickness at any point when the pipe is cut & inspected.
- 4.7.3 External indication colour striping shall be used to identify the pipes use. Striping compounds shall meet the requirements of clauses 3.1 & 3.2 of this appendix. Clause 4.3 of BS EN 12201-1 requiring compounds to be black or blue in colour shall not apply to striping compounds.
- Un-pigmented compound of the same base polymer and brand name as the compound used for pipe manufacture shall be used as the base

compound for indication striping. This striping compound shall be pigmented by a compounder in accordance with clause 2.1.3 of this appendix.

Striping colours given in **Table 5A-1** shall apply for the following pipeline applications:

Sewerage rising main:	pairs of red brown stripes
Stormwater rising main:	pairs of fern green stripes
Sewerage gravity drainage:	red brown stripes
Stormwater gravity drainage:	fern green stripes

4.7.4 Indication stripe width and configuration shall be as follows:

≥ 6 single stripes for gravity or ≥ 6 pairs of stripes for pressure, 6-24mm wide equispaced around the circumference

4.8 Length of pipes shall be nominally 6.0 m or 12.0m +50 / -250mm supplied in straight lengths. 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 17 pipes supplied by the supplier and a sample of DN/OD 160 SDR 17 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,
- 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 for pressure or non-pressure applications or BS EN 12666-1 for non-pressure applications and the requirements stipulated in Clause 5 of this Appendix, and shall be manufactured from compounds complying with Clause 3 of this Appendix.

Where the difference between the internal diameters of pipes or spigot fittings being joined where  $(ID_{\max} / ID_{\min}) - 1 = \geq 5\%$ , a transition fitting or internal taper with an angle  $\leq 30^{\circ}$  to the pipe axis shall be used.

- 5.2 Fittings for pressure use shall have a PN rating and fittings for gravity use shall have a SN rating. The PN or SN rating of all fittings shall be the same as, or higher than the nominal rating of the connecting pipes. The fittings shall be supplied with complete set of accessories including joint rings, flange gaskets, studs, bolts and nuts, etc. as appropriate.
- 5.3 The colour of PE fittings shall be in accordance with **Table 5A-1**.
- 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 Not used.
- 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 for pressure applications shall be either injection moulded as defined in clause 2.1.3, fabricated as defined in clause 5.5.7. Swept or segmented bends shall be manufactured from pipe complying with Clause 4 of this Appendix, with a 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 for pressure applications. 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.

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- 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 elbows and electrofusion repair patches and pressure saddles shall comply with BS EN 12201-3. Non-pressure electrofusion fittings, including intake saddles and manhole chamber connectors shall comply with either BS EN 12201-3 or BS EN 12666-1.
- 5.6.2 All electrofusion socket fittings with sizes DN/OD  $\leq$  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 'L<sub>2</sub>' 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 5A-4**, where L<sub>2, min</sub> is given in BS EN 12201-3 Table 1.

**Table 5A-4**

Nominal diameter of the fitting d <sub>n</sub> (mm)	Minimum fusion zone length for electrofusion sockets ≥ SDR 11 (mm)	Minimum fusion zone length for electrofusion sockets < SDR 11 (mm)
≤ 355	≥ 1.8 x L <sub>2, min</sub>	≥ 1.5 x L <sub>2, min</sub>
> 355, ≤ 800	≥ 1.6 x L <sub>2, min</sub>	≥ 1.5 x L <sub>2, min</sub>
> 800	≥ 2 x t <sub>min</sub>	≥ 2 x t <sub>min</sub>

*t<sub>min</sub> is the pipe minimum pipe wall thickness according to BS EN 12201-2 Table 3*

- 5.6.5 Outer cold zone length 'L<sub>3</sub>' as shown in BS EN 12201-3: Figure 1, shall comply with the dimensions stated in **Table 5A-5**:

**Table 5A-5**

Nominal diameter of the fitting d <sub>n</sub> (mm)	Minimum outer cold zone length 'L <sub>3</sub> ' (mm)
≤ 125	≥ 15.0
125 – 180	≥ 20.0
250 – 355	≥ 25.0
450 – 630	≥ 30.0
710 – 800	≥ 40.0
> 800	≥ 70.0

- 5.6.6 Internal diameter of the fusion zone in electrofusion socket fittings shall comply with the dimensions stated in **Table 5A-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 5A-6**

Nominal size of electrofusion socket DN/OD (mm)	Maximum Internal diameter D <sub>1</sub> (mm)
≤ 125	≤ d <sub>n</sub> + 1.0
> 125 - ≤ 250	≤ d <sub>n</sub> + 1.8
> 250 - ≤ 355	≤ d <sub>n</sub> + 2.3
> 355 - ≤ 710	≤ d <sub>n</sub> + 3.0
> 710	≤ d <sub>n</sub> + 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 in sizes  $\leq$  DN/OD 900. For fittings  $\geq$  DN/OD 900, only the manufacturers recommended fusing equipment shall be used.
- 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 5A-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 Manhole / Chamber Connectors

Rigid manhole chamber connectors (Type B) shall be manufactured in accordance with clause 5.10.3 of this appendix, with the following additional requirement that the length of one spigot dimension 'L2' which terminates in the chamber shall be 0 mm.

Flexible manhole chamber connectors (Type A) shall be made of two components; a cast in ring for the chamber wall and a matching push in spigot connecting to the pipe. Connectors shall comply with the following requirements;

- 5.7.1 Components shall be manufactured from compounds complying with clause 3.4 and 3.6 of this appendix and each shall be moulded or fabricated from a single piece of PE. No welds or joints shall be permitted in the construction of manhole chamber connectors.
- 5.7.2 Manhole connectors shall have two elastomeric sealing rings of either: NBR, SBR or nitrile, complying with EN 681 and a Hydrophilic vulcanized expansive rubber sealing ring between them. Groove dimensions shall be in accordance with the ring manufacturers recommendations to achieve a seal at 0.5 bar test pressure.
- 5.7.3 Assembled joints shall be type tested to be leak tight at 0.5bar. Type testing shall be conducted in accordance with BS EN 12666-1 and for guidance CEN-TS 12666-2 Table 5. The assembly of the joint prior to testing shall be independently witnessed.
- 5.7.4 Flexible manhole connectors installed above ground shall be used in conjunction with a puddle flange from section 5.10.3 when connecting to PE pipe to prevent thermal forces acting on the chamber wall & manhole connector.
- 5.7.5 The dimensions of the manhole connectors shall be as required to meet the test requirements in clause 5.7.3. The fitting dimensions shall allow the spigot to be inserted into the cast in ring during on site assembly without requiring excessive force. A non-petroleum based lubricant such as a liquid soap may be used to assist assembly, no lubricant shall interfere with the Hydrophilic seal function.
- 5.7.6 Alternate products designed for achieving the same type of connection complying with the principals above may be considered by the engineer.

## 5.8 **Non-Pressure fittings**

The following requirements shall apply to fittings used only in non-pressure applications. (Operating pressure  $\leq$  PN 0.5).

- 5.8.1 PE fittings shall comply with either BS EN 12201-3 or BS EN 12666-1 and shall be manufactured from compounds complying with clause 3.4 and 3.6 of this specification. The fittings shall have a SN rating  $\geq$  to that of the pipe they are connecting to.
- 5.8.2 Notwithstanding clause 5.3, Light coloured moulded fittings to assist CCTV inspection, where installed below ground or not exposed to UV, may be considered by the engineer where they meet the requirements of section 3.4 and the relevant parts of sections 5 of this specification applicable to the fitting under consideration. Blue fittings indicating potable water or Orange fittings, indicating gas, shall not be used.

5.8.3 Bends used in non-pressure applications shall be manufactured from pipe which meets the requirements clause 4 of this appendix and have a SN rating  $\geq$  of the pipe it is connecting to and shall be manufactured in accordance with the following:

5.8.3.1 Bends DN/OD  $\leq$  500 shall be swept bends fabricated in accordance with BS EN 12201-3 Annex B.4 with the exception that the minimum wall thickness of a swept pipe bend after bending shall be  $\geq$  0.93 x the minimum thickness of the pipe required in EN 12201-2.

5.8.3.2 Bends DN/OD  $>$  500 shall be swept bends fabricated in accordance with clause 5.8.3.1 or segmented bends fabricated in accordance with BS EN 12201-3 Annex B.3 and clause 5.8.4 of this appendix.

5.8.4 Swept and fabricated bends used in non-pressure applications shall have a radius of curvature to the centreline of the bend as given in **Table 5A-7**. The number of segments for fabricated bends shall be as given in **Table 5A-7**.

**Table 5A-7**

Angle	Radius	Number of segments in fabricated bends $>$ 500 DN/OD
$\leq 22^\circ$	$r \geq 4 \times \text{pipe DN/OD}$	$\geq 3$
$> 22^\circ - \leq 45^\circ$	$r \geq 7 \times \text{pipe DN/OD}$	$\geq 4$
$> 45^\circ$	$r \geq 10 \times \text{pipe DN/OD}$	$\geq 6$

5.8.5 Notwithstanding clause 5.8.4, bends used for vertical drops may have a radius  $<$  4 x pipe DN/OD. The engineer may require such bends to include a rodding point and cap for access.

5.8.6 Minimum allowable installed radius for bends made by cold deforming straight PE pipe during installation, shall be made in accordance with **Table 5A-8**.

**Table 5A-8**

Pipe SDR	PE pipe bending radius
SDR 21	$\geq 28 \times \text{DN/OD}$
SDR 17	$\geq 27 \times \text{DN/OD}$
SDR 13.6	$\geq 25 \times \text{DN/OD}$
SDR 11	$\geq 25 \times \text{DN/OD}$
SDR 9	$\geq 20 \times \text{DN/OD}$

The heating of PE pipes or hot bending of pipe on site is prohibited

5.8.7 Electrofusion connection intake saddles shall be fused in accordance with the manufactures instructions and prepared in accordance the following requirements; The intake entry hole into the main way shall be drilled through the saddle only after the fusion cooling time is complete. The hole shall be cut post fusion using the cutter

recommended by the fitting manufacture and shall form a smooth transition between the connecting pipe and the main way pipe. Cut out coupons for each connection shall be retained and each held for inspection by the engineer to confirm the requirements have been met.

5.8.8 Fabricated connection intakes shall be fabricated from pipe complying with section 4 of this specification and in accordance with BS EN 12201-3 Annex B.5 and shall comply with clauses 5.2 & 5.4 of this specification.

5.8.9 Transition fittings for the connection of other pipe materials to PE shall be manufactured from compound complying with clause 3.4 of this specification and comply with BS EN 12666-1. Where the actual inside diameter differential between the two connecting materials is  $\geq 5\%$ , the transition shall be eccentric in design to maintain a level invert to the connecting material.

5.8.9.1 Socket transition fittings made in Polyethylene to connect to the spigot end or pipe of another material by rubber ring joint, shall have a sealing ring manufactured from SBR, Nitrile or NBR complying with EN 681-1.

5.8.9.2 Spigot transition fittings made in Polyethylene to connect to another pipe materials socket end by rubber ring joint shall be dimensioned to suit the sealing ring supplied with the socket.

5.8.10 Stainless steel saddle intakes or repair clamps may be used with the approval of the engineer. Saddles shall be manufactured from material complying with BS EN 10088-2 grade X5 CrNiMo17-12-2 (316SS) and shall have a gasket covering the entire saddle surface manufactured from SBR, Nitrile or NBR material.

Fasteners on such saddles shall be 316 stainless steel, grade A4-70, complying with BS EN ISO 3506. The thread of the bolt shall be pre-coated with a high-pressure dry lubricant such as 'molybond' or equivalent to prevent cold welding of the nut & bolt during tightening (Oil or grease shall not be used).

## 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 300 $\mu$ m. The coating material shall meet the performance requirements of WIS 4-52-



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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.
- 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' or an alternative flange standard and PN rating specified by the Engineer.

## 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 5A-2** of this Appendix.

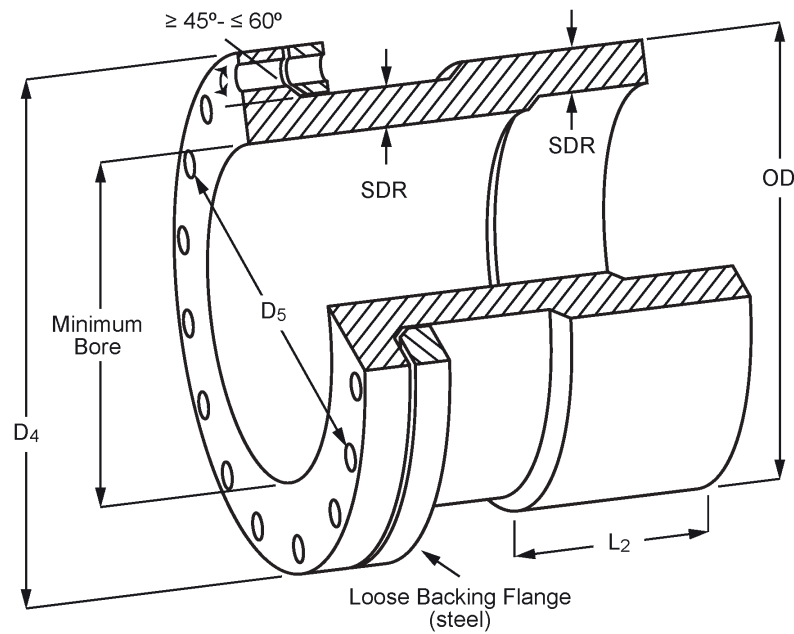
5.10.1.2 For  $DN/OD \leq 180$  mm, the flange adaptor head OD, 'D4' as shown in ISO 9624 Figure 2, shall be as given in ISO 9624 Table 3. The flange adaptor shank OD, 'D5' as shown in ISO 9624 Figure 2, shall be as given in ISO 9624 Table 3, with the exception that the flange adaptor shank OD shall 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 5A-1** of this Appendix. The design shown in **Figure 5A-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 diameters to fit over the hex head to tighten or loosen the fasteners.

**Figure 5A-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 / 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 5A-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 not used

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 5A-2** of this Appendix. The loose backing flanges shall have dimensions conforming to **Table 5A-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 'B<sub>1</sub>' which shall comply with Table 5A-7 of this Appendix. The thickness of the flange shall be in accordance with BS EN 1092-1 Table 13 'C<sub>1</sub>'.

- 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 5A-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  $< 5000\text{MPa}$ .
- Dimensions given in **Table 5A-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 5A-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 5A-9 – Dimensions of loose backing flanges**

<b>DN (mm)</b>	<b>Nominal Size OD / dn (mm)</b>	<b>Minimum flange outside diameter D (mm)</b>	<b>Maximum flange bore (B1) or internal diameter (mm)</b>
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.

5.10.3 Puddle flanges supplied under this contract shall be fabricated or injection-moulded and shall meet the following requirements:

5.10.3.1 Fabricated puddle flanges shall be machined from a single piece of homogeneous PE. No welds or joints shall be permitted on

the puddle flange ring 'W' or within the body of the puddle flange between the transitions ' $\geq 2xW$ '.

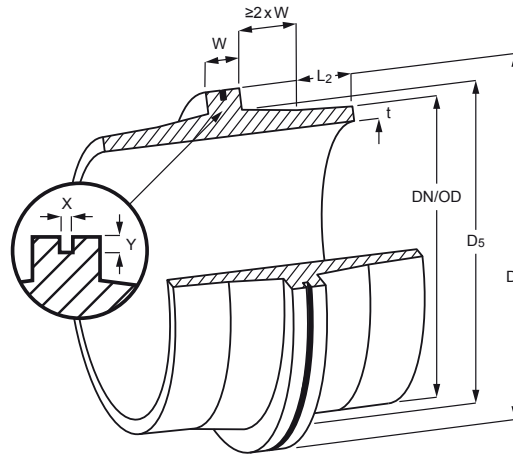
5.10.3.2 Dimensions of puddle flanges  $\leq$  DN/OD 800 as shown in **Figure 5A-2** shall comply with the following:

- OD of the puddle flange ring, 'D4' shall be  $\geq 1.25 \times$  DN/OD of the connecting pipe.
- Width of the puddle flange ring, 'W' shall be  $\geq 1.25 \times$  't', but not less than 20mm wide.
- Transition between the puddle flange ring and the spigot shall be tapered on both sides of the ring. The OD of the taper 'D5' shall be as given in ISO 9624 Table 3, dimension 'D5'. The length of the taper shall be  $\geq 2 \times$  dimension 'W'.
- Thickness of the fusion ends, 't' shall be equal to the wall thickness of the connecting pipes as given in BS EN 12201-2 Table 2.
- Length of the spigot ' $l_{e,min}$ ', shall be in accordance with BS EN 12201-3 Table B2.
- Sizes  $>$  DN/OD 800 the Contractor shall submit the design of puddle flanges to the Engineer for approval.

5.10.3.3 Hydrophilic vulcanized expansive rubber sealing ring shall be fitted into a machined external groove on the circumference of the puddle flange ring 'W' and shall meet the following requirements:

- The machined external groove dimensions and the hydrophilic sealing ring cross sectional area shall be as given in **Table 5A-10**. The design shown in **Figure 5A-2** is typical only.
- The expansion rate of the sealing ring after 48 hours when tested in accordance with ASTM D471 shall be  $\geq 600\%$  of its original cross sectional area.
- The hydrophilic ring shall not protrude above the machined groove at any time before the puddle flange is surrounded by concrete on site. Hydrophilic rings which have protruded above the groove dimensions given in Table 5-4 shall be removed and replaced with a new sealing ring.
- The hydrophilic rings shall be securely fitted into the groove in the puddle flange such that it cannot become detached. The hydrophilic sealing ring shall be sealed from the atmosphere by a sealing tape to protect it from moisture. The sealing tape shall be clearly marked continuously along its length stating it shall be removed only immediately prior to casting the puddle flange in concrete.

**Figure 5A-2** Dimensions of puddle flange



**Table 5A-10** – Dimensions of sealing ring and groove

PE Nominal Size DN/OD / $d_n$ (mm)	Minimum sealing ring groove dimensions $X \times Y$ (mm)	Minimum sealing ring cross sectional area ( $mm^2$ )
110	9 x 10	50
125	9 x 10	50
180	9 x 10	50
250	9 x 10	50
315	9 x 10	50
355	9 x 10	50
450	21 x 7	100
500	21 x 7	100
560	21 x 7	100
630	21 x 7	100
710	21 x 7	100
800	21 x 12	200
900	21 x 12	200
1000	21 x 12	200
1200	21 x 12	200
1400	21 x 12	200
1600	21 x 12	200
1800	21 x 12	200
2000	21 x 12	200

- 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 pressure fittings in accordance with the requirements given in Table 5 of PD

CEN/TS 12201-7 and for non-pressure fittings in accordance with the requirements given in Table 4 of PD CEN-TS 12666-2.

- 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 pressure fittings in accordance with the requirements given in Table 13 of PD CEN/TS 12201-7 and non-pressure fittings in accordance with the requirements given in Table 9 of PD CEN-TS 12666-2.
- 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 5A-11**:

**Table 5A-11**

<b>Pipe DN/OD</b>	<b>Text height</b>	<b>Marking repeating each metre of pipe</b>	<b>Bar codes repeating each meter of pipe</b>	<b>DSD Logo quantity and height</b>
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 pressure 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  $\leq 63$  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 Not used.
  - 8.1.8 Not used.

- 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

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- 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 numbers(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 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 Not used

- 11.2 For the fittings delivered to site, the fittings shall be grouped into three groups as given in **Table 5A-12**, 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 5A-12 – 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 <sup>(Note 1)</sup>
(c)	Fabricated spigot fittings	For sizes < OD 250 one complete fabricated fitting For sizes ≥ OD 250 a spigot cut from the fitting <sup>(Note 1)</sup>

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 DSD 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

DSD PS Appendix 5A (WSD PS Appendix 22.09 - clause for clause match)

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.

Annex 1 – Not used.