BS 3212:1991

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Specification for

Flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations

Confirmed
January 2012

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/66, upon which the following bodies were represented:

Association of Metropolitan Authorities
British Coal Corporation
British Compressed Gases Association
British Gas plc
British Rubber Manufacturers' Association
Chief and Assistant Chief Fire Officers' Association
Energy Industries Council
Fire Extinguishing Trades Association
Home Office
Institution of Fire Engineers
Liquefied Petroleum Gas Industry Technical Association (UK)
London Fire and Civil Defence Authority
London Regional Transport
Malaysian Rubber Producers' Research Association
Ministry of Defence
Society of Motor Manufacturers and Traders Limited

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Fluid Power Association
Engineering Equipment and Materials Users' Association

This British Standard, having been prepared under the direction of the Plastics and Rubber Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
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Contents

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Foreword

This British Standard, prepared under the direction of the Plastics and Rubber Standards Policy Committee, is a revision of BS 3212:1975 which is withdrawn.

The major changes from the 1975 edition are as follows.

a) The colour identification requirements are more stringent.

b) The marking clause requires the manufacturer's name to be given instead of the supplier's name.

c) Resistance to ozone is now carried out at 40 °C instead of at room temperature for both tubing and hose and the test sample is examined for cracks under a × 2 magnification.

Appendix L details safety recommendations in the operation of tubing and hose/hose assemblies complying with this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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1 Scope

This British Standard specifies performance and dimensional requirements for rubber tubing, hose and complete assemblies for use in LPG vapour phase and LPG/air installations in environments up to a maximum ambient temperature of 60 °C.

NOTE 1 Tubing and hoses specified in this standard should not be used for gas cutting and allied processes using oxygen unless they also comply with the requirements of BS 5120.

NOTE 2 The abbreviation "LPG" (liquid petroleum gas) as used in this standard refers to butane and propane as defined in BS 4250-1.

NOTE 3 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the definitions given in BS 3558 apply.

3 Classification and colour identification

3.1 Classification

Rubber tubing and hose shall be classified as follows.

a) Type 1: flexible tubing for applications not exceeding 50 mbar[1)] working pressure.

b) Type 2: hoses for applications not exceeding 17.5 bar working pressure.

3.2 Colour identification

Rubber tubing and hose shall be identified by colour as follows.

a) Type 1 shall be black.

b) Type 2 shall have an orange cover except hose supplied as a complete assembly with crimped or swaged ferrules for use in fixed LPG installations where a black cover is permissible.

4 Sampling and acceptance criteria

4.1 Sampling

The sample selected shall be representative of the consignment or batch supplied and of appropriate size for the number of test specimens required for testing.

4.2 Criteria for compliance

If any of the test specimens, taken from within the sample selected, fails to comply with this standard, two further samples from the same batch or consignment shall be taken for testing. If any of the test specimens in either of these additional samples fails, the batch or consignment represented by the samples shall be deemed not to comply with this standard.

5 Temperature of testing

Unless otherwise specified, all tests shall be carried out at 23 ± 2 °C.

6 Type 1, flexible tubing for applications not exceeding 50 mbar working pressure

6.1 General

The materials used in the manufacture of the tubing shall be homogeneous, free from odour, and resistant to outdoor exposure. The walls shall be seamless and free from all visible defects such as lumps, blowholes or cracks. The bore shall be clean and free from loose particles.

NOTE An appropriate metal nozzle for type 1 is shown in Figure 1.

6.2 Dimensions

The bore of the tubing shall be 8 ± 0.4 mm.

6.3 Test sample

A sample 3 m long shall be provided for test purposes.

6.4 Performance

6.4.1 *Strength, adhesion and stretch*

When tested in accordance with Appendix A the tubing shall comply with the following requirements.

a) It shall fit over the oversize nozzle shown in Figure 2;

b) It shall remain attached to both nozzles throughout the period of test;

c) It shall show no signs of splitting or cracking and no leakage when tested at 0.7 bar air pressure under water for 5 min.

[1)] 1 mbar = 10^2 N/m^2 = 10^2 Pa.

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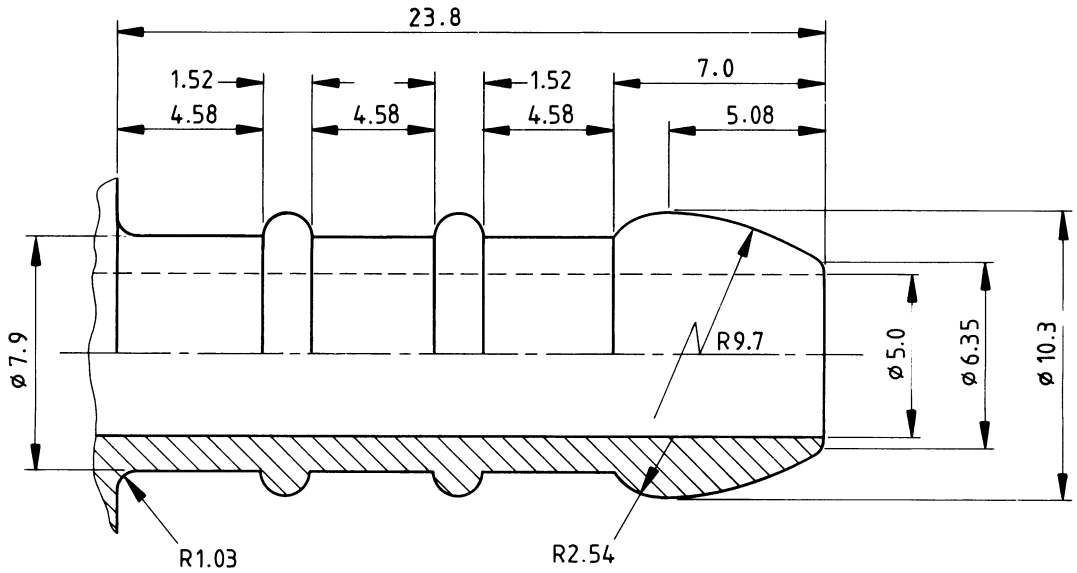
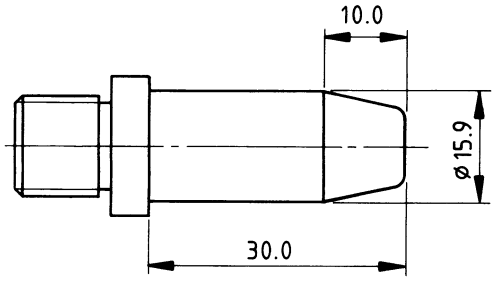


All dimensions are in millimetres.

NOTE The tolerance on all dimensions is 15 ± 0.125 mm.

Figure 1 — Metal nozzle for type 1 (tubing)



All dimensions are in millimetres

NOTE The tolerance on all dimensions is ± 0.125 mm.

Figure 2 — Stretch test oversize metal nozzle for type 1 (tubing)

6.4.2 *Resistance to pressure*

When immersed in water for 5 min under an internal air pressure of 3.5 bar, the increase in outside diameter shall be not more than 15 % and there shall be no sign of leakage.

6.4.3 *Resistance to kinking*

When tested in accordance with Appendix B the gas pressure shown in the manometer shall drop by not more than 10 mbar.

NOTE A diagram illustrating a kinking test is shown in Figure 3.

6.4.4 *Burning behaviour*

When tested in accordance with Appendix C the tubing shall not burn to either of the outer marks within 45 s.

NOTE A test for burning behaviour is shown in Figure 4.

6.4.5 *Resistance to n-pentane*

When tested in accordance with Appendix D the *n*-pentane absorbed shall not exceed 15 % of the initial mass of the tubing and the amount of *n*-pentane extractable matter shall not exceed 10 % of the initial mass of the tubing.

6.4.6 *Resistance to crushing*

6.4.6.1 When tested in accordance with **E.1**, with a crushing force of 125 N, after removal of the force, the tubing shall not show subsequent deformation or collapse, nor shall it leak when subjected to an internal air pressure of 0.75 bar.

6.4.6.2 When tested in accordance with **E.2**, the gas flow rate shall be not less than 0.07 m^3/h.

6.4.7 *Flexibility*

When tested in accordance with Appendix F no cracking of the tube shall occur.

6.4.8 *Resistance to ozone*

When tested in accordance with Appendix G no cracks shall be visible.

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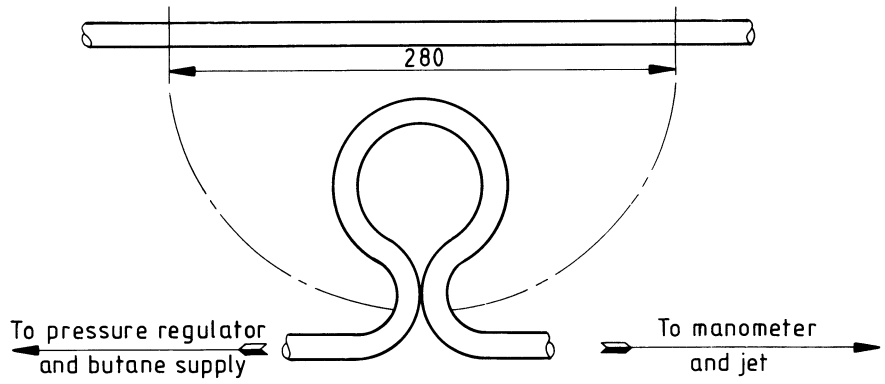
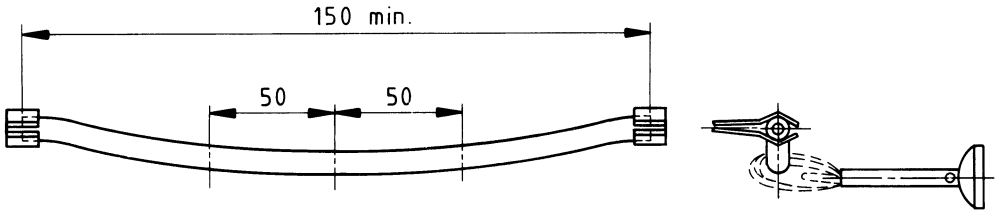


Dimension is in millimetres.

NOTE Not to scale.

Figure 3 — Diagram illustrating kinking test



Dimensions are in millimetres.

Figure 4 — Test for burning behaviour

6.4.9 *Resistance to bending*

When tested in accordance with BS 5173-103.5 using a minimum radius of curvature of five times the outer diameter of the test specimen, the deformation in the outside diameter shall be not greater than 10 %.

7 Type 2, hoses for applications not exceeding 17.5 bar working pressure

7.1 General

The material used in the manufacture of the hose shall be free from odour. The hose lining shall be seamless and free from all visible defects and the hose shall contain a suitable reinforcement. Pricking of the hose cover shall not constitute a defect. The bore of the hose shall be clean and free from loose particles.

NOTE Appropriate nozzles for type 2 are shown in Figure 5.

7.2 Dimensions of nominal bore

When measured in accordance with BS 5173-101.1 the bore of the hose shall be as given in Table 1.

Table 1 — Nominal bore of hose

Nominal bore	Allowed limits
mm	mm
4.8	± 0.5
6.3	± 0.6
8.0	± 0.8
10.0	± 0.8
12.5	± 0.8

7.3 Test sample

A sample 5 m long shall be provided for test purposes.

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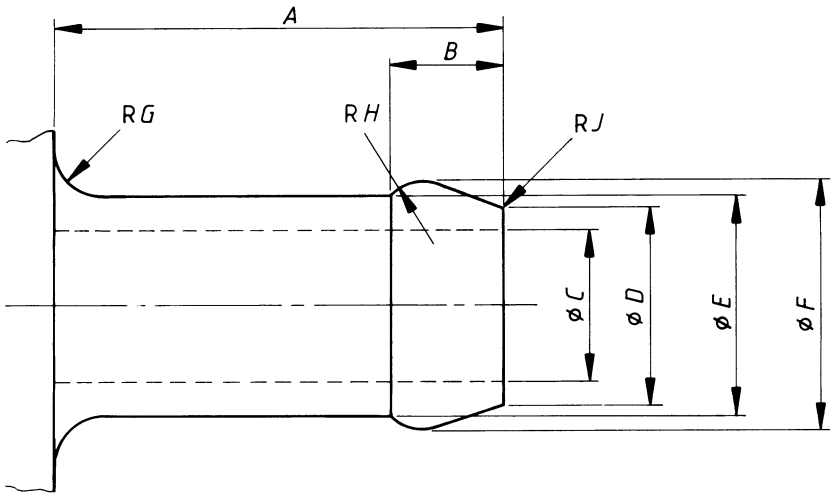

Nominal bore	*A*	*B*	Dia. *C*	Dia. *D*	Dia. *E*	Dia. *F*	Rad. *G*	Rad. *H*	Rad. *J*
5	25.0	6.4	3.2	4.5	5.0	5.94	1.0	1.0	0.4
6.3	25.0	8.0	4.8	6.2	6.3	7.95	1.3	1.3	0.4
8	25.0	8.7	6.3	6.9	8.0	9.04	1.5	1.5	0.4
10	38.0	8.7	7.9	8.6	9.5	11.1	2.0	2.0	0.4
12.5	38.0	12.0	8.7	11.6	12.5	14.3	2.5	2.5	0.4

NOTE Tolerance on all dimensions: ± 0.125 mm.

Dimensions are in millimetres.

Figure 5 — Nozzles for type 2 (hose)

7.4 Performance

7.4.1 *Adhesion*

When tested by the method for type 1 described in BS 5173-103.1, the adhesion between cover and reinforcement and between lining and reinforcement shall be not less than 1.5 kN/m.

7.4.2 *Strength, stretch and ageing resistance*

The hose shall fit over the appropriate nozzle shown in Figure 5 and the nozzle shall remain in the hose without leakage. The hose shall show no fractures, cracks or leakage when tested in accordance with Appendix H.

7.4.3 *Resistance to burst*

When tested in accordance with Appendix J the hose shall not burst at a pressure below 52 bar.

7.4.4 *Resistance to kinking*

When tested in accordance with Appendix B the gas pressure shown on the manometer shall drop by not more than 10 mbar.

7.4.5 *Burning behaviour*

When tested in accordance with Appendix C the hose shall not burn to either of the outer marks within 45 s.

7.4.6 *Resistance of lining to n-pentane*

When the hose lining is tested in accordance with Appendix D the *n*-pentane absorbed shall not exceed 15 % of the initial mass of the lining and the amount of *n*-pentane extractable matter shall not exceed 10 % of the initial mass of the lining.

7.4.7 *Resistance to crushing*

7.4.7.1 When tested in accordance with **E.1**, with a crushing force of 340 N, after removal of the force, the hose shall not show subsequent deformation or collapse, nor shall it leak when subjected to an internal air pressure of 0.75 bar.

7.4.7.2 When tested in accordance with **E.2**, the gas flow rate shall be not less than 0.07 m^3/h.

7.4.8 *Resistance to ozone*

When tested in accordance with Appendix G no cracks shall be visible.

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7.4.9 *Permeability to propene*

When tested in accordance with BS 5173-103.11 using a test gas of minimum 95 % propene, in accordance with BS 4947 at cylinder pressure [approximately 0.6 MPa (6 bar)] and standard laboratory temperature as defined in BS 903-A35, the amount of propene collected shall not exceed 25 mL/m per hour.

7.4.10 *Resistance to bending*

When tested in accordance with BS 5173-103.5 using a minimum radius of curvature of five times the outer diameter of the test specimen, the deformation in the outside diameter shall be not greater than 10 %.

8 Connections for screwed ends

Connections shall be of fire resistant and corrosion resistant material, preferably of brass or steel. Design of the connections shall be such that the assembly can be secured at one end without the necessity of turning the hose relative to its mating piece and without the use of additional fittings.

NOTE Other aspects of the design should be agreed between the purchaser and the supplier.

9 Complete assemblies (hoses including connections)

9.1 General

The hose shall be secured to end fittings by means of swageing, crimping or the use of suitable clips. Separate complete assemblies shall be supplied for compliance with **9.2.2** to **9.2.5**.

9.2 Performance

9.2.1 *General*

In addition to testing of hose for compliance with **7.4.1** and **7.4.4** to **7.4.9**, assemblies shall be tested for compliance with **9.2.2** to **9.2.5**.

9.2.2 *Strength, stretch and ageing resistance*

Each of four assemblies shall show no cracks, flaws or leakage when tested in accordance with Appendix H.

9.2.3 *Resistance to burst*

When tested in accordance with Appendix J the hose assembly shall not burst before sustaining a pressure of 52 bar.

9.2.4 *Flexing resistance*

When subjected to conditions described in Appendix K, the assembly shall then withstand without leakage the unaged test described in **H.1** to **H.3**, using an internal air pressure of 26 bar.

9.2.5 *Resistance to bending*

When tested in accordance with BS 5173-103.5 using a minimum radius of curvature of five times the outer diameter of the test specimen, the deformation in the outside diameter shall be not greater than 10 %.

10 Marking

Each length of flexible tubing and hose shall be clearly and durably marked at intervals of not more than 1 m with the following information:

a) the manufacturer's name or identification;

b) the number and date of this British Standard, i.e. BS 3212:1991[2)]);

c) the type number;

d) the nominal bore;

e) for type 1 tubing, LOW PRESSURE LPG, for type 2 hose, HIGH PRESSURE LPG;

f) the month and year of manufacture;

The information shall be stated in the form of the following example:

MN/BS 3212:1991/2/6.3/ HIGH PRESSURE LPG Dec 90

[2)] Marking BS 3212:1991 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 therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

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Appendix A Test for strength, adhesion and stretch of tubing

A.1 Four specimens of tubing, each 150 mm long and free of lubricant, shall be tested.

A.2 Force each test piece over an appropriate nozzle (see Figure 1) at one end and an oversize nozzle at the other. The oversize nozzle shall consist of a cylindrical piece of metal of diameter corresponding to that shown in Figure 2. The metal in contact with the rubber lining shall not contain copper or manganese.

A.3 Attach each appropriate nozzle to a hook and suspend the test pieces so that the axis of the tubing and nozzle are in the same vertical straight line.

A.4 Attach a mass of 4.5 kg to the lower (oversize) nozzle and leave the assembly for 30 min. Reject a test piece if it slips off either nozzle during this period. Place the test pieces not rejected in an ageing oven (normal oven) (see BS 903-A19) and leave them for 168 h at 70 °C. After this period examine the test pieces for signs of splitting or excessive cracks.

A.5 Cool to room temperature then test the assemblies for leaks at 0.7 bar air pressure under water for 5 min.

Appendix B Test for resistance to kinking

Connect one end of a straight length of tubing or hose to a supply of butane gas (see BS 4250-1) and the other to a water manometer calibrated in millibars and a jet which will permit a flow of gas of 0.225 m^3/h at 28 mbar in such a way that about 0.6 m of tubing lies horizontally on the bench. Adjust the pressure of the gas to read 28 mbar on the manometer with the gas flowing through the orifice. Place a rule marked in millimetres on the bench alongside the sample under test.

Take in the fingers two points on the sample spaced in accordance with Table 2 and bring them together so that the sample takes the form of a loop as illustrated in Figure 3.

Hold the loop for 30 s and record any pressure drop shown on the manometer during this period.

Table 2 — Spacing of the two points for the kinking test

Nominal bore of tubing or hose	Spacing
mm	mm
Up to and including 8	280
10	350
12.5	440

Appendix C Test for burning behaviour

Support horizontally a length of tubing or hose of minimum length 150 mm. Make three marks on the sample, the middle one approximately midway along the sample and the other two on either side, 50 mm from the middle mark. Direct a well aerated bunsen flame (approximately 1 800 kJ/h and about 25 mm in diameter) on to the sample so that the flame is horizontal, in the plane of the sample and perpendicular to the axis of the sample, the central mark being in the middle of the flame (see Figure 4). Apply the flame for 5 s and then remove it for 1 s. Repeat the application of the flame until the material catches fire and continues to burn or until a total test period of 45 s has elapsed. If the material catches fire and continues to burn without further application of the flame, note whether the flame reaches either of the outer marks within 45 s of the commencement of the test.

Appendix D Test for resistance to *n*-pentane

D.1 Immerse a weighed portion of the tubing or hose lining in liquid *n*-pentane, minimum 98 % as determined by gas chromatography at room temperature for 72 h. The volume of the *n*-pentane shall be at least 50 times the volume of the test piece. Following immersion reweigh the test piece after 5 min conditioning in air at room temperature and reweigh again after 24 h further conditioning under the same conditions.

D.2 Calculate the percentage *n*-pentane absorbed and the *n*-pentane extractable matter as follows:

a) percentage *n*-pentane absorbed

$$= \frac{(W_1 - W_2)}{W_0} \times 100\ \%$$

b) percentage *n*-pentane extractable matter

$$= \frac{(W_0 - W_2)}{W_0} \times 100\ \%$$

where

W_0 is the initial mass of sample;

W_1 is the mass of sample after immersion and 5 min conditioning;

W_2 is the mass of sample after 24 h further conditioning.

Appendix E Tests for resistance to crushing

E.1 Subject the test specimen of minimum length 100 mm (tube or hose) to the specified crush force applied evenly over a length of 25 mm for 30 s.

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E.2 Connect the test specimen to a supply of butane (see BS 4250-1) maintained at a constant pressure of 28 mbar at the inlet to the test specimen. Adjust a variable control fitted at the outlet end to give a gas flow rate of 0.28 m^3/h. Apply the specified force evenly over a length of 25 mm of the test specimen. After 30 s while the force is still maintained on the test specimen measure the gas flow rate.

Appendix F Test for flexibility

Immerse a length of tubing for 72 h at 23 ± 2 °C in liquid *n*-pentane, the volume of which is at least 50 times that of the tubing.

Remove the tubing from the *n*-pentane and condition at room temperature for 24 h. Bend it round a former of radius 85 mm and attach a mass of 1.6 kg to each end of the tube. Contact shall be made for at least 110° of the circumference of the former. Examine the tubing for signs of cracking.

Appendix G Test for resistance to ozone

For tubing prepare a test specimen by bending a 250 mm length of tubing around a mandrel of diameter eight times the outside diameter of the tubing.

For hose prepare a test specimen by pushing one end of a sample of hose 150 mm in length up to the collar of an appropriate nozzle (see Figure 5).

Place the test specimen in a test chamber and expose to ozone at a concentration of 50 ± 5 pphm for 72 h at 40 ± 2 °C as described in BS 5173-106.3 for method 1. After exposure view the tubing hose under a × 2 magnification.

Appendix H Test for strength, stretch and ageing resistance of hoses and hose assemblies

H.1 Four specimens of hose or hose assembly each at least 150 mm long, shall be tested.

H.2 Suspend each test piece vertically with a mass of 22.5 kg attached to its lower end and leave the assembly to stand for 30 min. Examine the test pieces and reject those which show signs of fracture or cracks.

H.3 Test for leakage the test pieces which were not rejected, by immersing them in water for 5 min with an internal air pressure of 26 bar. After immersion reject those test pieces which show signs of leakage.

H.4 Place the test pieces which were not rejected in **H.2** or **H.3** in an ageing oven (see BS 903-A19) for 168 h at 70 °C and after cooling to room temperature again immerse them in water for 5 min with an internal air pressure of 26 bar. Re-examine the test pieces for leakage.

Appendix J Test for resistance to burst

Subject a sample of hose or sample assembly with hose, of minimum length 0.6 m clear of test fittings and reinforcement to a hydraulic pressure built up at a rate of between 0.7 bar/s and 1.8 bar/s until the hose bursts. The test medium shall be water.

Report if the hose or hose assembly bursts below 52 bar. After testing discard the complete hose sample or hose assembly.

Appendix K Conditions prior to testing for resistance to flexing

Immerse a complete hose assembly for 72 h in liquid *n*-pentane and then condition at room temperature for 24 h. Hold the assembly rigidly at one end and subject to 7500 right angle pulls of 30 N applied at the rate of 30 per min (see Figure 6).

Appendix L Safety recommendations

The following recommendations are intended to assist generally in the safe operation of tubing and hose complying with this standard but are particularly intended to provide guidance to appliance manufacturers.

a) Care should be taken to ensure that the design of an appliance is such that when tubing or hose is fitted it is not subjected to a bend radius less than that specified in **6.4.9** and **7.4.10** of this standard.

b) Care should be taken to ensure that any clips, clamps or spigots used to retain the tubing or hose on the fittings are free from burrs and rough edges and are not over-tightened. Excessive compression of the tubing or hose is unnecessary and can lead to deleterious effects. Clips when used should comply with BS 5315.

c) Care should be taken to ensure that the tubing or hose does not come into direct contact with parts of the appliance which become hot during use.

d) The tubing and hose should not be used where the ambient temperature is greater than 60 °C.

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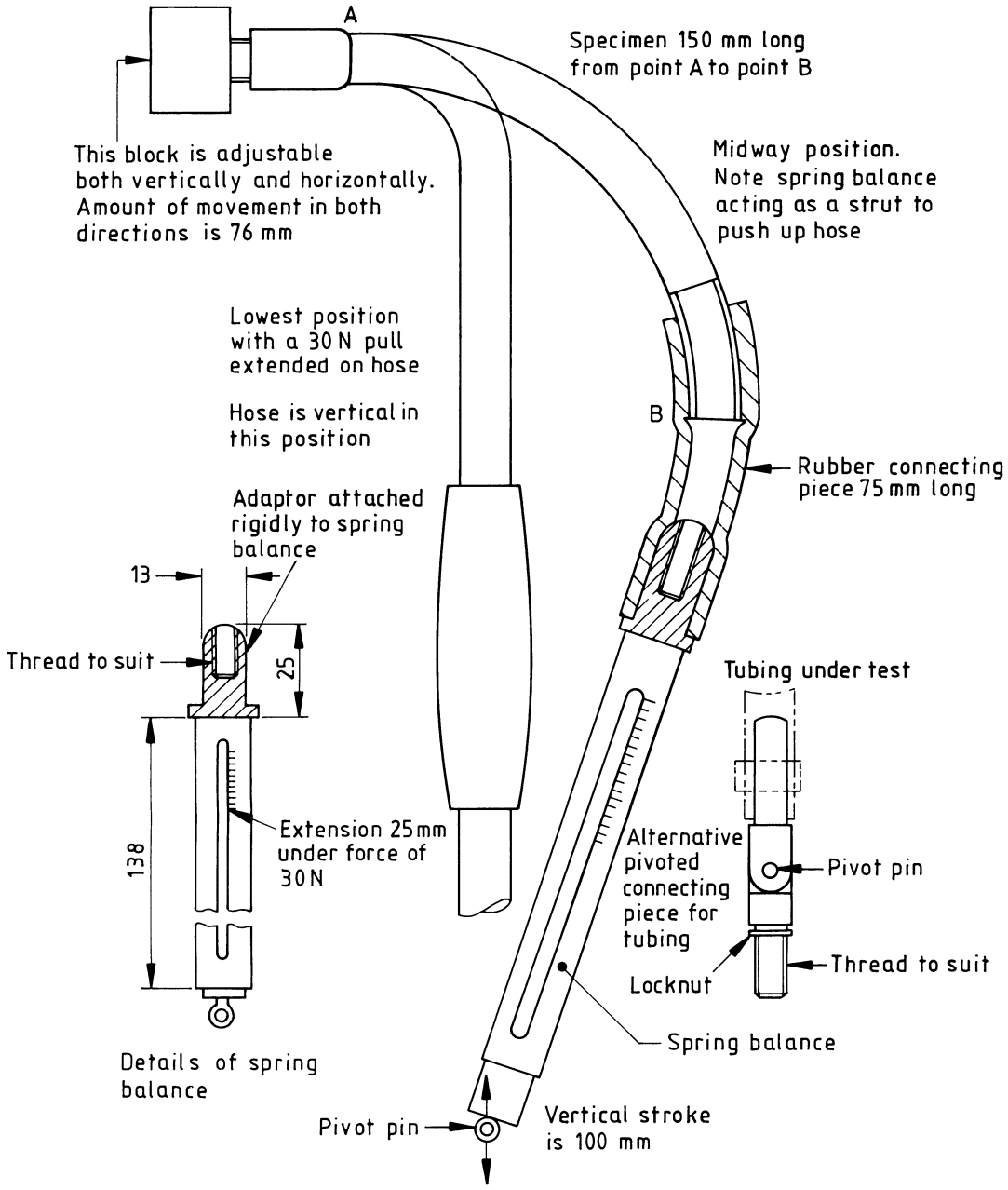

Dimensions are in millimetres.

Figure 6 — Diagram illustrating flexing test

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Publication(s) referred to

BS 903, *Physical testing of rubber.*
BS 903-A19, *Heat resistance and accelerated ageing tests.*
BS 903-A35, *Temperatures, humidities and times for conditioning and testing of test pieces.*
BS 3558, *Glossary of rubber terms.*
BS 4250, *Liquefied petroleum gas.*
BS 4250-1, *Specification for commercial butane and propane.*
BS 4947, *Specification for test gases for gas appliances.*
BS 5120, *Specification for rubber hoses for gas welding and allied processes.*
BS 5173, *Methods of test for rubber and plastics hoses and hose assemblies.*
BS 5173-101.1, *Measurement of dimensions (excluding length).*
BS 5173-103.1, *Determination of adhesion between components.*
BS 5173-103.5, *Bending tests.*
BS 5173-103.11, *Determination of gas permeance.*
BS 5173-106.3, *Determination of ozone resistance.*
BS 5315, *Specification. Hose clamps (worm drive type) for general purpose use (metric series).*

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