BRITISH STANDARD

BS 7838:1996
Incorporating Amendment No. 1

Specification for

Corrugated stainless steel semi-rigid pipe and associated fittings for low-pressure gas pipework of up to DN 50

ICS 23.040.10; 23.040.40

Confirmed February 2012

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee GSE/1, Gas fittings and connections, upon which the following bodies were represented:

British Combustion Equipment Manufacturers' Association

British Gas plc

British Rubber Manufacturers' Association Ltd.

British Turned-parts Manufacturers' Association

LP Gas Association

Society of British Gas Industries

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Contents

Foreword

This British Standard has been prepared by Technical Committee GSE/1. It gives requirements for bendable corrugated stainless steel pipe and associated fittings for the supply of 1st, 2nd and 3rd family gases. The requirements relate to materials, dimensions, mechanical properties and performance.

Information to be provided concerning installation is included in Annex A. It is anticipated that this will eventually form the basis of a separate installation standard analogous to BS 6891.

Product certification. Users of this British Standard are advised to consider the desirability of third-party certification of product conformity with this standard, based on testing and continuing product surveillance, which may be coupled with assessment of a supplier's quality system against the appropriate standard in the BS EN ISO 9000 series.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 25 and a back cover.

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1 Scope

This British Standard specifies requirements for semi-rigid (bendable) corrugated stainless steel pipe and associated fittings in the nominal size range DN 10 to DN 50 and intended for use as installation pipework for the supply of 1st, 2nd and 3rd family gases in permanent buildings. It applies to corrugated pipe and fittings which are suitable for a maximum working pressure of 75 mbar when installed in accordance with BS 6891 or BS 5482-1 in domestic premises, or in accordance with the Institution of Gas Engineers publication IGE/UP/2 [1] in other premises. Requirements for the protection of the outer surface of the corrugated pipe by a coating or a cover are included.

Corrugated stainless steel semi-rigid pipe to this standard is not intended for applications in which during installation, or subsequent to installation, it can be subjected to repeated bending (see **A.5**).

Information to be provided in the installation instructions is specified in Annex A.

Annex B gives guidance on the nature of the requirements and test methods, to assist in the preparation of quality plans for the manufacture of corrugated pipe and fittings.

Annex C gives the suggested sizes of fittings.

NOTE 1 A typical method of installation, using corrugated pipe and fittings conforming to this standard, is to connect the meter outlet to a centrally placed manifold by the use of suitably sized corrugated pipe. Each appliance can then be connected directly to the manifold, again by the use of suitably sized corrugated pipe. Alternatively, for small installations, tees can be used. As the corrugated pipe can be readily bent to the required shape, bend and sweep fittings are generally not required.

NOTE 2 The threaded end-fittings covered by this standard are required to conform to BS 21 (see **6.4**) and are therefore suitable for use in conjunction with fittings to BS 143 & 1256 or BS EN 10242 which have jointing threads in accordance with BS 21.

NOTE 3 Attention is drawn to the possibility of restricted access on site and the need to consider the application of forces and torques required for assembly, particularly for larger diameters, when designing and planning the installation.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 24. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the definitions given in BS 1179:1967 and BS 1179-6:1980 apply, together with the following.

3.1
bend radius
the radius measured to the axial centre-line of the corrugated pipe

3.2
coating
a layer of material bonded to the external surface of the corrugated pipe by the manufacturer and intended to improve the resistance of the pipe to external corrosion and mechanical damage

3.3
cover
a tubular outer sheath applied to the corrugated pipe by the manufacturer and intended to improve the resistance of the pipe to external corrosion and mechanical damage

3.4 Fittings

3.4.1
capillary adaptor
a fitting with one end intended for connection to corrugated pipe and the other end having a spigot for soldering into a capillary fitting

3.4.2
end-fitting
a fitting with one end intended for permanent attachment to corrugated pipe, and the other end threaded to BS 21

3.4.3
connector
a coaxial fitting with both of its ends intended for permanent attachment to corrugated pipe

3.4.4
manifold
a multiway fitting able to accept one threaded inlet connection and three or more threaded outlet connections

3.4.5
meter union
a fitting with an outlet intended for permanent attachment to corrugated pipe and an inlet suitable for direct connection to the meter outlet

3.4.6
strapped elbow
a fitting with one end intended for permanent attachment to corrugated pipe and the other end threaded to BS 21, and including a right-angle bend and lugs for wall mounting

3.4.7
push end-fitting
end-fitting intended to form a leak tight seal when assembled by the application of a linear force to the fitting

3.4.8
screw end-fitting
end-fitting intended to form a leak tight seal when assembled by the application of a tightening torque to the fitting

3.5
gasway
a duct conveying gas

3.6
manufacturer's instructions
instructions issued by the manufacturer for the assembly and installation of the corrugated pipe, fittings and component parts

3.7
nominal size (DN)
a numerical designation of size which is common to all components in a piping system other than components designated by outside diameter or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions

3.8
non-chlorinated material
a synthetic polymer or elastomer with a total chloride content not exceeding 50 ppm

3.9
retaining device
a circlip or other fastener providing a mechanical connection between an end-fitting and a corrugated pipe

3.10
semi-rigid
capable of being bent by hand without tools during installation

NOTE The term "bendable" is sometimes used as a synonym for "semi-rigid".

3.11
visible
that can be seen when examined in daylight or normal room lighting, by the unaided eye, corrected, if necessary, for abnormal vision

4 Materials

4.1 Corrugated pipe

The corrugated pipe shall be manufactured from one of the following materials:

a) stainless steel strip, conforming to grade 304S11, 316S11, 320S31 or 321S31 of BS 1449-2:1983;

b) seamless stainless steel tube with composition and properties as for grade 304S11, 316S11, 320S31 or 321S31 of BS 1449-2:1983.

4.2 Coating or cover

The coating or cover shall be of a non-chlorinated material.

4.3 Fittings (see 3.4)

Fittings shall be made from material conforming to one of the following specifications:

a) BS 970 303 S31	stainless steel for machining;
b) BS 970 316 S11	stainless steel for machining;
c) BS 970 316 S31	stainless steel for machining;
d) BS 970 321 S31	stainless steel for machining;
e) BS 1400 DCB 1	brass for gravity die casting;
f) BS 1400 LG 2	gunmetal for casting;
g) BS 1400 LG 3	gunmetal for casting;
h) BS 2872 CZ 122	brass for hot stamping;
i) BS 2874 CZ 121 Pb3	brass for machining;
j) BS 2874 CZ 121 Pb4	brass for machining;
k) BS 6681 B30-06	malleable iron for casting;
l) BS 6681 W35-04	malleable iron for casting.

Fittings intended for soldering (see **6.3.9**) shall be made from material conforming to e), f), g), h), i) or j) above.

4.4 Elastomeric seals

4.4.1 An elastomeric seal which is exposed to gas shall be a static seal made from material conforming to class A2/H3 of BS EN 549:1995, and shall be coloured black.

4.4.2 If a second elastomeric seal is required to enable end-fittings to meet the requirements of **9.6**, it shall be made from silicone and be colourless or coloured white. The seal shall be fitted outside the seal described in **4.4.1**.

4.4.3 If the hardness of the seals is outside the range 66 to 75 IRHD, the hardness should be stated in the manufacturer's instructions.

NOTE It is recommended that seals be in the hardness range 66 to 75 IRHD.

4.4.4 Seals shall be resistant to damage during assembly when assembled in accordance with the manufacturer's instructions. If a fitting tool is necessary for assembly, the tool shall be supplied with the seals or corrugated pipe and its use stipulated in the manufacturer's instructions.

4.5 Retaining device

The retaining device shall be made from one of the materials specified in **4.3**, or from one of the following spring steels which can be assembled without permanent set:

a) carbon spring steel, phosphated and oiled, conforming to condition and grade CS70 or CS80 of BS 1449-1.15;

b) hard drawn stainless steel wire conforming to BS 2056.

NOTE The joint between a connector (both ends), end-fitting (one end), meter union (one end), strapped elbow (one end) or tee (all three ends) and the corrugated pipe will typically incorporate two elastomeric seals and a steel retaining device.

5 Finish

5.1 Corrugated pipe

5.1.1 Welds shall be free from globular deposits, discontinuities, porosity and undercutting, and shall have a regular surface. The bore of the corrugated pipe shall be clean and free from swarf and other foreign matter. The ends of the corrugated pipe, as supplied, shall be cleanly cut and free from burrs.

5.1.2 The corrugated pipe shall be coated or fitted with a tightly fitting cover in accordance with **4.2** and **6.2**.

5.1.3 The corrugated pipe shall be free from dents and shall be supplied either straight or coiled, without kinks or other irregularities.

5.2 Fittings

5.2.1 Gravity die-castings shall be sound in all respects, free from laps, blow holes, pitting and other defects likely to affect the integrity of the pipework. All surfaces not machine-finished shall be clean and smooth. The castings shall be neatly dressed and no casting shall be rectified by burning, plugging, stopping or patching.

5.2.2 Hot brass stampings shall be sound and solid without laminations, and shall be smooth and well finished.

5.2.3 Machined components shall be of a fine finish and free from scores and surface defects likely to affect the integrity of the pipework. The texture of surfaces intended for capillary soldering or in contact with any seal, during or after assembly, shall not exceed 0.8 mm R_a, in accordance with BS 1134-1 and BS 1134-2.

5.2.4 Gasways and washer seatings shall be free from burrs and sharp edges. The interior of components shall be free from swarf and other foreign matter.

5.2.5 Components shall be free from scores, dents, cuts and other damage likely to cause a malfunction of the component.

6 Design and dimensions

6.1 Corrugated pipe

6.1.1 The corrugated pipe shall be constructed from single-ply seamless or single longitudinally butt-welded tube, subsequently annularly corrugated. The corrugations shall be of uniform height and pitch, and continuous along the length of the pipe. Transverse jointing of strip or circumferential jointing of pipe shall not be permitted at any stage of manufacture. If jointing is carried out after corrugating (prior to coating or covering), such jointing shall be either machine butt-welded or machine edge-welded as shown in Figure 1 and all the appropriate tests described in clauses **8** and **9** shall be carried out on pipe incorporating such jointing.

6.1.2 The dimensions of the corrugated pipe shall be as given in Table 1.

Table 1 — Dimensions of corrugated pipe

Nominal size of pipe DN	Maximum external diameter of bare metal pipe mm	Minimum thickness of steel (finished product) mm
10	13,5	0,18
12	16	0,18
15	20	0,20
22	27	0,25
28	34	0,25
32	42	0,30
40	48	0,30
50	63	0,30

6.2 Coating or cover

6.2.1 The corrugated pipe shall have a coating or cover suitable for continuous use at a temperature of 95 °C.

6.2.2 The coating or cover shall have a minimum thickness of 0.5 mm.

6.2.3 The coating or cover shall be coloured yellow in accordance with BS 4800:1989, colour code 08C35 or 10E53.

6.3 Fittings

6.3.1 *General*

NOTE A suggested range of fittings is given in Annex C.

6.3.1.1 The end designed to receive corrugated pipe shall be of the same design for all fittings.

NOTE Consideration should be given to forces and torques required for assembly, particularly for larger diameters, when designing and planning the installation, due to the possibility of restricted access on site.

a) Butt-welded b) Edge-welded

Figure 1 — Jointing of corrugated pipe

6.3.1.2 The joint between the coated or covered pipe and the fitting shall be designed to resist the passage of liquids. If it is necessary to fit a boot or sleeve in order to achieve a liquid-resistant joint, this shall be stated in the manufacturer's instructions.

NOTE This requirement is to prevent liquids from reaching the stainless steel.

6.3.1.3 The wall thickness between any gasway and any exterior surface of a fitting shall be not less than 1 mm at any point. Fittings shall be free from internal fins or other irregularities which might restrict the free flow of gas, and shall be designed so that resistance to the flow of gas is minimized. Castings shall be free from visible porosity.

6.3.2 *Connectors*

Connectors shall have both ends designed to receive corrugated pipe directly.

6.3.3 *Straight end-fittings*

Straight end-fittings shall have one end designed to receive corrugated pipe directly. The other (threaded) end shall be in accordance with **6.4**. The ends shall be coaxial.

6.3.4 *Elbow end-fittings*

Elbow end-fittings shall have bends of 90° ± 1°. One end shall be designed to receive corrugated pipe directly and the other (threaded) end shall be in accordance with **6.4**.

6.3.5 *Tees*

Tees shall have all ends designed to receive corrugated pipe directly.

6.3.6 *Manifolds*

Manifolds shall have an inlet and three or more outlets. Where threaded, the inlet/outlet shall conform to **6.4**. The axes of the outlets shall be parallel. Where manifolds accept corrugated pipe directly, they shall satisfy the requirement of **6.3.1.1**.

Manifolds shall have a minimum of two fixing holes not less than 5.5 mm in diameter, positioned so that the fixings will adequately support the manifold and associated fittings. The distance between the centres of the holes shall be not less than $0.4l$, where l is the overall length of the manifold, measured parallel to the axis of the inlet. (See also **6.3.1.3**.)

6.3.7 *Meter unions*

Meter unions shall comprise an inlet (with a nut and washer) conforming to BS 746 and an outlet to receive corrugated pipe directly. The axes of the inlet and outlet shall be at an angle to each other of 90° ± 1°.

6.3.8 *Strapped elbows*

Strapped elbows shall have an inlet designed to receive corrugated pipe directly and an outlet threaded in accordance with BS 21. The outlet shall be at an angle of 90° ± 1° to the inlet and its axis shall be perpendicular to the back plane.

6.3.9 *Capillary adaptors*

Capillary adaptors shall have one end designed to receive corrugated pipe directly. The other end shall have a spigot, for soldering to a capillary fitting conforming to **10.9** of BS 864-2:1983. The length of the capillary adaptor shall be such that, when installed, the distance between the end of the corrugated pipe and the end of the capillary fitting is not less than 5 mm.

6.4 Threads

Dimensions of the threads of threaded ends shall conform to clause **4** of BS 864-2. Meter union threads shall conform to BS 746. All other threads shall conform to BS 21.

NOTE The threaded end-fittings covered by this standard are required to conform to BS 21 and are therefore suitable for use in conjunction with fittings to BS 143 & 1256 or BS EN 10242 which have jointing threads in accordance with BS 21.

The gauging system for BS 21 threads on end-fittings, manifolds and tees shall be in accordance with appendix A (system B) of BS 21:1985, except that the chamfer at the start of the thread shall not exceed one thread pitch and shall be angled at 45° ± 5°.

7 Soundness test

7.1 General

Perform this test initially on the samples of corrugated pipe, the test assembly or the fittings (as appropriate) which are to be tested in accordance with the subclauses given in Table 2. Repeat the test on the same samples after they have been tested in accordance with these subclauses.

Table 2 — Application of soundness test

Type of sample	Test the sample before and after testing in accordance with subclause
Uncoated/uncovered corrugated pipe	**8.2**, **8.3**, **8.4**
Coated/covered corrugated pipe	**9.2**, **9.3**, **9.4**, **9.5**, **9.6**, **9.7**, **9.8**, **9.9**
Test assembly (see **10.1**)	**10.2**, **10.3**, **10.4**, **10.7**
Fitting	**11.2**, **11.3**, **11.4**

7.2 Requirement

The sample shall show no sign of leakage.

7.3 Method

Immerse the sample in water. While immersed, subject the sample to an internal air pressure of at least 2 bar for a period of (60 ± 5) s. With the unaided eye, observe the sample for signs of leakage, indicated by the presence of air bubbles. An alternative test offering at least an equivalent level of accuracy of leak detection may be used.

8 Type tests on corrugated pipe (bare metal)

8.1 General

The tests of **8.2**, **8.3** and **8.4** shall be performed before the application of any coating or cover to the pipe.

8.2 Bend test

8.2.1 *Requirement*

The corrugated pipe shall show no visible sign of cracking.

8.2.2 *Method*

Place a 500 mm ± 5 mm length of corrugated pipe between two parallel cylindrical formers such that the bend radius is as given in Table 3. Fix one end of the corrugated pipe rigidly in position 150 mm ± 5 mm below the horizontal axis of the formers. Take care to ensure that the corrugated pipe is not crushed or otherwise damaged during the setting up.

Bend the corrugated pipe over one former, making contact for 90° of its circumference, into the starting position for the test (see position A, Figure 2).

Over 10 s bend the pipe at a uniform rate through 180° in the opposite direction, making contact for 90° of the circumference of the former (see position B, Figure 2). At the same rate, bend the pipe back to position A. Repeat this procedure until the pipe has been bent a total of 12 times through 180°.

Table 3 — Bend test

Nominal size of pipe DN	Bend radius mm
10	20
12	25
15	25
22	30
28	45
32	60
40	95
50	125

8.3 Welded seam test

8.3.1 *General*

This test shall be performed on corrugated pipe which is constructed from single longitudinally butt-welded tube (see **6.1.1**).

8.3.2 *Requirement*

The welded seam shall show no visible sign of cracking or permanent impairment.

8.3.3 *Method*

Wrap a 1 m ± 5 mm length of corrugated pipe tightly and closely around a cylindrical former such that the bend radius is as given in Table 3, and so that the welded seam of the pipe faces outwards. Commence at a position in the centre of the corrugated pipe and wrap the pipe through two complete turns. Perform this procedure three times, unwrapping the pipe to approximate straightness before each repeat.

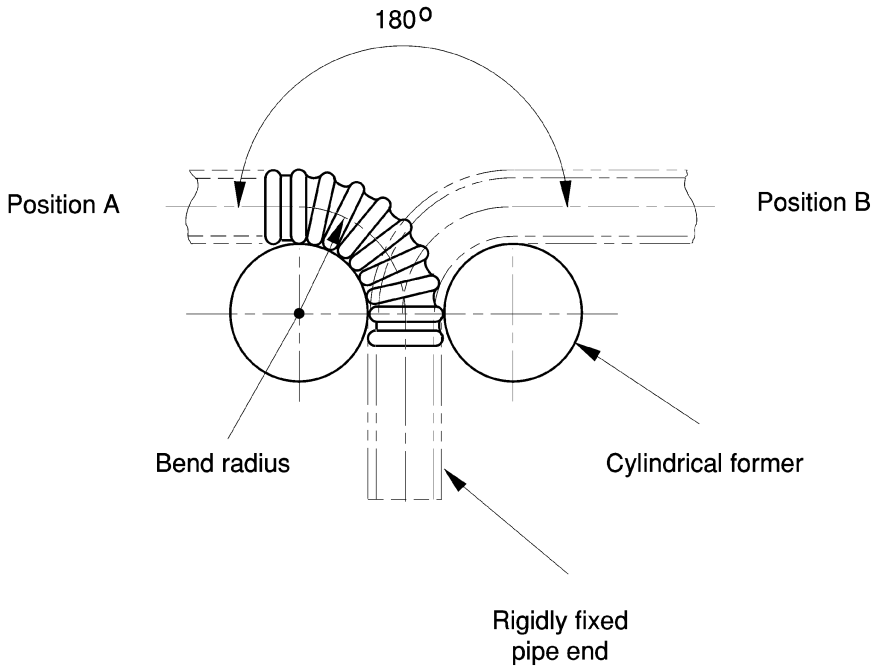

Figure 2 — Bend test for corrugated pipe

If, owing to the method of manufacture, the seam is not straight, rotate the corrugated pipe between each test so that the seam appears uppermost at the centre for the first test, at one end for the second test and at the other end for the third test.

8.4 Pressure drop test

8.4.1 *Requirement*

The pressure drop shall not exceed the appropriate value given in Table 4.

8.4.2 *Method*

Pass gas with a relative density of 0.6, or air, through a 1 000 $^{+5}_{0}$ mm straight length of corrugated pipe, without fittings, at the appropriate flow rate given in Table 4. Measure and record the pressure drop.

Table 4 — Pressure drop test

Nominal size of pipe	Flow rate (minimum)	Pressure drop (maximum)	
	Gas or air	Gas	Air
DN	m3/h	mbar	mbar
10	0,2	0,04	0,06
12	0,5	0,05	0,07
15	1	0,05	0,07
22	2	0,06	0,08
28	4	0,07	0,09
32	8	0,102	0,132
40	16	0,184	0,238
50	48	0,338	0,437

9 Type tests on corrugated pipe complete with coating or cover

9.1 General

The tests of **9.2**, **9.3**, **9.4**, **9.5**, **9.6**, **9.7**, **9.8** and **9.9** shall be carried out on the corrugated pipe after the application of the coating or cover and after marking as specified in clause **13**.

9.2 Bend test

9.2.1 *Requirement*

The corrugated pipe and coating or cover shall show no visible sign of splitting or cracking.

9.2.2 *Method*

Proceed as described in **8.2.2**.

9.3 Impact test

9.3.1 *Requirement*

The cross-sectional area of the corrugated pipe shall not decrease by more than 50 % of the original cross-sectional area. During the test and during the next 5 min there shall be no loss of pressure.

9.3.2 *Apparatus*

9.3.2.1 *Hardened steel striker* of 3 kg mass, with a flat end 12 mm ± 0.2 mm in diameter.

9.3.2.2 *Rigid tube* of smooth bore, in which the striker (**9.3.2.1**), with an overall clearance of not more than 0.5 mm, is free to slide, as shown in Figure 3.

9.3.3 *Method*

Support a 500 mm ± 5 mm length of corrugated pipe evenly in a vee block on a flat steel surface and apply to it internally a pneumatic pressure of 350 mbar ± 0.5 mbar. Using the apparatus described in **9.3.2**, make a series of five impacts of 14 J at 100 mm intervals along the centre of the corrugated pipe. During the test and during the next 5 min, monitor the pressure in the pipe.

9.4 Scratch resistance test

9.4.1 *Requirement*

The coating or covering shall not be fully penetrated.

9.4.2 *Apparatus*

The apparatus shall be in accordance with clause **4** of BS 3900-E2:1992 or in accordance with **B.1** of BS 4161-3:1989.

9.4.3 *Method*

Fit end plugs with centre holes to a 50 mm ± 5 mm length of corrugated pipe with its coating or cover. Mount the pipe with end plugs between centres such that the pipe can be rotated under the test point, with the crest of a corrugation under the test point. Adjust the apparatus to apply a force of 30 N, and rotate the pipe through 350° ± 5°, at a surface speed of 35 mm/s ± 5 mm/s. Visually examine the coating or covering for penetration.

9.5 Chemical resistance test

9.5.1 *Requirement*

There shall be no visible sign of blistering, cracking or penetration of the coating or cover.

9.5.2 *Method*

9.5.2.1 Perform the test described in **9.5.2.2** using each of the following liquids in turn:

a) lubricating oil (see note 1);

b) pentane (C_5H_{12});

c) toluene (C_7H_8);

d) heptane (C_7H_{16});

e) digol ($C_4H_{10}O_3$);

f) methanol (CH_3OH);

g) deionized or distilled water (H_2O);

h) detergent (see note 2).

NOTE 1 A suitable lubricating oil is "Shell Oil Vitrea 22".

NOTE 2 A suitable detergent is "Shell Teepol HB7".

Use a separate test sample for each liquid.

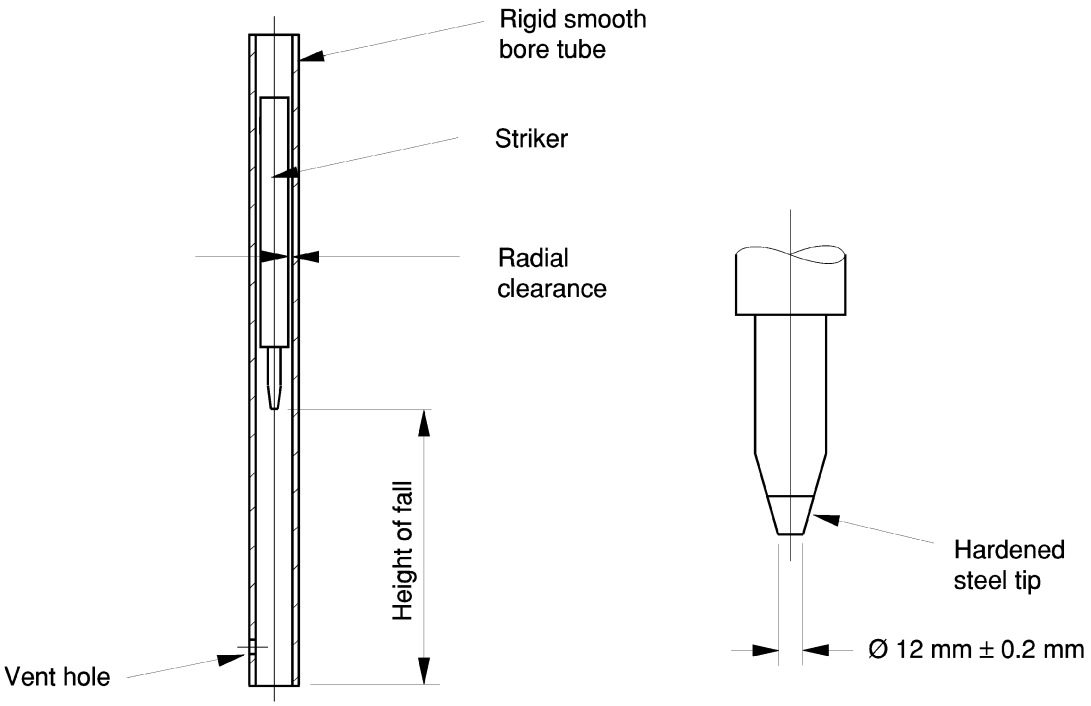

Figure 3 — Impact test

9.5.2.2 Bend a 500 mm ± 5 mm length of corrugated pipe through 90° over a cylindrical former to the bend radius given in Table 3. Partially immerse the length of pipe in the appropriate liquid (see **9.5.2.1**) at 20 °C ± 2 °C, so that at least 80 mm of the length of the sample, including the bend, is below the liquid surface. Leave the sample immersed for a period of 1 000 h.

9.6 Low-temperature flexibility test

9.6.1 *Requirement*

The corrugated pipe and coating or cover shall show no visible sign of splitting or cracking.

9.6.2 *Method*

Subject a length of corrugated pipe to the test described in method B (clause **4**) of BS EN 24672:1993, using a mandrel to bend the pipe to the appropriate radius specified in Table 3. Conduct the test at a temperature of –15 °C ± 2 °C. Do not perform the pressure test described in the last paragraph of **4.4** of BS EN 24672:1993.

9.7 High-temperature ageing test

9.7.1 *Requirement*

The corrugated pipe and coating or cover shall show no visible sign of splitting or cracking.

9.7.2 ***Apparatus***

9.7.2.1 *Oven*, as described in **3.2.1** or **3.2.2** of BS 903-A19:1986.

9.7.3 ***Method***

Preheat the oven (**9.7.2.1**) to a temperature of 95 °C ± 2 °C. Place a length of corrugated pipe in the oven for 21 days. Maintain the oven at 95 °C ± 2 °C throughout this period.

On completion of the heating period, remove the pipe from the oven and allow the pipe to cool to a temperature of 20 °C ± 2 °C. Using a mandrel, bend the pipe to the appropriate radius specified in Table 3.

9.8 Ozone resistance test

9.8.1 ***Requirement***

The corrugated pipe and coating or cover shall show no visible sign of splitting or cracking.

9.8.2 ***Method***

Expose a length of corrugated pipe to ozone for 168 h in accordance with method 1 of BS EN 27326:1993, using a test-piece holder to give the appropriate bend radius specified in Table 3.

9.9 Ultraviolet resistance test

9.9.1 ***Requirement***

There shall be no cracking or change in colour or appearance of the coating or cover.

9.9.2 ***Method***

Expose a length of corrugated pipe to ultraviolet radiation in accordance with method 1 of BS EN ISO 8580:1995.

10 Type tests on test assemblies

10.1 General

Each test shall be carried out on a test assembly consisting of a 500 mm ± 5 mm length of corrugated pipe (coated or covered) and two straight end-fittings in accordance with Table 5 (including all the appropriate seals and other components), assembled in accordance with the manufacturer's instructions. All components of the test assembly shall have been marked in accordance with clause **13**.

Table 5 — End-fittings (basic sizes) for test assemblies — Bend test

End to receive corrugated pipe DN	**End threaded to BS 21**
10	R $\frac{1}{4}$
12	R $\frac{3}{8}$
15	R $\frac{1}{2}$
22	R $\frac{3}{4}$
28	R 1
32	R 1 $\frac{1}{4}$
40	R 1 $\frac{1}{2}$
50	R 2

10.2 Bend test

10.2.1 ***Requirement***

The test assembly shall show no visible sign of cracking or permanent impairment.

10.2.2 ***Method***

Place the test assembly between two cylindrical formers such that the bend radius is as given in Table 3. Fix one of the end-fittings of the assembly rigidly in position, so that the horizontal axis of the formers is in the same plane as the end face of the fitting (see Figure 4).

Bend the assembly over one former, making contact for 90° of its circumference, into the starting position for the test (see position A, Figure 4).

Over 10 s, bend the assembly at a uniform rate through 180° in the opposite direction, making contact for 90° of the circumference of the former (see position B, Figure 4). At the same rate, bend the assembly back to position A. Repeat this procedure until the assembly has been bent a total of 12 times through 180°.

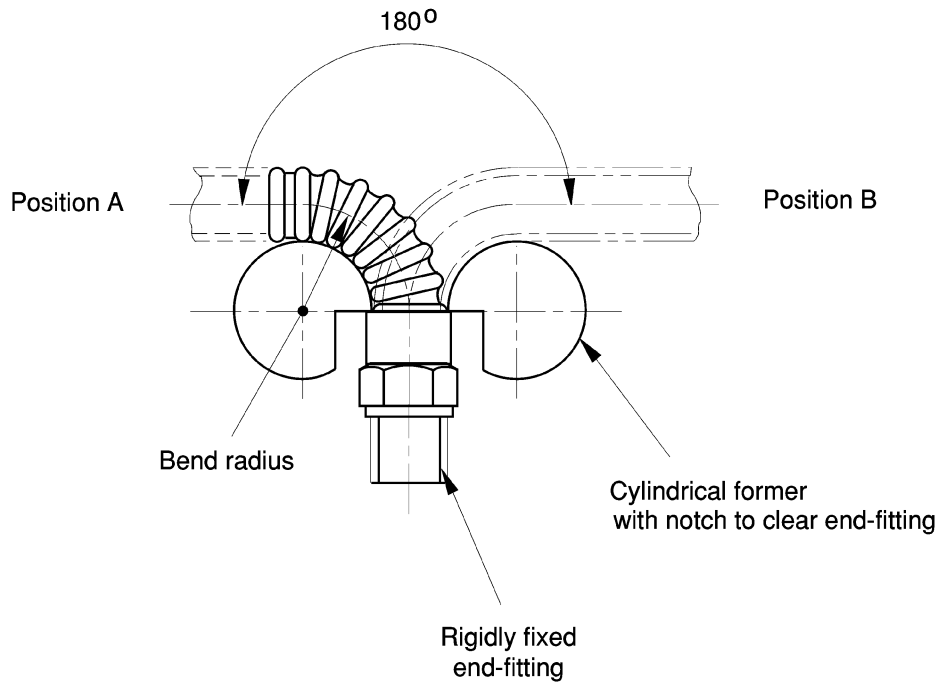

Figure 4 — Bend test for corrugated pipe to end-fitting joint

10.3 Impact test

10.3.1 ***Requirement***

During the test and during the next 5 min there shall be no loss of pressure.

10.3.2 ***Method***

Screw the test assembly into a BS 21 R_c threaded block. Support the block rigidly so that the corrugated pipe is horizontal. Subject the pipe to an internal pneumatic pressure of 350 mbar ± 0.5 mbar. Using the test apparatus described in **9.3.2**, strike with an impact energy of 14 J the furthest surface of the end-fitting that is screwed into the manifold. During the test and during the next 5 min, monitor the pressure in the pipe.

10.4 Tensile test

10.4.1 ***Requirement***

The corrugated pipe shall show no sign of leakage, as tested by the method given in clause **7**.

NOTE Extension of the corrugated pipe is acceptable.

10.4.2 ***Method***

Subject the test assembly to the appropriate tensile force given in Table 6, for a period of 5 min, by applying the force without shock to the end-fittings.

Table 6 — Tensile test

Nominal size of pipe DN	Tensile force N
10	500
12	700
15	1 400
22	2 200
28	3 000
32	3 800
40	4 600
50	6 000

10.5 Hydraulic pressure test

10.5.1 *Requirement*

The test assembly shall show no sign of leakage. During the test, there shall be no loss of pressure.

NOTE Extension of the corrugated pipe is acceptable.

10.5.2 *Method*

Subject the test assembly to an internal hydraulic pressure of 20 bar for a period of 60 s ± 5 s. Monitor the pressure and check for leakage.

10.6 Fire resistance test

10.6.1 *General*

Where the corrugated pipe is to be supplied with a coating, the test shall be carried out on coated corrugated pipe. Where the corrugated pipe is to be supplied with a cover, the test shall be carried out on the corrugated pipe without the cover.

10.6.2 *Requirement*

With the exception of the coating, the test assembly shall not collapse, melt or show any significant deformation during the test period. Throughout the test, the leakage rate of the test assembly shall not exceed 140 dm^3/h, whilst a constant test pressure of 50 mbar is maintained. After cooling to room temperature, the end-fittings shall show no visible sign of cracking, and shall remain securely attached to the corrugated pipe.

10.6.3 *Apparatus*

10.6.3.1 *Furnace* that produces standard heating conditions as specified in **6.1** of BS 476-20:1987, for a temperature rise of 821 K, and of sufficient size to accept the test assembly in the form described in **10.6.4**.

The apparatus shall permit air to be supplied to the test assembly.

10.6.3.2 *Air supply* to the apparatus, with arrangements for recording the flow rates and pressures of the air supplied.

10.6.4 *Method*

Bend the test assembly into a U shape with a bend radius of 75 mm ± 10 mm and straight portions of equal length. Connect the test assembly to the apparatus so that the end-fittings are uppermost and positioned in the centre of the furnace. With the bleed valve closed, apply an internal air pressure of 50 mbar to the test assembly and check that no loss of pressure occurs.

With the test assembly at a pressure of 50 mbar, increase the temperature of the furnace by 821 K over a period of 30 min in accordance with the temperature/time curve shown in Figure 2 of BS 476-20:1987. During the specified temperature rise, maintain the internal pressure at 50 mbar by means of the bleed valve. Record the leakage rate. After 30 min, allow the test assembly to cool to room temperature.

10.7 Torsion test

10.7.1 *Requirement*

The test assembly shall show no visible sign of cracking or other damage.

10.7.2 *Method*

Secure one end-fitting of the test assembly in a BS 21 R_c threaded block as shown in Figure 5. Rotate the other end-fitting around its longitudinal axis until the applied torque has reached the value given in Table 7 or until the free end of the test assembly has passed through 10 complete rotations, whichever is the sooner. During the test, restrain the end-fittings so that the length of the test assembly remains the same and the axes of the end-fittings remain in line.

Table 7 — Torsion test

Nominal size of pipe DN	Torque N·m
10	6
12	9
15	15
22	25
28	30
32	45
40	60
50	80

10.8 Electrical resistance test

10.8.1 *General*

In the case of corrugated pipe with a cover, the electrical resistance test shall be carried out with the cover stripped back from the ends of the pipe and the end-fittings reattached in accordance with the manufacturer's instructions.

10.8.2 *Requirement*

The electrical resistance between an end-fitting and the other end-fitting, and between an end-fitting and any other accessible metallic part, shall not exceed the values given in Table 8.

Table 8 — Electrical resistance

Nominal size of pipe DN	Resistance Ω
10	0,30
12	0,25
15 to 28	0,20
32 to 50	0,15

10.8.3 *Method*

Pass a current of 25 A, derived from an a.c. source having a no-load voltage not exceeding 12 V, between an end-fitting of the test assembly and each of the accessible metal parts in turn. Measure the voltage drop between the end-fitting and any accessible metal part. Calculate the resistance from the voltage drop and the current.

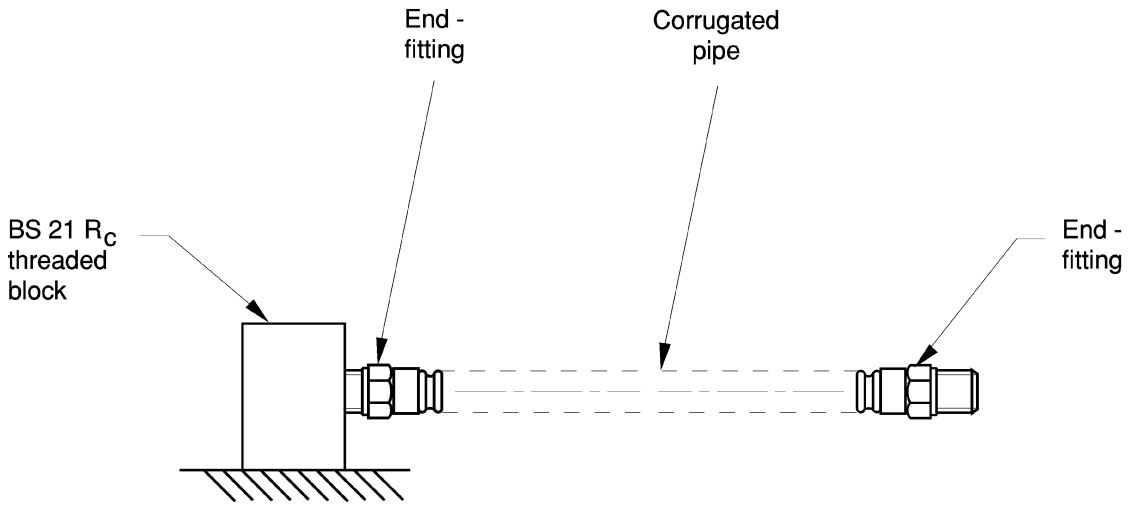

Figure 5 — Torsion test

11 Type tests on fittings and seals

11.1 General

Straight end-fittings shall be used in the type tests to demonstrate the suitability of the design for all types of end-fitting.

The tests shall be performed on samples that have been marked in accordance with clause **13**.

11.2 Assembly force test for push end-fittings

11.2.1 *Requirement*

The force required during the assembly of a straight end-fitting shall not exceed 150 N for fittings up to and including DN 28 and 200 N for larger sizes. The fitting shall satisfy the requirements of **7.2** and **7.3** after the assembly force test.

11.2.2 *Method*

Perform the test using a 500 mm ± 5 mm length of corrugated pipe and the component parts of a straight end-fitting. In the case of coated components this test shall be carried out with the corrugated pipe in the coated condition.

Assemble the straight end-fitting to the corrugated pipe in accordance with the manufacturer's instructions and record the peak force necessary during assembly.

11.3 Assembly torque test for screw end-fittings

11.3.1 *Requirement*

The torque required during the assembly of a straight end-fitting shall not exceed the manufacturer's specification. The fitting shall satisfy the requirements of **7.2** and **7.3** after the assembly torque test (see note to **6.3.1.1**).

11.3.2 *Method*

Perform the test using a 500mm ± 5 mm length of corrugated pipe and the component parts of a straight end-fitting.

Assemble the straight end-fitting to the corrugated pipe in accordance with the manufacturer's instructions and record the peak torque necessary during assembly.

11.4 Torsion test on internally threaded connection conforming to BS 21 (e.g. manifold connection)

11.4.1 *Requirement*

The fitting shall show no deformation, and shall show no sign of leakage when tested by the method given in clause **7**.

11.4.2 *Method*

Screw hand-tight into the threaded port of the fitting a 325 mm ± 25 mm length of steel pipe conforming to BS 1387 and threaded in accordance with BS 21 R.

If the fitting has fixing holes (with or without spanner flats), hold it down by means of fasteners of the appropriate size through the fixing holes.

If the fitting has spanner flats but no fixing holes, clamp it securely across a pair of opposing flats.

Apply to the pipe the test torque given in Table 9 for approximately 10 s. If the fitting has more than one threaded inlet/outlet, perform the test for each threaded inlet/outlet in turn.

Table 9 — Torsion and bending moment tests for fittings

Nominal inlet size Pipe thread to BS 21	Torque N·m	Bending moment N·m
¼	20	35
⅜	35	70
½	50	105
¾	85	225
1	125	340

11.5 Bending moment test on fittings with internally threaded connection conforming to BS 21 (e.g. manifold connection)

11.5.1 *Requirement*

The fitting shall show no deformation, and shall show no sign of leakage when tested by the method given in clause **7**.

11.5.2 *Method*

Perform this test immediately after the test of **11.2**, using the same sample of corrugated pipe assembled to the fitting. Clamp the corrugated pipe at a point within a distance of five pipe diameters (nominal) of the fitting. Apply to the pipe a force equivalent to the bending moment given in Table 9.

Apply this force for approximately 10 s in each of four directions perpendicular to each other and to the axis of the thread, including the direction of minimum strength of the fitting.

11.6 Assembly durability test on elastomeric seals

11.6.1 *Requirement*

The seal or seals shall show no significant damage.

11.6.2 *Method*

Assemble a straight end-fitting and a 150 mm ± 5 mm length of corrugated pipe in accordance with the manufacturer's instructions, but omit any fasteners which would prevent subsequent disassembly. Then disassemble this pipe and fitting.

Assemble and disassemble the same pipe and fitting a total of five times.

After the five cycles of assembly and disassembly, examine the seal or seals visually for physical damage.

11.7 Test for liquid penetration on corrugated pipe supplied with cover

NOTE The purpose of this test is to check that the cover makes a liquid-proof seal to the wall of the fitting (see **6.3.1.2**).

11.7.1 *Requirement*

The filter paper shall show no discoloration.

11.7.2 ***Apparatus***

11.7.2.1 *Filter paper*, white, 75 mm wide and equal in length to the overall length of the end-fitting which is to be used for the test.

11.7.2.2 *Bung, or cap* threaded in accordance with BS 21, to fit the end-fitting.

11.7.3 ***Method***

Assemble a 150 mm ± 5 mm length of corrugated pipe and a straight end-fitting (including the appropriate seals and other components) in accordance with the manufacturer's instructions. Before attaching the end-fitting, drill a 1 mm ± 0.1 mm diameter hole through the stainless steel wall between the end of the cover and the adjacent seal.

Roll up the piece of white filter paper (**11.7.2.1**) and place it inside the end-fitting. Fit the bung or cap (**11.7.2.2**) to the end-fitting, so as to provide a watertight seal. Bend the portion of the corrugated pipe adjacent to the fitting through an angle of 90°, at the appropriate radius given in Table 3.

Immerse the capped end-fitting and the adjacent portion of the corrugated pipe in water to which a coloured dye has been added, so that the top edge of the end-fitting is 10 mm below the surface of the liquid. After 48 h, remove the filter paper and visually examine it.

11.8 Test for excessive residual stress

11.8.1 ***General***

All types of brass component shall be subjected to this test.

11.8.2 ***Requirement***

No cracks shall be visible in the component.

11.8.3 ***Reagents***

11.8.3.1 *Nitric acid*, density 1.42 g/ml, 50 % *V/V* aqueous solution.

11.8.3.2 *Mercury (I) nitrate solution*, prepared as follows.

Dissolve 11.4 g of mercury (I) nitrate dihydrate ($HgNO_3.2H_2O$) or 10.7 g of mercury (I) nitrate monohydrate ($HgNO_3.H_2O$) in approximately 40 ml of distilled or deionized water acidified with 10 ml of nitric acid (**11.8.3.1**). When the crystals are completely dissolved, dilute the solution with distilled or deionized water to make up a volume of 1 000 ml.

NOTE If heating is used to aid dissolution, care should be exercised to prevent loss of nitric acid.

WARNING. Mercury (I) nitrate is highly toxic and should be treated with due care.

11.8.4 ***Method***

Ensure that the fitting is not marked for identification by indenting. During the selection and preparation of the fitting ensure that it is not subjected to further mechanical working that could raise its level of internal stress.

Degrease the component (e.g. in acetone). Totally immerse it in the nitric acid solution (**11.8.3.1**) for a period not exceeding 30 s, to remove all traces of carbonaceous matter and oxide film.

Remove the component, wash it thoroughly in cold water and totally immerse it in the mercury (I) nitrate solution (**11.8.3.2**). Use at least 1.5 ml of solution for each 100 mm^2 of exposed surface area of the fitting.

NOTE The solution should not be re-used for testing, unless the tester has the facility to assay the mercury (I) content and control it.

After immersion for 30 min, remove the component from the solution and wash it thoroughly in cold water. Wipe off excess mercury from the surface of the fitting. Examine the component immediately for visible evidence of cracks.

12 Production test on corrugated pipe

12.1 General

All pipe and circumferential welds, where used, shall be tested for soundness immediately prior to coating or covering.

NOTE Where excessive bending is applied during manufacture subsequent to this initial soundness test, a further test of the finished product for soundness prior to despatch is recommended, noting the necessity to ensure that the coating or covering is not inhibiting potential leakage.

12.2 Requirement

The corrugated pipe shall show no sign of leakage.

12.3 Method

Immerse the sample in water. While immersed, subject the sample to an internal air pressure of at least 2 bar for a period of at least (60 ± 5) s. With the unaided eye observe the sample for signs of leakage, indicated by the presence of air bubbles. An alternative test offering at least an equivalent level of accuracy of leak detection may be used.

13 Marking

13.1 Corrugated pipe

Corrugated pipe shall be permanently and legibly marked along its length with the following legend in black, repeated at intervals of 1 m.

The legend shall consist of the word "GAS" in lettering not less than 8 mm high, repeated three times at regular intervals within the metre, together with the following information marked once per metre:

a) the nominal size, e.g. DN 15;

b) the number and date of this British Standard, i.e. BS 7838:1996[1)]

c) the manufacturer's name;

d) the manufacturer's trade name or trade mark;

e) the month and year of manufacture, e.g. Oct 96;

f) a sequential number, increasing at 1 m intervals along the pipe.

Marking shall be made in a manner which does not cause distortion or affect the soundness of the pipe.

13.2 Fittings

The following information shall be marked on each fitting:

a) the nominal size, e.g. DN 15;

b) the number and date of this British Standard, i.e. BS 7838:1996[1)];

c) the manufacturer's name or trade mark;

d) the month and year of manufacture, e.g. Oct 96.

Marking shall be made in a manner which does not cause distortion or affect the soundness of the component.

14 Instructions for assembly and installation

The manufacturer shall provide full and detailed instructions, illustrated where appropriate, for the assembly and installation of corrugated pipe and fittings. The instructions shall include the substance of the information given in Annex A in a format appropriate to the product.

The instructions shall require that the components of the installation pipework be assembled, installed and tested in accordance with the instructions.

[1)] Marking BS 7838:1996 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annex A (normative)
Installation

A.1 Installation procedures

The installation pipework should be installed and tested in accordance with BS 6891 or the Institution of Gas Engineers publication IGE/UP/2 [1] as appropriate, supplemented by the manufacturer's instructions.

When designing and planning the installation, consideration should be given to the possibility of restricted access on site and the forces and torques required for assembly, particularly for larger diameters.

A.2 Compatible products

Corrugated pipe from a particular manufacturer should be assembled directly to fittings supplied or specified by the same manufacturer and should not be directly assembled to fittings from other sources.

A.3 Pipe sizes

Sizing of installation pipework should be carried out in accordance with the principles given in clause **4** of BS 6891:1988 and in section 4 of The Institution of Gas Engineers publication IGE/UP/2 [1], as appropriate. Account should be taken of the flow rates and pressure drops given in Table 4 of this standard.

A.4 Seals

Care should be taken to avoid damaging seals. Any damaged seals should be discarded.

A.5 Pipe supports and appliance connection

Corrugated stainless steel semi-rigid pipe to this standard should not be used where during installation, or subsequent to installation, it can be subjected to repeated bending. Corrugated stainless steel semi-rigid pipe to this standard is an alternative to traditional rigid pipe systems.

Installation pipework should be adequately supported in accordance with the requirements of BS 6891 for sizes up to 28 mm, and the manufacturer's instructions for larger sizes.

A movable appliance (e.g. cooker, tumble drier) should not be connected directly to corrugated pipe. Connection should be made in accordance with BS 6172, BS 6173 or BS 7624, as appropriate.

The length of unsupported corrugated pipe connected directly to any fixed appliance should not exceed 500 mm. Where the final connection is made indirectly by using a length of rigid pipe, the end-fittings or capillary adaptor should be permanently fixed. If the appliance is normally moved for servicing, an isolation valve and a union coupling or other suitable means of disconnection should be fitted at the appliance inlet.

During assembly or disassembly, manifolds should be adequately supported by wrenches or other means, to avoid excessive strain on fixings or attached pipework.

A.6 Connections to copper pipe

Any soldering necessary for connection to copper pipe should be carried out, and the soldered component cleaned of flux, before assembly to the corrugated pipe. It is important that stainless steel is not contaminated in any way with flux.

Annex B (informative)
Guidance on quality-control testing

The following guidance on the nature of the requirements and test methods specified in this standard is provided to assist in the preparation of quality plans for the manufacture of corrugated pipe or fittings which conform to this standard.

The applicability of specific requirements and associated methods of test to different properties and parts of corrugated pipe or fittings is summarized in Table B.1, in which each requirement is classified as being considered particularly suitable for type test and/or production test purposes.

Type tests are intended to prove the suitability and performance of a material composition, a compounding or processing technique or a design or size of corrugated pipe or fitting. Such tests should be performed when any introduction or change is made in one or more of those aspects, but they may be performed more frequently by incorporation into a plan for monitoring the consistency of manufacture.

Production tests are carried out during and/or following manufacture to monitor the quality of a product item.

Some of the requirements in this standard are relevant to both type test and inspection purposes, e.g. those for dimensions. Attention is drawn to guidance given in **4.1.4** of BS EN ISO 9003:1994 concerning use of alternative inspection procedures and equipment, for quality-control purposes under production conditions.

Table B.1 — Applicability of requirements and test methods

Product	Property	Clause	Method	Test type	
				Type test	Production test
Corrugated pipe	Material	**4.1**		×	
Coating, cover	Material	**4.2**		×	
Fittings	Material	**4.3**		×	
Elastomeric seals	Material	**4.4**		×	
Retaining devices	Material	**4.5**		×	
Corrugated pipe	Finish	**5.1**		×	
Fittings	Finish	**5.2**		×	
Corrugated pipe	Dimensions	**6.1.2**		×	×
Coating, cover	Thickness	**6.2.2**		×	×
Corrugated pipe	Soundness	**7**		×	
Corrugated pipe	Bendability	**8.2**		×	
Corrugated pipe	Weld quality	**8.3**		×	
Corrugated pipe	Pressure drop	**8.4**		×	
Corrugated pipe with cover	Bendability	**9.2**		×	
Corrugated pipe with cover	Impact resistance	**9.3**		×	
Corrugated pipe with cover	Scratch resistance	**9.4**		×	
Corrugated pipe with cover	Chemical resistance	**9.5**		×	
Corrugated pipe with cover	Low-temperature flexibility	**9.6**	**9.6** and BS EN 24672, method B	×	
Corrugated pipe with cover	High-temperature ageing	**9.7**		×	
Corrugated pipe with cover	Ozone resistance	**9.8**	BS EN 27326, method 1	×	
Corrugated pipe with cover	Ultraviolet resistance	**9.9**	BS EN ISO 8580, method 1	×	
Test assemblies	Soundness test	**7**		×	
Test assemblies	Bend test	**10.2**		×	
Test assemblies	Impact test	**10.3**		×	
Test assemblies	Tensile test	**10.4**		×	
Test assemblies	Hydraulic pressure test	**10.5**		×	
Test assemblies	Fire resistance test	**10.6**	**10.6** and BS 476-20	×	
Test assemblies	Torsion test	**10.7**		×	
Test assemblies	Electrical resistance test	**10.8**		×	
Straight end-fittings	Soundness test	**7**		×	
Straight end-fittings	Assembly force test	**11.2**		×	

Table B.1 — Applicability of requirements and test methods *(concluded)*

Product	Property	Clause	Method	Test type	
				Type test	Production test
Internally threaded fittings	Torsion test	**11.3**		×	
Internally threaded fittings	Bending moment test	**11.4**		×	
Elastomeric seals	Assembly durability	**11.6**		×	
Straight end-fittings and pipe with cover (straight pipe)	Liquid penetration	**11.7**		×	
Brass components	Residual stress	**11.8**		×	
Corrugated pipe	Marking	**13.1**		×	
Fittings	Marking	**13.2**		×	

Annex C (informative)
Sizes of fittings

A suggested range of fittings is listed below. A DN designation indicates an end to receive corrugated pipe directly.

a) straight connectors:

DN 10 × DN 10
DN 12 × DN 12
DN 15 × DN 15
DN 22 × DN 22
DN 28 × DN 28
DN 32 × DN 32
DN 40 × DN 40
DN 50 × DN 50

b) straight end-fittings, in accordance with Table C.1;

Table C.1 — Straight end-fittings

End to receive corrugated pipe DN	End threaded to BS 21
10	R $\frac{1}{4}$
10	R $\frac{1}{2}$
12	R $\frac{1}{4}$
12	R $\frac{3}{8}$
12	R $\frac{1}{2}$
15	R $\frac{1}{4}$
15	R $\frac{1}{2}$
15	R $\frac{3}{4}$
15	R_p $\frac{1}{2}$
22	R $\frac{1}{2}$
22	R $\frac{3}{4}$
28	R 1
32	R 1 $\frac{1}{4}$
40	R 1 $\frac{1}{2}$
50	R 2

c) elbow end-fittings: sizes in accordance with Table C.1;

d) tees (size of run first, followed by size of branch):

DN 15 × DN 15 × DN 15
DN 22 × DN 15 × DN 15
DN 22 × DN 22 × DN 15
DN 22 × DN 22 × DN 22
DN 28 × DN 28 × DN 28
DN 32 × DN 32 × DN 32
DN 40 × DN 40 × DN 40

e) manifolds: inlet R_p ¾ to BS 21 and three or more outlets R_p ½ to BS 21;

f) meter unions: inlet to BS 746 and outlet DN 22;

g) strapped elbows: inlet DN 15 and outlet R_p ½ to BS 21;

h) capillary adaptors:

DN 15 and 15 mm capillary spigot;
DN 22 and 22 mm capillary spigot;
DN 28 and 28 mm capillary spigot.

List of references

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 21:1985, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).*

BS 476, *Fire tests on building materials and structures.*

BS 476-20:1987, *Method for determination of the fire resistance of elements of construction (general principles).*

BS 746:1987, *Specification for gas meter unions and adaptors.*

BS 864, *Capillary and compression tube fittings of copper and copper alloy.*

BS 864-2:1983, *Specification for capillary and compression fittings for copper tubes.*

BS 903, *Physical testing of rubber.*

BS 903-A19:1986, *Heat resistance and accelerated ageing tests.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes.*

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BS 1134, *Assessment of surface texture.*

BS 1134-1:1988, *Methods and instrumentation.*

BS 1134-2:1990, *Guidance and general information.*

BS 1179:1967, *Glossary of terms used in the gas industry.*

BS 1179, *Glossary of terms used in the gas industry.*

BS 1179-6:1980, *Combustion and utilization including installation at consumers' premises.*

BS 1387:1985, *Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads.*

BS 1400:1985, *Specification for copper alloy ingots and copper alloy and high conductivity copper castings.*

BS 1449, *Steel plate, sheet and strip.*

BS 1449-1, *Carbon and carbon-manganese plate, sheet and strip.*

BS 1449-1.15:1991, *Specification for cold rolled narrow strip supplied in a range of conditions for heat treatment and general engineering purposes.*

BS 1449-2:1983, *Specification for stainless and heat-resisting steel plate, sheet and strip.*

BS 1710:1984, *Specification for identification of pipelines and services.*

BS 2056:1991, *Specification for stainless steel wire for mechanical springs.*

BS 2872:1989, *Specification for copper and copper alloy forging stock and forgings.*

BS 2874:1986, *Specification for copper and copper alloy rods and sections (other than forging stock).*

BS 3900, *Methods of test for paints.*

BS 3900-E2:1992, *Scratch test.*

BS 4161, *Gas meters.*

BS 4161-3:1989, *Specification for diaphragm meters of 6 cubic metres (or 212 cubic feet) per hour rating for working pressures up to 50 mbar.*

BS 4800:1989, *Schedule of paint colours for building purposes.*

BS EN 549:1995, *Specification for rubber materials for seals and diaphragms for gas appliances and gas equipment.*

BS EN 24672:1993, *Rubber and plastics hoses — Sub-ambient temperature flexibility tests.*

BS EN 27326:1993, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions.*

BS EN ISO 8580:1995, *Rubber and plastics hoses — Determination of ultra-violet resistance under static conditions.*

Informative references

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BRITISH STANDARDS INSTITUTION, London

BS 143 & 1256:1986, *Specification for malleable cast iron and cast copper alloy threaded pipe fittings.*

BS 5482, *Domestic butane- and propane-gas-burning installations.*

BS 5482-1:1994, *Specification for installations at permanent dwellings.*

BS 6172:1990, *Specification for installation of domestic gas cooking appliances (1st, 2nd and 3rd family gases).*

BS 6173:1990, *Specification for installation of gas-fired catering appliances for use in all types of catering establishments (1st, 2nd and 3rd family gases).*

BS 6891:1988, *Specification for installation of low pressure gas pipework of up to 28 mm (R1) in domestic premises (2nd family gas).*

BS 7624:1993, *Specification for installation of domestic direct gas-fired tumble dryers of up to 3 kW heat input (2nd and 3rd family gases).*

BS EN 10242:1995, *Threaded pipe fittings in malleable cast iron.*

BS EN ISO 9003:1994, *Quality systems. Model for quality assurance in final inspection and test.*

Other publication

[1] THE INSTITUTION OF GAS ENGINEERS. *Utilization Procedures IGE/UP/2. Gas installation pipework, boosters and compressors on industrial and commercial premises.* 1994[2)].

[2)] Available from The Institution of Gas Engineers, 21 Portland Place, London WIN 3AF.

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