BRITISH STANDARD

Electric cables – Rubber or silicone rubber insulated flexible cables and cords for coil end leads

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard was published by BSI and came into effect on 15 July 2006. It was prepared by Subcommittee GEL/20/17, *Low voltage cables*, under the authority of Technical Committee GEL/20, *Electric cables*.

Supersession

This British Standard supersedes BS 6195:1993, which is withdrawn.

Information about this document

This new edition of BS 6195 retains requirements in respect of cable types 4 and 5 only. Requirements for other types have been withdrawn as they are no longer considered to be maket relevant.

The other principal changes introduced in this edition are to call up CENELEC harmonized test methods in place of earlier national methods.

Product certification/inspection/testing

Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Users seeking assitance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquires to the relevant association.

WARNING

This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

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 various types of insulation, voltage categories and dimensions for a standard range of insulated flexible cables and flexible cords (commonly known as "coil end leads"), that are intended to be connected directly and permanently to a coil winding or other component of electrical apparatus.

The types of cable specified in this standard are as follows:

Type 4 cable, voltage categories A, C, D, E and F, for a designated temperature of 90 °C (flame retardant, rubber insulated coil leads);

Type 5 cable, voltage categories A, C, D, E and F, for a designated temperature of 180 °C (180 °C silicone rubber insulated coil leads).

NOTE A guide to the use of the cables specified in this British Standard is given in Annex A. A summary of the tests applicable to the cables is given in Annex B.

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 4727-2: *Group 08, Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms — Part 2: Terms particular to power engineering — Group 08: Electric cables.*

BS 5099 *Electric cables — Voltage levels for spark testing.*

BS 5629-3:1979 *Insulating varnishes containing solvent — Part 3: Method for specifying requirements for individual materials*

BS 7655 *Specification for insulating and sheathing materials for cables — Part 1: Cross-linked elastomeric insulating compounds — Section 1.5 Flame retardant composites*

BS EN 50356, *Method for spark testing of cables.*

BS EN 50363-1, *Insulating, sheathing and covering materials for low voltage energy cables — Part 1: Cross-linked elastomeric insulating compounds*

BS EN 60228, *Conductors of electric cables*

BS EN 60332-1-2, *Tests on electric and optical fibre cables under fire conditions — Part 1—2: Test for vertical flame propagation for a single insulated wire or cable — Procedure for 1 kW pre-mixed flame*

BS EN 60811-1-1, *Insulating and sheathing materials of electric cables — Common test methods — Part 1-1: General application — Measurement of thickness and overall dimensions — Tests for determining the mechanical properties.*

BS EN 60811-1-2, *Insulating and sheathing materials of electric cables — Common test methods — Part 1-2: General application – Thermal ageing methods*

PD 2379, *Register of colours of manufacturers' identification threads for electric cables and cords.*

3 Terms and definitions

For the purposes of this British Standard the definitions given in BS 4727-2: Group 08 apply, together with the following.

3.1 values

3.1.1 approximate value

value which is only indicative

NOTE Values described as "approximate" do not constitute requirements to be checked by measurement.

3.1.2 nominal value

value by which a quantity is designated

NOTE Nominal values usually give rise to values to be checked by measurements taking into account specified tolerances.

4 Voltage categories

The cables shall be divided into the voltage categories listed in Table 1, which are defined by the appropriate maximum voltage between conductors, or between conductor and earth, to which the cable is liable to be subjected during a 1 min test of the equipment to which it is connected.

Table 1 **Voltage categories**

Voltage category	**Maximum equipment test voltage (a.c.) r.m.s.** kV
A	2.5
C	4.0
D	9.5
E	17
F	27

5 Conductors

5.1 Type

The conductors shall conform to BS EN 60228, class 5. The conductors shall be circular, tinned annealed copper.

NOTE For these cables tinned conductors are not required to meet a test for tinning.

5.2 Tapes

If required, a tape or tapes shall be applied over the conductor.

In the case of voltage categories E and F, if a tape is used it shall be a semi-conducting tape consisting of a textile fabric proofed with a suitable semi-conducting compound with a surface resistivity not exceeding 100 000 ohms per square. Conformity shall be checked by the test method in Annex C.

6 Insulation

6.1 Types

The insulation shall be as follows:

- for type 4 cable in voltage categories A and C, composite insulation type FR 1 as specified in BS 7655-1.5;
- for type 4 cable in voltage categories D, E and F, composite insulation type FR 2 as specified in BS 7655-1.5;
- for type 5 cable, insulation type EI 2 as specified in BS EN 50363-1.

6.2 Application

The insulation shall be applied closely to the conductor or conductor taping by the extrusion process.

When the application is tested by removing the insulation from the conductor, there shall be no damage to the insulation itself, the conductor, or the tin coating.

In the case of type 4 cable, there shall be no voids between the composite layers of insulation which shall be continually adherent.

Conformity shall be checked by visual examination and by a manual test.

6.3 Thickness

The thickness of the insulation, when determined by taking the mean of six measurements in accordance with BS EN 60811-1-1, **8.1**, shall be not less than the appropriate value given in Table 2 for the type and voltage category of cable.

The smallest of the measured values shall not fall below the value given in Table 2 by more than 0.1 mm + 10 %.

In the case of Type 4 cable, the thickness of the outer layer of the composite insulation shall be the following percentage of the total thickness of the insulation:

a) for voltage categories A, C, D and E: 25% to 50%;

b) for voltage category F: 20% to 35%;

7 Identification

7.1 General

All cables shall be identified by colour. The colour shall be either throughout the insulation or on its external surface.

The colour of the inner layer for type 4 cable shall be of a contrasting colour to that of the outer layer.

NOTE *This standard does not require a specific colour for any particular cable.*

7.2 Bi-colour combination

Where the bi-colour combination green-and-yellow is used, the distribution of these colours shall be such that for every 15 mm length

of cable, one of these colours shall cover at least 30% and not more than 70% of the surface of the cable, while the other colour covers the remainder of the surface.

Conformity shall be checked by measurement.

*NOTE 1 In cases of dispute regarding the green-and-yellow combination and where appropriate to the method of colour marking of the insulation, a suitable test method for checking conformity is given in BS EN 50396:2005, **5.2**.*

NOTE 2 Attention is drawn to the fact that, according to the use to which cables are put, they could be subject to core colour requirements specified in BS 7671, in other British Standards or in other standards, or in regulations or statutory instruments.

NOTE 3 In accordance with BS EN 60446, the single colours green and yellow are only permitted where a confusion with the colouring of the protective conductor is not likely to occur.

7.3 Clarity and durability

When the cable is tested by the method described in Annex D, its colour shall be clearly identifiable.

8 Cable marking

The cable shall be marked with the number of this British Standard, i.e. BS 6195[1)], on the outer surface by printing, indenting or embossing.

All cables shall be provided with an indication of origin consisting of an identification thread or threads, or a continuous marking of the manufacturer's name or trademark.

If coloured threads are used, the colours shall conform to those registered in PD 2379, where applicable. The colours shall be easy to recognize or shall become recognizable by cleaning with petrol or other suitable solvent, if necessary.

Any marking shall be legible and regarded as continuous if the gap between the end of one complete inscription and the beginning of the next does not exceed 550 mm.

Any marking by printing shall be durable. Conformity shall be checked by rubbing the marking lightly ten times with a piece of cotton wool or cloth soaked in water.

9 Routine tests for finished cables

9.1 General

Routine tests shall be carried out as identified in Table B.1.

The test specified in 9.2 shall be carried out under the test conditions specified in Annex E unless otherwise specified in the details for the particular test.

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1) Marking BS 6195 or BS 6195:2006 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.

NOTE 1 The schedule of tests given in Annex B shows the category of each test parameter, and gives cross-references to the appropriate requirements and test methods.

*NOTE 2 Routine tests for components are covered in Clauses **5** to **7** and are identified in Table B.1.*

9.2 Absence of faults on insulation

All cable that is in its final stage of manufacture and either in delivery lengths or in manufacturing lengths prior to being cut into delivery lengths, shall be tested in accordance with Annex F. The insulation shall withstand the applied voltage without breakdown.

10 Sample tests for finished cables

10.1 General

Sample tests shall be carried out as identified in Table B.1.

The tests specified in this clause shall be carried out under the test conditions specified in Annex E unless otherwise specified in the details for the particular test.

NOTE 1 The schedule of tests given in Annex B shows the category of each test parameter, and gives cross-references to the appropriate requirements and test methods.

*NOTE 2 Sample tests for components are covered in Clauses **5** to **7** and are identified in Table B.1.*

10.2 Conductor resistance

When measured in accordance with BS EN 60228 and corrected to 20 °C, on a sample of cable not less than 1 m in length, the d.c. resistance of each conductor shall conform to the requirements specified in BS EN 60228.

10.3 Voltage withstand of completed cable

When a sample of completed cable is tested in accordance with Annex G, no breakdown of the insulation shall occur.

10.4 Mean overall dimensions

The mean overall diameter of the cable shall be within the limits specified in Table 2.

Conformity shall be checked by the method described in BS EN 60811-1-1:1995, **8.3**.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

For diameters not exceeding 25 mm, take the mean of six measurements as the mean overall diameter.

For diameters exceeding 25 mm, take the mean of three measurements as the mean overall diameter.

When marking in accordance with Clause **8** is achieved by embossing, the points at which measurements are made shall not coincide with the embossing.

Table 2 **Dimensional requirements for cables**

Nominal cross-sectional area of conductor	**Radial thickness of insulation Voltage category**					**Mean overall diameter (upper limit) Voltage category**				
mm^2	**A** mm	**C** mm	**D** mm	**E** mm	**F** mm	**A** mm	**C** mm	**D** mm	**E** mm	**F** mm
0.5	0.8	1.4				3.3	4.5			
0.75	0.8	1.4				3.5	4.7			
1.0	0.8	1.4				3.7	4.9			
1.5	0.8	1.4				4.0	5.2			
2.5	0.9	1.4	2.8			4.6	5.6	8.5		
4	1.0	1.4	2.8			5.4	6.3	9.1		
6	1.0	1.5	2.8			6.5	7.5	10.3		
10	1.2	1.5	2.8			7.9	8.5	11.3		
16		1.5	2.8	5.0			9.6	12.4	17.2	
25		1.6	2.8	5.0	7.6		11.4	13.8	18.6	24.1
35		1.6	2.8	5.0	7.6		12.8	15.2	20.0	25.5
50		1.7	2.8	5.0	7.6		14.8	17.1	22.1	27.3
70		1.8	2.8	5.0	7.6		17.2	19.2	24.2	29.4
95		2.0	3.0	5.0	7.6		19.7	22.0	26.3	31.5
120		2.2	3.0	5.0	7.6		21.9	23.5	27.8	33.3
150		2.3	3.0	5.0	7.6		24.1	25.5	29.8	35.3
185		2.4	3.0	5.0	7.6		26.3	27.5	32.1	37.3
240		2.4	3.0	5.0	7.6		28.3	30.6	35.1	40.3
300		2.6	3.0				33.0	33.8		
400		2.8	3.0				37.4	37.8		

NOTE The dimensional requirements in this table apply to type 4 and type 5 cables

11 Type tests for finished cables

11.1 General

Type tests shall be carried out as identified in Table B.1.

The tests specified in clauses **11.2** to **11.5** shall be carried out under the test conditions specified in Annex E unless otherwise specified in the details for the particular test.

NOTE 1 The schedule of tests given in Annex B shows the category of each test parameter, and gives cross-references to the appropriate requirements and test methods.

*NOTE 2 Type tests for components are covered in Clauses **5** to **7** and are identified in Table B.1.*

11.2 Flame propagation on single cable

When tested in accordance with BS EN 60332-1-2, the completed cable shall conform to the requirements specified in that standard.

11.3 Resistance to bending

When tested in accordance with Annex H, the insulation shall show no signs of cracks or other deterioration after the bending, and no breakdown of the insulation after the application of the voltage.

11.4 Effect of heating

When tested in accordance with Annex I, the insulation shall show no signs of cracks or other deterioration after the bending, and no breakdown of the insulation after the application of the voltage.

11.5 Solvent resistance

When tested in accordance with Annex J, the insulation shall show no signs of swelling, cracks or other deterioration after the bending, and no breakdown of the insulation after the application of the voltage.

11.6 Varnish resistance

When tested in accordance with Annex K, the insulation shall show no signs of swelling, cracks or other deterioration after the bending, and no breakdown of the insulation after the application of the voltage.

NOTE The standard grades of varnish used in this test, and the heating cycle applied, may not be the same as that intended in the actual application. Reference should be made to the manufacturer by the purchaser to ascertain the suitability of the cable in respect of the varnish grade/baking cycle intended to be used.

Annex A (informative) Guide to Use

NOTE Details given in this annex are intended only as general technical guidance and not as interpretation of any UK statutory requirements.

A.1 General

The cable specified in this standard is designed to be connected directly and permanently to a coil winding or other component of electrical apparatus and usually connected to some form of terminal.

A.2 Varnish

The cable usually has to withstand the same treatment as the parts to which it is connected, often including immersion in varnish and exposure to high temperatures in a baking cycle cure. Although a varnish resistance and heating test is included as type test, reference should be made to the manufacturer by the purchaser to ascertain the suitability of the cable in respect of the varnish grade/baking cycle intended to be used.

A.3 Temperature

The cables specified in this standard are normally suitable for operation at the designated temperature stated in Clause **1**. The designated temperatures are not related to the "hot spot" temperature of the machine or apparatus to which the cables are attached.

The choice of cable is never straightforward, because the classification temperature of motors etc. are related to the hottest part of the coil winding, whereas the coil end lead is normally attached to the coolest part of the coil winding. The designated temperature of the coil end lead is normally at a lower temperature rating than that of the coil winding to which it is attached.

Typically a type 4 cable, with a designated temperature of 90 °C would be selected for use at a coil winding temperature of 130 °C (thermal class B), and a type 5 cable, with a designated temperature of 180 °C would be selected for use at a coil winding temperature of 180 °C (thermal class H). If no varnish is used, or if a varnish of appropriate temperature is used, type 5 cable can be used at a coil winding temperature of 220 °C.

However, the exact selection of coil end lead is dependent on many factors, and consideration should be given to product design, product performance records and/or verification testing for the exact installation conditions concerned.

Annex B (normative) Schedule of tests

Table B.1 lists the range of tests applicable to the cables covered by this British Standard and gives cross-references to the requirements and test methods. The last column shows the category of each test, i.e. T, S or R.

The categories and corresponding designations, as defined in IEC/CENELEC standards for cables, are as follows.

a) *Type tests (T)*: tests required to be made before supplying, on a general commercial basis, a type of cable covered by this British Standard, in order to demonstrate satisfactory performance characteristics to meet the intended application. These tests are of such a nature that after they have been made, they need not be repeated unless changes are made in the cable material, design or type of manufacturing process which might change the performance characteristics.

b) *Sample tests (S)*: tests made on samples of completed cable, or components taken from a completed cable adequate to verify that the product meets the design requirements.

c) *Routine test (R)*: tests made on all production cable lengths to demonstrate their integrity.

Table B.1 **Schedule of tests**

Parameter	Requirement (clause reference)	Test method	Test category
Components			
Conductor construction	**5**	BS EN 60228	S
Semi-conducting tape	**5.3**	Annex C	T
Insulation:			
— type	**6.1**	BS 7655-1.5 or BS EN 50363-1	T
— application	**6.2**	Visual examination and manual test	S
— thickness	**6.3**	BS EN 60811-1-1, **8.1**	S
Complete cables			
Identification and durability of colour	**7**	Visual examination and manual test	S
Cable marking	**8**	Visual examination and measurement	R
Durability of marking	**8**	Manual test	S
Absence of faults on insulation	**9.2**	Annex F	R
Conductor resistance	**10.2**	BS EN 60228	S
Voltage withstand of completed cable	**10.3**	Annex G	S
Mean overall diameter	**10.4**	BS EN 60811-1-1, **8.3**	S
Performance under fire conditions:			
— flame propagation on single cable	**11.2**	BS EN 60332-1-2	T
Resistance to bending	**11.3**	Annex H	T
Effect of heating	**11.4**	Annex I	T
Solvent resistance	**11.5**	Annex J	T
Varnish resistance	**11.6**	Annex K	T

NOTE 1 Tests classified as sample (S) and routine (R) may be required as part of a type approval scheme.
NOTE 2 The order of the tests in this schedule does not imply a sequence of testing.

Annex C (normative) Method of measuring the surface resistivity of semiconducting tapes

Material: Perform this test on a clean unused sample of semi-conducting tape.

Method: Clamp a length of tape between the electrodes (see Figure C.1), ensuring that the tape is connected at right angles to the electrodes with just enough tension to prevent a sag in the tape. Adjust the d.c. power supply to produce a reading of approximately 1 mA on the ammeter and note the voltage indicated on the voltmeter.

Using a graduated scale, measure the width of the tape and its length between the voltage electrodes.

Calculation: Calculate the surface resistivity ρ (ohms per mm/mm) of the semi-conducting tape from the equation,

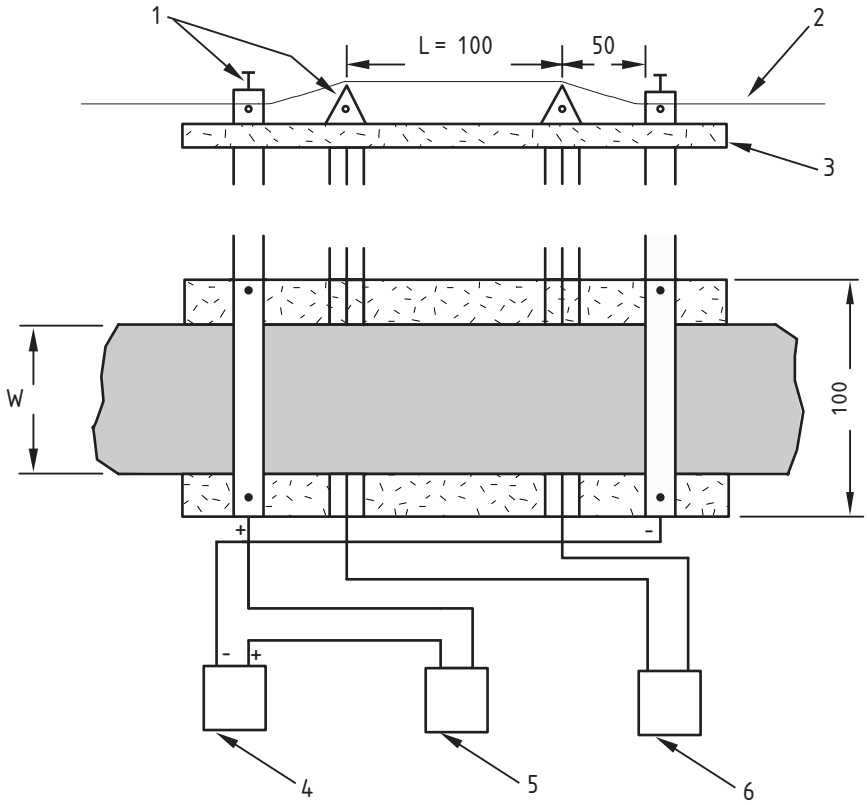
$$\rho = \frac{V}{10^{-3} \times I} \times \frac{w}{L}$$

Where

V is the indicated voltage, (in V);
I is the indicated current, (in mA);
w is the measured width of tape, (in mm);
L is the measured length of tape, (in mm).

Figure C.1 **Method of measuring the surface resistivity of semiconducting tape**

Dimensions in millimetres



Key

1 Electrodes
2 Tape
3 Non-conducting base
4 DC supply
5 Digital ammeter
6 Digital voltmeter

Annex D (normative) Colour durability

Heat a sample of cable, to 160 °C in the case of type 4 cable, and to 250 °C in the case of type 5 cable, using the equipment described in BS EN 60811-1-2, **8.1.2**.

Annex E (normative) Test conditions

WARNING. This British Standard calls for the use of procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

E.1 Ambient temperature

Tests shall be made at an ambient temperature of (20 ± 5) °C unless otherwise specified in the details for the particular test.

E.2 Frequency and waveform of power frequency test voltages

Unless otherwise specified in the particular test, the frequency of the alternating test voltages shall be in the range 49 Hz to 61 Hz. The waveform shall be substantially sinusoidal. The ratio peak value/r.m.s. value shall be equal to $\sqrt{2}$ with a tolerance of ± 7%.

Annex F (normative) Test for the absence of faults on insulation

F.1 Cables in voltage categories A, C and D

Cables shall be tested in accordance with BS EN 50356, using the test voltages specified in BS 5099.

F.2 Cables in voltage categories E and F

Immerse the cable in water, with a length of about 250 mm at each end of the coil lead projecting above the water, for 1 h. Apply a voltage between the conductor and water, raising it gradually until it reaches the appropriate value listed in Table H.2, and maintain it at that value for 5 min.

Annex G (normative) Method of test for voltage withstand

The test method given in **F.2** shall be used.

Annex H (normative) Method of test for resistance to bending

H.1 Sample preparation

Prepare a sample of suitable length of coil lead by exposing the copper conductor at one end for the purpose of making an electrical connection.

H.2 Bending

Bend the prepared sample slowly through 180° on a mandrel of the diameter specified in Table H.1.

H.3 Immersion and voltage application

Immerse the bent sample of coil lead in water at (20 ± 5) °C, ensuring that the ends of the coil lead protrude above the water by a distance sufficient to prevent excessive surface leakage when the test voltage is applied, and that the bent portion of the coil lead is at least 50 mm below the surface of the water. Apply a voltage between the conductor and water, raising it gradually until it reaches the appropriate value listed in Table H.2, and maintain it at that value for 1 min.

Table H.1 **Diameters of mandrels for bending in different tests**

Conductor size		**Diameter of mandrel (mm)**			
Above mm^2	**Up to and including** mm^2	**Resistance to bending** (Annex H)	**Effect of heating** (Annex I)	**Solvent resistance** (Annex J)	**Varnish resistance** (Annex K)
-	25	1.5D	2D	2D	3D
25	95	2.0D	3D	3D	4.5D
95	240	2.5D	4D	4D	6D
240	400	3.0D	5D	4D	8D

NOTE D *is the specified mean overall diameter (upper limit) of the coil lead*

Table H.2 **Test voltages**

Voltage category	**Proof voltage (a.c. r.m.s.)** kV
A	3.0
C	6.0
D	15.0
E	20.0
F	35.0

Annex I (normative) Method of test for the effect of heating

I.1 Sample preparation

Prepare a sample of suitable length of coil lead by exposing the copper conductor at one end for the purpose of making an electrical connection.

Using the equipment described in BS EN 60811-1-2, **8.1.2**, heat the sample, to 150 °C for type 4 cable, or to 250 °C for type 5 cable, and maintain it at that temperature for 48 h. At the end of that period, allow the sample to cool to room temperature before proceeding.

I.2 Bending

Bend the prepared sample slowly through 180° on a mandrel of the appropriate diameter specified in column 4 of Table H.1.

I.3 Immersion and voltage application

Immerse the bent sample of coil lead in water at (20 ± 5) °C, ensuring that the ends of the coil lead protrude above the water by a distance sufficient to prevent excessive surface leakage when the test voltage is applied, and that the bent portion of the coil lead is at least 50 mm below the surface of the water. Apply a voltage between the conductor and water, raising it gradually until it reaches the appropriate value listed in Table H.2, and maintain it at that value for 1 min.

Annex J (normative) Method of test for solvent resistance

Using the equipment described in BS EN 60811-1-2, **8.1.2**, heat the sample, to 150 °C for type 4 cable, or to 250 °C for type 5 cable, and maintain it at that temperature for 24 h.

Whilst still hot, immerse the sample in xylene, at room temperature, for 1 h.

Withdraw the sample from the xylene and allow it to dry at room temperature for 15 min.

Repeat the initial heating cycle, and then allow the sample to cool at room temperature for 1 h.

Test the sample in accordance with Annex H, using a mandrel of the appropriate diameter specified in column 5 of Table H.1.

Annex K (normative) Method of test for varnish resistance

Using the equipment described in BS EN 60811-1-2, **8.1.2**, heat the sample, to 150 °C for type 4 cable, or to 250 °C for type 5 cable, and maintain it at that temperature for 24 h.

Within 2 min of removal from the oven, immerse the sample in varnish at room temperature for 1 h. The varnish to be used shall be in accordance with BS 5629-3:1979 and of the following grades:

- for type 4 cable – varnish grade type 2.1
- for type 5 cable – varnish grade type 2.3

Withdraw the sample from the varnish and allow it to dry at room temperature for 15 min.

Repeat the initial heating cycle, and then allow the sample to cool at room temperature for 1 h.

Test the sample in accordance with Annex H, using a mandrel of the appropriate diameter specified in column 6 of Table H.1.

Bibliography

BS EN 50396, *Nonelectrical test methods for low voltage energy cables*

BS EN 60446, *Basic and safety principles for the man-machine interface, marking and identification. Identification of conductors by colours or numerals*

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