BRITISH STANDARD AEROSPACE SERIES

BS 4G 198 :
Part 1 : 1997

Sleeves and moulded components for aircraft electric cables and equipment wires

Part 1. Specification for elastomeric sleeves for binding and identification

ICS 49.060

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee ACE/6, Aerospace avionic, electrical and fibre optic technology, upon which the following bodies were represented:

British Airways
British Cable Makers' Confederation
British Rubber Manufacturers' Association
Civil Aviation Authority (Airworthiness Division)
Federation of the Electronics Industry
Ministry of Defence
Society of British Aerospace Companies

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Contents

Foreword

This Part of BS G 198 has been prepared by Technical Committee ACE/6. It specifies requirements for elastomeric sleeves for aircraft electric cables and insulated equipment wires. BS G 198 is published in the following separate Parts.

Part 1 *Specification for elastomeric sleeves for binding and identification*

Part 2 *Specification for slip-on sleeves for identification purposes*

Part 3 *Specification for heat-shrinkable sleeving for binding, insulation and identification*

Part 4 *Specification for fluoropolymer heat-shrinkable sleeving for binding and insulation*

Part 5 *Specification for heat-shrinkable moulded shapes*[1)]

NOTE. It is envisaged that there will be a further Part on heat-shrinkable dual wall sleeves.

This Part of BS G 198 supersedes BS 3G 198 : Part 1 : 1989 which is withdrawn.

This Part of BS G 198 specifies requirements for elastomeric sleeves, in a range of diameters, lengths and materials, for binding and identification purposes on electric cables, and insulated equipment wires in aircraft. Sleeves are available in a range of colours.

The various types of sleeves specified by this British Standard have been designated by the allocation of type numbers. These numbers have been adopted by the aircraft industry over a period of years and do not necessarily run consecutively through the different Parts of BS G 198.

Sleeves should be installed in accordance with the manufacturer's or the supplier's instructions. It should be noted that the sleeves are to be used under mechanical strain not exceeding 50 % diameter expansion.

WARNING NOTE 1. This standard calls for the use of substances and/or test procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and in no way absolves either the supplier or the user from statutory obligations relating to health and safety at any stage of manufacture or use.

WARNING NOTE 2. It should be clearly understood that the flammability tests specified in this standard are not for assessing a total fire hazard situation. It is solely for the purpose of specifying the basic material quality requirements of the elastomeric sleeves.

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 26, an inside back cover and a back cover.

[1)] In preparation.

Specification

1 Scope

This Part of BS G 198 specifies the design, performance, quality assurance and methods of test for the types of elastomeric sleeves shown in table 1. These sleeves are for binding and identification purposes. Routine and quality tests are specified.

In addition to the definitive requirements, this standard also requires the items detailed in clause **3** to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

NOTE 1. Recommendations for the storage of finished sleeves is given in annex A.

NOTE 2. The latest revision of an Aerospace Series standard is indicated by a prefix number.

Whilst not primarily intended for insulation purposes, this standard includes electrical tests to determine insulating properties.

2 References

2.1 Normative references

This Part of BS 4G 198 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 26.

For dated references, only the edition cited applies, any subsequent amendments to or revisions of the cited publication apply to this Part of BS 4G 198 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 Part of BS 4G 198 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 Information and requirements to be agreed and documented

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, or shall be fully documented. Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

a) the number of this British Standard (i.e. BS 4G 198 : Part 1 : 1997);

b) the total quantity required;

c) cut length, if required (see **7.2**) and tolerance on cut length, if the tolerance required is different from that given in table 2;

d) the printing requirements (see clause **8** and clause **10**);

e) the codified identification(see note 1 to **13.1**);

f) the packaging requirements (see clause **13**);

g) other environmental requirements (see the note to table 3);

h) whether the sleeving is to be tested in any other fluids, in addition to those given in table 4 (see **12.7**);

i) the test fluid(see table 4);

j) the dimensional requirements, if non-standard (see clause **7**).

Table 1. Types of elastomeric sleeve materials

Type	Guide to temp range	Exposure temperature °C			Material	Other main properties
	°C[1)]	(1)	(2)	(3)		
1	− 40 to + 70	70	95	115	Polychloroprene	Flame retardant
2	− 25 to + 75	75	100	120	PVC-Nitrile	Oil resistant
3	− 65 to + 140	140	170	190	Fluorinated Silicone	Flame retardant and oil resistant
4	− 65 to + 160	160	220	260	Silicone	Heat resistant

[1)] Low temperature flexibility is assessed in accordance with clause **12.14**.
NOTE 1. Exposure (1) is for a minimum of 20,000 h when assessed in accordance with clause **12.16**.
NOTE 2. Exposure (2) is for a minimum of 1000 h when assessed by clause **12.17**.
NOTE 3. Exposure (3) is for a minimum of 168 h when assessed by clause **12.17**.

Table 2. Standard cutting tolerances for cut lengths of sleeves

Cut length (mm)	Tolerance (mm)
0 to 9.9	± 0.5
10 to 24.9	± 1.0
25 to 49.9	± 1.5
50 to 99.9	± 3.0
100 to 149.9	± 4.0
150 to 249.9	± 5.0
250 to 1200	± 12.5

Table 3. Materials and characteristics

Type	Material	Characteristics
1	Polychloroprene	Occasional contamination by mineral oils, petroleum fuels, and mineral or castor oil based hydraulic fluids
2	PVC-Nitrile	Occasional contamination by fuels, lubricants and non-ester based hydraulic fluids
3	Fluorinated Silicone	Oil, hydraulic fluid and fuel resistant
4	Silicone	Oil and hydraulic fluid resistant. Not for contact with fuels

NOTE. If the material is required to withstand certain specific environmental conditions not specified by this standard, then guidance should be sought from the manufacturer/supplier.

Table 4. List of test fluids

Test fluid reference (See BS 3G 100 : Part 2 : Section 3 : Subsection 3.12 : 1991)	Sleeve type			
	1	2	3	4
	Test temperature (°C)	Test temperature (°C)	Test temperature (°C)	Test temperature (°C)
(b) Aircraft fuel. Gasoline (piston engine). BS 903 : Part A.16	Test 1 (40 ± 1)	Test 1 (40 ± 1)	Test 1 (40 ± 1)	Not suitable
(d) Phosphate ester-based (synthetic). BS 903 : Part A.16	Not suitable	Not suitable	Test 1 (70 ± 1)	Test 2 (125 ± 2)
(g) Lubricating oil. Ester based (synthetic). BS 903 : Part A.16	Not suitable	Test 2 (100 ± 2)	Test 1 (150 ± 2)	Test 2 (150 ± 2)
(c) Hydraulic fluid. Mineral-based to NATO H-520 (OM-18)[2)]	Test 2 (95 ± 1)	Test 2 (100 ± 2)	Test 1 (80 ± 1)	Test 2 (150 ± 2)
(h) De-icing fluid; Propan-2-ol (isopropyl alcohol) to BS 1595 : Part 1 : 1986	Test 1 (50 ± 1)	Test 1 (50 ± 1)	Test 1 (50 ± 1)	Test 2 (50 ± 1)
(m) De-icing fluid; inhibited ethylene glycol 50 % solution in water (*V/V*). BS 6580	Test 1 (50 ± 1)	Test 1 (50 ± 1)	Test 1 (50 ± 1)	Test 1 (50 ± 1)
Cleaning fluid[1)]	Test 2 (50 ± 1)	Test 2 (50 ± 1)	Test 2 (50 ± 1)	Not suitable
(r) Sullage fluid; (4 ± 0.1 %) formaldehyde plus (1 ± 0.1 %) o-cresol (GPR) in water.	Test 1 (20 ± 5)	Test 1 (20 ± 5)	Test 1 (20 ± 5)	Test 1 (20 ± 5)
(e) Silicone based synthetic hydraulic fluid; dimethyl silicone 10 mm^2/s (cst) at 25 °C ZX42; NATO S1714	Test 1 (80 ± 1)	Test 1 (80 ± 1)	Test 1 (80 ± 1)	Not suitable

[1)] The test fluid shall be agreed between the manufacturer/supplier and the purchaser and shall be documented (see 3i)).
[2)] Defence Standards are obtainable from Ministry of Defence, Directorate of Standardization.
NOTE. Commercial fluids of the types represented by test fluids (c), (d) and (r) will stain subjected sleeving. Sleeves should not be used purely as colour identifiers in areas subject to contamination by the fluids.

4 Materials and characteristics

4.1 Materials and characteristics

Sleeves shall be made from materials that ensure that the finished sleeves conform to the appropriate requirements of clause **12**. Printing on sleeves shall conform to clause **8** and the appropriate requirements of table 5.

NOTE 1. Materials known to meet the requirements of the tests specified in clause **12** have the characteristics shown in table 3.

NOTE 2. Printing on sleeves may affect properties.

NOTE 3. The tests specified in clause **12** are performed on finished sleeves, except for test **12.9**.

4.2 Overlays

Overlays may be used to provide added protection for the sleeve or marking, provided the finished sleeve conforms to clause **12**. For the purpose of this standard the overlay shall be regarded as part of the sleeve.

Table 5. Type tests

Title	Clause
Finish	**12.1**
Printing	**12.2**
Dimensions	**12.3**
Circumferential extension	**12.4**
Tension set	**12.5**
Voltage proof[1)]	**12.6**
Resistance to fluids[1) 2)]	**12.7**
Silver staining[2)]	**12.8**
Volume resistivity	**12.9**
Resistance to extremes of temperature[1)]	**12.10**
Colour fastness to light[1) 2) 3)]	**12.11**
Resistance to mould growth[2)]	**12.12**
Resistance to ozone	**12.13**
Low temperature flexibility	**12.14**
Flammability[2)]	**12.15**
Thermal endurance[2)]	**12.16**
Extensibility after ageing	**12.17**

[1)] If the manufacturer/supplier intends to supply printed sleeves, only printed sleeves shall be tested.
[2)] For the purposes of this test, one sleeve may be taken as representative of other sizes.
[3)] All colours are to be tested.

5 Colour

The colour shall be uniform and evenly dispersed, and where applicable, the colour shall be recognizable as those given in BS 6746C. Standard colours are detailed in table 6.

Table 6. Standard colours availability and their allocated numbers

Colour	Types	Printed number	Colour code
Black	All	0	0
Brown	All	1	1
Red	All	2	2
Orange	All	3	3
Yellow	All	4	4
Green	All	5	5
Blue	All	6. or $\underline{6}$	6
Violet	All	7	7
Grey	All	8	8
White	All	9. or $\underline{9}$	9
Pink	All	—	2L
Translucent	3 and 4	—	TL

6 Finish

The sleeves shall be free from bubbles, pinholes, and other defects that may affect performance.

7 Dimensions

NOTE. If sizes and/or tolerances other than those specified in this standard are required, full details of the requirements should be specified by the purchaser in the contract or order (see clause **3**).

7.1 The internal diameter and the wall thickness of the sleeves shall conform to the requirements of tables 7, 8, and 9.

7.2 Sleeves shall be supplied to lengths specified by the purchaser and shall be cut to the tolerances specified in table 2.

8 Printing

8.1 When required, sleeves shall be indelibly printed with a character or legend to the specific requirements of the purchaser and such printing shall not be affected by normal handling.

8.2 The printing shall be blue-black except on sleeves that would not provide adequate contrast.

The characters shall be clearly printed, of uniform density and shall be legible with normal reading vision.

The characters shall be underlined or have a dot following the legend when it is capable of being misinterpreted e.g M. $\underline{M}$ W. $\underline{W}$ 6. $\underline{6}$ 9. $\underline{9}$

The printing shall be longitudinal on the sleeve. (See figure 1).

8.3 When sleeves are marked more than once, the printing shall be equally spaced around the sleeve. The characters shall be of a height such that the total number of upper case characters shall cover at least 25 % of the circumference. Lower case characters shall be the same point size as the upper case characters.

NOTE. The preferred size and repetition of characters are given in table 10.

8.4 Single printed colour code numbers shall conform to table 6.

8.5 The production routine test for sleeves shall be 25 strokes of tissue paper impregnated with fluid h in table 4 after which the printing shall be legible with normal reading vision.

Table 7. Dimensions of type 1 sleeves

Size code	Internal diameter (mm)			Wall thickness (mm)		
	Nominal	Minimum	Maximum	Nominal	Minimum	Maximum
01	0.5	0.4	0.7	0.5	0.4	0.6
02	0.8	0.6	0.9	0.5	0.4	0.6
03	1.0	0.9	1.2	0.5	0.4	0.6
04	1.2	1.1	1.4	0.5	0.4	0.6
05	1.2	1.1	1.4	0.7	0.6	0.8
06	1.5	1.3	1.8	0.6	0.5	0.7
07	1.5	1.3	1.8	0.8	0.7	0.9
08	2.0	1.7	2.3	0.6	0.5	0.7
09	2.0	1.7	2.3	0.8	0.7	0.9
22	2.5	2.1	2.9	0.6	0.5	0.7
23	2.5	2.1	2.9	0.8	0.7	0.9
10	3.0	2.5	3.5	0.6	0.5	0.7
11	3.0	2.5	3.5	0.8	0.7	0.9
24	4.0	3.3	4.6	0.65	0.5	0.8
25	4.0	3.3	4.6	0.85	0.7	1.0
26	4.0	3.3	4.6	1.05	0.9	1.2
12	5.0	4.2	5.8	0.65	0.5	0.8
27	5.0	4.2	5.8	0.85	0.7	1.0
13	5.0	4.2	5.8	1.05	0.9	1.2
14	8.0	6.8	9.2	0.65	0.5	0.8
28	8.0	6.8	9.2	0.9	0.7	1.1
15	8.0	6.8	9.2	1.25	1.0	1.5
16	10.0	8.6	11.4	0.65	0.5	0.8
29	10.0	8.6	11.4	1.0	0.8	1.2
17	10.0	8.6	11.4	1.5	1.2	1.8
18	15.0	13.0	17.0	0.7	0.5	0.9
30	15.0	13.0	17.0	1.15	0.9	1.4
19	15.0	13.0	17.0	1.7	1.4	2.0
20	20.0	17.5	22.5	0.7	0.5	0.9
31	20.0	17.5	22.5	1.2	0.9	1.5
21	20.0	17.5	22.5	2.05	1.7	2.4
32	25.0	21.5	28.5	0.7	0.5	0.9
33	25.0	21.5	28.5	1.2	0.9	1.5
34	25.0	21.5	28.5	2.05	1.7	2.4

NOTE. The data of this table is arranged so that the nominal internal diameters are in consecutive numeric order.

Table 8. Dimensions of type 2 sleeves (mm)

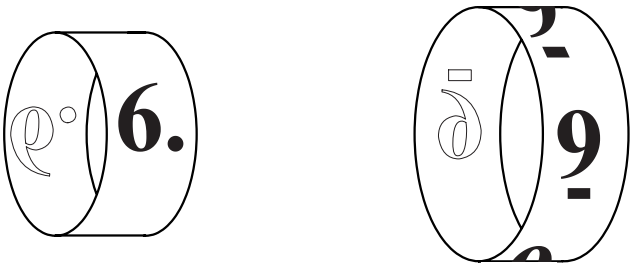
Size code	Internal diameter (mm)			Wall thickness (mm)		
	Nominal	Minimum	Maximum	Nominal	Minimum	Maximum
01	0.5	0.4	0.7	0.6	0.5	0.7
02	0.8	0.6	0.9	0.6	0.5	0.7
03	1.0	0.9	1.2	0.6	0.5	0.7
04	1.5	1.3	1.8	0.6	0.5	0.7
05	2.0	1.7	2.3	0.6	0.5	0.7
06	3.0	2.5	3.5	1.0	0.8	1.2
07	4.0	3.3	4.6	1.0	0.8	1.2
08	5.0	4.2	5.8	1.0	0.8	1.2
09	8.0	6.8	9.2	1.25	1.0	1.5
10	10.0	8.6	11.4	1.4	1.0	1.8
11	15.0	13.0	17.0	1.4	1.0	1.8
12	20.0	17.5	22.5	1.4	1.0	1.8
13	25.0	21.1	28.5	1.4	1.0	1.8

NOTE. The data of this table is arranged so that the nominal internal diameters are in consecutive numeric order.

Table 9. Dimensions of type 3 and 4 sleeves

Size code	Internal diameter (mm)			Wall thickness (mm)		
	Nominal	Minimum	Maximum	Nominal	Minimum	Maximum
01	0.5	0.4	0.7	0.5	0.4	0.6
02	1.0	0.9	1.2	0.5	0.4	0.6
03	1.5	1.3	1.8	0.5	0.4	0.6
04	2.0	1.7	2.3	0.5	0.4	0.6
05	2.5	2.1	2.9	0.5	0.4	0.6
06	3.0	2.5	3.5	0.5	0.4	0.6
07	4.0	3.3	4.6	0.5	0.4	0.6
08	5.0	4.2	5.8	0.5	0.4	0.6
09	6.0	5.1	6.9	0.7	0.55	0.85
10	7.0	6.0	8.0	0.7	0.55	0.85
11	8.0	6.8	9.2	0.7	0.55	0.85
12	9.0	7.7	10.3	0.7	0.55	0.85
13	10.0	8.6	11.4	0.7	0.55	0.85
14	11.0	9.5	12.5	1.0	0.8	1.2
15	12.0	10.4	13.6	1.0	0.8	1.2
16	15.0	13.0	17.0	1.0	0.8	1.2

NOTE. The data of this table is arranged so that the nominal internal diameters are in consecutive numeric order.



5 mm size 20 mm size

Figure 1. Disposition of characters on identification sleeves

Table 10. Size and repetition of characters for single identification sleeves

Nominal internal diameter of sleeve	Nominal height of character	Preferred number of times printed around periphery of sleeve
(mm)	(mm)	
0.5 to 1.6	2.0 (1.6 min.)	1
1.61 to 4.0	2.5	2
4.1 to 10.0	4.5	2
10.1 to 25.0	6.0	4

9 Shelf life

Shelf life shall conform to BS 3F 68.

10 Type testing

10.1 Type tests

10.1.1 The manufacturer or supplier shall provide details of the following:

material composition;

agreed techniques (including printing); and

evidence, to the satisfaction of the type approving authority[2)], that sleeves supplied in accordance with this standard conform to the tests listed in table 5.

10.1.2 Manufacturers/suppliers of printed sleeves shall demonstrate that the sleeves conform to all the material and printing requirements of this standard. Manufacturers/suppliers of unprinted sleeves shall demonstrate conformance to the material requirements. Certification to this standard shall indicate the scope of the manufacturer's/supplier's and printer's approval.

10.1.3 Type tests shall be performed on sizes taken from the top, middle and bottom of the manufacturer or supplier's range for each different material, unless otherwise specified in table 5. The smallest sleeve to be tested shall have a specified internal diameter of not less than 2 mm.

10.1.4 In the event of failure of the sleeves to conform to the requirements of a test, the batch shall be re-sampled and the test repeated using two further sets of test pieces. Both sets shall conform to the appropriate test requirements, otherwise the sleeves shall be deemed not to conform to this standard.

10.1.5 No changes shall be made to the declared material composition and agreed techniques used in the production of the sleeves without the prior written agreement of the type approving authority.

NOTE. Following such changes, the type approving authority may require a repetition of type testing.

10.1.6 Type approval is valid for a period of 5 years after which time the manufacturer or supplier shall apply for reapproval of the material.

10.2 Test conditions

10.2.1 Unless otherwise specified in a particular test, the tests shall be carried out under normal test conditions without control of humidity, at a temperature of $(20 \pm 5)\ ^{\circ}C$. In the event of a dispute, the tests shall be conducted at $(23 \pm 2)\ ^{\circ}C$.

10.2.2 ***Conditioning***

The test pieces and measurement gauges (if used) shall be conditioned for at least 4 h under the conditions specified in clause **10.2.1** prior to testing.

10.2.3 Unless otherwise specified, a fan assisted air oven shall be used to heat test specimens.

[2)] The approving authority for civil aircraft applications is the Civil Aviation Authority, Airworthiness Division or an organization approved by them, and for Ministry of Defence applications will be nominated by the Directorate of Standardization.

11 Production routine and production quality testing

11.1 Production routine tests

Production routine tests shall be applied to samples, taken at random, from every batch, and shall consist of the tests listed in table 11.

11.2 Production quality tests

The frequency of application of each production quality test shall be in accordance with the requirements of the approving authority and will depend on the maintenance of the basic formulation of the sleeve material and the manufacturing conditions. Production quality tests shall be applied to samples taken at random from batches, and shall consist of the tests listed in table 12.

Table 11. Production routine tests

Title	Clause
Finish	**12.1**
Printing	**12.2**
Dimensions	**12.3**
Circumferential extension (unaged)	**12.4**
Tension set	**12.5**

Table 12. Production quality tests

Title	Clause
Circumferential extension (aged)	**12.4**
Voltage proof[1)]	**12.6**
Resistance to fluids[1) 2)]	**12.7**
Silver staining[2)]	**12.8**
Volume resistivity	**12.9**
Resistance to extremes of temperature[1)]	**12.10**
Colour fastness to light[1) 2) 3)]	**12.11**
Resistance to mould growth[2)]	**12.12**
Resistance to ozone	**12.13**
Low temperature flexibility	**12.14**
Flammability[2)]	**12.15**
Thermal endurance[2)]	**12.16**
Extensibility after ageing	**12.17**

[1)] If the manufacturer/supplier intends to supply printed sleeves, only printed sleeves shall be tested.
[2)] For the purposes of this test, one sleeve may be taken to be representative of other sizes.
[3)] All colours are to be tested.

11.3 Batch

A batch of sleeves shall consist of those sleeves of the same type, dimensions and colour (printed if required) produced from a single mix provided that the curing conditions of temperature and time are maintained constant throughout. For continuous processing a single mix shall be defined by the manufacturer or supplier to the satisfaction of the approving authority.

12 Tests and requirements

Table 13. Tests and requirements

Clause	Title	Method	Requirements
12.1	**Finish**	Inspect	All sleeves shall conform to the requirements of clause **6.**
12.2	**Printing**	Inspect	All printed sleeves shall conform to the requirements of clause **8**.
12.3	**Dimensions**	Sleeves shall be selected for measurement. Determine internal diameter, wall thickness and length. Determine the minimum and maximum wall thickness of a section taken at a single position along each test piece. The methods of measurement can be mechanical or optical. Wall thickness shall be measured to an accuracy of at least 0.025 mm and internal diameter to an accuracy of at least 0.05 mm. In the case of dispute an optical method shall be used, having an accuracy of at least 0.01 mm.	All sleeves shall conform to the requirements of clause **7**.
12.4	**Circumferential extension**	**Test 1.** Four rings of length not greater than 2 mm shall be cut from sleeves perpendicular to the longitudinal axis and conditioned at (20 ± 5) °C for at least 12 h before testing. Two of the four rings shall be aged for (168 ± 2) h at (70 ± 1) °C for types 1 and 2 and (150 ± 3) °C for types 3 and 4 in a fan circulating oven as described in BS 903 : Part A19, followed by a further period of conditioning at (20 ± 5) °C for at least 12 h. Each ring shall be rolled up a tapered mandrel having an included angle of (15 ± 1)° and kept in that position. The test pieces shall be extended to the following diameters	The rings shall not split within 10 s.

Types	1 and 2	3 and 4
Aged:	5 D	4 D
Unaged:	6 D	5 D

Where D is the nominal internal diameter.

Test 2. Two 15 mm to 20 mm long sleeves shall be tested for ability to withstand expansion using any three or four pronged device capable of achieving the required degree of expansion. For sleeve sizes 2 mm to 10 mm nominal internal diameter, the device shall be a commercially available tool of a size recommended by the manufacturer. The sleeves shall be expanded until they pass over a mandrel of the following extension ratios: Types 1 and 2 : 3.5D Types 3 and 4 : 4D	The sleeves shall not split.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.4 (cont.)		Where D is the nominal internal diameter. This test shall be performed before and after the accelerated ageing treatment specified in test 1.	
		Test 3. Two 15 mm to 20 mm long sleeves shall be tested by fitting them over a mandrel three times the nominal internal diameter of the sleeve using the minimum quantity of lubricant. Each sleeve shall be fitted to the mandrel at the first attempt. If unsuccessful, the sleeve shall be discarded and a further sleeve cut. After fitting, make a cut 1 mm to 2 mm long on one end through the complete wall thickness of each length parallel to the axis of the mandrel. Leave the sleeve for at least 1 h.	The sleeves shall not split off the mandrel over a period of 1 h.
		Test 4. Sufficiently long sleeves shall be aged in an oven at (95 ± 2) °C for (168 ± 2) h. Upon removal from the oven, the lengths shall be allowed to stabilize at room temperature for 2 h ± 10 min. After this time the sleeving lengths shall be subjected to test 3. NOTE. Tests 2, 3 and 4 are not applicable to sleeves with less than 2 mm nominal internal diameter.	The sleeves shall not split off the mandrel over a period of 1 h.
12.5	**Tension set**	For nominal internal diameters of 8 mm or less two sleeves of at least 120 mm long shall be used. For nominal internal diameters greater than 8 mm use two dumbbells according to BS 903 : Part A2 Type 2. The test pieces shall be conditioned at (20 ± 5) °C for a minimum of 12 h. Each test piece shall be marked with two lines 20 mm apart, then stretched until the marked lines are 80 mm apart. The time taken to complete the stretching shall be approximately 10 s. Each test piece shall be held in the stretched position for 10 min ± 10 s and then released and allowed to rest on a smooth flat surface for a further 10 min ± 10 s. At the end of this period the lengths between the marked lines shall be remeasured to determine the percentage increase for each test piece.	Not greater than 25 %.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.6	**Voltage proof**	At least three 35 mm long sleeves shall be tested, each fitted to a smooth non-ferrous metal mandrel so that the mandrel protrudes from each end of the sleeve. A mandrel diameter of twice the nominal specified internal diameter of the sleeve shall be used. No lubricant other than distilled water shall be used. The sleeves shall be fitted so that they have uniform wall thickness and are not less than 32 mm long on the mandrel. Determine the wall thickness. The assemblies shall be immersed in distilled water for 24 h ± 15 min at a temperature of (20 ± 5) °C. The assemblies shall be removed from the water and the surface moisture shall be immediately removed from the sleeves with a clean filter paper. A strip of metal foil 6 mm wide shall be wrapped round the centre of each sleeve and held in place. Alternating voltage with a nominal frequency of 50 Hz and waveform approximately sinusoidal with a peak factor within limits of $\sqrt{2} \pm 7$ % (1.32 to 1.51) shall be applied between the foil and the mandrel. The voltage shall be increased at a uniform rate so that the required voltage is reached in approximately 10 s and is maintained at this value for 1 min ± 5 s. NOTE. It is important that the assembly is prepared and the test voltage is applied within 10 min after the removal of the mandrel from the water.	Minimum voltage (R.M.S.) **Type** / **Up to and including 0.5 mm wall** / **Over 0.5 mm wall** 1,3,4 / 2000 / 4000 2 / 1500 / 3000 There shall be no breakdown.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.7	**Resistance to fluids**	**WARNING**. Some test fluids may have a flash-point close to or below the temperature of test. Appropriate precautions should be taken during testing. Some test fluids may themselves, or in combination with the test piece, be toxic. Due consideration should be given to this possibility before commencing the test. Sleeve lengths shall be as follows: **Nominal internal diameter** mm / **Length of sleeve** mm 0.5 to 1.5 — 4 ± 1 2 to 9.0 — 7 ± 2 10 to 25 — 12 ± 3 The test pieces, three for each fluid, shall be subjected to test 1 or test 2 as detailed in table 4[1)] NOTE. The purchaser may require sleeving to be tested in fluids in addition to those listed in table 4, in which case the additional fluids should be discussed with the manufacturer or supplier, see clause **3**. **Test 1.** Three test pieces shall be fitted to a smooth aluminium mandrel, the diameters of which are twice the nominal internal diameter of the sleeves, to make an assembly. For each of the test fluids specified in table 4, an assembly shall be immersed vertically for 24 h ± 15 min, maintaining each fluid at the test temperature specified in that table. At the end of this period each assembly shall be removed from the fluid and examined. The sleeves shall be allowed to drain vertically in an oven at (70 ± 1) °C for 2 h ± 5 min and then removed and allowed to cool to room temperature. Printing shall be rubbed 25 times with a clean, dry, soft cloth and the sleeves shall be re-examined.	Sleeves shall not slip down the mandrel under their own weight and shall not split, blister or become gelatinous or tacky, either on removal from the fluid or after conditioning. With the exception of the fluids known to stain as given in table 4[1)], there shall be no marked change in colour. Printing shall remain legible and the transparent overlay, if any, shall not be affected.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.7 (cont.)		**Test 2.** Test assemblies, as described in test 1, shall be tested in each of the fluids, and at the temperatures specified in table 4. The assemblies shall remain vertical throughout the following 24 h cycle. For each fluid; a) dip the assembly in the fluid for 5 s to 10 s. b) store the assembly for 2 h ± 5 min at the specified temperature. c) condition the assembly for (45 ± 5) min at normal temperature (see **10.2.1**). d) repeat steps a) b) and c). e) repeat step a) (a total of 3 dips per cycle). f) store at the specified temperature for a period such that the total cycle time is 24 h. g) repeat c). This cycle shall be repeated a total of seven times. Whenever consecutive 24 h cycles are not possible the assemblies shall be stored at room temperature. The seven cycles shall be completed within a total of ten consecutive days.	
12.8	**Silver staining**	A freshly cut surface of a sleeve shall be placed in contact with a piece of analytical silver foil, as used for assay purposes, which has been polished and degreased by means of jeweller's rouge and water only and rubbed dry with a clean cloth. The foil with the sleeve resting on it shall be placed in a horizontal position in a chamber and maintained at (70 ± 1) °C dry heat for (30 ± 1) min. It shall be removed from the chamber and allowed to cool to room temperature. The silver foil shall be examined for stain. Any stain shall be compared with the standard shade (BS 1834) on a photographic stain tester prepared to the following specification, viewing the stain through the clear part of the film adjacent to the standard shade. **Stain tester** The stain tester shall consist of a rectangular piece of clear photographic film with a strip of the standard shade 3 mm wide across it, equidistant from each end. The stain tester shall fulfil the following requirements when measured in accordance with BS 1384. The clear photographic film background shall have a visual density not greater than 0.050.	Any stain shall not be darker than the standard shade.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.8 (cont.)		The difference in density between the standard shade and the clear photographic film background shall be 0.015 ± 0.005.	
12.9	**Volume resistivity**	This test shall be carried out on moulded sheets produced from the same batch of material as used for the sleeves. **Dry** Carry out the test as described in BS 903 : Part C2 (BS 2782 : Part 2 : Method 230 A) with the exception that **10.2.1** of this standard shall apply to the conditioning period and the conditions of test. **Damp** The moulded sheets shall be placed in a chamber provided with means for circulating damp air and subjected to damp heat treatment as follows: a) Maintain the chamber for 16 h ± 15 min in such conditions that the temperature near the test piece is (55 ± 1) °C and the relative humidity is not less than 95%. b) Turn off the source of heat and allow the closed chamber to cool for at least 5 h with the damp air circulation maintained. c) Turn on the source of heat so that 24 h ± 15 min from the beginning of the treatment the chamber conditions specified in a) are restored. d) Repeat the cycle of operations described in a), b) and c). e) Repeat the cycle of operations described in a) and b) except that between 4 h and 5 h after the source of heat has been turned off withdraw the test piece from the chamber, remove surface water and leave it to recover in normal atmospheric conditions. Between 1.5 h and 2 h after removal of the sheets from the chamber, the volume resistivity shall be measured using the procedure given in BS 903 : Part C2 (BS 2782 : Part 2 : Method 230 A). NOTE. Metallic electrodes may be used, provided good electrical contact is achieved.	The volume resistivity, dry and damp, shall be not less than: **Type** / **Ω · cm** 1 / 1×10^{11} 2 / 5×10^{9} 3 / 1×10^{11} 4 / 1×10^{13}

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.10	**Resistance to extremes of temperature**	**WARNING NOTE**. Some materials may release toxic fumes at these temperatures. Due consideration should be given to this possibility before commencing these tests. For each of the following tests, three sleeves shall be fitted to a smooth aluminium mandrel, the diameter of which is twice the nominal internal diameter of the sleeve, to make an assembly. The lengths of the sleeves shall be as follows: **Nominal internal diameter** mm / **Length of sleeve** mm 0.5 to 1.5 — 4 ± 1 2.0 to 9.0 — 7 ± 2 10 to 25 — 12 ± 3 The assembly shall be conditioned for (48 ± 2) h under normal conditions (see **10.2.1**).	
		Test 1. The assembly shall be placed in an oven for (168 ± 2) h at the following temperature: Type 1: (95 ± 1) °C Type 2: (120 ± 1) °C Type 3: (220 ± 2) °C Type 4: (275 ± 5) °C After this period the assembly shall immediately be transferred to a chamber at a temperature of (−65 ± 3) °C for (60 ± 1) min. It shall then be conditioned for (60 ± 1) min, at normal temperature after which any printing shall be rubbed 25 times with a clean, dry, soft cloth. The assembly shall be vertical throughout the test.	The sleeves shall show no signs of cracking, splitting or change of colour. The sleeve shall not slip off the mandrel under its own weight. Any printing shall remain legible.
		Test 2. The assembly described in test 1 shall be stored vertically for 5 min ± 5 s in an oven at the following temperature: Type 2: (250 ± 5) °C Type 3: (300 ± 5) °C Type 4: (350 ± 5) °C On removal from the oven, the assembly shall be examined. NOTE. Test 2 is not applicable to type 1 sleeves.	The sleeves shall not split, crack or slip off the mandrel.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.11	**Colour fastness to light**	A sleeve of each colour shall be subjected to the test for colour fastness to artificial light described in BS 2782 : Part 5 : Method 540B with the following additional provisions: a) the temperature of the test enclosure shall not exceed 40 °C; b) no control of humidity shall be exercised; c) any printing shall face the light source. NOTE. The test may be terminated after the standard blue wool has faded.	Colour fastness of at least Standard No. 3 for type 1 sleeves and No.5 for types 2, 3 and 4 sleeves. Any printing shall remain legible.
12.12	**Resistance to mould growth**	The test shall be conducted in accordance with the requirements of BS 2011 : Part 2.1 J (28 day test). The sleeve shall be approximately 25 mm long.	Mould growth shall not be greater than scale 2.
12.13	**Resistance to ozone**	Three sleeves approximately 25 mm long shall be fitted to a smooth mandrel that has a diameter twice the nominal internal diameter of the sleeve. The mounted sleeves shall be conditioned for (48 ± 2) h in a substantially ozone free atmosphere at the conditions specified in **10.2.1** and in the dark. It shall then be exposed for the following times and ozone concentrations at (30 ± 2) °C. **Type** / **Exposure time** / **Ozone concentration** 1 / 20 h ± 15 min / (1.0 ± 0.2) ppm 2 / 5 h ± 5 min / (25 ± 5) ppm 3 and 4 / 20 h ± 15 min / (25 ± 5) ppm The sleeves, whilst still on the mandrel shall be examined using normally corrected vision.	There shall be no signs of cracking.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.14	**Low temperature flexibility**	Three test pieces are required, each approximately 200 mm in length. For sleeves of internal diameter 6 mm or less, apply the test to sleeves. For sleeves of internal diameter greater than 6 mm, apply the test to strips 6 mm wide cut longitudinally. The test pieces and a mandrel of diameter 20 times the wall thickness in the case of tubing, or 15 times the wall thickness in the case of strips, shall be stored at the following maximum temperatures for a period of not less than 2 h. **Type** / **Max. temperature °C**: 1 / −40; 2 / −25; 3 / −65; 4 / −65 At the end of this period the test pieces shall be wrapped in a close helix (taking not more than 10 s) 360° around the mandrel and then examined.	There shall be no signs of cracking.
12.15	**Flammability**	**WARNING NOTE.** Care should be exercised in performing this test as toxic fumes may be given off during combustion. It is recommended that the test chamber is placed in a fume cabinet which will allow evacuation of gaseous products of combustion at the end of the test. Five sleeves approximately 600 mm long having an internal diameter between 5 mm and 10 mm shall be tested to prove the flammability performance of the size under test and all other sizes. Each sleeve shall be mounted on a close fitting metal rod.	The test piece shall not emit flaming or glowing droplets at any time during the test, such that would ignite the tissue paper on the floor of the chamber.
		The burner shall have a nominal bore of (9.5 ± 1) mm. For natural gas, a conventional Bunsen burner may be used, the burner shall be regulated to give a flame approximately 125 mm long with an inner blue cone approximately 40 mm long. If propane is used, the burner specified in figure 2 shall be used.	Type 1 and 3 shall also meet the following requirements: Time to extinguish ≤ 30 s Length of afterburn ≤ 100 mm
		It may be convenient for burners to use a small pilot flame.	The indicator flag shall not be burnt.

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.15 (cont.)		The satisfactory operation of the burner shall be checked as follows, with the base of the burner being horizontal: a bare copper wire, (0.71 ± 0.025) mm in diameter, having a free length of not less than 100 mm shall be inserted horizontally in the flame about 10 mm above the top of the blue cone, so that the free end of the wire is vertically above the edge of the burner on the side remote from the supported end of the wire. The time required for the wire to melt shall be not more than 6 s and not less than 4 s. The test shall be conducted in an exhaust hood or cabinet with the specimen surrounded by a three-sided metal enclosure to protect it from draughts. Conduct the test using a three-walled sheet metal enclosure approximately 500 mm wide × 300 mm deep × 700 mm high, open at the front and free from draughts. The arrangement of test piece and burner are shown in figure 2. The test piece shall be secured with its longitudinal axis vertical in the centre of the enclosure. A wedge to which the base of the burner can be secured shall be provided for tilting the barrel (20 ± 2)° from the vertical in the same plane as the specimen. The burner shall be secured to the wedge and the assembly placed in an adjustable support jig. The jig shall be placed with the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen so that the barrel points to the rear of the enclosure. The jig shall also be adjusted to position the point A approximately 40 mm from the point B, which is the point at which the tip of the blue inner cone touches the centre of the front of the specimen. The specimen shall be adjusted vertically to prevent point B from being any closer than 75 mm to the lower clamp or other support for the specimen. A layer of untreated surgical cotton, approximately 3 mm thick, shall cover the floor of the enclosure including the wedge and the base of the burner. The upper surface of the cotton shall be no more than 240 mm below point B.	

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.15 (cont.)		A strip of unreinforced kraft paper (80 g/m^2 to 100 g/m^2) that is 13 mm wide, approximately 0.1 mm thick and is gummed on one side, is to be used to make an indicator flag. The gum shall be moistened just sufficiently to obtain adhesion. With the gum toward the specimen, the strip shall be wrapped around the specimen once with its lower edge 250 mm above point B. The ends of the strip shall be pressed together evenly and trimmed to provide a flag that projects 20 mm from the specimen toward the rear of the enclosure with the flag parallel to the sides of the enclosure. The flame shall be applied to the specimen for 15 s, removed and reapplied at 15 s intervals for a total of five 15 s applications of the gas flame to the specimen with 15 s between applications unless flaming or glowing of the specimen persists longer than 15 s after the previous application of the gas flame, in which case the gas flame shall not be reapplied until the flaming or glowing of the specimen ceases of its own accord.	
12.16	**Thermal endurance**	Conduct the test generally in accordance with the appropriate Part of BS 5691. Measure the ultimate elongation in accordance with BS 903 : Part A2. The rate of jaw separation shall be (500 $\pm$ 50) mm/min. The test pieces shall be prepared in accordance with BS 903 : Part A2, type 2.The end point shall be 50 % absolute elongation for types 1 and 2 and 50 % of the initial tensile strength for types 3 and 4, carried out on a black sleeve having an internal diameter of 5 mm to 10 mm. NOTE. It is recognized that other colours may give different results. The manufacturer/supplier may be required to provide evidence to the approval authority that other colours will meet the mininum temperature index.	The minimum temperature index shall be as follows: **Type** / **Temperature index** 1 — 70 2 — 75 3 — 140 4 — 160

Table 13. Tests and requirements (*continued*)

Clause	Title	Method	Requirements
12.17	**Extensibility after ageing**	NOTE. For sleeves of nominal internal diameter 6 mm and less, cut five test pieces 150 mm long. For sleeves greater than 6 mm, prepare five test pieces in accordance with BS 903 : Part A2, type 2. Age the test pieces in accordance with the table as follows and test in accordance with BS 903 : Part A 19. The rate of jaw separation shall be (500 ± 50) mm/min.	Minimum of 50 % absolute elongation

Type	Temperature °C	Ageing time h
1	95	1000
	115	168
2	100	1000
	120	168
3	170	1000
	190	168
4	220	1000
	260	168

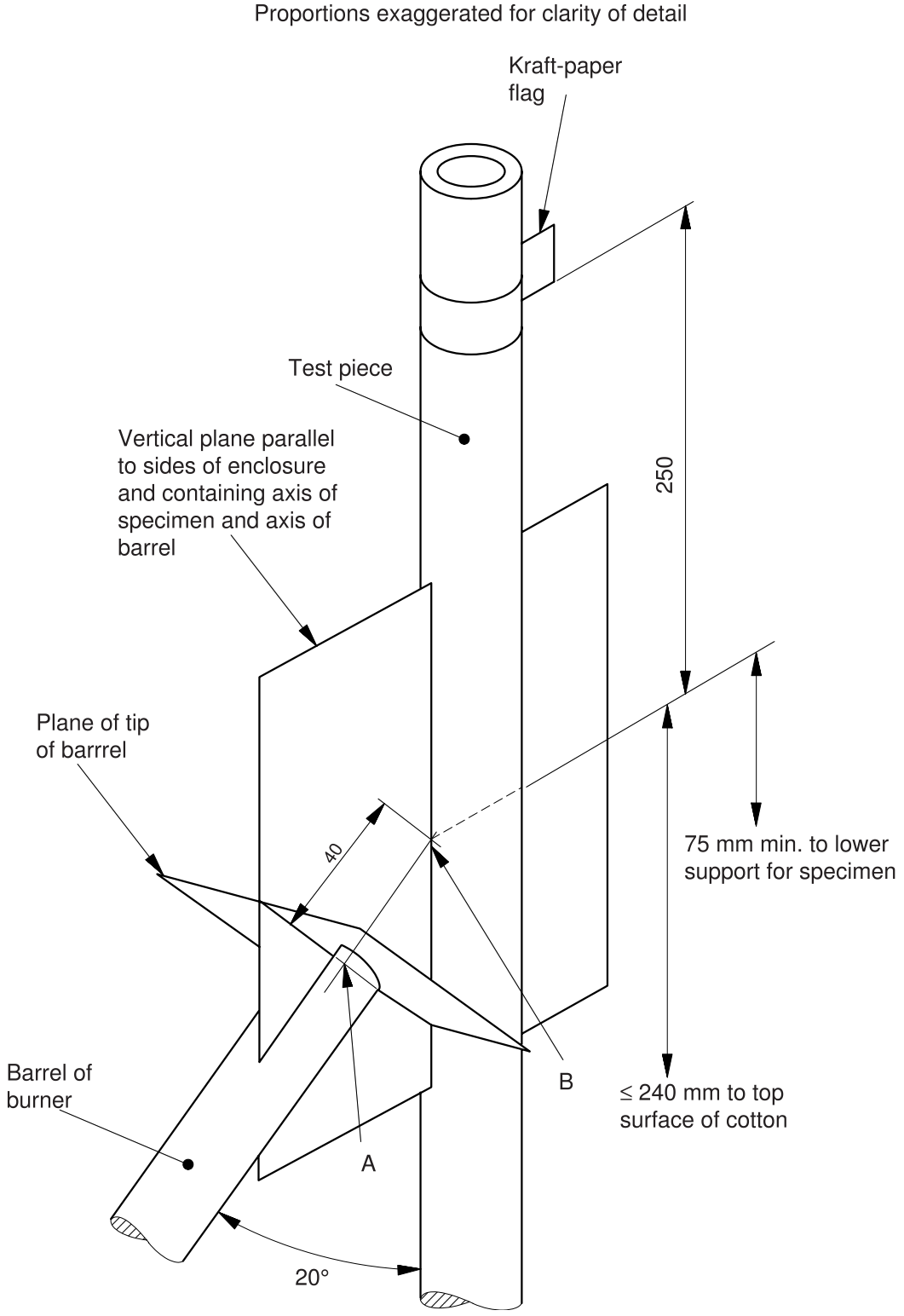
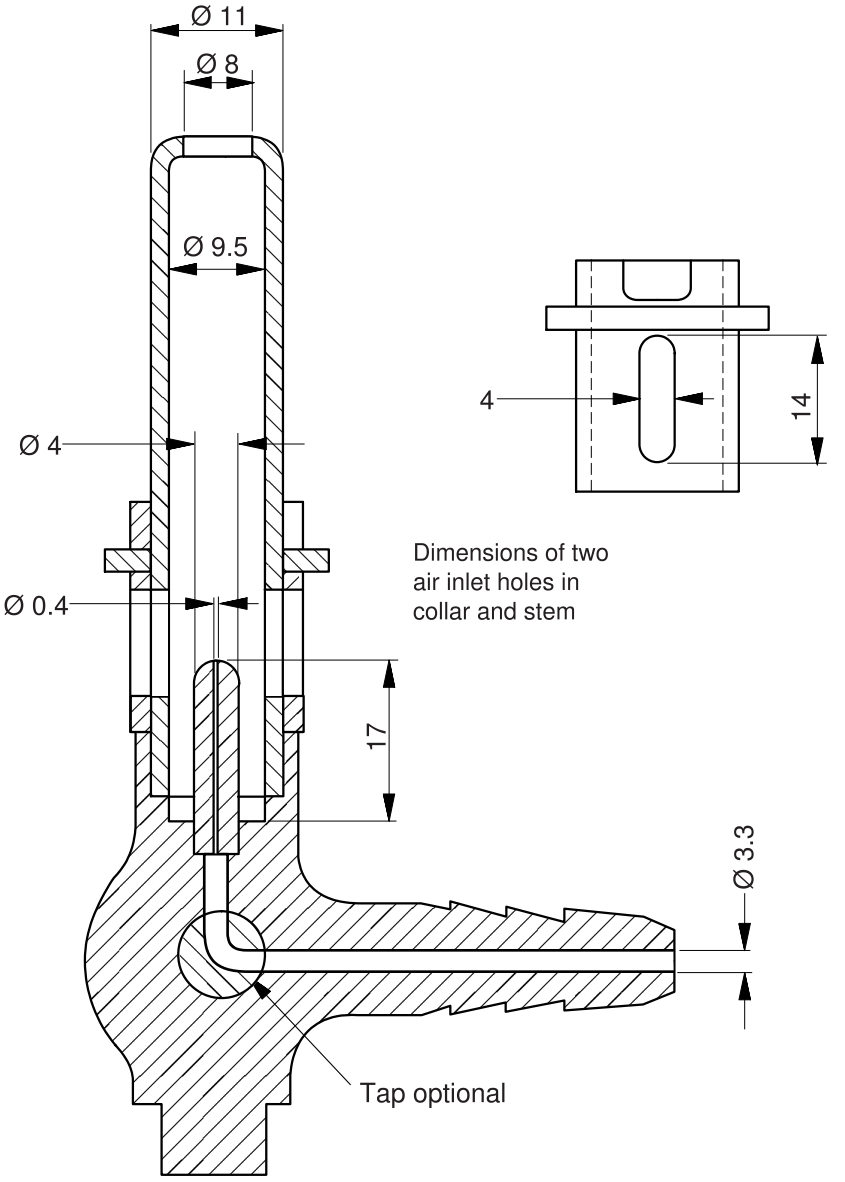


Figure 2. Test configuration for the flammability test



All dimensions are given in mm

Figure 3. Standard propane burner for flammability test. (Sectional view)

13 Marking and packaging

13.1 General

Each package of sleeves shall be marked with the following information:

a) the number and date of this British Standard, (i.e. BS 4G 198 : Part 1 : 1997)[3)];

b) the type number;

c) the size code if relevant;

d) the colour code; (see table 6);

e) the lengths and quantity of the sleeves;

f) the manufacturer's or supplier's name or recognized mark;

g) the batch number;

h) the use by date[4)];

i) the character/legend printed on the sleeves.

NOTE 1. The number of this British Standard, including the Part number, the type, the size code, and colour code may be codified as in the following example.

4G198	−1	−4	−05	−0	
					Colour (see table 6)
					Size code
					Type
					British Standard Part
					British Standard Number

In the example shown, type 4 sleeving of 2.5 mm nominal internal diameter, colour black, conforming to this standard would be supplied.

NOTE 2. The purchaser should use this code to identify sleeving in the contract or order (see clause **3**).

13.2 Non-transparent packages

If packed in non-transparent packages, the outside of the container shall be marked to show the colour of the sleeving.

NOTE 1. Packaging requirements will vary and should be specified by the purchaser in the contract or order (see clause **3**).

NOTE 2. For UK Government Services, these instructions are based on Defence Standard 81-41/3 *Packaging of defence material*.

[3)] Marking BS 4G 198 : Part 1 : 1997 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.

[4)] The use by date only applies when the storage conditions have conformed to BS 3F 68 and those given in annex A.

Annex

Annex A (informative)

Storage recommendations

The following recommendations are intended to assist prevention of sleeve degradation caused by conditions existing in the stores:

a) No sleeve should be stored in direct sunlight.

b) Sleeves should not be stored within 2 m of a direct ultraviolet (fluorescent) light source.

c) Sleeves delivered in packages should be left packaged until required.

d) Material used in packaging should preferably be of a light-proof material.

e) Packages which are opened for removal of part of their contents should be resealed.

f) Unpackaged sleeves should be stored in dust-excluding containers.

g) Periodically, containers should be emptied and cleaned if they contain unpackaged sleeves.

h) Artificial conditions, such as high ambient temperatures, dry humidities and chemical vapours should be avoided.

i) Items removed from storage for test should not be reinstated into production stock.

blank

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 903	*Physical testing of rubber*
BS 903 : Part A1 : 1980	*Determination of density*
BS 903 : Part A2 : 1989	*Determination of the effect of liquids*
BS 903 : Part A16 : 1987	*Determination of tensile stress-strain properties*
BS 903 : Part A19 : 1986	*Heat resistance and acceleration ageing tests*
BS 903 : Part C2 : 1982	*Determination of volume resistivity*
BS 1384:	*Photographic density measurements*
BS 1384 : Part 1 : 1985	*Guide for terms, symbols and notations*
BS 1384 : Part 2 : 1993	*Specification for geometric conditions for transmission density*
BS 1595	*Propan-2-ol (isopropyl alcohol) for industrial use*
BS 1595 : Part 1 : 1986	*Specification for propan-2-ol (isopropyl alcohol)*
BS 1834 : 1968	*Specification for isopropyl acetate*
BS 2011 :	*Environmental testing*
BS 2011 : Part 2.1	*Tests*
BS 2011 : Part 2.1J : 1989	*Test J and guidance. Mould growth*
BS 2782 :	*Methods of testing plastics*
BS 2782 : Part 2 :	*Electrical properties*
BS 2782 : Part 2 : Method 230A : 1982	*Determination of volume resistivity*
BS 2782 : Part 3 :	*Mechanical properties*
BS 2782 : Part 3 : Methods 320A to 320F : 1976	*Tensile strength, elongation and elastic modulus*
BS 2782 : Part 5 :	*Optical and colour properties, weathering*
BS 2782 : Part 5 : Method 540B : 1982	*Methods of exposure to laboratory light sources (Xenon arc lamp, enclosed carbon arc lamp, fluorescent tube lamps)*
BS 5691:	*Guide for the determination of thermal endurance properties of electrical insulating materials*
BS 5691 : Part 1 : 1995	*General guidelines for ageing procedures and evaluation of test results*
BS 5691 : Part 2 : 1995	*Choice of test criteria*
BS 5691 : Part 3:	*Instructions for calculating thermal endurance characteristics*
BS 5691 : Part 3 : Section 3.1 : 1995	*Calculations using mean values of normally distributed complete data*
BS 5691 : Part 4:	*Ageing ovens*
BS 5691 : Part 4 : Section 4.1 : 1995	*Single chamber ovens*
BS 5691 : Part 5 : 1995	*Guidelines for the application of thermal endurance characteristics*
BS 6580 : 1985	*Specification for corrosion inhibiting, engine coolant concentrate ('antifreeze')*
BS 6746C : 1993	*Colour chart for insulation and sheath of electric cables*
BS 3F 68 : 1977	*Specification for controlled storage of vulcanized rubber for use in aerospace applications*

BS 3G 100 :	*Specification for general requirements for equipment for use on aircraft*
BS 3G 100 : Part 2 :	*All equipment*
BS 3G 100 : Part 2 : Section 3	*Environmental conditions*
BS 3G 100 : Part 2 : Section 3 : Subsection 3.12 : 1991	*Fluid contamination*

Informative references

Other reference

Defence Standard 81-41/3 : Part 2.3 : 1991 *Packaging of defence materials*[5)]

[5)] Available from the Ministry of Defence, Directorate of Standardization.

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