BS 6391:2009

BSI British Standards

Specification for non-percolating layflat delivery hoses and hose assemblies for fire fighting purposes

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Contents

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This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 26, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 28 February 2009. It was prepared by Subcommittee FSH/17/6, *Hoses for fire service use*, under the authority of Technical Committee FSH/17, *Fire brigade equipment*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 6391:1983, which is withdrawn.

Information about this document

This British Standard has been revised to bring it up to date. The test methods have been clarified and a method of test for hot surface resistance (Annex G) has been added.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for types 1, 2 and 3 of non-percolating layflat delivery hoses for fire fighting purposes, which are intended for use at working pressures not exceeding 15 bar, and at a minimum ambient temperature of –20 °C.

The hoses covered are suitable for use with fire hose couplings conforming to BS 336. Additional requirements are specified for hose assemblies, which are hoses supplied with couplings conforming to BS 336 already fitted.

NOTE 1 The working pressure of the hoses in service will not normally exceed 10 bar, but they can be used at pressures up to 15 bar, e.g. when connected to high rise mains.

NOTE 2 1 bar = 10^5 N/m^2 = 10^5 Pa. All pressure values specified in this standard are gauge pressures.

NOTE 3 BS EN 14540 specifies requirements for non-percolating layflat hoses for fixed systems. Requirements for semi-rigid hoses are given in BS EN 1947 for pumps and vehicles and in BS EN 694 for fixed systems.

Annex A gives recommendations for the pressure testing of hoses in service. Annex B specifies the minimum frequency of tests.

2 Normative references

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

BS 336:2009, *Specification for fire hose couplings and ancillary equipment* (in preparation)

BS 1052, *Specification for mild steel wire for general engineering purposes*

BS 3558-2, *Glossary of rubber terms – Part 2: Additional British terms*

BS EN ISO 1402, *Rubber and plastics hoses and hose assemblies – Hydrostatic testing*

BS EN ISO 4671:2007, *Rubber and plastics hoses and hose assemblies – Methods of measurement of the dimensions of hoses and the lengths of hose assemblies*

BS EN ISO 8330, *Rubber and plastics hoses and hose assemblies – Vocabulary*

BS ISO 1431-1:2004, *Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing*

BS ISO 1817, *Rubber, vulcanized – Determination of the effect of liquids*

FEPA 43-1-2006, *Grains of fused aluminium oxide, silicon carbide and other abrasive materials for coated abrasives, Macrogrits P 12 to P 220,* Paris: Fepa Abrasives [1)]

[1)] Available from www.fepa-abrasives.org

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 3558-2 and BS EN ISO 8330 and the following apply.

3.1 flaked hose
layflat hose folded backwards and forwards on itself in a series of folds of equal length

NOTE See Figure 1.

3.2 flake
one fold of a flaked hose

4 Classification

4.1 Type 1 (Uncoated)

Hoses to which no external treatment has been applied to the reinforcement and are therefore liable to absorb liquids.

NOTE These need to be thoroughly dried after use.

4.2 Type 2 (Coated)

Hoses to which an external elastomeric coating has been applied to the reinforcement to give some protection against the absorption of liquids, and to improve resistance to abrasion of the reinforcement.

4.3 Type 3 (Covered or coated)

Hoses to which an external elastomeric coating or covering has been applied. Covering can alternatively be incorporated in the reinforcement to give the hoses very low absorption of liquids and high resistance to abrasion and heat.

5 Construction

All hose types shall comprise the following:

a) an impermeable internal elastomeric lining;

NOTE The inner surface of the lining should be as smooth as possible so as to minimize friction.

b) a circular woven seamless reinforcement;

NOTE The reinforcement is often referred to as the "jacket".

c) additionally, for types 2 and 3, an externally applied elastomeric coating or covering of the reinforcement; type 3 hoses can incorporate the coating in the reinforcement.

NOTE The construction of the hoses should be such that it is possible to repair a damaged hose so that it will pass the pressure test recommended in Annex A.

6 Dimensions

NOTE Recommended nominal lengths of hoses are 15 m, 18 m, 25 m, 30 m and 36 m.

The total length of hose supplied shall be in accordance with the purchaser's requirements. Tolerance on length shall be 0^{+2}_{0}%.

When measured in accordance with BS EN ISO 4671:2007, **4.2**, the inside diameter (bore) of the hose shall conform to the requirements of Table 1.

Table 1 **Inside diameter**

ID (bore)	Equivalent sizes in BS 336		Minimum bore	Maximum bore
	in	mm	mm	mm
38	1.5	38	38.1	39.7
45	1.75	45	44.5	46.1
51	2	51	50.8	52.4
64	2.5	64	63.5	65.1
70	2.75	70	69.9	71.5
76	3	76	76.2	77.8
89	3.5	89	88.9	90.5

NOTE The values for minimum bore correspond to the values specified for the minimum external diameter of couplings in BS 336.

7 Mass

When a length of hose at least 2 m long, without couplings attached, is measured in accordance with BS EN ISO 4671 and then weighed, the mass per unit length shall not exceed the appropriate value given in Table 2.

Table 2 **Mass per unit length**

ID (bore)	Maximum mass per unit length
mm	kg/m
38	0.32
45	0.37
51	0.49
64	0.62
70	0.68
76	0.79
89	0.93

8 Type tests

8.1 Hydrostatic tests

8.1.1 Dimensional stability

When the hose is tested in accordance with Annex C:

a) the length contraction of the hose when the pressure is first increased to 0.7 bar shall not exceed 1% of the reference length of the unpressurized test piece;

b) the increase in length, when the pressure is increased from 0.7 bar to 12 bar, shall not exceed 5% of the length measured originally at 0.7 bar, and the increase in outside diameter shall not exceed 10% of the original diameter;

c) the residual increase in length, determined when the pressure is returned to 0.7 bar, shall not exceed 1% of the length measured originally at 0.7 bar.

8.1.2 Kinked test piece under pressure

When tested in accordance with Annex D, the test piece shall neither burst nor show any visible signs of defect.

8.1.3 Burst pressure

When tested in accordance with BS EN ISO 1402, the average value of the burst pressure for five test pieces shall be not less than 45 bar and no individual result shall be less than 43 bar for hoses up to and including 76 mm. For 89 mm diameter test pieces, the average burst pressure shall be not less than 35 bar and no individual result shall be less than 33 bar.

8.2 Adhesion

When tested in accordance with Annex E, the rate of separation of the lining and reinforcement and, for type 3 hoses, the rate of separation of the cover and reinforcement, shall not exceed 25 mm/min.

8.3 Moisture absorption (types 2 and 3 only)

When tested in accordance with Annex F, the amount of moisture absorbed shall not exceed 0.17 kg/m^2 for type 2 hoses and 0.02 kg/m^2 for type 3 hoses.

NOTE The resistance of fire hoses to acids and alkalis has been found to relate to their resistance to moisture absorption, thus type 3 hoses can be expected to have the greatest resistance to acids and alkalis.

8.4 Flexibility

8.4.1 At a temperature greater than 5 °C, the hose shall be capable of being laid in flakes (see Figure 1) of 2 m length and coiled into a smooth roll without any straight sections.

8.4.2 After conditioning at –20 °C ± 1 °C for 24 h ± 1 h, a dry, rolled length of not less than 15 m of hose shall be capable of being unrolled immediately. After the hose has been unrolled and immediately

folded back on itself through 180°, it shall withstand, without any sign of leakage, a proof pressure of 22.5 bar maintained for 1 min, in accordance with BS EN ISO 1402.

8.5 Heat ageing

8.5.1 Six 1 m lengths of hose shall be conditioned for 120 h at 20 °C ± 2 °C and 65% ± 2% relative humidity, and then aged for 336 h at 70 °C ± 2 °C. After ageing, there shall be no tackiness of the surface of the lining or, for type 3 hoses, of the surface of the cover.

8.5.2 Five of the 1 m lengths of hose aged in **8.5.1** shall then be subjected to a burst pressure test in accordance with BS EN ISO 1402. The average value of the burst pressure for five test pieces shall be not less than 35 bar and no individual result shall be less than 33 bar.

8.5.3 The remaining 1 m length of hose aged in **8.5.1** shall be tested in accordance with Annex E. The rate of separation of the lining and reinforcement and, for type 3 hoses, the rate of separation of the cover and reinforcement, shall not exceed 25 mm/min.

8.6 Hot surface resistance

When tested in accordance with Annex G, at a test temperature of 300 °C ± 10 °C for types 1 and 2, and 400 °C ± 10 °C for type 3, in none of the four tests shall the test piece show signs of leakage within 120 s from the application of the filament rod or on removal of this filament rod after the specified period.

8.7 Heat resistance (for type 3 only)

When tested in accordance with Annex H, none of the test pieces shall leak or burst within 15 s of the application of the hot cube.

8.8 Abrasion resistance

When tested in accordance with Annex I, the average number of cycles completed before bursting for five test pieces shall be not less than the appropriate value specified in Table 3.

Table 3 **Abrasion resistance**

Bore size	Minimum number of cycles		
	Type 1 hose	Type 2 hose	Type 3 hose
⩽ 51 mm	35	55	65
64 mm/70 mm	45	65	90
76 mm/89 mm	55	75	100

8.9 Oil resistance (for type 3 only)

A 1 m length of hose shall be immersed in oil number 3, as specified in BS ISO 1817, with its ends maintained above the surface of the oil, at 50 °C ± 2 °C for 70^{+2}_{0} h.

Test pieces taken from the central (fully immersed) portion of the hose shall then be subjected to an adhesion test in accordance with Annex E. The rate of separation of the cover and reinforcement shall not exceed 25 mm/min.

8.10 Ozone resistance

When tested in accordance with Annex J, the lining and, for type 3 hoses, the cover, shall exhibit no cracking or crazing visible under × 2 magnification, except at the cut edges of the hose.

8.11 Pressure loss

When tested in accordance with Annex K, the pressure loss per 23 m length shall not exceed the values specified in Table 4 at the specified flow rate and inlet pressure.

Table 4 **Pressure loss**

Bore	**Inlet pressure**	**Flow rate**	**Max. pressure loss/23 m**
mm	bar	L/min	bar
38	7	180	0.75
45	7	225	0.60
51	7	225	0.40
64	7	450	0.50
70	7	450	0.40
76	7	750	0.60
89	7	750	0.40

9 Production test

Each length of hose shall, when subjected to a proof pressure of 22.5 bar maintained for 1 min, in accordance with BS EN ISO 1402, show no sign of leakage or any other defect.

10 Hose assemblies

10.1 General

Hose assemblies shall conform to Clause **6**, Clause **7**, Clause **8** and Clause **9** and the additional requirements in **10.2**, **10.3** and **10.4**.

10.2 Couplings

Hose assemblies shall be fitted with delivery hose couplings conforming to BS 336:2009, Clause **8**.

The couplings shall be tied in by binding ("bound in") with galvanized mild steel wire of diameter 1.6 mm, conforming to BS 1052, and applied over a hose guard of synthetic fibre to protect the hose from the wire.

Multi-serrated type couplings shall be secured by 20 continuous turns of wire and ribbed type couplings shall be secured by ties of at least eight continuous turns on both sides of the rib. The ends of the wire shall be secured by twisting them together and embedding them in the hose guard.

NOTE The security of the wire can be improved by soldering over the final turns of the wire.

10.3 Type test for security of couplings

When tested in accordance with Annex L, the hose assembly shall show no sign of leakage.

10.4 Production test

Each hose assembly shall, when subjected to a proof pressure of 22.5 bar maintained for 1 min, in accordance with BS EN ISO 1402, show no sign of leakage or any other defect.

11 Marking

11.1 Each length of hose shall be clearly and indelibly marked with the following information:

a) the manufacturer's means of identification;

b) the number and date of this British Standard, i.e. BS 6391:2009 [2)], and the type number of the hose;

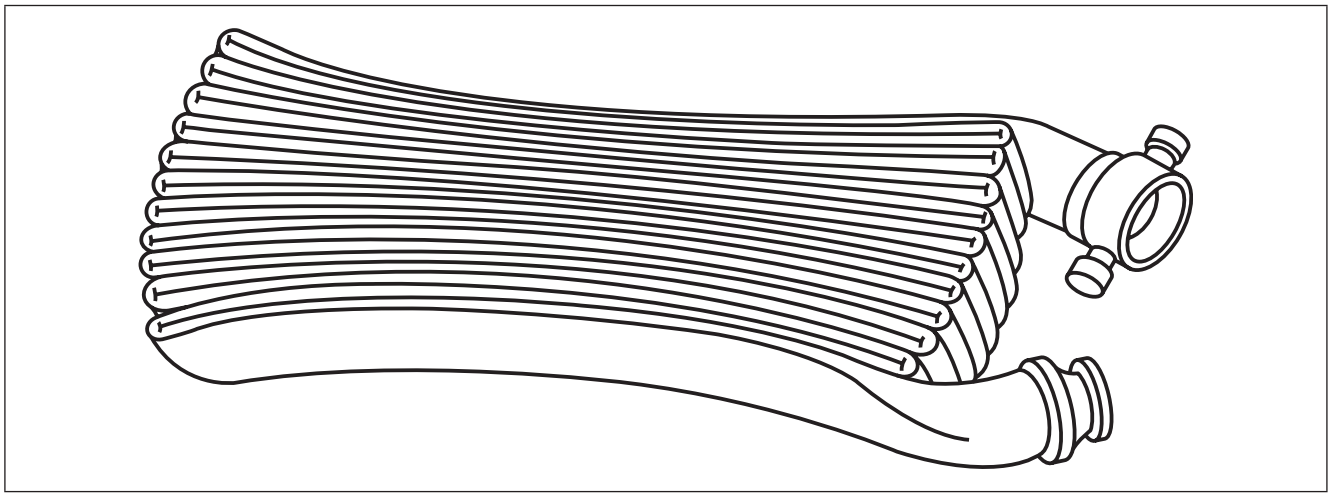
c) the ID bore in millimetres;

NOTE The equivalent imperial size, as given in Table 1, may also be given, in parentheses.

d) the month and year of manufacture.

11.2 In addition to the marking specified in **11.1**, each hose assembly shall have a tag attached marked with the words "Hose assembly to BS 6391".

Figure 1 **A flaked hose**



[2)] Marking BS 6391:2009 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.

Annex A (informative)

Recommendations for pressure testing of hoses in service

Once in service, a hose should be hydrostatically tested at 12 month intervals and after each occasion of operational use. The hose should be tested at a pressure 50% in excess of the intended working pressure or at 10 bar, whichever is the greater, and maintained for 1 min. If the hose shows any sign of leakage, it should be repaired and retested; if it cannot be satisfactorily repaired, it should be discarded.

Annex B (normative) Minimum frequency of testing

The minimum frequencies for the tests specified in this standard shall be as specified in Table B.1.

Type tests are those tests carried out to determine that the hose design and method of manufacture meet the full requirements of this standard. They shall be repeated whenever the hose construction or the materials are modified, or every five years, whichever occurs first.

Batch tests are those tests to be carried out on a hose or sample of hose from every batch manufactured.

Production tests are those tests to be carried out on every length of hose manufactured.

Table B.1 **Minimum frequency of testing**

Dimension/property under test (with reference to relevant clause)	**Type test**	**Batch test**	**Production test**
Tolerance on length (Clause **6**)	✓	✓	✓
Inside diameter (Clause **6**)	✓	✓	✓
Maximum mass (Clause **7**)	✓	✓	✓
Hose contraction [**8.1.1**a)]	✓	✓	
Increase in hose length [**8.1.1**b)]	✓	✓	
Residual increase in length [**8.1.1**c)]	✓	✓	
Kink pressure (**8.1.2**)	✓	✓	
Minimum burst pressure (**8.1.3**)	✓	✓	
Adhesion (**8.2**)	✓	✓	
Moisture absorption (**8.3**)	✓		
Flexibility – Flaked test (**8.4.1**)	✓		
Flexibility – Low temperature (**8.4.2**)	✓		
Heat ageing (**8.5**)	✓		
Hot surface resistance (**8.6**)	✓		
Heat resistance (**8.7**)	✓		
Abrasion resistance (**8.8**)	✓		
Oil resistance (**8.9**)	✓		
Ozone resistance (**8.10**)	✓		
Pressure loss (**8.11**)	✓		
Hose production test (Clause **9**)	✓	✓	✓
Hose assemblies tests (**10.2**, **10.3** and **10.4**)	✓	✓	✓

Annex C (normative) Method of test for dimensional stability

C.1 Test piece

C.1.1 *1 m length of hose*.

C.2 Procedure

C.2.1 Subject the test piece to a test for dimensional stability in accordance with BS EN ISO 1402, with the modifications given in **C.2.2** to **C.2.5**.

C.2.2 Straighten the test piece, lay it out horizontally and apply the reference marks. Take the initial measurement of the length between the two outermost marks while the test piece is unpressurized.

C.2.3 Measure the length and diameter of the test piece while it is being subjected to an internal hydrostatic pressure of 0.7 bar.

C.2.4 Raise the pressure to 12 bar, maintain the pressure for 1 min, and take a further measurement of length and diameter.

C.2.5 Reduce the pressure to 0.7 bar, maintain the pressure for 1 min, and measure the length only.

C.3 Test report

Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose under test;

c) the change in length when the pressure is first increased to 0.7 bar, expressed as a percentage of the reference length of the unpressurized test piece;

d) the change in length when the pressure is increased from 0.7 bar to 12 bar, expressed as a percentage of the length measured originally at 0.7 bar;

e) the change in outside diameter when the pressure is increased from 0.7 bar to 12 bar, expressed as a percentage of the original diameter;

f) the difference between the two measurements of length at 0.7 bar, expressed as a percentage of the first measurement.

Annex D (normative) Method of test for leakage or damage in kinked test piece under pressure

D.1 Test piece

D.1.1 *1.5 m length of hose*.

D.2 Apparatus

D.2.1 *Source of hydrostatic pressure*, with water as the test medium, capable of maintaining a pressure of 22.5 bar in the test piece.

D.3 Procedure

D.3.1 Connect the test piece to the pressure source and fill the test piece with water, expelling all the air.

D.3.2 Apply a pressure of 0.7 bar to the test piece and bend it through 180° at a point approximately 0.5 m from its free end. Tie the free end of the test piece back against itself, as close as possible to the secured end, so as to form a sharp kink. Ensure that the tie does not prevent subsequent expansion of the diameter of the test piece.

D.3.3 Gradually raise the pressure in the test piece to 22.5 bar, over a period of 1 min. Examine the test piece for any sign of leakage or damage and then release the pressure.

D.4 Test report

Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose under test;

c) any evidence of leakage or damage observed.

Annex E (normative) Method of test for adhesion

E.1 Test piece

E.1.1 *Cylindrical section of hose, 25 mm ± 0.5 mm long*, cut perpendicular to the axis of the hose with a sharp tool.

E.2 Apparatus

E.2.1 *Mandrel*, which is a snug fit in the test piece, with a central shaft.

E.2.2 *Means of supporting the mandrel*, so that it can rotate in an essentially friction-free manner on its shaft.

E.2.3 *Means of applying a load to the test piece*, incorporating a grip for attachment to the lining or cover and a spring for supporting weights.

NOTE A typical apparatus is shown in Figure E.1.

E.3 Procedure

E.3.1 Lining/reinforcement adhesion

Turn the test piece inside out, to expose the lining, and separate the lining and reinforcement just sufficiently to enable the grip to be attached. Slide the test piece on to the mandrel and insert in the apparatus. Attach the grip together with weights to give a total mass of 2.5 kg, and measure the length of lining separated after 1 min.

E.3.2 Cover/reinforcement adhesion (for type 3)

For type 3 hoses, repeat the procedure described in **E.3.1** using a separate test piece, but test the cover adhesion without reversing the test piece, and apply a total mass of 4.5 kg.

E.4 Test report

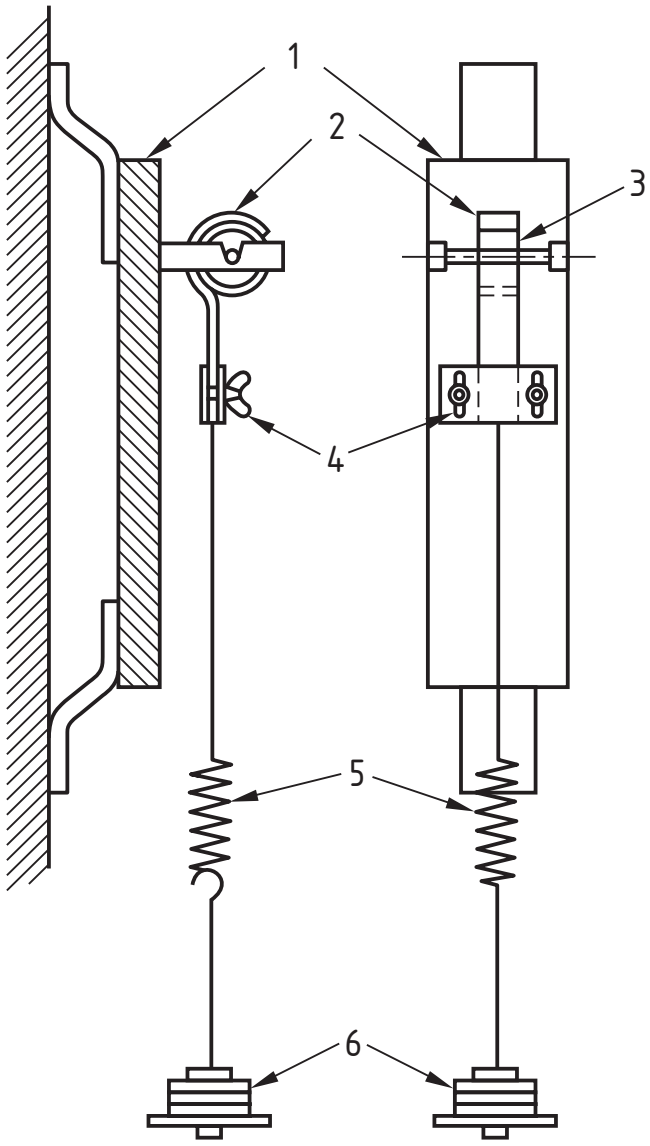
Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose under test;

c) the length of separation, if any, after 1 min.

Figure E.1 **Typical apparatus for the adhesion test**



Key

1	Vertical support	4	Grip
2	Test piece	5	Spring
3	Mandrel	6	Weights

Annex F (normative) Method of test for moisture absorption

F.1 Test piece

F.1.1 *600 mm length of hose*, marked around the circumference at distances of 50 mm from each end.

F.2 Apparatus

F.2.1 *Forced circulation air oven*, capable of being controlled at 50 °C ± 1 °C.

F.2.2 *Water bath*, consisting of a flat tray with sides and internal dimensions of 710 mm long × 450 mm wide × 55 mm high filled with distilled water, capable of being controlled at 20 °C ± 5 °C.

F.3 Conditioning

Condition the test piece in the oven at 50 °C ± 1 °C for 3 h immediately prior to testing.

F.4 Procedure

F.4.1 Weigh the conditioned test piece to an accuracy of 0.1 g.

F.4.2 Fold the test piece inside the marks so that the ends are vertical.

F.4.3 Place the test piece in the water bath, maintained at 20 °C ± 5 °C, and clamp the ends of the test piece so that the test piece is completely flat and horizontal, the marks are level with the surface of the water and all the test piece within the marks is immersed.

F.4.4 After a period of 6 h, remove the test piece from the water, wipe the surface dry with an absorbent cloth and reweigh.

F.5 Calculation of moisture absorption

Calculate the external surface area of the whole test piece (in m^2) and express the moisture absorption as the increase in mass per unit area (in kg/m^2).

F.6 Test report

Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose under test;

c) the moisture absorption in kg/m^2.

Annex G (normative) Method of test for hot surface resistance

G.1 Test piece

G.1.1 *0.5 m length of hose*, marked in four places at approximately 90° intervals circumferentially, three of the marks being coincident with the flat edges of the hose.

NOTE This sampling procedure is designed to eliminate eccentric covers.

G.2 Apparatus

G.2.1 *Filament rod*, consisting of an electrically heated spiral resistance wire with a resistance of approximately 80 Ω wound around a ceramic tube of diameter 21 mm, enclosed in a tube of quartz glass containing a mass fraction of at least 95% of SiO_2 (silicon dioxide) and fitted with a brass sleeve (see Figure G.1). An example of the design is given in Figure G.2.

G.2.2 *Temperature controller and recorder*, capable of restoring the set temperature within 15 s of commencement of the test and maintaining the set temperature within the specified limits.

G.2.3 *Thermocouple*, type J or K (i.e. not twisted together), jacketed type diameter of 1.5 mm.

G.2.4 *Loading weight*, designed to press the filament rod against the vertically mounted test piece with a force (F) equivalent to 4 N (see Figure G.3).

G.2.5 *Cabinet or small enclosure*, to eliminate local air movement in the vicinity of the test piece and filament rod.

Figure G.1 **Detail of brass metal sleeve**

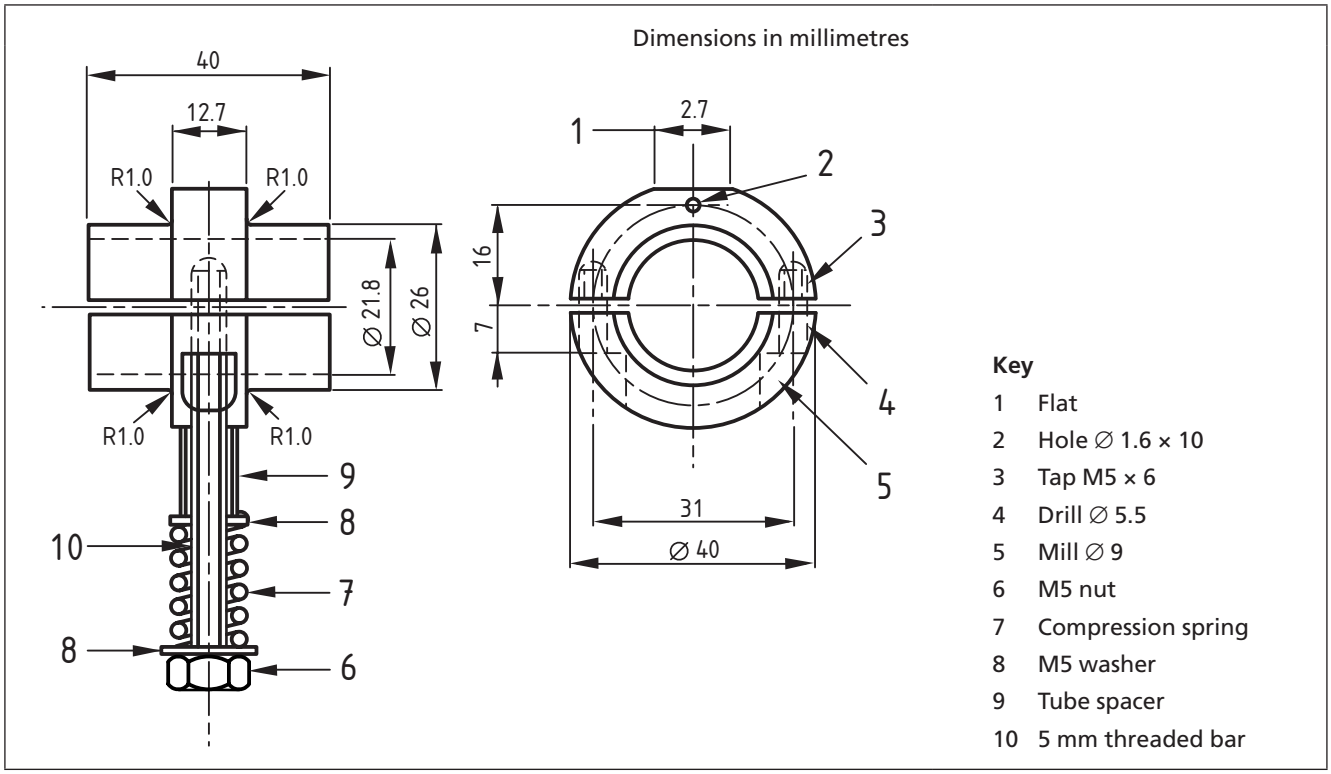
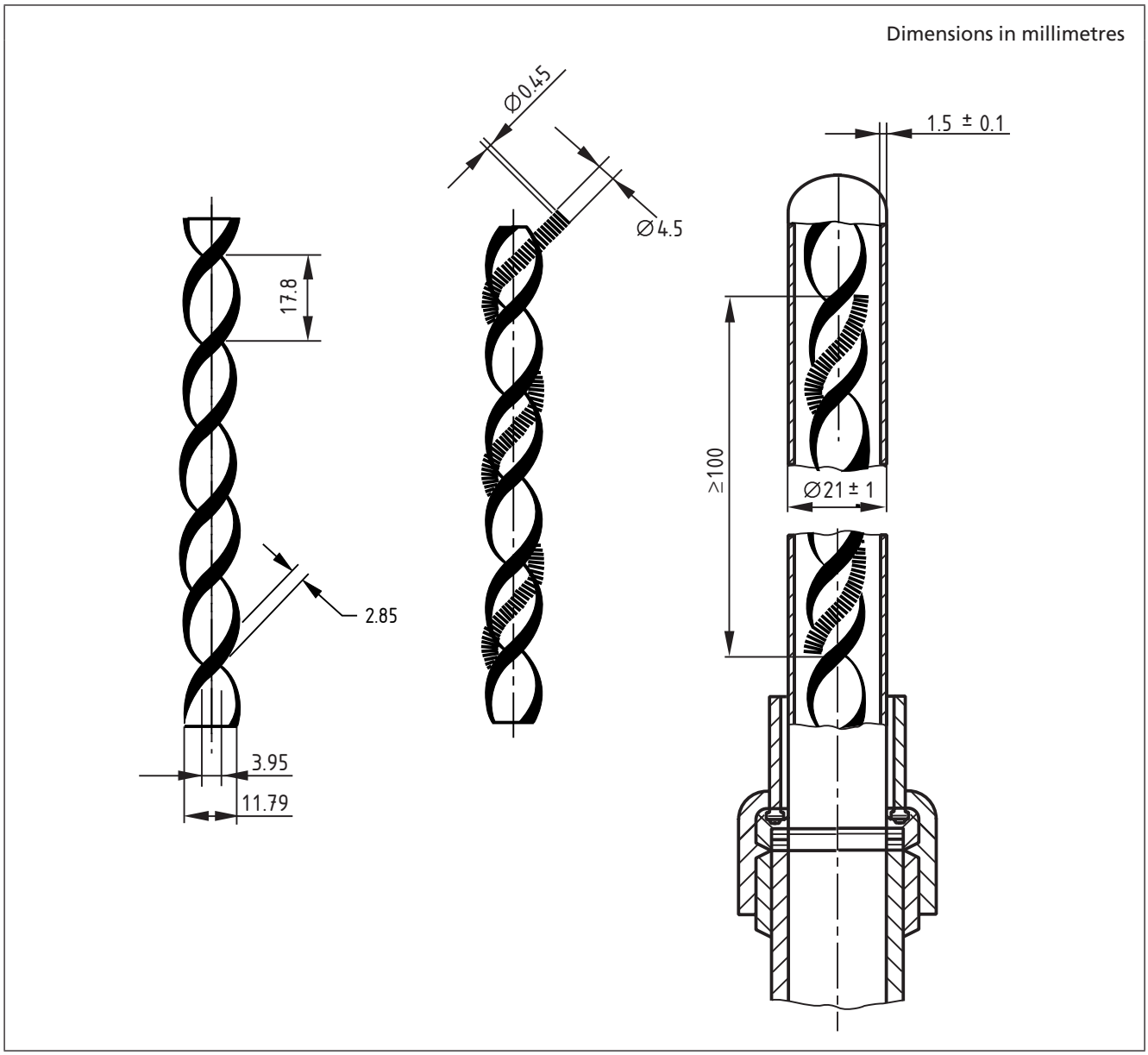


Figure G.2 **Example of a suitable filament design**



G.3 Procedure

G.3.1 Couple the test piece in a vertical position, fill it with water at a test temperature of 15 °C ± 5 °C, expelling all air and subject it to a pressure of 0.7 MPa.

G.3.2 At ambient temperature, adjust the test piece and the sleeve on the filament rod such that the flat side of the sleeve is in contact with one of the marks on the test piece.

G.3.3 Swing the filament rod away from the test piece, switch on the temperature controller and adjust to the test temperature specified in **8.6**. Maintain and record the test temperature throughout the tests.

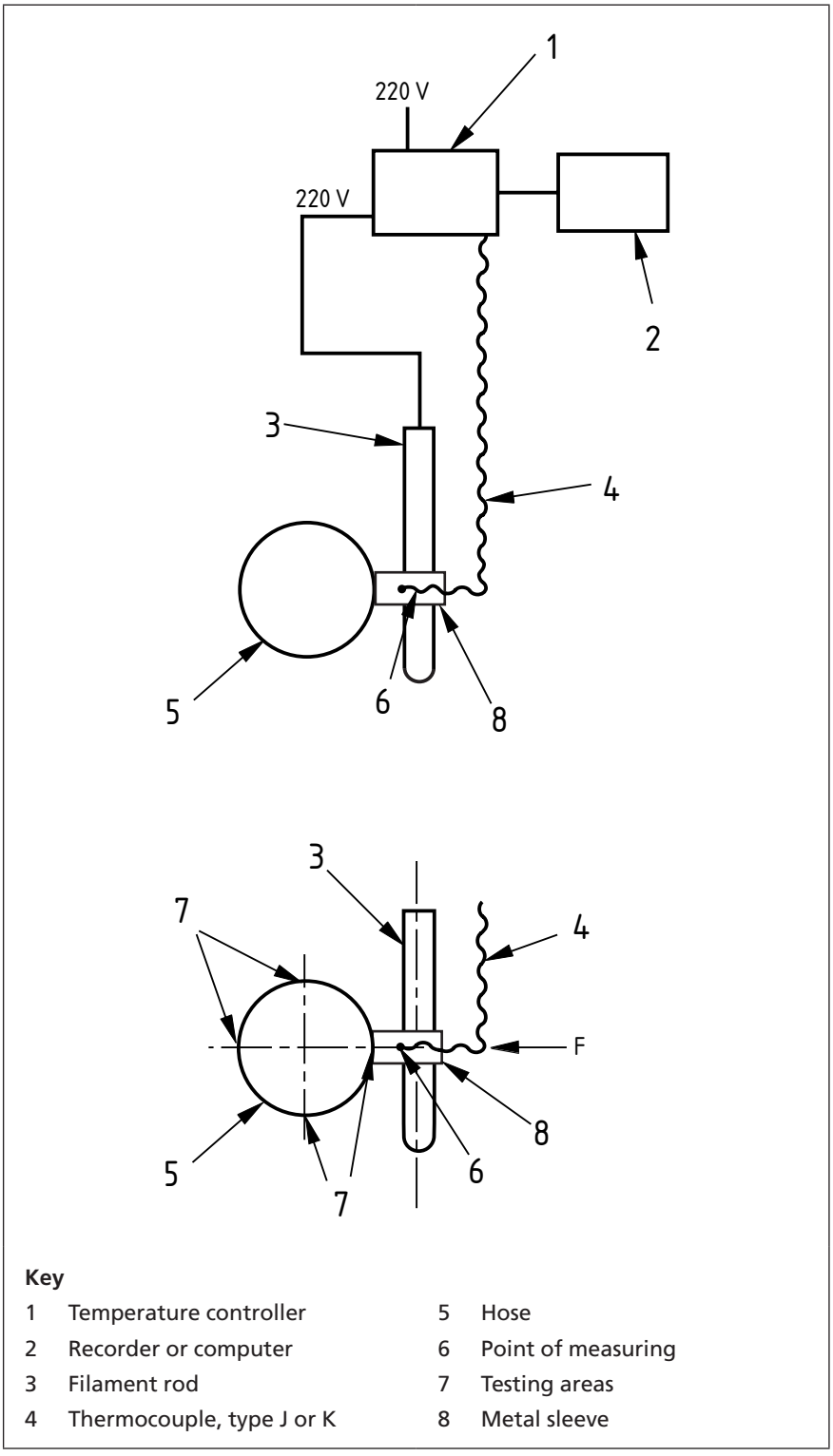
G.3.4 Press the filament rod against the mark on the test piece with a force of 4 N.

G.3.5 After 120 s, remove the rod and examine the test piece for leaks.

G.3.6 If a leak occurs in less than the specified time period, stop the test and record the time to failure.

G.3.7 If no leak occurs, repeat the test at the further three marked test positions after ensuring that the sleeve contact area is clean.

Figure G.3 **Point of contact of filament rod with hose (from above)**



Key

1	Temperature controller	5	Hose
2	Recorder or computer	6	Point of measuring
3	Filament rod	7	Testing areas
4	Thermocouple, type J or K	8	Metal sleeve

G.4 Test report

Include the following information:

a) the date of the test;

b) all details necessary for the complete identification of the hose under test;

c) all test results, whether there were any leaks, failures, exposure and burst test value;

d) the temperature at which the test was carried out.

Annex H (normative) Method of test for heat resistance

WARNING. In this test, the test piece bursts under pressure following the application of a hot metal cube. It is essential that the operator is protected from the risk of injury caused by the metal cube and/or any debris which might be discharged.

H.1 Test pieces

H.1.1 *Five pieces of hose*, each of 1 m length.

H.2 Apparatus

H.2.1 *Laboratory furnace*, capable of being controlled at a temperature greater than 600 °C.

H.2.2 *Five steel cubes*, with sides of 13 mm.

H.2.3 *Source of hydrostatic pressure*, with water as the test medium, capable of maintaining a pressure of 7 bar in the test piece.

H.3 Procedure

H.3.1 Heat the steel cubes in the furnace at a temperature greater than 600 °C for at least 30 min before use.

H.3.2 Connect the test piece to the pressure source and fill the test piece with water, expelling all the air. With the test piece laid horizontally, apply a pressure of 7 bar.

H.3.3 Transfer one of the heated cubes from the furnace and place it on top of the test piece within 10 s, ensuring that the temperature of the cube is 600^{+20}_{0} °C at the point of application to the test piece.

NOTE 1 The temperature can be measured by use of a thermocouple attached to the cube or any other suitable method.

NOTE 2 For small diameter test pieces, the cube can be held in position by means of a light wire support.

H.3.4 Record the time elapsed from the instant of placing the cube on the test piece until the test piece leaks or bursts.

H.4 Test report

Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose under test;

c) the time lapse, in seconds, before leakage or bursting for each test piece.

Annex I (normative) Method of test for abrasion resistance

I.1 Test pieces

I.1.1 *Five pieces of hose*, each of 1 m length.

I.2 Apparatus

I.2.1 *Source of hydrostatic pressure*, with water as the test medium, capable of maintaining a pressure of 7 bar in the test piece.

I.2.2 *Machine for abrading the test piece with a reciprocating movement*.

I.2.3 *Strip of abrasive cloth,* measuring 25 mm × 300 mm, the abrasive being:

- a synthetic 15, good quality fused aluminium oxide (Al_2O_3) with a minimum Al_2O_3 content with mass fraction of 70%; and
- of a grain size of P60 as specified in the Grain Size Standard (43-1-2006) of the Federation of European Producers of Abrasive Products (FEPA);

and the cloth being of good quality cotton having a minimum warp way breaking strength of 1 392 N and a maximum weft way breaking strength of 431 N.

I.2.4 *Means of producing a continuous jet of air*, to remove debris from the plane of abrasion.

NOTE 1 A typical layout of the apparatus is shown in Figure I.1.

NOTE 2 It is recommended that the apparatus be made of rust-resistant material.

I.3 Procedure

I.3.1 Mount the abrading strip in a carrier and set it at an angle of 45° to the horizontal axis of the test piece and at an angle of 20° to the direction of the reciprocating action of the test machine. Set the reciprocating movement to a frequency of 50 to 60 cycles (double strokes) per minute and the length of a single stroke to 230 mm, and the downward force on the test piece to 15.5 N.

I.3.2 Connect the test piece to the pressure source and fill the test piece with water, expelling all the air. Apply a pressure of 7 bar to the test piece and place it in the test machine (see **I.2.2**). Start the test machine and record the number of cycles completed before the test piece bursts.

I.3.3 Use a new strip for each test.

I.4 Test report

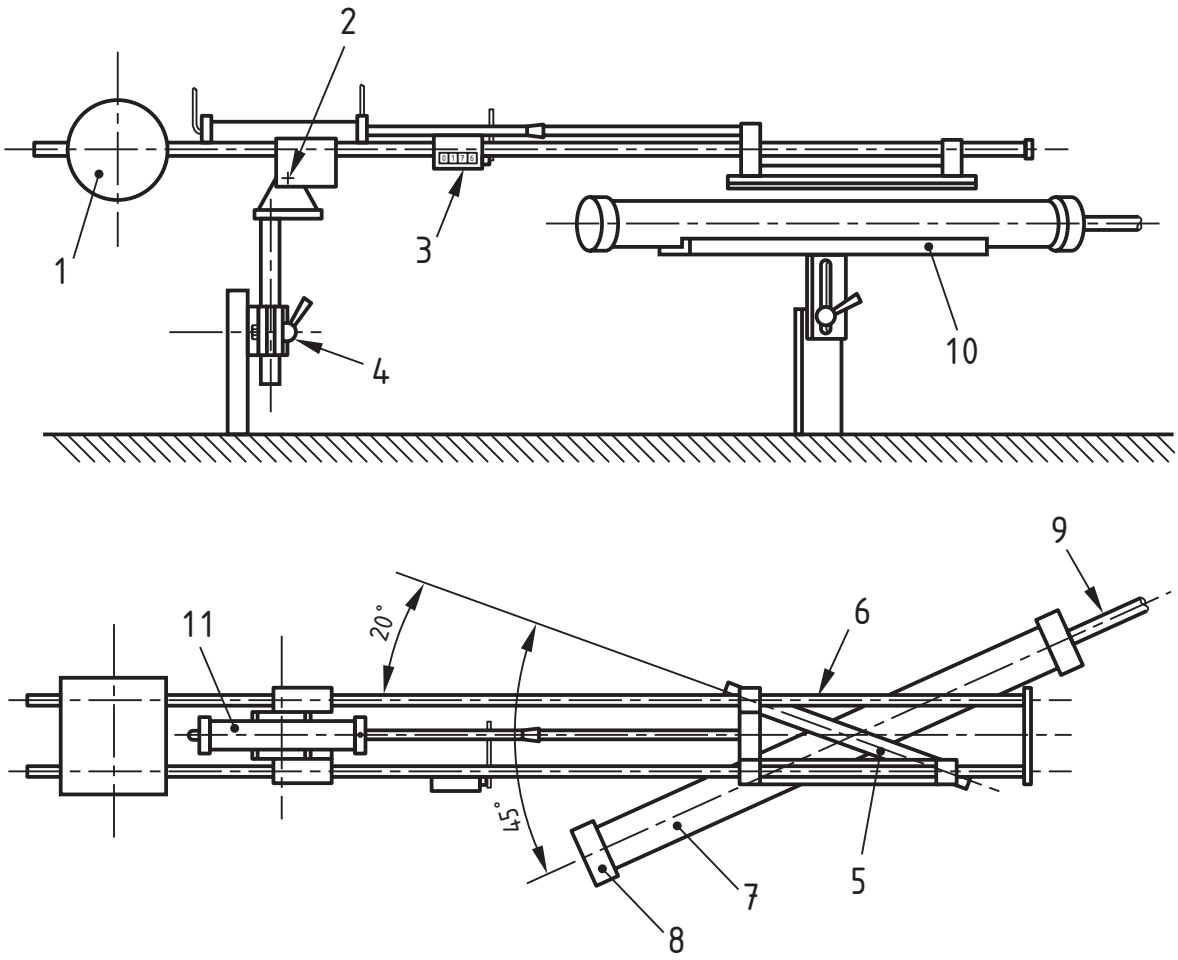
Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose under test;

c) the average number of cycles completed before bursting for the five test pieces.

Figure I.1 **Typical layout of apparatus for the abrasion resistance test**



Key

1 Counterbalance
2 Pivot
3 Stroke counter
4 Levelling clamp
5 Abrading strip carrier
6 Carrier slide bars
7 Test piece
8 Blank end
9 Water inlet
10 Hose support platform
11 Pneumatic cylinder

Annex J (normative) Method of test for ozone resistance

J.1 Test pieces

J.1.1 Cover (for type 3 hoses only)

J.1.1.1 *150 mm length of hose*, formed and secured into a tightly held coil around an aluminium mandrel with a diameter between 8 and 12 times the thickness of the hose wall.

J.1.2 Lining

J.1.2.1 *150 mm length of hose*.

J.1.2.2 Cut the test piece lengthwise through the centre of one of the faces ensuring that the knife does not cut or mark the lining on the opposite face.

J.1.2.3 Fold the test piece, lining side out, ensuring that the folded edge is not in the area of the natural fold of the hose.

J.1.2.4 Tightly coil and secure the test piece around an aluminium mandrel with a diameter between 8 and 12 times the thickness of the hose wall.

J.2 Apparatus

As specified in BS ISO 1431-1:2004, **5.1** to **5.5**.

J.3 Conditioning

Condition the prepared test piece at 23 °C ± 2 °C in a substantially ozone free atmosphere in the dark for at least 48 h immediately prior to testing.

J.4 Procedure

Place the test piece on the mandrel in an ozone cabinet containing an ozone concentration of 50 ± 5 parts per hundred million by volume (pphm) at 40 °C ± 2 °C for 48 h for type 1 and type 2 hoses, and for 96 h for type 3 hoses. After exposure, examine the test piece with a lens of × 2 magnification for any signs of cracking or crazing, ignoring any failure at the cut edge.

J.5 Test report

Include the following information:

a) date of test;

b) all details necessary for the complete identification of the hose under test;

c) the nature and location of any cracking or crazing observed.

Annex K (normative) Method of test for pressure loss

K.1 Principle

A straight length of hose is subjected to a given pressure and flow and the pressure loss due to friction is then calculated.

K.2 Test piece

K.2.1 *Straight length of hose,* approximately 23 m ± 0.2 m, complete with couplings and adaptors tapped for pressure measuring connections, and connections such as to minimize turbulence (thus reducing errors in pressure measurement).

NOTE A differential pressure gauge may be used instead of a single pressure gauge at hose assembly inlet and outlet adaptors.

K.3 Apparatus

K.3.1 *A hydraulic test rig,* which can pressurize the hose assembly test piece to 7 bar and maintain the flow rate given in Table 4.

K.3.2 *Suitable coupling adaptors,* for this required application and sizes of hose.

K.3.3 *A variable flow rate branch pipe or monitor,* to achieve the required flow rate.

K.4 Procedure

K.4.1 Maintain the pressure at the inlet end at (7 ± 0.35) bar.

K.4.2 Maintain the flow rate of Table 4 within ± 2%.

K.4.3 Ensure the hose assembly is in a straight line and measure the exact length of the hose assembly at the pressure and flow rate given in Table 4. Use the length to calculate the pressure loss.

K.4.4 Record the pressure loss as the difference between the pressure at the inlet and the outlet end of the test piece.

K.4.5 Calculate the pressure loss per 23 m length.

K.5 Test report

Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose assembly;

c) the pressurized length of the hose assembly;

d) the pressure loss per 23 m length in bar.

Annex L (normative) Method of test for security of couplings in hose assemblies

L.1 Test piece

L.1.1 *A complete hose assembly*.

L.2 Apparatus

L.2.1 *Source of hydrostatic pressure*, with water as the test medium, capable of maintaining pressures of 15 bar and 22.5 bar in the test piece.

L.3 Procedure

L.3.1 Connect the test piece to the pressure source and fill the test piece with water, expelling all the air.

L.3.2 Raise the pressure in the test piece to 22.5 bar and maintain this pressure. After 1 min, examine the test piece for any sign of leakage, particularly around the couplings, and then release the pressure.

L.3.3 Unless leakage has already been observed, raise the pressure in the test piece to 22.5 bar again and maintain this pressure. After 1 min, examine the test piece for any sign of leakage and then release the pressure.

L.4 Test report

Include the following information:

a) the date of test;

b) all details necessary for the complete identification of the hose assembly under test;

c) any evidence of leakage observed.

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 694, *Fire-fighting hoses – Semi-rigid hoses for fixed systems*

BS EN 1947, *Fire-fighting hoses – Semi-rigid delivery hoses and hose assemblies for pumps and vehicles*

BS EN 14540, *Fire-fighting hoses – Non-percolating layflat hoses for fixed systems*

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