

Sleeves and moulded components for aircraft electric cables and equipment wires —

Part 4: Specification for fluoropolymer heat shrinkable sleeving for binding and insulation

ICS 49.060



Committees responsible for this British Standard

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- 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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Foreword

This Part of BS G 198 has been prepared by Technical Committee ACE/6 and specifies requirements for heat shrinkable sleeves and sleeving 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 shapes¹⁾.*

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

This Part of BS G 198 specifies requirements for fluoropolymer, high performance heat shrinkable sleeving, in a range of diameters, lengths and materials, suitable for binding and insulation of electric cables and insulated equipment wires in aircraft. These sleeves are not normally printed.

The various types of sleeving covered by this Part of BS G 198 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 Parts of BS G 198.

Sleeving should be installed in accordance with the manufacturer's or the supplier's instructions and, in particular, it should be noted that when shrinkage is restricted some properties may be impaired, e.g. wall thickness will be reduced, and sleeving life may also be reduced.

It should be noted that the majority of heat guns available for the application of sleeving are not suitable for use in potentially explosive atmospheres. Application tools suitable for the installation of heat-shrinkable sleeving in these areas should be designed for Zone 2 areas as specified in BS 5345-2.

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 test is in no way suitable for assessing a fire hazard situation. It is solely for the purpose of specifying the basic material requirements of the heat-shrinkable sleeving.

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

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

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

¹⁾ In preparation.

1 Scope

This Part of BS G 198 specifies the design, performance, quality assurance requirements and methods of test for the types of heat-shrinkable sleeving given in Table 1. These sleeves are suitable for binding and insulation purposes. Routine and quality tests are specified.

In addition to the definitive requirements, this Part of BS G 198 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 Guidance 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.

NOTE 3 Sleeving that has been shrunk is referred to as recovered.

2 References

2.1 Normative references

This Part of BS G 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 20. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

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

3 Information to be supplied by the purchaser

The following information to be supplied by the purchaser 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 3G 198-4:1996);
- b) the total quantity required;
- c) cut length, if required (see 6.2) and tolerance on cut length, if the tolerance required is different from Table 7;
- d) minimum continuous lengths on spools, if required (see note 1 of 6.2);
- e) whether the sleeving is to be tested in any further fluids in addition to those given in Table 12 (see 10.20);
- f) coded identification (see note 1 of 11.1);
- g) packaging requirements (see 11.2).

If sizes and/or tolerances other than those specified in this Part of BS G 198 are required, full details of the requirements should be specified by the purchaser in the contract or order.

Table 1 — Types of heat-shrinkable sleeving

Type	Guide to temperature range °C	Exposure temperature °C			Recommended minimum shrink temperature ^d and shrink ratio °C	Guide to stiffness	Other main properties
		a ^a	b ^b	c ^c			
20	– 55 to 175	175	225	275	175 2 : 1	Semi-rigid	Abrasion resistant, clear and low combustibility
20A	– 55 to 150	150	225	275	175 2 : 1	Semi-flexible	Abrasion resistant, clear and low combustibility
21A	– 65 to 260	260	350	400	330 3 : 2	Semi-rigid	Abrasion resistant and low combustibility
21B	– 65 to 260	260	350	400	330 4 : 1	Semi-rigid	Abrasion resistant and low combustibility

^a Temperature *a* is for a minimum of 20 000 h when assessing in accordance with 10.21 for types 20 and 20A only. See 10.21 for types 21.

^b Temperature *b* is for a minimum of 1 68 h when assessing in accordance with 10.9.

^c Temperature *c* is for a minimum of 4 h when assessing in accordance with 10.11.

^d The minimum shrink temperature is the minimum temperature at which full recovery can be guaranteed. Refer to the manufacturer/supplier for actual values.

Table 2 — Materials and characteristics

Type	Materials	Characteristics
20	Polyvinylidene fluoride	This sleeving is basically transparent but may be tinted. It is semi-rigid, tough and abrasion resistant, and is suitable for use where strain relief and mechanical protection are required, or where their transparent properties are desirable. It is not suitable for shrinkage onto surfaces having sharp changes in profile.
20A	Semi-flexible polyvinylidene fluoride	This sleeving is transparent, semi-flexible, tough and abrasion resistant and is suitable for use where strain relief and mechanical protection are required or where its transparent properties are desirable. It is not suitable for use where contamination from phosphate ester based hydraulic fluid is possible.
21A	Polytetrafluoroethylene (PTFE) (low shrink ratio)	This sleeving is milk white translucent. It is suitable for use where resistance to chemicals and high temperature performance are required. It is flame resistant and has a low shrink ratio.
21B	Polytetrafluoroethylene (PTFE) (high shrink ratio)	This sleeving is milk white translucent. It is suitable for use where resistance to chemicals and high temperature performance are required. It is flame resistant and has a high shrink ratio.

4 Materials and characteristics

Sleeving shall be made from materials that ensure that the finished sleeving conforms to the appropriate requirements of clause 10.

NOTE 1 Materials known to meet the requirements of the tests specified in clause 10 will have the characteristics given in Table 2.

NOTE 2 The tests specified in clause 10 are performed on finished sleeving.

5 Finish

The sleeving, both before and after unrestricted shrinkage, shall be free from bubbles, pinholes and other defects that may affect performance.

6 Dimensions

6.1 The internal diameters and related wall thickness of the sleeving, both before and after unrestricted shrinkage, as applicable, shall conform to the requirements given in Table 3 to Table 6, unless otherwise agreed with the purchaser (see clause 3).

6.2 Cut lengths of sleeving shall be cut to the tolerances specified in Table 7 unless otherwise agreed with the purchaser (see clause 3).

NOTE 1 Sleeving supplied on a spool may not necessarily be in a continuous length. If a minimum cut length is required, the length should be stated by the purchaser in the contract or order (see clause 3).

NOTE 2 The minimum continuous lengths will vary with size and material.

Table 3 — Dimensions of type 20 sleeves

All dimensions in millimetres

Size code	As supplied	After unrestricted shrinkage		
	Internal diameter (min.)	Internal diameter (max.)	Wall thickness	Tolerance on wall thickness
01	1.2	0.6	0.25	± 0.05
02	1.6	0.8	0.25	± 0.05
03	2.4	1.2	0.25	± 0.05
04	3.2	1.6	0.25	± 0.05
05	4.8	2.4	0.25	± 0.05
06	6.4	3.2	0.30	± 0.10
07	9.5	4.8	0.30	± 0.10
08	12.7	6.4	0.30	± 0.10
09	19.0	9.5	0.45	± 0.10
10	25.4	12.7	0.50	± 0.10
11	38.0	19.0	0.55	± 0.15

Table 4 — Dimensions of type 20A sleeves

All dimensions in millimetres

Size code	As supplied	After unrestricted shrinkage		
	Internal diameter (min.)	Internal diameter (max.)	Wall thickness	Tolerance on wall thickness
01	1.2	0.6	0.25	± 0.05
02	1.6	0.8	0.25	± 0.05
03	2.4	1.2	0.25	± 0.05
04	3.2	1.6	0.25	± 0.05
05	4.8	2.4	0.25	± 0.05
06	6.4	3.2	0.30	± 0.10
07	9.5	4.8	0.30	± 0.10
08	12.7	6.4	0.30	± 0.10
09	19.0	9.5	0.45	± 0.10
10	25.4	12.7	0.50	± 0.10

Table 5 — Dimensions of type 21A sleeves

All dimensions in millimetres

Size code	As supplied	After unrestricted shrinkage		
	Internal diameter (min.)	Internal diameter (max.)	Wall thickness	Tolerance on wall thickness
01	0.85	0.4	0.23	± 0.08
02	1.00	0.5	0.25	± 0.08
03	1.25	0.7	0.25	± 0.08
04	1.40	0.8	0.30	± 0.08
05	1.50	1.0	0.30	± 0.08
06	1.90	1.3	0.30	± 0.08
07	2.35	1.6	0.30	± 0.08
08	3.00	2.0	0.30	± 0.08
09	3.80	2.3	0.30	± 0.08
10	4.85	2.9	0.30	± 0.08
11	6.10	3.6	0.38	± 0.12
12	7.65	4.6	0.38	± 0.12
13	9.40	5.7	0.38	± 0.12
14	10.90	7.1	0.38	± 0.12
15	11.90	8.9	0.38	± 0.12

Table 6 — Dimensions of type 21B sleeves

All dimensions in millimetres

Size code	As supplied	After unrestricted shrinkage		
	Internal diameter (min.)	Internal diameter (max.)	Wall thickness	Tolerance on wall thickness
01	1.95	0.65	0.23	± 0.08
02	3.15	0.95	0.25	± 0.08
03	6.35	1.60	0.30	± 0.10
04	9.50	2.45	0.30	± 0.10
05	12.70	3.70	0.38	± 0.12
06	15.85	4.55	0.38	± 0.12
07	19.00	5.70	0.38	± 0.12
08	25.40	7.10	0.38	± 0.12
09	31.75	8.85	0.38	± 0.12

Table 7 — Standard cutting tolerances for cut lengths of sleeving

All dimensions in millimetres

Cut length	Standard cutting tolerance
0 to 9.9	± 0.5
10 to 24.9	± 1.0
25 to 49.9	± 1.5
50 to 100.9	± 3.0
101 to 150.9	± 4.0
151 to 250.9	± 5.0
251 to 1 200.9	± 12.0
1 201 and over	± 1 %

7 Shelf life

NOTE The use by date is the shelf life when stored under the conditions specified in Annex A.

The use by date shall be the guaranteed minimum storage time for which the sleeving retains the as supplied internal diameter. Also, following unrestricted shrinkage in accordance with 10.3, the sleeving shall conform to the internal diameter, wall thickness and longitudinal change requirements specified in this Part of BS G 198.

8 Type testing

8.1 Type tests

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

- material composition;
- agreed techniques; and
- evidence, to the satisfaction of the type approving authority²⁾, that sleeving supplied in accordance with this Part of BS G 198 conforms to the requirements of clause 10, which describes the tests listed in Table 8. All test results shall be recorded and retained for the duration of the approval.

8.1.2 Type tests shall be performed on sizes taken from the top, middle and bottom of the manufacturer's or supplier's range for each different material, unless otherwise indicated in Table 8. The smallest sleeving to be tested shall have a specified recovered internal diameter of not less than 2 mm.

8.1.3 In the event of a failure of the sleeving 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 sleeving shall be deemed not to conform to this standard.

8.1.4 No changes shall be made to the declared material composition and agreed techniques used in the production of the sleeving 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.

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

Table 8 — Type tests

Title	Clause
Finish	10.1
Dimensions	10.2
Longitudinal change	10.3
Relative density ^a	10.4
Tensile strength and elongation at break	10.5
Dielectric strength	10.6
Volume resistivity after damp heat	10.7
Low temperature flexibility	10.8
Heat ageing	10.9
Water absorption ^a	10.10
Heat shock	10.11
Secant modulus at 2 % strain	10.12
Dynamic cut-through ^a	10.13
Scrape abrasion ^a	10.14
Transparency ^b	10.15
Resistance to mould growth ^a	10.16
Copper mirror corrosion ^a	10.17
Restricted shrinkage	10.18
Flammability ^a	10.19
Resistance to fluids ^a	10.20
Thermal endurance ^a	10.21
^a Only one size of sleeving needs to be tested.	
^b Test the greatest wall thickness produced.	

Table 9 — Production routine tests

Title	Clause
Finish	10.1
Dimensions	10.2
Longitudinal change	10.3
Relative density	10.4
Tensile strength and elongation at break	10.5
Dielectric strength	10.6
Heat shock	10.11
Secant modulus at 2 % strain	10.12
Transparency	10.15

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 is an organization nominated by the Ministry of Defence, Directorate of Standardization.