SPECIFICATION FOR STEEL PIPES, FITTINGS AND JOINTS FOR WATER AND SEWAGE - Part 1: Technical delivery requirements
9.2 Location, orientation and preparation of samples and test pieces................................. 18
10. Test methods................................................................................................................. 20
10.1 Chemical analysis.................................................................................................... 20
10.2 Mechanical tests..................................................................................................... 20
10.3 Leak tightness test................................................................................................. 20
10.4 Non destructive testing of the welds of fittings.................................................... 20
10.5 Visual examination.................................................................................................. 20
10.6 Dimensional inspection.......................................................................................... 20
11. Retests, sorting and reprocessing.............................................................................. 21
12. Marking....................................................................................................................... 21
13. The corrosion protection requirement ...................................................................... 21
14. Effect of non-metallic products on water quality ..................................................... 21
15. Types of joints .......................................................................................................... 22
15.1 General.................................................................................................................... 22
15.2 Sleeve joints for welding........................................................................................ 22
15.3 Flange joints.......................................................................................................... 25
15.4 Slip-on type couplings.......................................................................................... 27
15.5 Push fit and gasket type couplings....................................................................... 28
15.6 Special joints.......................................................................................................... 29
16. Protection against corrosion...................................................................................... 30
16.1 General.................................................................................................................... 30
16.2 Surface preparation................................................................................................ 30
16.3 Coatings and linings.............................................................................................. 31
16.4 External protection.................................................................................................. 31
16.5 Internal protection................................................................................................... 32
16.6 Tests on applied external and internal protections.............................................. 33
16.7 Concrete lining and cement mortar lining.............................................................. 34
16.8 Stop Back of protection at ends ............................................................................ 37
16.9 Completion of protections at joints ....................................................................... 37
16.10 Protection of coated and lined pipes against damage in storage, transport and handling 38

Appendix A Electrical test for continuity....................................................................... 39
COMMITTEE REPRESENTATION

The System, Product, Material and Research & Development Committee of National Water Services Commission (SPAN) consist of representatives from the following organizations:

Suruhanjaya Perkhidmatan Air Negara (SPAN)
Public Works Department (PWD / JKR)
Ministry of Science Technology and Innovation (MOSTI)
Jabatan Bekalan Air, KeTTHA (JBA)
Jabatan Perkhidmatan Pembetungan, KeTTHA (JPP)
Department of Standard Malaysia (DSM)

The Working Group on steel pipes, fittings and joints for water and sewage which developed this SPAN Technical Specification consist of representatives from the following organizations:

Suruhanjaya Perkhidmatan Air Negara (SPAN)
Public Works Department (PWD / JKR)
IKRAM QA Services Sdn. Bhd.
SIRIM QAS International Sdn. Bhd.
The Institution of Engineers, Malaysia (IEM)
Association of Consulting Engineers Malaysia (ACEM)
Malaysian Iron and Steel Industry Federation (MISIF)
Syarikat Bekalan Air Selangor Sdn. Bhd. (SYABAS)
SAJ Holdings Sdn. Bhd.
Lembaga Air Perak
PPI Industries Sdn. Bhd.
FOREWORD

This SPAN Technical Specification was developed by the Working Group of Steel Pipes, Fittings and Joints for Water and Sewage under the authority of System, Product, Material and Research & Development Committee of National Water Services Commission (SPAN).

This specification is adapted and improved from the following standards:-


ii) BS 534 : 1990 - Steel Pipes, Joints and Specials for Water and Sewage.

Compliance with a SPAN Technical Specification does not of itself confer immunity from legal obligations.
Specification for steel pipes, fittings and joints for water and sewage

1 Scope

This SPAN Technical Specification specifies requirements for seamless and welded carbon steel pipes, fittings and joints in respects of the pipe end preparation, in sizes 60.3 mm to 2743 mm outside diameter, for the conveyance of water for human consumption and conveyance of sewage. It includes external and internal protection against the corrosive action of the surrounding medium and conveyed fluid.

NOTE 1 This specification does not apply to those steel tubes and tubular with screwed and socketed joints, which are covered by the requirements of BS EN 10255.

NOTE 2 For recommendations on the basis of design and service limitations, reference should be made to CP 2010: Part 2.

2 Normative references

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

EN 10020, Definition and classification of grades of steel.
EN 10021, General technical delivery conditions for steel products.
EN 10052, Vocabulary of heat treatment terms for ferrous products.
EN 10266, Steel tubes, fittings and structural hollow sections – Symbols and definitions of terms for use in product standards.
EN 10027-1, Designation systems for steels – Part 1: Steel names.
EN 10027-2, Designation systems for steels – Part 2: Steel numbers.
EN 287-1, Approval testing of welders – Fusion welding – Part 1: Steels.
EN 10204, Metallic products – Types of inspection documents.
EN ISO 377, Steel and steel products – Location and preparation of samples and test pieces for mechanical testing.
3. Terms and definitions

3.1 General

For the purposes of this SPAN Technical Specification the terms and definitions given in EN 10020, EN 10021, EN 10052 and EN 10266 (excluding the term tube and fitting in EN 10266) and the following apply.

The symbols used in this SPAN Technical Specification are defined in EN 10020, EN 10021, EN 10052 and EN 10266.

Other symbols for sampling and testing are given in the appropriate sampling and testing standards referenced in clauses 9 and 10.

3.2 Tube

A straight conduit for conveyance of fluid, of bare circular cross section, with plain or prepared ends.
3.3 Pipe

Tube complete with coating and lining.

3.4 Fitting

A component fitted to a pipe for jointing, connecting or changing the direction or bore of a pipe including special fitting made from manipulated tube or fabricated pipe, i.e. bend, gusseted bend and tee.

3.5 Effective length

The actual length that a pipe contributes when correctly assembled in a run of piping. This dimension excludes the additional length contributed by a slip-on type coupling when this is used.

3.6 Cut length

Pipes cut to a specified length on which only a small tolerance is allowed.

3.7 Allowable operating pressure (PFA)

Maximum hydrostatic pressure that a component is capable of withstanding continuously in service.

3.8 Glass tissue

A uniformly porous mat, of minimum mass 40g/m², made of glass monofilaments in random arrangement bonded with a thermosetting resin.

3.9 Reinforced glass tissue

Glass tissue with the addition of strand of glass yarn to give additional longitudinal tensile strength, the whole being bonded with a thermosetting resin.

3.10 Woven glass cloth

A loom state fabric, of minimum mass 120g/m², made of low alkali glass, complying with BS 3396-1 and uniformly woven from continuous filament yarn to form a porous cloth with selvedges well made, substantially straight and even, or a lock woven square mesh lacquer bonded fabric.

3.11 Composite glass fibre fabric

A reinforcement consisting of glass lock welded fabric and glass fibre combined.

Note. This reinforcement may be impregnated uniformly with a suitable bitumen or coal tar derived material.

3.12 Lining

A durable material applied to the internal surface of tubes and fittings to protect the metal from corrosion, erosion or chemical attack.

3.13 Coating

A durable material applied to the external surface of tubes and fittings to protect the metal.
4. Classification and designation

4.1 Classification

All steel covered by this SPAN Technical Specification are classified as non-alloy steels in accordance with EN 10020.

4.2 Designation

4.2.1 For products covered by this SPAN Technical Specification, the steel designation consists of the number of this Technical Specification (SPAN TS 21827 : Part 1) and either the steel name in accordance with EN 10027-1 or the steel number in accordance with EN 10027-2 (see Table 1 of SPAN TS 21827 : Part 2).

4.2.2 The steel name consist of the following:
   - the capital L for line pipe;
   - the specified minimum yield strength of the steel for wall thicknesses less than or equal to 16 mm, expressed in MPa² (see table 3 of SPAN TS 21827 : Part 2).

5. Information to be supplied by the purchaser

5.1 Mandatory Information

The following information shall be supplied by the purchaser at the time of inquiry and order.

5.1.1 Pipes
a) The quantity (mass or total length or number);
b) The term ‘pipe’;
c) The number of this Technical Specification;
d) The designation (see 4.2);
e) The dimensions (Outside diameter and thickness. See 7.6 of SPAN TS 21827 : Part 2);
f) The type of coating and lining requirements (see Clause 13 and 16);
g) The type of joint required (see 15.1);
h) The type of flange required (see 15.3);
i) The application (water or sewage) (see 12.1);
j) The options required (see 5.3).

5.1.2 Fittings
a) The quantity (number);
b) The type of fitting (see 7.6);
c) The number of this Technical Specification;
d) The designation (see 4.2);
e) The dimensions (see 7.6);
f) The maximum and, where vacuum conditions exist, the minimum, allowable operating pressure (PFA) (see 7.1);
g) The type of coating and lining required (see Clause 13 and 16);
h) The type of joint required (see 15.1);
i) The type of flange required (see 15.3);
j) The application (water or sewage) (see 12.1);
k) The options required (see 5.3).

5.2 Options

A number of options are specified in this Technical Specification and these are listed below. In the event that the purchaser does not indicate his wish to implement any of these options, at the time of enquiry and order the products shall be supplied in accordance with the basic specification.

Option: 1) The type of pipe, seamless (S), butt welded (BW), electric welded (EW) or submerged arc weld (SAW) shall be as specified (see 6.3.4.1 of SPAN TS 21827: Part 2).

Option: 2) Rectification of the body of SAW fittings by welding shall not be permitted (see 7.4).

Option: 3) The ends of fittings shall be prepared for butt welding (see 7.8).

Option: 4) An alternative bevel end preparation for butt welding shall be provided (see 7.8.4.2).

Option: 5) Products shall be supplied with specific inspection and testing (see 8.1).

Option: 6) An inspection certificate 3.1 or an inspection report 3.2 shall be supplied (see 8.2).

Option: 7) The method of non destructive testing for the welds of fittings shall be as specified (see 10.4).

Option: 8) The individual sleeve joints are required to be pressure tested after welding (see 15.2.5).

Option: 9) The surface finish shall be to first quality in accordance with BS EN ISO 8501-1 (see 16.2.3).

Option: 10) An adhesion test is required (see 16.6.2).

Option: 11) The sulphate-resisting Portland cement lining is required (see 16.7.1.1).

Option: 12) The curing period for more than 7 days is required (see 16.7.1.6).

Option: 13) The number of cube crushing tests required (see 16.7.5).
Option: 14) Material for completing the internal and external protection of joints at site is required (see 16.9.1 and 16.9.2).

5.3 Examples of an order

Example 1

8 km of submerged arc welded pipes in accordance with SPAN TS 21827: Part 1 with outside diameter of 914mm and a thickness of 10.0 mm made from steel L275 with corrosion protection of bitumen coating and cement mortar lining, the preparation of pipe ends for flange joints and subjected to specific inspection and testing.


Example 2

5 gusseted bends in accordance with SPAN TS 21827: Part 1 with outside diameter of 914mm and thickness of 10.0mm made from steel L275, with a 30˚ angle for operation at 10 bar gauge pressure, with corrosion protection of bitumen coating and concrete lining and supplied with an inspection certificate 3.1.


6. Materials

6.1 Pipes

6.1.1 Pipes shall be manufactured from tubes manufactured in accordance with SPAN TS 21827: Part 2 and shall be protected against corrosion as specified in Clause 13.

6.1.2 The requirements and test method for tubes are specified in SPAN TS 21827: Part 2. All tubes shall be manufactured and supplied with full compliance to SPAN TS 21827: Part 2.

6.1.3 Whenever the tube is purchased from the external supplier, the tube shall be from a certified supplier complying to SPAN TS 21827: Part 2.

6.2 Fittings

6.2.1 The steel from which the fittings are made shall be in accordance with 6.1 and 6.2 of SPAN TS 21827: Part 2.

6.2.2 Fittings shall be manufactured from tubes manufactured in accordance with SPAN TS 21827: Part 2 or from plate or strip made from one of the steel grades specified in Table 1 of SPAN TS 21827: Part 2.

6.2.3 All welds of fittings made from plate or strip and all fabrication welds shall be arc welds and the preparation for welding and the welding shall be carried out to qualified procedures using competent welders. Procedures in accordance with BS EN ISO 15607, BS EN ISO 15609-1 and BS EN ISO 15614-1 carried out by welders qualified in accordance with EN 287-1 meet this requirement.

6.2.4 The NDT activities for fittings shall be in accordance with 6.3.3 of SPAN TS 21827: Part 2.
7. **Requirements for fittings**

7.1 **General**

Fittings, when inspected and tested in accordance with clauses 9 and 10, shall comply with the requirements of 7.2 to 7.8. In addition to the requirements of this SPAN Technical Specification the general technical delivery conditions specified in EN 10021 apply.

Fittings shall be designed to withstand a pressure of not less than 1.5 times the allowable operating pressure.

**NOTES** It is essential that the allowable operating pressure (PFA) is stated in the enquiry and order (see 5.2.2.f).

7.2 **Chemical composition**

Cast analysis and product analysis requirement shall comply with the requirement of 7.2.1 and 7.2.2 of SPAN TS 21827: Part 2.

7.3 **Mechanical properties**

7.3.1 **Tensile test**

The minimum yield strength, tensile strength range and minimum elongation for fittings covered by this SPAN Technical Specification shall be in accordance with Table 3 of SPAN TS 21827: Part 2.

For even curvature bends and fittings made from plate or strip the tensile test properties shall be determined after forming.

7.3.2 **Weld bend test**

7.3.2.1 The seam weld of fittings and fittings components made from plate or strip shall pass a weld bend test in accordance with 10.2.4 of SPAN TS 21827: Part 2 on the root and face of the weld using a mandrel of diameter specified in Table 3 of SPAN TS 21827: Part 2. No cracks or imperfections shall be permitted in the weld metal, fusion line, heat affected zone or parent metal, except as permitted in 7.3.2.2.

7.3.2.2 The opening out of an imperfection due to incomplete root penetration or lack of fusion shall not be cause for rejection, provided that the imperfection has sound metal at the back and on each side of it. Cracks originating at the edges of the test piece which are less than 6mm long and which do not penetrate through the wall shall not be cause for rejection.

7.4 **Appearance**

Fittings shall be free from external and internal surface defects which can be established by visual inspection in accordance with this SPAN Technical Specification.

The outside surface condition, and where practicable, the inside surface condition shall be such that surface defects, and/or surface imperfections requiring rectification, can be identified.

It shall be permissible to rectify surface imperfections by grinding or machining provided that after so doing the wall thickness in the rectified area is not less than the specified minimum thickness. All ground or machined areas shall blend smoothly in the contour of the fittings.

Surface imperfections which encroach on the minimum permissible wall thickness shall be considered defects and shall not be permitted. Rectification of such defects in fittings by grinding or machining...
followed by welding shall be permitted on the body of fittings unless Option 2 is specified by the purchaser.

Option 2  Rectification of the body of SAW fittings by welding shall not be permitted.

### 7.5 Soundness

#### 7.5.1 General

Fittings shall meet the requirements for soundness and freedom from internal imperfections specified in 7.5.2 and 7.5.3.

#### 7.5.2 Leak tightness

All fittings shall be leak tight. Leak tightness shall be demonstrated either by a hydrostatic test in accordance with 10.3.2 of SPAN TS 21827: Part 2 or by an electromagnetic test in accordance with 10.3.3 of SPAN TS 21827: Part 2.

#### 7.5.3 Soundness of welds

The welds of all fittings shall be shown to be sound when tested in accordance with the requirements of 10.4.

### 7.6 Types and dimension of fittings

#### 7.6.1 General

The fittings covered by the requirements of this SPAN Technical Specification are even curvature bends, gusseted bends, and tees, the dimensions shall be in accordance with 7.6.2, 7.6.3 and 7.6.4 respectively.

#### 7.6.2 Even curvature bends

7.6.2.1 For general applications, the dimensions of even curvature bends, formed by manipulation of tubes, for tubes with outside diameters from 60.3mm to 323.9mm shall be as given in Table 1 (see Figures 1 and 2). The purchaser shall specify the outside diameter, wall thickness and angle of the bend at the time of enquiry and order (see 5.2.2.e).

**NOTE 1** Tighter radius bends may be agreed between the purchaser and manufacturer.

**NOTE 2** Bends are commonly specified with angles of 11° 15', 22° 30', 45° and 90° but they may be of any angle as required by the purchaser.

7.6.2.2 The bending radius \( R \) (see Figure 1 and 2) for tube with outside diameters greater than 323.9mm up to and including 1016mm shall be specified by the purchaser at the time of enquiry and order (see 5.2.2.e).

**NOTE** Even curvature manipulated bends in diameters greater than 1016mm may be available by agreement with the supplier.

7.6.2.3 The length of straight \( S \), specified in Table 1 shall be the minima applicable to bends prepared for butt welding. The lengths of straight \( S \) may be modified to suit other types of joint but shall be not less than the values specified in Table 1 or 1.5 \( D \) for tubes of diameter greater than 323.9mm.

7.6.2.4 When bitumen lining is required on even curvature manipulated bends of diameter greater than 168.3mm, the tube length in the bend shall be limited to 1800mm or a gusseted bend used.
Figure 1. Even curvature bend of 90°

Figure 2. Even curvature bend less than 90°

Table 1. Dimensions of even curvature bends: tube outside diameters from sizes 60.3 mm to 323.9 mm inclusive

<table>
<thead>
<tr>
<th>Tube Diameter D (mm)</th>
<th>Minimum thickness T (mm)</th>
<th>Bend R (mm)</th>
<th>S min(^a) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.3</td>
<td>3.6</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td>76.1</td>
<td>3.6</td>
<td>325</td>
<td>150</td>
</tr>
<tr>
<td>88.9</td>
<td>4.0</td>
<td>400</td>
<td>150</td>
</tr>
<tr>
<td>114.3</td>
<td>4.5</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td>139.7</td>
<td>4.5</td>
<td>625</td>
<td>190</td>
</tr>
<tr>
<td>168.3</td>
<td>4.5</td>
<td>750</td>
<td>225</td>
</tr>
<tr>
<td>219.1</td>
<td>5.0</td>
<td>1000</td>
<td>300</td>
</tr>
<tr>
<td>273</td>
<td>6.3</td>
<td>1250</td>
<td>375</td>
</tr>
<tr>
<td>323.9</td>
<td>7.1</td>
<td>1500</td>
<td>450</td>
</tr>
</tbody>
</table>

\(^a\) See Figures 1 and 2.
7.6.3 Gusseted bends

Gusseted bends shall be of the general form shown in Figures 3 or 4 or 5 dependent on the angle of the bend. For bends with angle \( \theta \) greater than 45° in tubes of 457mm diameter and above, the bend radius \( R \) shall be not less than 1.0 \( D \). For other conditions the bend radius \( R \) shall be not less than 1.5 \( D \). The diameter, thickness, the type (1, 2 or 3) and the angle \( \theta \) shall be specified by the purchaser and the dimensions \( L \) and \( R \) agreed between purchaser and manufacturer at the time of enquiry and order (see 5.2.2.e).

Figure 3. Gusseted bend type 1, \( \theta \leq 30° \)

Figure 4. Gusseted bend type 2, \( 31° < \theta \leq 60° \)
7.6.4 Tees

Tees shall be supplied with plain ends (see Figure 6) or with ends suitable for sleeve joints (see Figure 7) or with flanges attached to the branch and/or the barrel (see Figure 8). Dimensions of standard tees shall be given in Table 2. The purchaser shall specify the diameter and wall thickness of the barrel and branch at the time of enquiry and order (see 5.2.2.e).

When sleeve joint tees or tees with flanges on the branch and/or on the barrel are required the dimensions C, E and F shall be as shown in Figures 7 and 8 as appropriate.

Note: For information on the dimensions of sleeves see 15.2.
### Table 2. Dimensions of tees: tube outside diameters from sizes 60.3mm to 2743mm inclusive.

<table>
<thead>
<tr>
<th>Diameter D or D1 (mm) (see Figure 6)</th>
<th>Barrel</th>
<th>Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F (Min) (mm)</td>
<td>G (mm)</td>
</tr>
<tr>
<td>0.5 D plus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60.3</td>
<td>240</td>
<td>200</td>
</tr>
<tr>
<td>76.1</td>
<td>240</td>
<td>200</td>
</tr>
<tr>
<td>88.9</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>114.3</td>
<td>270</td>
<td>200</td>
</tr>
<tr>
<td>139.7</td>
<td>280</td>
<td>200</td>
</tr>
<tr>
<td>168.3</td>
<td>290</td>
<td>200</td>
</tr>
<tr>
<td>219.1</td>
<td>370</td>
<td>250</td>
</tr>
<tr>
<td>273</td>
<td>410</td>
<td>250</td>
</tr>
<tr>
<td>323.9</td>
<td>450</td>
<td>250</td>
</tr>
<tr>
<td>355.6</td>
<td>530</td>
<td>300</td>
</tr>
<tr>
<td>406.4</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>457 to 711</td>
<td>300</td>
<td>230</td>
</tr>
<tr>
<td>762 to 914</td>
<td>380</td>
<td>300</td>
</tr>
<tr>
<td>1016 to 2540</td>
<td>380</td>
<td>380</td>
</tr>
<tr>
<td>2642</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>2743</td>
<td>420</td>
<td>420</td>
</tr>
</tbody>
</table>

Note 1. Dimensions F, G, E and H should be rounded to the nearest 10mm.
Note 2. The effective length of the barrel of tees with sleeve joint for welding equals 2 F.
Note 3. Any barrel may have a branch of equal or smaller diameter attached to it.
Note 4. Reinforcement may be required to prevent over stressing.
Figure 6. Plain end tee for butt-welded joint

Figure 7. Sleeve joint tee for welding

Figure 8. Tee with flanged branch
7.7  Tolerance for Fittings

7.7.1  General

The ends of fittings (except for socketed or flanged tees) shall be prepared to match those of the pipes to which they are to be joined.

7.7.2  Bends

Bends shall be supplied with plain ends cut nominally square to the axis of the bend unless the purchaser specifies end preparation for butt welding in accordance with 7.8 (option 3). The ends shall be free from excessive burrs.

Option 3  The ends of fittings shall be prepared for butt welding.

NOTE  Information on end preparation for jointing other than butt welding is given in Clause 15 and may be agreed between the purchaser and the manufacturer.

Tolerance on the angle between the end faces shall be within ±1 % of the specified bend angle θ (see Figure 1 to 5).

The radius R of the bend shall be within ±1 % of the specified radius.

The minimum wall thickness of even curvature bends shall be not less than that permitted in the tube of equivalent material to which it is intended to be connected.

The tolerance on leg length L₁, L₂ and L₃ for gusseted bends (see Figure 3 to 5) shall be ±35mm for outside diameters less than or equal to 219.1mm and ±70mm for outside diameters greater than 219.1mm. When a fixed leg length is specified the tolerance on the leg length shall be ±6mm.

7.7.3  Tees

Plain end tees shall be supplied with the ends cut nominally square to the axis of the barrel and the branch as appropriate unless the purchaser specifies end preparation for butt welding in accordance with 7.8 (option 3). The ends shall be free from excessive burrs.

Option 3  The ends of fittings shall be prepared for butt welding.

NOTE  Information on end preparation for jointing other than butt welding is given in Clause 15 and may be agreed between the purchaser and the manufacturer.

The tolerance on the angle of branch relative to the axis of the barrel shall be ±1°.

The tolerance on the dimensions E, F, G and H (see Figures 6 to 8) shall be ±6mm.

7.8  End preparation of fittings for butt welding

7.8.1  General

The purchaser may specify that the ends of fittings shall be prepared for butt welding in accordance with 7.8.2 to 7.8.4.

Option 3  The ends of fittings shall be prepared for butt welding.
7.8.2 Diameter tolerance at fittings ends

The tolerance on the outside diameter of the fittings for a distance to be agreed at each end shall be in accordance with Table 3. Out of roundness shall be within the limits for the diameter tolerance for fittings with D/T less than or equal to 100. For D/T values above 100 the out of roundness shall be agreed between the purchaser and the manufacturer.

<table>
<thead>
<tr>
<th>Outside diameter (mm)</th>
<th>End tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 219.1</td>
<td>± 0.5mm or ± 0.5% D whichever is the greater</td>
</tr>
<tr>
<td>219.1 &lt; D ≤ 2032</td>
<td>± 1.6mm</td>
</tr>
<tr>
<td>&gt;2032</td>
<td>± 3mm</td>
</tr>
</tbody>
</table>

7.8.3 Squareness of ends

The ends of fittings shall be at right angles to the axis of the fittings within 1.6mm measured across the diameter as shown in Figure 9.
7.8.4 Bevelled ends

7.8.4.1 The ends of fittings of thickness less than 3.2mm shall be supplied without bevelled ends.

7.8.4.2 Fittings of thickness equal to or greater than 3.2mm shall be supplied with ends bevelled as shown in Figure 10 unless option 4 is specified by the purchaser.

Option 4 An alternative bevel end preparation for butt welding shall be provided; the purchaser shall specify the type of preparation required.
8. Inspection

8.1 General

Compliance with the requirements of this SPAN Technical Specification shall be checked by non-specific inspection and testing (see EN 10021) unless option 5 is specified by the purchaser.

Option 5 The products shall be supplied with specific inspection and testing (see EN 10021).

8.2 Inspection documents

When products according to this SPAN Technical Specification are checked by non-specific inspection and testing, a test report type 2.2 in accordance with EN 10204 shall be supplied. When products according to this SPAN Technical Specification are checked by specific inspection and testing (see option 5), an inspection certificate type 3.1 in accordance with EN 10204 shall be supplied unless option 6 is specified by the purchaser.

Option 6 For product checked by specific inspection and testing an inspection certificate type 3.1 or an inspection report type 3.2 in accordance with EN 10204 shall be supplied. The type of document to be supplied shall be specified by the purchaser.

When an inspection document 3.1 or 3.2 is specified the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and produce the inspection document. In the case of an inspection report 3.2 it shall also be agreed which party is to issue the document.

8.3 Summary of inspection and testing

8.3.1 Fittings

Fittings or components of fittings which are manufactured from tubes or formed into tubes prior to the completion of the fittings shall be tested at the tubular stage in accordance with 8.3.1 of SPAN TS 21827: Part 2 and Table 4. Fittings or components not tested as a tube, or when forming has been undertaken, shall be tested in accordance with 8.3.1 of SPAN TS 21827: Part 2 and Table 4, where applicable.

Even curvature bends previously tested as a tube shall only be subject to a tensile test in accordance with 10.2.1 of SPAN TS 21827: Part 2 after forming.

All welds which have not been tested as part of a tube shall be tested in accordance with 10.4 before the application of any coating or lining material.

Fittings shall be subject to visual examination (see 10.5) and dimensional inspection (see 10.6).

<table>
<thead>
<tr>
<th>Outside diameter mm</th>
<th>Number of fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 60.3 ≤ 114.3</td>
<td>100</td>
</tr>
<tr>
<td>&gt; 114.3 ≤ 323.9</td>
<td>100</td>
</tr>
<tr>
<td>&gt; 323.9</td>
<td>100</td>
</tr>
</tbody>
</table>

NOTE Any residual fraction of a test unit should be considered as a test unit.
9. Sampling of fittings

9.1 Frequency of testing

For non-specific inspection and testing, the tests shall be carried out by the manufacturer in accordance with their own procedures (see EN 10021).

For specific inspection and testing, the tests shall be carried out on the products to be supplied or on test units of which the product to be supplied is a part (see EN 10021).

9.1.1 Test unit

When specific inspection and testing is carried out, the test unit shall consists of the number of fittings specified in Table 4 of the same type, specified diameter, specified thickness, steel grade and manufactured using the same processing conditions e.g. welding process, heat treatment.

In addition, for fusion welded products, the test unit shall consist of products which have been welded using the same type of flux and filler wire.

9.1.2 Number of sample products

One sample fittings shall be selected for the mechanical test (one per test unit), and where appropriate, the product analysis (one per steel grade).

9.1.3 Type of test and number of tests

See 8.3.

9.2 Location, orientation and preparation of samples and test pieces

9.2.1 General

Samples and test pieces shall be taken from the end of fittings in the final delivery condition in accordance with Figure 11 and EN ISO 377.

9.2.2 Product analysis

Samples for product analysis shall be taken from the test pieces or samples for mechanical testing or from the whole thickness of the tube at the same location as for the mechanical test samples, in accordance with EN ISO 14284.

9.2.3 Tensile test

The test piece for the tensile test shall be a test piece taken from the sample fitting in accordance with BS EN ISO 6892-1.

The test piece may be taken either longitudinally or transversely at the discretion of the manufacturer.

9.2.4 Weld bend test

The test piece for the weld bend test shall be in accordance with BS EN ISO 5173.
Figure 11 – Location and direction of test pieces for the tensile and weld bend test

Key
1 Seamless tube
2 Longitudinally welded tubes
3 Strip end weld
4 Helically welded tubes
W Sample of the weld
WS Sample of the strip end weld
w Width of the strip
10. Test methods

10.1 Chemical analysis

Chemical analysis test method for fittings shall be in accordance with 10.1 of SPAN TS 21827: Part 2.

10.2 Mechanical tests

Mechanical tests method for fittings shall be in accordance with 10.2 of SPAN TS 21827: Part 2 with exclusion of 10.2.2 and 10.2.3 of SPAN TS 21827: Part 2.

10.3 Leak tightness test

See 7.5.2.

10.4 Non destructive testing of the welds of fittings

The seam weld of fittings or fittings components which have not previously been tested (i.e. as a tube) shall be tested in accordance with 10.4.3 of SPAN TS 21827: Part 2.

All welds other than seam welds shall be tested by one of the following methods;

a) Penetrant testing in accordance with EN 571-1;
b) Magnetic particle testing in accordance with BS EN ISO 17638;
c) Ultrasonic testing in accordance with BS EN ISO 17640;
d) Radiographic testing in accordance with EN 1435.

The method of non-destructive testing is at the discretion of the manufacturer unless a specific method from those given above is specified by the purchaser.

The acceptance level shall be agreed between the purchaser and manufacturer.

Option 7 The method of non destructive testing is specified by the purchaser from those listed in 10.4.

10.5 Visual examination

The fittings shall be visually examined for compliance with the requirements of 7.4.

10.6 Dimensional inspection

Fittings shall be inspected for compliance with the requirements of 7.6, 7.7 and 7.8. A gauge is normally used for measurement of outside diameter.

However, for fittings with outside diameter equal to or greater than 406.4mm, a circumference tape may be used.
11. Retests, sorting and reprocessing.

For retests, sorting and reprocessing of pipes and fittings the conditions of EN 10021 shall apply.

12. Marking.

12.1 Each pipe and fitting shall be legibly marked by stencilling or other indelible marking with the following information in the sequence indicated:

(a) the manufacturer’s name or identification mark;
(b) the number of this SPAN Technical Specification (SPAN TS 21827: Part 1);
(c) the steel name (see 4.2.2);
(d) the dimensions;
(e) the type of coating and lining applied (see 16.1);
(f) the certification mark of certification body;
(g) in the case of specific inspection and testing;
   - an identification number (e.g. order or item number) which permits the correlation of the product or delivery unit with the related inspection document;
   - the mark of the inspection representative when specific inspection is required;
(h) when the type of pipe, seamless (S), butt welded (BW), electric welded (EW) or submerged arc weld (SAW) is specified (see option 1) the letter representing the type of pipe, as appropriate.
(i) the (SEWAGE) when sewage application is specified by the purchaser (see 5.1.1.i & 5.1.2.j).

Marking on the pipes shall commence not more than 300mm from one end.

12.2 For pipes that are bundled and fittings that are bagged, the information given in 12.1, shall be either stamped on one or more metal or other durable tags, or printed on banding clips or straps, which shall be securely attached to each bundle. Not more than one steel grade shall be included in any one bundle.

13. The corrosion protection requirement

For protection against corrosion, the pipes and fittings shall be protected with a coating and lining. The type of coating and lining shall be agreed between the purchaser and the supplier at the time of enquiry and order (see 5.1.1.f and 5.1.2.g).

The methods of protection against corrosion and the selections of coatings and linings shall be in accordance with Clause 16.

14. Effect of non-metallic products on water quality

When used under the conditions for which they are designated, non-metallic products in contact with or likely to come into contact with potable water shall comply with MS 1583.
15. Types of joints

15.1 General

15.2 to 15.5 specifies the type of joints, except for the preparation for butt welding, requirements for which are given in 7.8 of SPAN TS 21827: Part 1 and Part 2. The types of joints are as follows:-

(a) Sleeve joints for welding;
(b) Flange joints;
(c) Slip-on type couplings;
(d) Push fit and gasket type couplings.

NOTE 1 It is essential that the type of joint is stated in the enquiry and order (see 5.1.1.g and 5.1.2.h).

NOTE 2 Illustrations showing the basic design principle for the more common types of joints appropriate in this Technical Specification are given in Figures 12 – 16. The actual details of the joints may differ from one manufacturer to another.

15.2 Sleeve joints for welding

15.2.1 General

Sleeve joint for welding shall comply with 14.2.2 or 14.2.3 or 14.2.4.

The joints shown in Figure 12 may differ in detail from one manufacturer to another provided the dimensions identified are maintained.

On sizes smaller than 711 mm OD, the joints should be welded in the outside only. On sizes 711 mm OD and larger, welding may be either inside, or outside, or both side and outside.

In general, sleeve welded joints are not suitable for lined tubes (pipes) in sizes 610 mm OD and smaller. When these sizes are required to be lined, consideration should be given to mechanical joints or other forms of joints designed to avoid damage to the lining.

15.2.2 Type 1 joints

For type 1 joints (see Figure 12) the tubes shall be supplied with spigot end parallel and sleeve end either parallel or with the diameter tapered to approximately 0.8mm per 25mm length of sleeve. The minimum length of sleeve shall be 75mm.

The sleeve shall be sized to ensure that the spigot will enter the sleeve freely and be engaged by the socket when fully home.

15.2.3 Type 2 joints

For type 2 joints (see Figure 12) the tubes shall be supplied with spigot end and the sleeve end parallel. The collar forming the sleeve shall be fabricated with not more than one longitudinal weld and shall be welded externally and internally to the sleeve tube. The minimum sleeve length shall be \((150 + 2t)\)mm, where \(t\) is the thickness of the sleeve, to ensure an adequate space between the spigot end and the internal collar weld to effect the inside joint weld if required.

The sleeve shall be sized to ensure that the spigot will enter the sleeve freely and be engaged by the socket when fully home.
15.2.4 Type 3 joints

For type 3 joints (see Figure 12) the tubes shall be supplied with the contact surfaces of the spigot end and sleeve end formed to the same spherical radius. The spherical radius shall be not less than half of the outside diameter of the tube. When fitted together the mean penetration of each spigot into the sleeve shall be not less than four times the tube thickness. (See note 1).

NOTE 1 These types of sleeve joint may be used to accommodate small changes in pipe line direction provided the spigot and the sleeve are engaged around the whole circumference and the mean penetrated is not less than four times the tube thickness.

15.2.5 Individual sleeve joints

When individual sleeve joints are required to be pressure tested after welding, each sleeve shall be provided with a nominal size ¼ tapped hole complying with BS EN 10226-1 fitted with a matching plug. The tapped holes shall be within the end 30mm of the sleeves and be clear of any possible shop or field welding runs.

The purchaser should state Option 8 in the enquiry and order if the individual sleeve joints are required to be pressure tested after welding.

Option 8 The individual sleeve joints are required to be pressure tested after welding.
Type 1 (parallel sleeve)

Type 1 (taper sleeve; taper approximately 0.8 mm on diameter for each 25 mm on length of socket)

Workshop fabrication weld

Type 2 (collar sleeve)

Spherical joint
(R > D/2 where D is the outside diameter)

Hemispherical joint
(R > D/2 where D is the outside diameter)

Type 3 (surfaced sleeve)

All dimensions are in millimeters

Figure 12. Sleeve welded joints
15.2.6 Welding collars

Welding collars shall be as shown in Figure 13 and should be at least equal in thickness to the adjoining components; the length of sleeve should be not less than 250mm.

When positioned for welding the collar should be a good fit on the outside diameter of the components to be joined. To ensure good welding conditions the gap should be not greater than 6mm.

Figure 13. Welding collar

15.3 Flange joints

15.3.1 Flange joints shall have flanges in accordance with BS EN 1092-1 or BS EN 1759-1, as appropriate to the design conditions (see Figure 14).

Note It is essential that the type of flange required is stated in the enquiry and order (see 5.1.1.h and 5.1.2.i).

The purchaser shall specify the type of flange required.

15.3.2 Welding shall be carried out to procedures in accordance with BS EN 15607, BS EN ISO 15609-1 and BS EN ISO 15614 by welders qualified to EN 287-1.
Figure 14: Flange joints.

Key:
1. Gasket
2. Weld
   i. Plate flange
   ii. Loose flange
   iii. Welded neck flange
15.4 Slip-on type couplings

15.4.1 Slip on type coupling for use with plain end tube shall be of the general form shown in Figure 15.

15.4.2 The lengths of the coupling sleeves (S) shall be as given in Table 5.

The details of the joints shown in Figure 15 may differ from one manufacturer to another provided the dimensions identified are maintained.

<table>
<thead>
<tr>
<th>Tube Size outside diameter D (mm)</th>
<th>Sleeve length (mm) S</th>
<th>Tolerance on sleeve lengths (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 60.3</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>76.1 to 323.9</td>
<td>100</td>
<td>±3</td>
</tr>
<tr>
<td>355.6 to 914</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>1016 to 1829</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>2032 and 2743</td>
<td>254</td>
<td></td>
</tr>
</tbody>
</table>

NOTE 1 Other sleeve lengths may be used for special service conditions but are not covered by this standard
NOTE 2 Coupling sleeves with a form of centre register may be specified by the purchaser.

15.4.3 When slip-on type couplings are used the tube ends for length L shall be within the tolerances on outside diameter as specified in Table 6 when checked by the measuring the circumference and shall permit the passage of a ring gauge, which has a bore 1.6mm larger than the maximum permissible diameter of the tube.

15.4.4 Surface irregularities such as peaks, flats or depressions shall be blend smoothly into the surface of the tube and their height or depth shall not exceed 0.25mm.
Table 6. Slip on type couplings – tolerances on outside diameter D over length L

<table>
<thead>
<tr>
<th>Tube Size outside diameter D (mm)</th>
<th>Tolerance on D (mm)</th>
<th>Length L over which tolerance applies (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 114.3</td>
<td>± 0.8</td>
<td>100</td>
</tr>
<tr>
<td>139.7 to 323.9</td>
<td>± 1.6 / - 0.8</td>
<td>100</td>
</tr>
<tr>
<td>355.6 to 1422</td>
<td>± 1.6</td>
<td>150</td>
</tr>
<tr>
<td>1524 to 1829</td>
<td>± 3</td>
<td>150</td>
</tr>
<tr>
<td>2032 to 2743</td>
<td>± 3</td>
<td>200</td>
</tr>
</tbody>
</table>

15.5 Push fit and gasket type couplings

15.5.1 Push fit and gasket type couplings should be of the general form shown in Figure 16.

15.5.2 The insertion depth, socket size and wall thickness should be as given in Table 7. The details of the joint shown in Figure 16 may differ from one manufacturer to another.

The connection is produced by inserting the tube spigot end into the socket end which contains a rubber gasket. By inserting the spigot end into the socket, the rubber ring is deformed in an axial direction and seals the connection by the resilience present in the rubber ring.

The connection in diameters up to and including 323.9mm is suitable for operating pressures up to maximum 40 bar. For larger diameters the maximum operating pressure is related to the diameter and thickness of the tubes. To absorb axial forces in the connection, special rubber rings may be required.

![Figure 16. Push fit and gasket type couplings.](image-url)
Table 7. Insertion depths, socket sizes and wall thicknesses for push fit and gasket type couplings.

<table>
<thead>
<tr>
<th>Tubes Outside Diameter D (mm)</th>
<th>Nominal wall thickness T (mm)</th>
<th>Insertion depth (mm)</th>
<th>Socket Outside Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>114.3</td>
<td>3.2</td>
<td>110</td>
<td>151</td>
</tr>
<tr>
<td>117.5</td>
<td>3.2</td>
<td>110</td>
<td>151</td>
</tr>
<tr>
<td>139.7</td>
<td>4.0</td>
<td>110</td>
<td>178</td>
</tr>
<tr>
<td>144</td>
<td>4.0</td>
<td>110</td>
<td>178</td>
</tr>
<tr>
<td>168.3</td>
<td>4.0</td>
<td>131</td>
<td>203</td>
</tr>
<tr>
<td>219.1</td>
<td>4.5</td>
<td>133</td>
<td>258</td>
</tr>
<tr>
<td>273</td>
<td>5.0</td>
<td>143</td>
<td>312</td>
</tr>
<tr>
<td>323.9</td>
<td>5.6</td>
<td>150</td>
<td>366</td>
</tr>
<tr>
<td>355.6</td>
<td>5-7.1a</td>
<td>120-150</td>
<td>405</td>
</tr>
<tr>
<td>406.4</td>
<td>5-7.1a</td>
<td>120-150</td>
<td>405</td>
</tr>
<tr>
<td>457</td>
<td>5-7.1a</td>
<td>120-150</td>
<td>510</td>
</tr>
<tr>
<td>508</td>
<td>5-7.1a</td>
<td>120-150</td>
<td>560</td>
</tr>
<tr>
<td>610</td>
<td>5-8a</td>
<td>120-200</td>
<td>660</td>
</tr>
<tr>
<td>610</td>
<td>8</td>
<td>200</td>
<td>690</td>
</tr>
<tr>
<td>711</td>
<td>8</td>
<td>200</td>
<td>791</td>
</tr>
<tr>
<td>813</td>
<td>8</td>
<td>200</td>
<td>893</td>
</tr>
<tr>
<td>914</td>
<td>8</td>
<td>200</td>
<td>994</td>
</tr>
<tr>
<td>1016</td>
<td>8</td>
<td>200</td>
<td>1096</td>
</tr>
</tbody>
</table>

*a Dependent on maximum working pressure.

15.6 Special joints

Other types of joint are available. If such joints are to be used any special requirements for the end preparation of the tube should be specified by the purchaser and agreed with the manufacturer at the time of enquire and order.
16. Protection against corrosion

16.1 General

This part of SPAN Technical Specification specifies methods of protecting tubes and fittings against corrosion. It covers external protection by bitumen, coal tar based and plastics materials, and internal protection by bitumen, concrete and cement mortar.

Other types of protection system shall be covered by other relevant standards or specifications approved by the Commission.

It is permissible for other surface protection system to be applied in which cases it is necessary for an agreement between the purchaser and the manufacturer to be reached. However, such systems do not form part of this standard.

The type of external and internal protection specified and the symbol to represent them under this specification are as follows:-

   a) Bitumen coating (B)
   b) Plastic Cladding (P)
   c) Epoxy coating (E)
   d) Bitumen Lining (BL)
   e) Concrete Lining (C)
   f) Cement Mortar Lining (M)

16.2 Surface preparation

16.2.1 General

The surfaces to be protected shall be clean and free from scale, loose rust, oil, grease or other foreign matter. Surface preparations for other than cement mortar or concrete linings shall be affected by one of the following methods:

(a) Acid pickling
(b) Abrasive, mechanical or flame, descaling

16.2.2 Acid pickling

Where surface preparation is by acid pickling, the tubes and fittings shall be immersed in an acid solution until all the scale has been removed, washed in clean water and the surface suitably inhibited.

16.2.3 Abrasive descaling

Where surface preparation is by abrasive descaling, the surface finish shall be at least to second quality in accordance with BS EN ISO 8501-1 unless option 9 is specified by the purchaser.

Option 9 The surface finish shall be to first quality in accordance with BS EN ISO 8501-1.
16.3 Coatings and linings

16.3.1 Bitumen

Coatings are applied hot or cold and, where bitumen coatings are applied by dipping, the tubes and fittings shall be immersed in a bath of molten bitumen until they attain the temperature of the bath. They shall be drained after the removal from the bath, where necessary for the purposes of jointing any excess coating shall be removed from the ends. Where coatings are applied by spray or brush, the application shall be such as to provide a smooth continuous coating.

NOTE 1 These bitumen coatings may be suitable for extended service.

16.4 External protection

16.4.1 Priming

Before the application of bitumen or coal tar external protection, tubes and fittings shall be primed with a compatible priming coat. Materials and methods complying with BS EN 10300 or BS 4164 shall be used as appropriate.

16.4.2 Bitumen sheathing

The materials shall consist of natural or blown petroleum bitumen mixed with an inert filler i.e. type 2 or type 3 in accordance with BS EN 10300.

The tubes and fittings shall be covered with a layer of sheathing material, applied as a hot coating or mastic to provide a seamless, consolidated and smooth layer having a minimum thickness as given in Table 8.

<table>
<thead>
<tr>
<th>Pipe outside diameter (mm)</th>
<th>Minimum thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>88.9 – 168.3</td>
<td>3</td>
</tr>
<tr>
<td>193.7 – 323.9</td>
<td>4.5</td>
</tr>
<tr>
<td>355.6 - 2743</td>
<td>6</td>
</tr>
</tbody>
</table>

16.4.3 Reinforced bitumen sheathing

Reinforced sheathing shall be bitumen complying with 16.4.2 with the addition of an overlapping spiral wrapping of woven glass cloth firmly embedded in to the sheathing

16.4.4 Bitumen enamel wrapping (filled bitumen with glass tissue)

The tubes shall be covered with a layer of bitumen containing mineral filler applied hot, i.e. type 2 in accordance with BS EN 10300, and an inner wrapping of glass tissue and an outer wrapping of bitumen impregnated reinforced glass tissue, the inner wrapping being embedded in the bitumen. For tubes, the glass tissue wrappings shall be wound spirally with an overlap. For fittings, the glass tissue wrapping shall be wound spirally or circumferentially with an overlap. There shall be not less than 1 mm of enamel between the tube surface and the inner wrapping and also between the inner and outer wrapping. The protection shall have a minimum thickness of 3 mm.
16.4.5 Reinforced bitumen enamel wrapping

Reinforced wrapping shall be bitumen enamel wrapping complying with 16.4.4 except that the outer wrapping shall be of composite glass fibre fabric.

16.4.6 Coal tar enamel wrapping (filled coal tar with glass tissue)

The tubes and fittings shall be covered with a layer of type 2 filled coal tar in accordance with BS 4164 and an inner wrapping of glass tissue and an outer wrapping of coal tar impregnated reinforced glass tissue, the inner wrapping being embedded in the coal tar. For tubes, the glass tissue wrapping shall be wound spirally on the tubes with an overlap. For fittings the glass tissue wrapping shall be wound spirally or circumferentially with an overlap. There shall be not less than 1 mm of enamel between the tube surface and the inner wrapping and also between the inner and outer wrapping. The protection shall have a minimum thickness of 3 mm.

16.4.7 Non-stick and reflective finish

For bitumen or coal tar coated pipes a non-stick and reflective coating shall be applied to the finish external protection.

16.4.8 Plastics cladding

Tubes shall be covered with an even layer of hot melt adhesive undercoat with a minimum thickness of 0.1 mm. The undercoat shall consist of a non-setting, pressure sensitive adhesive based on a blend of elastomer resin and fluxing oil.

Immediately after the application of this undercoat, a seamless sheath of medium/high density polyethylene shall be continuously applied and shrunk on to the tube to provide a smooth outer sheath, free from pinholes and cracks. The thickness of the polyethylene shall be in accordance with Table 9.

The minimum thickness of polyethylene shall be the thickness as given in table 9 minus 12.5%.

<table>
<thead>
<tr>
<th>Tube outside diameter (mm)</th>
<th>Polyethylene thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 60.3</td>
<td>0.6</td>
</tr>
<tr>
<td>88.9 – 114.3</td>
<td>0.9</td>
</tr>
<tr>
<td>139.7 - 457</td>
<td>1.3</td>
</tr>
</tbody>
</table>

16.5 Internal protection

16.5.1 Priming

Before internal bitumen protection is applied, tubes and fittings shall be primed with a compatible priming coat. Materials and methods complying with BS EN 10300 shall be used.

16.5.2 Bitumen lining of tubes

16.5.2.1 The materials shall consist of a uniform blend of natural or blown bitumen mixed with an inert filler to produce a homogeneous composition of type 2 in accordance with BS EN 10300.

16.5.2.2 The lining material, in a hot fluid condition, shall be applied centrifugally to straight lengths of tube to give a smooth continuous lining, having a minimum thickness as given in Table 10.
16.5.3 Bitumen lining of fittings

The lining material and the finished lining shall comply with the corresponding requirement of clause 16.5.2 for straight tubes.

NOTE. In view of the variety of methods adopted for the lining of fittings, this specification does not specify the procedure to be followed.

<table>
<thead>
<tr>
<th>Tube outside diameter (mm)</th>
<th>Minimum thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.3 – 323.9</td>
<td>1.5</td>
</tr>
<tr>
<td>355.6 – 610</td>
<td>3</td>
</tr>
<tr>
<td>660 – 914</td>
<td>4.5</td>
</tr>
<tr>
<td>1016 - 2743</td>
<td>6</td>
</tr>
</tbody>
</table>

16.6 Tests on applied external and internal protections

16.6.1 ‘Holiday’ test

All coated tubes (pipes) and fittings shall be checked for continuity of the applied protection in accordance with appendix A using a ‘Holiday’ detection unit. Discontinuities and pinholes indicated by the test shall be made good.

16.6.2 Adhesion test

When an adhesion test is carried out it shall comprise one of the following methods. The manufacturer shall select the first test method.

a) The ring test.

A ring 75mm wide shall be cut cold from one end of finished pipes. The ring shall be flattened at a temperature between 10° C and 20° C to 50 % of the original diameter. The lining and/or coating shall not part from the metal under this test.

b) The strip test

Using a tool with a thin sharp blade, two cuts approximately 50 mm apart shall be made through the protection to the metal pipes. Sudden impact, which would cause untimely separation, shall be avoided. The blade shall be worked under the protection and an attempt made to peel it from the metal. The adhesion shall be considered satisfactory if removal of the protection causes cohesive failure and the protection does not peel cleanly from the primer or the pipe surface.

The test shall be performed when the protection has been allowed to cure at a temperature not less than 10°C or more than 35 °C for a minimum of 48 h after application.

When an adhesion test is required, this should be stated by the purchaser in the enquiry and order (Option 10).

Option 10 An adhesion test is required.
16.6.3 Repairs

Any defective coatings and linings shall be made good using compatible materials.

16.7 Concrete lining and cement mortar lining

16.7.1 Concrete lining of tubes

16.7.1.1 The lining shall be concrete made from Portland cement complying with MS EN 197-1 or from sulphate-resisting Portland cement complying with BS 4027:1996 and fine aggregate complying with table 5 of MS EN 12620, grading zones 1, 2 or 3, except that the maximum size of aggregate shall not exceed one-third the thickness of the lining.

The manufacturer has the option of supplying pipe lined with either Portland cement or sulphate-resisting Portland cement unless Option 11 is specified by the purchaser in the enquiry and order.

Option 11 The sulphate-resisting Portland cement lining is required.

NOTE The use of additives or any other admixture is not covered by this specification. Such use is not permitted unless specifically agreed in detail with the purchaser.

The minimum cement content shall be 330kg/m³ and the maximum water cement ratio shall not exceed 0.46:1.

16.7.1.2 The water used in the preparation of the concrete shall be neither deleterious to concrete nor deleterious to the water that the pipe is eventually intended to convey. (see clause 14).

16.7.1.3 The concrete lining in contact with potable water shall not discolour the water, impart any objectionable taste or odour or release any toxic substances into the water or support any microbial growth. (see clause 14).

16.7.1.4 The concrete shall give, upon testing, the compressive strength and density specified in 16.7.5.

16.7.1.5 The tube shall be charged in a single operation and spun at a suitable speed to achieve a minimum rate of radial acceleration of 250m/s² (25gₜ) until the uniform thickness of concrete lining given in Table 11 has been attained over the whole of the inner surface with the exception of stock backs for jointing.

The spinning of the tube shall continue until surplus water has been dispersed and the greatest possible density of lining obtained. Any damage caused to the lining by the removal of the end rings shall immediately be made good by hand before the lining is set. Not more than 1 h shall elapse between the removal of the lined pipe from lining machine and the commencement of the approved curing procedure.

16.7.1.6 After being lined, the fresh lining shall be marked with the date of lining and the pipe shall be stored undisturbed for the lining to be cured for at least 7 days for maturing. Means shall be employed to prevent the lining from drying too rapidly, particularly during the 48 h. period after the lining operation. The lining shall be kept damp by spraying with water or by other means, e.g. by closing the pipe with end caps until curing is complete.

16.7.1.7 The surface of the lining shall be smooth and free from irregularities.

Fine surface crazing, hair cracks, or cracks up to 0.25mm in width in saturated linings and not over 300mm in length shall not be cause for rejection.

Cracks over 0.25 mm in width in saturated linings, and crack over 300 mm in length or other defective linings shall be made good using compatible materials.
The pipes may be dispatched at any time after the seven-day curing period provided the cube strength of the test cube after 7 days of curing has achieved the required strength as specified in 16.7.5 unless option 12 is specified by the purchaser.

Option 12 The curing period for more than 7 days is required.

<table>
<thead>
<tr>
<th>Outside diameter of tube or special (mm)</th>
<th>*Minimum thickness of concrete (mm)</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 168.3</td>
<td>6</td>
<td>+3, -0</td>
</tr>
<tr>
<td>193.7 – 323.9</td>
<td>10</td>
<td>+3, -0</td>
</tr>
<tr>
<td>355.6 – 610</td>
<td>13</td>
<td>+3, -0</td>
</tr>
<tr>
<td>660 – 1219</td>
<td>19</td>
<td>+6, -0</td>
</tr>
<tr>
<td>1422 - 2743</td>
<td>25</td>
<td>+6, -0</td>
</tr>
</tbody>
</table>

* Thicker linings may be specified

16.7.2 Concrete lining of fittings

16.7.2.1 When it is practicable to do so, fittings shall be made from cut lengths of mature lined straight pipes.

NOTE. See 16.7.2.3 for situations where it is impracticable to do so.

The lining shall be cut back from the end or ends to be beveled and welded, for a sufficient distance to ensure that any of the concrete which is intended to remain as part of the lining shall not suffer damage by the cutting or welding process. The lining shall be made good by rendering by hand.

16.7.2.2 Hand rendering of fittings shall consist of freshly mixed concrete of a mixture equivalent to that of the lining being repaired, and shall be thoroughly compacted and finished to a smooth surface of the correct form.

16.7.2.3 Fittings other than those made from cut length of measured lined straight pipes shall be lined by hand rendering as specified in 16.7.2.2. The rendering of fittings of 323.9 mm outside diameter and above shall be reinforced with expanded metal or equivalent, securely attached to the inner surface.

16.7.2.4 Curing shall comply with 16.7.1.6.

16.7.3 Centrifugally applied cement mortar lining

16.7.3.1 The lining shall be cement mortar made from Portland cement complying with MS EN 197-1 or from sulphate-resisting Portland cement complying with BS 4027:1996 and specially graded washed silica sand complying with grading zone 4 in table 5 of MS EN 12620.

The manufacturer has the option of supplying pipe lined with either Portland cement or sulphate-resisting Portland cement unless Option 11 is specified by the purchaser in the enquiry and order.

Option 11 The sulphate-resisting Portland cement lining is required.

NOTE. The use of additives or any other admixture is not covered by this standard. Such use is not permitted unless specifically agreed in detail with the purchaser.
The cement mortar shall have a minimum cement content of 1000 kg/m³ and a water cement ratio of between 0.30 : 1 and 0.45 : 1 by mass.

16.7.3.2 The water for mixing shall comply with 16.7.1.2. (see clause 14)

16.7.3.3 The lining in contact with potable water shall comply with the requirements of 16.7.1.3. (see clause 14)

16.7.3.4 The cement mortar lining shall be carried out by one of the following methods.

(a) Centrifugally spraying and subsequent rotation to achieve smoothing.

(b) Centrifugally spraying and simultaneously smoothing by trowelling.

The spray operation shall be such that a continuous feed of freshly mixed mortar shall be evenly applied to the whole bore of the tube in a single pass in one continuous operation. Where smoothing by rotating is utilized, the duration and speed of rotation shall be kept to a minimum to prevent separation of the constituents of the mortar.

16.7.3.5 The curing process shall comply with 16.7.1.6.

16.7.3.6 The surface of the lining shall be smooth and free from irregularities.

Fine surface crazing, hair cracks or cracks up to 0.25mm wide in saturated linings and not over 300mm in length shall not be a cause for rejection.

Cracks over 0.25 mm in width in saturated linings, cracks over 300 mm in length or other defective linings shall be made good using compatible materials.

16.7.3.7 Formed ends of linings, when specified by the purchaser in the enquiry and order, shall be made after the spraying and smoothing processes unless formed by the insertion of removable formers or end rings.

16.7.3.8 Lining thickness shall be not less than the minimum thicknesses given in Table 12.

16.7.3.9 Hand finishing of the end of the bore of the pipe, for not more than 100 mm, shall be permitted to rectify the thinning of linings.

16.7.3.10 Fittings shall be centrifugally spray lined to the same requirements as straight pipes or, if this is precluded by their shape, be hand finished and cured so as to achieve comparable results.

### Table 12. Thickness of cement mortar lining

<table>
<thead>
<tr>
<th>Outside diameter of tube or special (mm)</th>
<th>*Minimum thickness of cement mortar (mm)</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 323.9</td>
<td>6</td>
<td>+ 2, - 0</td>
</tr>
<tr>
<td>355.6 – 610</td>
<td>7</td>
<td>+ 2, - 0</td>
</tr>
<tr>
<td>660 – 1219</td>
<td>9</td>
<td>+ 2, - 0</td>
</tr>
<tr>
<td>1422 - 2743</td>
<td>12</td>
<td>+ 3, - 0</td>
</tr>
</tbody>
</table>

* Thicker linings may be specified

16.7.4 Spun cement mortar lining

The lining materials, thicknesses and tests shall comply with the requirements for the centrifugally applied cement mortar lining as specified in 16.7.3. The method of application and the curing of the linings shall comply with the requirements for spun concrete linings as specified in 16.7.1.
16.7.5 Tests on concrete and cement mortar used for lining

Test blocks of the same material as used for the pipe lining shall be made in 100 mm or 150 mm cube moulds and subjected to cube crushing tests. Each block shall be removed from its mould as soon as practicable and cured under conditions of temperature and humidity identical with those in which the lining of the pipe is cured.

The cube strength of the test cube shall be not less than 17N/mm² after 7 days of curing and 31N/mm² after 28 days of curing. The density of the test cube shall be not less than 2300kg/m³ in the case of concrete and 2100 kg/m³ in the case of cement mortar.

Purchaser may specify Option 13 on the number of cube crushing tests required.

Option 13 The number of cube crushing tests required.

16.8 Stop Back of protection at ends

16.8.1 Pipes and fittings supplied with concrete or cement mortar linings which are to be joined together by internal welding shall have the lining stopped back at the ends a distance sufficient to permit welding of the joints without damage to the lining.

16.8.2 Pipes and fittings supplied with bitumen, and linings shall have the external protection stopped back a distance sufficient to permit assembly of the joint. The internal protection shall extend to pipe end.

Pipes and fittings to be joined together by welding shall have the external and internal protection stopped back at the end as follows

(a) Butt welded joint. 75mm from the ends of pipes to be welded.

(b) Sleeve welded joint. For sleeve and spigot sleeve length plus 75mm

In all cases, priming shall extend to the ends of the pipes.

16.9 Completion of protections at joints

16.9.1 External protection

When material is supplied to make good the joints, or to repair minor damage of sheathed or wrapped pipes and fittings, the material supplied shall be compatible with the factory coating.

The purchaser should state in the enquiry and order his requirements for material to be supplied (Option 14).

Option 14 Material for completing the internal and external protection of joints at site is required.

A sufficient quantity of primer, bitumen based or coal tar based composition, and glass tissue cloth where appropriate, should be supplied with each consignment to cover the joints after laying and to repair minor damage.

16.9.2 Internal protection

When material is supplied to make good the joints, or to repair minor damage of bitumen lined pipes or fittings, the material supplied shall be compatible with the factory coating.
The purchaser should state in the enquiry and order his requirements for material to be supplied (Option 14).

Option 14 Material for completing the internal and external protection of joints at site is required.

A sufficient quantity of lining material should be supplied with each consignment to ensure continuity of the internal protection at joints and to repair minor damage.

16.10 Protection of coated and lined pipes against damage in storage, transport and handling

16.10.1 Coated pipes and fittings shall be protected against damage in storage, transport and handling, e.g. by using straw or wood wool pads.

16.10.2 The ends of all lined pipes and fittings shall be covered to exclude foreign matter during transit and storage.

NOTE. Suitable protection may be in the form of plugs, discs or plastic sheeting.
Appendix A : Electrical test for continuity.  
(Normative).

A.1 Principle.

Possible faults in the protection are examined for using a high tension scanning electrode.

A.2 Equipment.

A.2.1 Variable voltage detector (Holiday detector).

A.2.2 Scanning electrode, in the form of a metallic brush or a jointed spiral spring or conductive rubber.

A.3 Procedure.

Ensure that the pipe and fittings protection is free from surface moisture. Connect the metal substrate, if possible, to earth.

Check at the time of testing that the spark length from the apparatus is 10mm or twice the minimum specified thickness of the coating, whichever is the greater.

Place the electrode in contact with the surface to be tested. Operate the electrode with a continuous movement at the rate recommended by the manufacturer of the equipment. In the absence of such recommendations, operate the electrode at a rate of approximately 0.2m/s.

When the brush passes over a fault, a spark will be produced between the electrode and the pipe.

Locate the fault.
Acknowledgements

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