

BS 6391:2009



BSI Standards Publication

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

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### Summary of pages

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## 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This British Standard supersedes BS 6391:1983, which is withdrawn.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<sup>5</sup> N/m<sup>2</sup> = 10<sup>5</sup> 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 <sup>1)</sup>

<sup>1)</sup> Available from [www.fepa-abrasives.org](http://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<sup>2</sup> for type 2 hoses and 0.02 kg/m<sup>2</sup> 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  $-20\text{ °C} \pm 1\text{ °C}$  for  $24\text{ h} \pm 1\text{ h}$ , 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  $20\text{ °C} \pm 2\text{ °C}$  and  $65\% \pm 2\%$  relative humidity, and then aged for 336 h at  $70\text{ °C} \pm 2\text{ °C}$ . 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  $300\text{ °C} \pm 10\text{ °C}$  for types 1 and 2, and  $400\text{ °C} \pm 10\text{ °C}$  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 |
| $\leq 51\text{ mm}$ | 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  $50\text{ °C} \pm 2\text{ °C}$  for  $70^{+2}_0\text{ h}$ .

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  $\times 2$  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.*