

Specification for

Armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire

Câbles armés d'alimentation à isolation
thermodurcissable et à faible émission de
fumée et de gaz corrosifs lorsqu'ils sont
exposés au feu — Spécifications

Duroplastisolierte bewehrte Kabel für die
Elektrizitätsversorgung mit im Brandfall
niedriger Abgabe von Russ und ätzenden
Gasen

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cables and Insulation Standards Policy Committee (CIL/-) to Technical Committee CIL/20, upon which the following bodies were represented:

Aluminium Federation
Association of Consulting Engineers
Association of Manufacturers of Domestic Electrical Appliances
British Approvals Service for Cables
British Cable Makers' Confederation
British Plastics Federation
British Railways Board
British Shipbuilders
British Telecommunications plc
Department of Energy (Electricity Division)
Department of the Environment (Property Services Agency)
Department of Trade and Industry (Consumer Safety Unit, CA Division)
ERA Technology Ltd.
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Institution of Electrical Engineers
London Regional Transport
Ministry of Defence

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

Association of Supervisory and Executive Engineers
British Gas Corporation

This British Standard, having been prepared under the direction of the Cables and Insulation Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 30 November 1990

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First published December 1986
Second edition November 1990

The following BSI references relate to the work on this standard:
Committee reference CIL/20
Draft for comment 89/22248 DC

ISBN 0 580 18216 9

Amendments issued since publication

Amd. No.	Date	Text affected

Amendment No. 1
published and effective from 24 December 1991
to BS 6724 : 1990

Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire

Revised text

AMD 6832
December 1991

Clause 10.1 General

Delete the existing text and substitute the following:
'The oversheath shall be an extruded layer of synthetic material complying with **18.2** and **10.2** to **10.4**.

NOTE. Oversheaths are normally black, but colours other than black may be provided by agreement between the manufacturer and purchaser, subject to their suitability for the particular exposure conditions under which the cables are to be used.'

AMD 6832
December 1991

Clause 11. Cable marking and end sealing

Delete **11.2** and **11.3** and substitute the following:

'11.2 External marking

The external surface of all cables complying with this British Standard shall be legibly marked with the following elements.

Element	Example of marking
(a) Electric cable	ELECTRIC CABLE
(b) Voltage designation	600/1000 V 3300 V 600/1000 V AUX
(c) British Standard number	BS 6724
(d) Manufacturer's identification	XYZ
(e) Number of cores, type and nominal area of conductor	
(1) Copper conductor cables NOTE 1. 4 x 50 indicates a four-core cable with 50 mm ² copper conductors.	4 x 50
(2) Copper conductor cables with reduced neutral NOTE 2. 3 x 50/25 indicates a four-core cable with three 50 mm ² copper phase conductors and one 25 mm ² copper neutral conductor.	3 x 50/25
(3) Aluminium conductor cables NOTE 3. 4 x 50AL indicates a four-core cable with 50 mm ² aluminium conductors.	4 x 50AL

The marking of the items (a) to (d) shall be by embossing or indenting on the oversheath.

For cables with tabulated approximate overall diameters above 15 mm, items (a), (b) and (c) shall appear, in any sequence that is deemed to neither confuse nor conflict, on two or more primary lines along the axis of the cable, approximately equally spaced

around the circumference of the cable. Items (d) and (e) shall appear on either one of the primary lines, or a secondary line or lines. They may appear in any sequence that is deemed to neither confuse nor conflict, and need not both be on the same line.

For cables with tabulated approximate overall diameters of 15 mm or smaller the elements of marking shall be disposed as for cables above 15 mm except that the marking for items (a), (b) and (c) shall appear on one or more primary lines.

The letters and figures shall consist of upright block characters with a minimum height of 3 mm.

The distance between the end of one element of marking and the beginning of the next identical element of marking shall be not greater than 550 mm for items (a), (b) and (c) and not greater than 1100 mm for items (d) and (e).

Compliance shall be checked by visual examination and measurement.

11.3 Identification of year of manufacture

A means of identifying the year of manufacture of the cable shall be provided throughout the length of the cable, either internally or by marking on the surface of the cable.

If the identification is internal the distance between the end of one mark and the beginning of the next mark shall be not greater than 550 mm.

NOTE. As an alternative internal marking, an identification thread may be used.

If the identification is by marking on the surface it shall comply with items (d) and (e) in 11.2 in respect of maximum distance between marks.

11.4 The mark of an approval organization

If the mark of an approval organization is used it shall be provided throughout the length of the cable.

If the mark is applied to the cable it shall be on the surface in the form of the symbol(s) specified by the approval organization, and shall comply with items (d) and (e) in 11.2 in respect of maximum distance between marks.

NOTE. As an alternative to the mark of the approval organization, an identification thread may be incorporated into the cable, as specified by the approval organization.

11.5 Additional marking

The use of additional marking is permitted. Where such marking is made it shall be throughout the length of the cable, and may be on the external surface of the cable, or by means of a tape or thread within the cable, or by a combination of these methods. If the additional marking is applied to the surface of the cable it shall not render illegible the marking specified in 11.2 to 11.4.

The additional marking, however made, shall be repeated at intervals not exceeding 1100 mm.

11.6 End sealing

Both ends of every length of cable shall be sealed in such a manner that it includes the oversheath.

NOTE. One example of end sealing is the use of close fitting plastic caps.

Appendix B.2 Minimum installation radius

Delete the existing text and substitute the following:

'The cables specified in this standard should not be bent during installation to a radius smaller than that recommended in table 23A. Wherever possible, larger installation radii should be used.'

Table 23A. Minimum installation radius		
1	2	3
Construction	Tabulated overall diameter, D	Minimum internal radius of bend
Circular copper conductor	any	$6D$
Solid aluminium or shaped copper conductors	any	$8D$

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Revised text

AMD 7569
July 1993

Contents

Below the entry for appendix L, insert the following new entries.

- 'M** Test for shrinkage of sheath on cable
N Water immersion test on sheath'

Below the entry for table 25, insert the following new entry.

'25A Minimum installation radius'

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Clause 5.2 Thickness of insulation

In line 3, delete 'BS 6469' and substitute 'BS 6469 : Section 1.1'.

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Clause 8.2 Thickness of extruded bedding

In line 2, delete 'BS 6469' and substitute 'BS 6469 : Section 1.1'.

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Clause 10.1 General (as amended by Amendment No. 1)

In line 3, delete '18.2' and substitute '18.3'.

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Clause 10.2 Thickness of oversheath

In line 3, delete 'BS 6469' and substitute 'BS 6469 : Section 1.1'.

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Table 2. Schedule of tests

Delete the existing table and substitute the new table 2 attached.

Table 2. Schedule of tests			
1	2	3	4
Test	Requirement given in clause	Test method	Category
<i>Test on components</i>			
Conductor construction	4	BS 6360	RS
Insulation:			
material	5.1	BS 6899	T
thickness	5.2	Appendix D and BS 6469 : Section 1.1	RS
spark test	5.3	BS 5099	R
corrosive and acid gas	5.4	BS 6425 : Part 1	T
core identification	6	Visual examination	RS
laid-up cores	6 and 7	Visual examination	RS
Bedding:			
physical properties	8.1 and 18.2	BS 6469 : Section 1.1 BS 6469 : Section 1.2	T
thickness	8.2	Appendix D and BS 6469 : Section 1.1	RS
corrosive and acid gas	8.3	BS 6425 : Part 1	T and RS
Fillers and binders:			
corrosive and acid gas	7	BS 6425 : Part 1	T
Armour:			
wire armour diameter	9.2(a)	H.1	SS
mass of zinc coating	9.2(b)	H.2	SS
wrapping test	9.2(c)	H.3	SS
tensile test (aluminium wire)	9.2(d)	H.4	SS
Oversheath:			
physical properties	10 and 18.3	BS 6469 : Section 1.1, BS 6469 : Section 1.2, appendices G and N	T
thickness	10.2	Appendix D and BS 6469 : Section 1.1	RS
spark test	10.3	BS 5099	R
corrosive and acid gas	10.4	BS 6425 : Part 1	T and RS
<i>Tests on complete cables</i>			
Cable markings	11	Visual examination and measurement	R
Conductor resistance test	14.2	BS 6360	R
Voltage test on complete cables	14.3	14.3	R
Armour resistance test	9.4	H.5	SS
Abrasion test	17.2	Appendix E	T
Shrinkage test	17.5	Appendix M	T
Tests under fire conditions:			
fire test on single cable	16.2	BS 4066 : Part 1	SS
fire test on multiple cables	17.3	BS 4066 : Part 3	T
smoke emission	17.4	Appendix F	T and RS
Compatibility test	5.1	18.1 and BS 6469 : Section 1.1	T

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Table 5. Regular sample tests

In column 3, lines 3, 5 and 8, delete BS 6469' and substitute 'BS 6469 : Section 1.1'.

Table 7. Type tests

Delete the existing table and substitute the following new table 7.

Table 7. Type tests		
1	2	3
Test	Requirement given in clause	Test method
Insulation material	5.1	BS 6899
Insulation: corrosive and acid gas	5.4	BS 6425 : Part 1
Bedding: corrosive and acid gas	8.3	BS 6425 : Part 1
Bedding: physical properties	8.1 and 18.2	BS 6469 : Section 1.1
Fillers and binders: corrosive and acid gas	7	BS 6425 : Part 1
Oversheath: physical properties	10 and 18.3	BS 6469 : Section 1.1, BS 6469 : Section 1.2 and appendices G and N
Oversheath: corrosive and acid gas	10.4	BS 6425 : Part 1
Abrasion test	17.2	Appendix E
Fire test on multiple cables	17.3	BS 4066 : Part 3
Smoke emission	17.4	Appendix F
Compatibility test	5.1	18.1 and BS 6469 : Section 1.1
Test for shrinkage of sheath on cable	17.5	Appendix M and BS 6469 : Section 1.3

New clause 17.5

After 17.4, insert the following new subclause.

'17.5 Test for shrinkage of sheath on cable

When a sample of the complete cable is tested at 80 °C for 4 h in accordance with appendix M, the shrinkage of the oversheath shall not exceed 4 %.'

Clause 18.1.2 Ageing treatment

Delete the existing subclause and substitute the following.

'18.1.2 Ageing treatment

The sample shall be aged for 7 days at 100 ± 2 °C in an air oven in accordance with BS 6469 : Section 1.2.

Clause 18.3.2 Ageing treatment

Delete the existing subclause and substitute the following.

'18.3.2 Ageing treatment

The sample for measurement of tensile properties after ageing shall be aged for 7 days at 100 ± 2 °C in an air oven in accordance with BS 6469 : Section 1.2.

New clause 18.3.3

After 18.3.2, insert the following new subclause.

'18.3.3 Water immersion test

The sample shall be immersed in water for 7 days at 70 ± 2 °C.'

Table 10. Requirements for oversheath

Delete the existing table and substitute the following new table 10.

Table 10. Requirements for oversheath	
1	2
Test	Requirements
Tensile properties of unaged test pieces	
Minimum tensile strength	10 N/mm ²
Minimum elongation at break	100 %
Tensile properties after ageing	
Minimum tensile strength	10 N/mm ²
Maximum variation ¹⁾ of tensile strength from unaged value	± 40 %
Minimum elongation at break	100 %
Maximum variation ¹⁾ of elongation from unaged sample	± 40 %
Cold elongation test	
Test temperature	-15 ± 2 °C
Minimum elongation	20 %
Cold impact test	
Test temperature	-15 ± 2 °C
Hot pressure test	
Test temperature	80 ± 2 °C
Maximum indentation	50 %
Insulation resistance constant	
Minimum <i>K</i> value at 20 °C	0.0035 MΩ·km
Water immersion test	
Maximum variation ¹⁾ of tensile strength from unaged value	± 30 %
Maximum variation ¹⁾ of elongation at break from unaged value	± 30 %
1) The variation is the difference between the respective values obtained prior to and after treatment expressed as a percentage of the former.	

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Table 18. Four-core 600/1000 V cables with solid aluminium conductors

Delete the existing footnote 3) and substitute the following.

⁽³⁾ Cables having conductors of nominal cross-sectional area 50 mm² and above have shaped solid conductors (class 1).'

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Appendix B.2 Minimum installation radius (as amended by Amendment No. 1)

In line 3, delete 'table 23A' and substitute 'table 25A'.

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Table 23A. Minimum installation radius (as amended by Amendment No. 1)

Delete the existing title of table 23A and substitute '**Table 25A. Minimum installation radius**'.

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D.2 Test procedure

In paragraph 1, line 3 delete 'BS 6469' and substitute 'BS 6469 : Section 1.1'.

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Appendix G.2 Calculation of results

In equation (4), delete ' $1000 \log_m D/d$ ' and substitute ' $1000 \log_{10} D/d$ '.

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Clause H.4 Tensile test for aluminium wires

In paragraph 1, line 4, delete 'BS 18 : Part 1' and substitute 'BS EN 10002-1'.

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Table 29. Minimum resistance of conductor and armour for single-core cables having aluminium wire armour

Delete the existing title and substitute the following.

'Table 29. Maximum resistance of conductor and armour for single-core cables having aluminium wire armour'

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Table 30. Maximum resistance of conductor and armour for two-core, three-core and four-core cables having steel wire armour

In the row for 25 mm², delete the entry in column 9 and substitute '4.1'.

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New clause K.3.5

After K.3.5, insert the following new subclause.

'K.3.6. Shrinkage test (see 17.5 and appendix M)

One test should be carried out on each cable selected.'

Appendix M. Test for shrinkage of sheath on cable

M.1 General

This test shall be carried out to determine the shrinkage of sheath during heat treatment, in accordance with BS 6469 : Section 1.3 as modified in this appendix.

M.2 Selection of samples

Take one sample of each cable to be treated, about 300 mm in length, and at least 500 mm away from the end of the cable length.

M.3 Preparation of test piece

Within an interval of not more than 5 min from the time of cutting the sample, mark a test length of 200 ± 5 mm on the middle part of the test piece. Measure the distance between the marks to an accuracy of 0.5 mm. Prepare the test piece by removing the sheath from both ends of the sample up to positions between 2 mm and 5 mm away from the marks. Bind the armour wires at both ends of the sample.

M.4 Procedure

Carry out the test in an air oven in accordance with BS 6469 : Section 1.2. Support the test piece by means of a freshly prepared talc bath. The combined volume of test apparatus and test piece shall not exceed 10 % of the volume of the oven. Preheat the oven with the test apparatus in place for a minimum of 2 h at 80 °C before the test piece is introduced.

Support the test piece horizontally on the surface of the talc bath. Ensure that there is sufficient depth of talc so that the test piece does not touch the bottom of the bath. Spread the talc evenly, without compacting it, at the start of the test, so as to permit free movement of the sheath.

With the test piece in place in the air oven, heat it at the temperature and time specified in 17.5. At the end of the test period, remove the apparatus with the test piece in place and allow it to cool in air at room temperature.

Remeasure the distance between the two marks on the test piece to an accuracy of 0.5 mm.

M.5 Evaluation of results

Calculate the difference in the distance between the marks before the heat treatment and after the heating and cooling, and record the shrinkage as a percentage of the distance between the marks before the treatment.

Appendix N. Water immersion test on sheath

N.1 General

This test shall be carried out to demonstrate the effect of water on the mechanical properties of sheath by determining the tensile strength and elongation at break of the sheathing material in the condition as manufactured and after immersion in water.

The tensile tests on the conditioned and unconditioned test pieces shall be made in immediate succession.

N.2 Sampling and preparation of test pieces

Test pieces shall be prepared in accordance with BS 6469 : Section 1.1.

N.3 Procedure

The dumb-bell samples shall be immersed in approximately 1 l of deionized water for the time and temperature given in 18.3.3. Following immersion, the test pieces shall be allowed to cool to a temperature of 20 ± 5 °C before removing them from the water. The test pieces shall then be dried with absorbent paper and within 60 min of drying both the tensile strength and elongation at break shall be measured in accordance with BS 6469 : Section 1.1.

N.4 Evaluation of results

Calculate the tensile strength and elongation at break in accordance with BS 6469 : Section 1.1.'

Publications referred to

Delete the entry for BS 18 and insert the following after the entry for BS 6899.

'BS EN 10002-1 Tensile testing of metallic materials
Part 1 Method of test at ambient temperature'

Delete the existing entry for BS 6469 and substitute the following.

'BS 6469 Insulating and sheathing materials of electric cables
Part 1 Methods of test for general application
Section 1.1 Measurement of thickness and overall dimensions – Tests for determining the mechanical properties
Section 1.2 Thermal ageing methods
Section 1.3 Methods of determining the density – Water absorption tests – Shrinkage test'

