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British Standard Specification for

Rubber-insulated cables for electric power and lighting

Conducteurs et câbles isolés au caoutchouc pour installations

Starkstromleitungen mit einer Isolierung aus Gummi

British Standards Institution

Contents

Foreword

This British Standard has been prepared under the direction of the General Electrotechnical Engineering Standards Committee. It is a revision of BS 6007 : 1975, but does not come into effect until 1 July 1984 (see back cover). In the meantime, BS 6007 : 1975 remains as the current standard until its withdrawal in July 1984 when this revision will supersede it.

This revision takes into account the second edition of CENELEC* Harmonization Document HD 22† issue dated October 1982, and is published in advance of the date on which it is anticipated that cables manufactured to comply with this revision will become available to enable manufacturers and users to be forewarned of the impending changes. The cable industry intends that cables complying with this standard will be available from 1 July 1984. However, it is understood that in the intervening period, cables complying with the 1975 edition of this standard will continue to be supplied.

Where Harmonized Code Designations are given, the requirements are in conformity with those of all countries which accept the basic principles of harmonization in accordance with the requirements of CENELEC. Designs shown as recognized national types are not harmonized but are regarded as representing a particular requirement in the UK which is not reflected in other countries.

Colours for core identification as agreed within CENELEC have been included in tables 1 to 6, as appropriate.

NOTE. BSI Sales Department will respond to purchase orders for BS 6007 by supplying copies of the 1983 edition. Copies of the 1975 edition may be obtained by quoting the number 'BS 6007/75'.

Certification. Attention is drawn to the certification services (see inside back cover) of the British Approvals Service for Electric Cables (BASEC)‡. These services include licensing manufacturers to use BASEC certification trade marks as independent assurance that cables or cords have been designed and manufactured to appropriate British Standards. BASEC is a subscriber to an agreement in CENELEC whereby cables or cords coming within Harmonized Code Designations and manufactured under a BASEC licence, can carry marks acceptable to other signatory countries (CENELEC 'Common Marking').

*European Committee for Electrotechnical Standardization.

†The second edition is in four Parts, HD 22.1.S2, HD 22.2.S2, HD 22.3.S2 and HD 22.4.S2.

‡British Approvals Service for Electric Cables, Maylands Avenue, Hemel Hempstead, Hertfordshire HP2 4SQ.

British Standard for

Rubber-insulated cables for electric power and lighting

1. Scope

This British Standard specifies requirements for the construction, electrical properties, mechanical properties and dimensions of non-armoured rubber-insulated cables and flexible cables for operation at voltages up to and including 450 V a.c. to earth and 750 V a.c. between conductors.

The types of cables included in the standard are:

(a) Table 1. Rubber-insulated, textile-braided and compounded cable, single core 450/750 V;

(b) Table 2. Rubber-insulated and sheathed cable, flat twin 300/500 V;

(c) Table 3. Rubber-insulated and sheathed flexible cable, 3-core and 4-core 300/500 V;

(d) Table 4. Rubber-insulated and sheathed flexible cable, single core, circular twin, 3-core, 4-core and 5-core 450/750 V;

(e) Table 5. Rubber-insulated, HOFR-sheathed flexible cable, single core, circular twin, 3-core, 4-core and 5-core 450/750 V;

(f) Table 6. Rubber-insulated, braided, heat-resistant flexible cable, single core and twisted twin 300/500 V.

A guide to the use of rubber-insulated cables is given in appendix A. Guidance to manufacturers on procedures for routine testing is given in appendix B.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2. Definitions

For the purposes of this British Standard, the definitions given in BS 4727 apply together with the following.

2.1 rated voltage U_0. The power-frequency voltage to earth for which the cable is designed.

2.2 rated voltage U. The power-frequency voltage between conductors for which the cable is designed.

3. Voltage designation

The rated voltage of a cable is the reference voltage for which the cable is designed and which serves to define the electrical tests and shall be expressed, in volts, by the following expression:

U_0/U

where

U_0 is the r.m.s. value between any insulated conductor and earth, i.e. the metal covering of the cable or the surrounding medium;

U is the r.m.s. value between any two phase-conductors of a multicore cable or of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended and this applies both to the value U_0 and to the value U.

In a direct current system, the nominal voltage of the system shall be not higher than 1.5 times the rated voltage of the cable.

NOTE. The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at 10 % higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

The rated voltages recognized for the purpose of this standard shall be 300/500 V and 450/750 V.

4. Conductors

4.1 Construction. The conductors shall be annealed copper conductors complying with BS 6360. Unless otherwise given in tables 1 to 6, as appropriate, the individual wires of conductors shall be plain or covered with an effective layer of commercial tin.

Where the wires are plain, a separator tape made of suitable material shall be placed between the conductor and the insulation.

NOTE. Where the wires are tinned and for cables whose properties are given in table 6, the application of a separator is left to the discretion of the manufacturer.

The solderability of plain conductors, except for the cables whose properties are given in table 6, shall be tested as described in appendix C. The part of the conductor that has been immersed in the solder bath shall be adequately tinned.

4.2 Class. The class of the conductor shall be as given in tables 1 to 6, inclusive.

5. Insulation

5.1 Type of insulation. The insulation shall be one of the following types complying with BS 6899 as given in tables 1 to 6, as appropriate:

(a) type EI1 rubber insulation;

(b) type GP1 rubber insulation;

(c) type EI2 rubber insulation;

Compliance shall be checked by carrying out the appropriate tests listed in table 8.

5.2 Application. The insulation shall be closely applied to the conductor or separator as follows:

(a) types EI1 and GP1: unless applied by the extrusion process, the insulation shall consist of at least two layers;

(b) type EI2: the insulation shall be extruded in a single layer.

It shall be possible to remove the insulation easily, without damage to the insulation itself, the conductor or the tin coating, if any.

Compliance shall be checked by examination and by a manual test.

5.3 Thickness. The mean value of the thickness of the insulation shall be not less than the value given for each type and cross section of cable in tables 1 to 6, as appropriate. However, it shall be permissible for the thickness at any one place to be less than the value specified provided that the difference does not exceed 0.1 mm +10 % of the value specified.

Compliance shall be checked by the test described in appendix D.

5.4 Addition of tape. Where stated in tables 1 to 6, it shall be permissible for a proofed textile tape to be applied over the insulation. The tape shall be applied helically with a minimum overlap of 1 mm. In the completed cable, it shall be possible to remove the proofed tape without damage to the insulation.

6. Core identification

6.1 General. Each core shall be identified by its colour. The colour shall be either throughout the whole of the insulation or on its surface, or, where it is given in tables 1 to 6 that it is permitted, on a proofed tape or textile braid which may be applied over the insulation. In the latter case, the identifying colour shall be visible on the external surface.

6.2 *Colours.* *The colours of the cores according to the* number of cores in the cable and also the sequence of these colours shall be as given in tables 1 to 6, as appropriate.

6.3 Harmonized code designations. A harmonized code designation is given in table 6 for single core non-sheathed cables. These cables shall be permitted to bear the Common Marking in accordance with **10.2**, provided the colours comply with the following:

(a) the colours available shall include the combination green/yellow and the colour blue;

(b) combinations of colours other than green/yellow and also the colours green or yellow separately shall not be considered harmonized.

Single-core non-sheathed cables complying with the properties given in tables 1 to 6 where harmonized code designations are given, but having core colours not in accordance with the requirements of this subclause, are not harmonized types and shall not bear the Common Marking.

NOTE. *Attention is drawn to the fact that, according to the use to* which the cables are put, it may be necessary to comply with core colour requirements specified in the 'Regulations for Electrical Installations'* published by the Institution of Electrical Engineers, any British or other standard applicable, or any appropriate regulations or statutory requirements.

6.4 Bi-colour combination. On the core marked with the bi-colour combination green/yellow, the distribution of these colours shall be such that for every 15 mm length of core, one of these colours shall cover at least 30 % and at most 70 % of the surface of the core, while the other colour covers the remainder of the surface.

NOTE 1. A test to check compliance is under consideration.

NOTE 2. ***Information on the use of the colours green/yellow and light blue.*** It is understood that the colours green and yellow when they are combined as specified above are recognized exclusively as a means of identification of the core intended for use at earth connection or similar protection and that the colour light blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, light blue can be used to identify any core except for earthing or protective conductor.

6.5 *Clarity and durability.* The colours shall be clearly identifiable and durable.

Compliance shall be checked by trying to remove the colour of the cores by rubbing the core 10 times with a piece of cotton wool or cloth soaked in water.

7. Filler

7.1 *Material.* *Unless otherwise specified, the filler shall be* composed of one of the following or of any combination of the following:

(a) a compound of rubber or equivalent synthetic elastomers, vulcanized or unvulcanized; *or*

(b) natural or synthetic textiles; *or*

(c) paper.

There shall be no harmful interactions between the constituents of the filler and the insulation and/or the sheath.

7.2 Application. Whether the cable includes fillers or whether the sheath may penetrate between the cores thus forming a filling, shall be as given in tables 1 to 6, as appropriate, for each type of cable. The fillers, if any, shall *fill the spaces between the cores, giving the assembly a* practically circular shape, and shall not adhere to the cores.

NOTE. The assembly of cores and fillers may be held together by a film or tape.

A centre filler, if used, shall comply with **7.1**

8. Braid

8.1 Fibre. The yarns forming the braid shall be one of the following:

(a) based on natural material, e.g. cotton or treated cotton;

(b) based on synthetic material, e.g. rayon or polyamide;

(c) fibre made of glass or equivalent material.

8.2 Construction. The braid shall have a uniform texture, *without knots or gaps. Braids made of glass fibres shall be* treated with a suitable substance in order to resist fraying.

9. Sheath

9.1 Type of sheath. The sheath shall be one of the following types complying with BS 6899 as given in tables 1 to 6, as appropriate:

(a) type EM1 ordinary duty rubber sheath;

(b) type EM2 ordinary duty oil-resisting and flame-retardant sheath;

*Available from the Institution of Electrical Engineers, 2 Savoy Place, London WC2 0BL.

(c) type RS4* heavy duty oil-resisting and flame-retardant sheath.

Compliance shall be checked by carrying out the appropriate tests given in table 8.

9.2 Construction

9.2.1 *General.* The protective sheath shall consist of a single layer or of two layers, as given in tables 1 to 6, as appropriate, complying with **9.2.2** or **9.2.3**.

9.2.2 *Single layer.* The sheath shall be applied in a single layer:

(a) to the core, in single-core cables;

(b) to the assembly of cores and any filler, in multicore cables.

The sheath shall be capable of being removed without damage to the cores. Where taped cores are employed, some transfer of proofing from the tape to the sheath shall be permissible.

NOTE. A tape or film may be applied under the sheath.

Where given in tables 1 to 6, the sheath shall penetrate into the space between the cores, thus forming a filler.

9.2.3 *Two layers.* The two layers shall be as follows.

(a) *Inner layer.* The inner sheath shall be applied as specified in **9.2.2**.

NOTE. A proofed tape or equivalent separator may be applied over the inner layer.

If the tape or separator, if any, adheres to the inner sheath, it shall be permitted for its thickness for values not exceeding 0.5 mm to be included in the measurement of thickness of the inner sheath.

(b) *Outer layer.* The outer sheath shall be applied over the inner sheath or over the tape or separator, if any.

NOTE. The outer sheath may or may not be bonded to the inner layer or to the tape or separator.

If the outer layer is bonded to the inner layer, it shall be visibly distinguishable from the inner layer; if it is not bonded, it shall be easily separable from the inner layer.

9.3 Thickness. The mean value of the sheath thickness shall be not less than the value given for each type and cross section of cable in tables 2, 3, 4 and 5, as appropriate. However, it shall be permissible for the thickness at any one place to be less than the value specified, provided that the difference does not exceed 0.1 mm +15 % of the value specified.

Compliance shall be checked by the test method described in appendix D.

9.4 Colour. The colour of the sheath is specified only for the cable whose properties are given in table 5 and shall be as given in table 5.

10. Marking

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

If coloured threads are used, the colours shall comply with 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.

The marking of the manufacturer's name or trademark, if used, shall be by one of the three following alternative methods:

(a) printed tape within the cable;

(b) printing, indenting or embossing on the insulation of at least one core, the core coloured blue, if any;

(c) printing, indenting or embossing on the sheath, if any.

The 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:

(1) 500 mm if the marking is on the sheath;

(2) 200 mm in all other cases.

10.2 CENELEC 'Common Marking'. It shall be permitted for a cable for which a Harmonized Code Designation is given in tables 1 to 6 to carry an indication that it has been manufactured under a licence issued by one of the Approvals organizations subscribing to the CENELEC Agreement on the use of a commonly agreed marking for cables and cords. If it does carry such an indication, this shall be one of the following.

(a) The mark of the Approvals Organization, followed by the Common Marking ◁HAR▷ applied by one of the three alternative methods specified in **10.1**.

(b) An identification thread extending throughout the length of the cable indicating the Approvals Organization. The base colour shall be yellow and this shall be serially dyed or printed red and black. The lengths of the coloured section shall comply with dimensions laid down by CENELEC for that Approvals Organization (see PD 2379).

Neither of these indications shall be used for a cable shown in tables 1 to 6 as a national type.

The name CENELEC, in full or abbreviated, shall not be directly marked on, or in, the cable.

10.3 Heat-resisting cables. Cables having type GP1 rubber insulation shall be identified throughout their length by the legend 'HEAT RESISTING 85', either printed on a tape within the cable or printed on the core, or printed, indented or embossed on the external surface of the cable. The gap between the end of one legend and the beginning of the next shall be not greater than 300 mm.

10.4 Outer marking. Type EM2 sheathed cables, whose properties are given in table 4, shall be distinguished from other rubber-sheathed cables having the same cross-sectional area and number of cores by means of the marking RN printed or embossed on or indented into the sheath.

The marking shall be continuous as specified in **10.1**.

10.5 Durability. Any marking by printing shall be durable.

Compliance shall be checked by rubbing the marking 10 times with a piece of cotton wool or cloth soaked in water.

*Currently known as 'Heavy duty HOFR' in BS 6899.

11. Construction and overall dimensions

11.1 Construction. The construction of the cables shall be as given in tables 1 to 6, as appropriate.

Compliance shall be checked by examination and measurement.

11.2 Mean overall dimensions. The mean overall dimensions of the cables shall be within the limits given in tables 1 to 6, as appropriate.

Compliance shall be checked by the measurements described in appendix D.

11.3 Ovality. The difference between any two values of the overall diameter of circular sheathed cables at the same cross section (ovality) shall not exceed 15 % of the upper limit given in tables 1 to 6, as appropriate, for the mean overall diameter.

Compliance shall be checked by the measurements described in appendix D.

12. Electrical requirements

12.1 Conductor resistance. When the d.c. resistance of each conductor is measured on a sample of cable at least 1 m in length it shall comply with BS 6360.

12.2 Voltage test on complete cable. When the cable is tested as described in **E.1** and **E.2** no breakdown of insulation shall occur.

12.3 Voltage test on core. When the core is tested as described in **E.1** and **E.3** no breakdown of insulation shall occur.

12.4 Test to check the absence of faults in insulation. When cable is tested as described in **E.1** and **E.4** no failure of insulation shall occur.

12.5 Surface resistance of sheath. When cable is tested as described in **E.1** and **E.5** the surface resistance of the sheath shall be not less than 1×10^9 Ω.

13. Test under fire conditions

The cables whose properties are given in tables 4 and 5 shall comply with BS 4066 : Part 1. The test shall be carried out on a sample of the complete cable.

14. Flexing test

When the 4 mm^2 flexible cables whose properties are given in tables 3, 4 and 5 are subjected to the flexing test described in BS 6500, except that the load on the cable shall be 2.0 kg, the pulley diameter 200 m and the current loading 32 A, they shall comply with BS 6500.

Flexible cables having conductors with a nominal cross section exceeding 4 mm^2 shall not be subjected to the flexing test.

Table 1. Rubber-insulated, textile-braided and compound cable, 450/750 V single core

National type

Construction

Tinned annealed copper conductor. Class 1 solid conductor and class 2 stranded conductor, as shown in the table.

Optional tape separator.

Rubber insulation type GP1.

Optional proofed tape.

Textile braid.

Preservative compound.

Colours for core identification. Black, red or other colours (see clause **6**).

Nominal cross-sectional area of conductor	Class of conductor	Radial thickness of insulation	Mean overall diameter (upper limit)
mm^2		mm	mm
1	1	0.8	4.3
1.5	1 or 2	0.8	4.6
2.5	1 or 2	0.8	5.0
4	2	1.0	6.4
6	2	1.0	7.0
10	2	1.2	8.6
16	2	1.2	9.6
25	2	1.4	11.5
35	2	1.4	13.0
50	2	1.6	14.5
70	2	1.6	16.5
95	2	1.8	19.0

Table 2. Rubber-insulated and sheathed cable, 300/500 V flat twin

National type

Construction

Tinned annealed copper conductor. Class 2 stranded conductor.

Rubber insulation type EI1.

Two cores laid parallel and sheathed with type EM2.

Colours for core identification. Black and red.

Colour of sheath. Not specified.

Nominal cross-sectional area of conductor	Radial thickness of insulation	Radial thickness of sheath	Mean overall dimensions	
			Lower limit	Upper limit
mm^2	mm	mm	mm	mm
2.5	0.8	1.1	5.4 × 8.8	6.8 × 11.0

Table 3. Rubber-insulated and sheathed flexible cable, 300/500 V 3-core and 4-core

NOTE. Sheathed flexible cords having conductor sizes smaller than 4 mm^2 are covered by BS 6500.

Harmonized code designation. HO5RR-F.

Construction

Plain or tinned annealed copper conductor. Class 5 flexible conductor.

Separator required for plain conductor, optional for tinned.

Rubber insulation type EI1.

Optional proofed tape.

The cores twisted together with optional fillers to form a practically circular assembly, a centre filler may be used.

Rubber sheath type EM1.

The sheath shall be extruded in a single layer and applied in such a way that it fills the spaces between the cores.

Colours for core identification

3-core: green/yellow, blue and brown.

4-core: green/yellow, black, blue and brown.

Colour of sheath. Not specified.

Number and nominal cross-sectional area of conductors	Radial thickness of insulation	Radial thickness of sheath	Mean overall diameter	
			Lower limit	Upper limit
mm^2	mm	mm	mm	mm
3 × 4	1.0	1.2	11.5	14.5
3 × 6	1.0	1.4	13.5	18.5
4 × 4	1.0	1.3	13.0	16.5
4 × 6	1.0	1.5	15.0	20.5

Table 4. Rubber-insulated and sheathed flexible cable, 450/750 V single core, circular twin, 3-core, 4-core and 5-core

NOTE. Sheathed flexible cords having conductor sizes smaller than 4 mm^2 are covered by BS 6500.

Harmonized code designation. HO7RN-F.

Construction

Plain or tinned annealed copper conductor. Class 5 flexible conductor.

Separator required for plain conductor, optional for tinned.

Rubber insulation type EI1.

A proofed textile tape may be applied on each core.

Unless applied by extrusion, the insulation of conductors having a nominal cross section in excess of 4 mm^2 shall be covered with a proofed textile tape, helically wound with an overlap of at least 1 mm.

If the insulation is extruded, the proofed tape is optional.

The cores twisted together without fillers to form a practically circular assembly, a centre filler may be used.

In the case of cores having conductors of large cross section a textile tape may be applied around the core assembly before application of the sheath, provided that the finished cables shall not have any substantial cavity in outer interstices between the cores.

Rubber sheath, as follows.

(a) *Single-core cable: a single layer type* EM2.

(b) Multicore cables:

(i) sizes up to 10 mm^2: a single layer type EM2;

(ii) sizes above 10 mm^2, either a single layer type EM2 or two layers, with the inner layer type EM1 and the outer layer type EM2.

The sheath in a single layer or the inner layer of the sheath in two layers shall fill the outer interstices between the cores and be capable of being removed without damage to the cores. Where taped cores are employed, some transfer of proofing from the tapes to the sheath is permissible.

Colours for core identification

Single core: black.
Twin: blue and brown.
3-core: green/yellow, blue and brown.
4-core: green/yellow, black, blue and brown.
5-core : green/yellow, black, blue, brown and black.

Colour of sheath. Not specified.

Table 4. *(continued)*

Nominal cross-sectional area of conductor	Radial thickness of insulation	Radial thickness of sheath												
		Single core. Single layer	2-core. Single layer	Two layers		3-core. Single layer	Two layers		4-core. Single layer	Two layers		5-core. Single layer	Two layers	
				Inner	Outer		Inner	Outer		Inner	Outer		Inner	Outer
mm²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
4	1.0	1.5	1.8	–	–	1.9	–	–	2.0	–	–	2.2	–	–
6	1.0	1.6	2.0	–	–	2.1	–	–	2.3	–	–	2.5	–	–
10	1.2	1.8	3.1	–	–	3.3	–	–	3.4	–	–	3.6	–	–
16	1.2	1.9	3.3	1.3	2.0	3.5	1.4	2.1	3.6	1.4	2.2	3.9	1.5	2.4
25	1.4	2.0	3.6	1.4	2.2	3.8	1.5	2.3	4.1	1.6	2.5	4.4	1.7	2.7
35	1.4	2.2	–	–	–	4.1	1.6	2.5	4.4	1.7	2.7	–	–	–
50	1.6	2.4	–	–	–	4.5	1.8	2.7	4.8	1.9	2.9	–	–	–
70	1.6	2.6	–	–	–	4.8	1.9	2.9	5.2	2.0	3.2	–	–	–
95	1.8	2.8	–	–	–	5.3	2.1	3.2	5.9	2.3	3.6	–	–	–
120	1.8	3.0	–	–	–	5.6	2.2	3.4	6.0	2.4	3.6	–	–	–
150	2.0	3.2	–	–	–	6.0	2.4	3.6	6.5	2.6	3.9	–	–	–
185	2.2	3.4	–	–	–	6.4	2.5	3.9	7.0	2.8	4.2	–	–	–
240	2.4	3.5	–	–	–	7.1	2.8	4.3	7.7	3.1	4.6	–	–	–
300	2.6	3.6	–	–	–	7.7	3.1	4.6	8.4	3.3	5.1	–	–	–
400	2.8	3.8	–	–	–	–	–	–	–	–	–	–	–	–
500	3.0	4.0	–	–	–	–	–	–	–	–	–	–	–	–
*630	3.0	4.1	–	–	–	–	–	–	–	–	–	–	–	–

*National type.

Table 4 *(concluded)*

Nominal cross-sectional area of conductor	Mean overall diameter									
	Single core		2-core		3-core		4-core		5-core	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
mm²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
4	7.4	9.0	12.0	15.0	13.0	16.0	14.5	18.0	16.0	19.5
6	8.0	11.0	13.0	18.5	14.5	20.0	16.5	22.0	18.0	24.5
10	9.8	12.5	18.5	24.0	20.0	25.5	21.5	28.0	24.0	30.5
16	11.0	14.5	21.0	27.5	22.5	29.5	24.5	32.0	27.0	35.5
25	12.5	16.5	25.0	31.5	26.5	34.0	29.5	37.5	32.5	41.5
35	14.0	18.5	–	–	29.5	38.0	33.0	42.0	–	–
50	16.5	21.0	–	–	34.5	44.0	38.0	48.5	–	–
70	18.5	23.5	–	–	39.0	49.5	43.0	54.5	–	–
95	21.0	26.0	–	–	44.0	54.0	49.0	60.5	–	–
120	23.5	28.5	–	–	47.5	59.0	53.0	65.5	–	–
150	26.0	31.5	–	–	52.5	66.5	58.5	74.0	–	–
185	27.5	34.5	–	–	58.0	71.5	64.5	79.5	–	–
240	30.5	38.0	–	–	65.5	81.0	73.0	90.0	–	–
300	33.5	41.5	–	–	72.5	89.5	80.5	99.5	–	–
400	37.5	46.5	–	–	–	–	–	–	–	–
500	41.5	51.5	–	–	–	–	–	–	–	–
*630	45.5	56.5	–	–	–	–	–	–	–	–

*National type.

Table 5. Rubber-insulated, HOFR-*sheathed flexible cable, 450/750 V single core, circular twin*, 3-core, 4-core and 5-core

NOTE. Sheathed flexible cords having conductor sizes smaller than 4 mm² are covered by BS 6500 and BS 6141.

National type

Construction

Tinned annealed copper conductor. Class 5 flexible conductor.

Optional separator.

Rubber insulation type GP1.

Optional proofed tape.

The cores twisted together with/without fillers to form a practically circular assembly, a centre filler may be used.

Optional tape, provided that the completed cable shall not have any substantial cavities in the outer interstices between the cores.

Rubber sheath type RS4.

Where separate fillers have not been used, the sheath shall fill the interstices between the cores.

Colours for core identification

Single core: black.
Twin: blue and brown.
3-core: green/yellow, blue and brown.
4-core: green/yellow, black, blue and brown.
5-core: green/yellow, black, blue, brown and black.

Colour of sheath. Black.

Nominal cross-sectional area of conductor	Radial thickness of insulation	Radial thickness of sheath					Mean overall diameter									
		Single core	2-core	3-core	4-core	5-core	Single core		2-core		3-core		4-core		5-core	
		Single layer	Single layer	Single layer	Single layer	Single layer	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
mm²	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
4	1.0	1.5	1.8	1.9	2.0	2.2	7.4	9.0	12.0	15.0	13.0	16.0	14.5	18.0	16.0	19.5
6	1.0	1.6	2.0	2.1	2.3	2.5	8.0	11.0	13.0	18.5	14.5	20.0	16.5	22.0	18.0	24.5
10	1.2	1.8	3.1	3.3	3.4	3.6	9.8	12.5	18.5	24.0	20.0	25.5	21.5	28.0	24.0	30.5
16	1.2	1.9	3.3	3.5	3.6	3.9	11.0	14.5	21.0	27.5	22.5	29.5	24.5	32.0	27.0	35.5
25	1.4	2.0	3.6	3.8	4.1	4.4	12.5	16.5	25.0	31.5	26.5	34.0	29.5	37.5	32.5	41.5
35	1.4	2.2	—	4.1	4.4	—	14.0	18.5	—	—	29.5	38.0	33.0	42.0	—	—
50	1.6	2.4	—	4.5	4.8	—	16.5	21.0	—	—	34.5	44.0	38.0	48.5	—	—
70	1.6	2.6	—	4.8	5.2	—	18.5	23.5	—	—	39.0	49.5	43.0	54.5	—	—
95	1.8	2.8	—	5.3	5.9	—	21.0	26.0	—	—	44.0	54.0	49.0	60.5	—	—
120	1.8	3.0	—	5.6	6.0	—	23.5	28.5	—	—	47.5	59.0	53.0	65.5	—	—
150	2.0	3.2	—	6.0	6.5	—	26.0	31.5	—	—	52.5	66.5	58.5	74.0	—	—
185	2.2	3.4	—	6.4	7.0	—	27.5	34.5	—	—	58.0	71.5	64.5	79.5	—	—
240	2.4	3.5	—	7.1	7.7	—	30.5	38.0	—	—	65.5	81.0	73.0	90.0	—	—
300	2.6	3.6	—	7.7	8.4	—	33.5	41.5	—	—	72.5	89.5	80.5	99.5	—	—
400	2.8	3.8	—	—	—	—	37.5	46.5	—	—	—	—	—	—	—	—
500	3.0	4.0	—	—	—	—	41.5	51.5	—	—	—	—	—	—	—	—
630	3.0	4.1	—	—	—	—	45.5	56.5	—	—	—	—	—	—	—	—

Table 6. Rubber-insulated, braided, heat-resistant flexible cable, 300/500 V single core and twisted twin*

NOTE. Heat-resistant flexible cords having conductor sizes smaller than 4 mm^2 are covered by BS 6500 and BS 6141.

Harmonized code designation. HO5SJ-K, single core.

Construction

Annealed copper conductor, plain or tinned or protected by a metal other than tin, for example silver. Class 5 flexible conductor.

Separator optional.

Rubber insulation type EI2.

Treated glass-fibre braid.

Colours for core identification. Green/yellow, blue or other colours (see **6.3**).

Nominal cross-sectional area of conductor	Radial thickness of insulation	Mean overall diameter of each braided core (upper limit)
mm^2	mm	mm
4	0.8	5.6
6	0.8	6.2
10	1.0	8.2
16	1.0	9.6

*Twisted twin is a national type.

Table 7. Summary of electrical tests

Test method	Unit	300/500 V cables	450/750 V cables
Conductor resistance (see **12.1**)			
Length of sample (minimum)	m	1	1
Voltage test on complete cable (see **12.2**)			
Length of sample (minimum)	m	20	20
Period of immersion (minimum)	h	1	1
Temperature of water	°C	20 ± 5	20 ± 5
Applied voltage (a.c.)	V	2000	2500
Time of application	min	15	15
Voltage test on cores (see **12.3**)			
Length of sample	m	5	5
Period of immersion (minimum)	h	1	1
Temperature of water	°C	20 ± 5	20 ± 5
Applied voltage (a.c.)	V	2000	2500
Time of application	min	5	5
Check on the absence of faults on insulation (see **12.4**)			
Spark test (see **E.4.2.2**)			
Result to be obtained		No failure	No failure
Voltage test (see **E.4.2.3**)			
Applied voltage a.c.	V	2000	2500
Applied voltage d.c. (minimum)	V	5000	5000
Duration of test	min	5	5
Result to be obtained		No breakdown	No breakdown
Surface resistance of EM2 sheath (see **12.5**)			
Surface resistance (minimum)	ohm	1×10^9	1×10^9

Table 8. List of tests applicable to the various types of cable

Clause number	Test description	Table number 1	2	3	4	5	6
	Electrical tests						
12.1	Conductor resistance	X	X	X	X	X	X
12.2	Voltage test on cable at 2000 V	–	X	X	–	–	X
12.2	Voltage test on cable at 2500 V	X	–	–	X	X	–
12.3	Voltage test on cores at 2000 V	–	X	X	–	–	–
12.3	Voltage test on cores at 2500 V	–	–	–	X	X	–
12.4	Test for faults on insulation	X	X	X	X	X	X
12.5	Surface resistance	–	X*	X	X†	–	–
	Constructional and dimensional tests						
11.1	Check on construction	X	X	X	X	X	X
4	Solderability test (untinned conductor)	–	–	X	X	–	–
5.3	Measurement of insulation thickness	X	X	X	X	X	X
9.3	Measurement of sheath thickness	–	X	X	X	X	–
11.2	Measurement of overall dimensions	X	X	X	X	X	X
11.3	Measurement of ovality	–	–	X	X	X	–
5.1	*Mechanical properties of insulation*						
	Tensile strength before ageing	X	X	X	X	X	X
	Elongation at break before ageing	X	X	X	X	X	X
	Tensile strength after ageing in air	X	X	X	X	X	X
	Elongation at break after ageing in air	X	X	X	X	X	X
	Tensile strength after ageing in oxygen	–	X	X	X	–	–
	Elongation at break after ageing in oxygen	–	X	X	X	–	–
	Hot set test	–	X	X	X	–	X
9.1	*Mechanical properties of sheath*						
	Tensile strength before ageing	–	X	X	X	X	–
	Elongation at break before ageing	–	X	X	X	X	–
	Tensile strength after ageing in air	–	X	X	X	X	–
	Elongation at break after ageing in air	–	X	X	X	X	–
	Tear resistance	–	–	–	–	X	–
	Oil resistance	–	X	–	X	X	–
	Hot set test	–	X	X	X	X	–
13	Test under fire conditions	–	–	–	X	X	–
14	Flexing test (4 mm^2 flexible cable only)	–	–	X	X	X	–

NOTE. X indicates that the particular test is applicable to the cables in the table shown at the head of each column.

*The cable whose properties are given in table 2 is a recognized national type.

†EM2 sheath only.

Appendix A

Guide to the use of rubber-insulated cables and flexible cables

NOTE 1. None of these types is intended to be laid underground.

IMPORTANT. Details given in this appendix are intended only as general technical guidance and not as an interpretation of any UK statutory requirements, where these apply.

The cables are suitable for use where the combination of ambient temperature and temperature rise due to load results in a conductor temperature not exceeding:

(a) 60 °C for type EI1 rubber insulation;

(b) 85 °C for type GP1 rubber insulation;

(c) 150 °C for type EI2 rubber insulation, but 180 °C if there are no limits imposed by environmental conditions.

In addition, in the case of a short circuit, the maximum conductor temperature should not exceed:

(1) 200 °C for type EI1 rubber insulation;

(2) 250 °C for type GP1 rubber insulation;

(3) 350 °C for type EI2 rubber insulation.

NOTE 2. These short-circuit temperatures are based on the intrinsic properties of the insulating materials. It is essential that the accessories which are used in the cable system with mechanical and/or soldered connections are suitable for the temperature adopted for the cable.

NOTE 3. Cables with rated voltage 450/750 V are considered suitable for fixed protected installations, in lighting fittings and inside appliances, up to 600/1000 V a.c. or up to 750 V to earth d.c.

NOTE 4. Installation requirements are detailed in the Regulations for Electrical Installations, published by the Institution of Electrical Engineers, or in individual appliance specifications.

Typical uses of the different types of cable are given in table 9.

Table 9. Guide to the use of rubber-insulated cables and flexible cables

Table ref.	Cable type and use
1	*Rubber-insulated, textile-braided and compounded* Installation in surface-mounted or embedded conduits or trunking; suitable for hot situations.
2	*Rubber-insulated and sheathed flat cable* For decorative lighting indoors or outdoors.
3	*Rubber-insulated and sheathed flexible cable* For general use in domestic premises, kitchens and offices and for supplying appliances where the cables are subjected to low mechanical stresses, e.g. vacuum cleaners, cooking appliances, soldering irons and toasters. Not suitable for permanent use outdoors, in agriculture, in industrial* or agricultural work-shops or for supplying non-domestic tools.
4	*Rubber-insulated and sheathed flexible cable* In dry, humid or moist situations, outdoors; for all medium duties, e.g. industrial and agricultural appliances, heating installations, electric tools such as drills and circular saws, and also for transportable motors or machines on building sites and in agricultural workings; also suitable for fixed installations and huts for accommodation purposes; suitable for the wiring of components in lifting apparatus and machinery.
5	*Rubber-insulated and sheathed flexible cable* The same provision as for the cable whose properties are given in table 4, with the addition that it is suitable for hot situations, e.g. block storage heaters and immersion heaters, and for situations involving contact with oils and grease.
6	*Rubber-insulated, braided flexible cable* At ambient temperatures; fixed protected installations.

*But permissible in tailors' workshops and similar premises.

Appendix B

Guidance on procedure for routine tests on rubber-insulated cables of rated voltages U_0/U up to 450/750 V

NOTE. The following information is intended to provide guidance to the cablemaker on suitable procedures for the routine testing of cores and completed cables. They may be instituted by the manufacturer at his option and in no way should it be regarded as requirements of this standard.

B.1 Core stage tests

B.1.1 *General.* All cores for cables and flexible cables should be subjected either to the spark test described in **B.1.2** or to the voltage and insulation resistance tests described in **B.1.3** and **B.1.4**, respectively.

B.1.2 *Spark test.* Carry out the spark test in accordance with BS 5099, using the test voltages given in table 10, which are based on the radial thickness of insulation.

Table 10. Spark test voltage

Tabulated radial thickness of insulation		Test voltage	
		a.c. (r.m.s.)	d.c.
Above	Up to and including		
mm	mm	kV	kV
–	1.0	6	9
1.0	1.5	10	15
1.5	2.0	15	23
2.0	2.5	20	30
2.5	–	25	38

B.1.3 *Voltage test*

B.1.3.1 *Procedure.* After the core has been immersed in water for not less than 12 h, apply a voltage between the water in which the core is immersed, which is earthed, and the conductor. Make the test at room temperature with an alternating voltage of approximately sine-wave form having a frequency in the range 49 Hz to 61 Hz.

Increase the applied voltage gradually and maintain it at the full r.m.s. value shown in table 11 for 5 min.

B.1.3.2 *Recommended test criteria.* No breakdown of insulation should occur.

Table 11. Insulation test voltage

Tabulated radial thickness of insulation		Test voltage
		a.c. (r.m.s.)
Above	Up to and including	
mm	mm	kV
–	1.0	2.0
1.0	–	2.5

B.1.4 *Insulation resistance test*

B.1.4.1 *Procedure.* Immediately after completion of the voltage test described in **B.1.3** apply a d.c. voltage of 300 V to 500 V between the conductor and the water in which the core is immersed for 1 min, the electrification proceeding in a regular manner, the deflection of the galvanometer, if used, decreasing steadily during the period of application.

Maintain the water in which the core is immersed as near to 20 °C as possible and record the temperature if it is not 20 °C.

B.1.4.2 *Recommended test criteria.* The insulation resistance of the length of core, in megohms kilometre, should be not less than that resulting from calculation using the following expression:

$$R_{1000} = K \log_{10} \frac{D}{d}$$

where

K is the insulation resistance constant at 20 °C specified in table 12 for the rubber concerned (in MΩ·km);

D is the diameter over insulation (in mm);

d is the diameter over conductor (in mm);

R_{1000} is the insulation resistance of cable (in MΩ·km).

When the temperature of the water is not 20 °C, the result obtained should be multiplied by the appropriate constant given in table 13 to obtain the corrected insulation resistance.

Table 12. Insulation resistance constant (K value) at 20 °C

Type of insulation	Insulation resistance constant
	MΩ·km
EI1	700
GP1	2400
EI2	870

Table 13. Temperature correction factor

Temperature	Multiplier constant	
	GP1 insulation	EI1 and EI2 insulation
°C		
10	0.50	0.67
11	0.54	0.69
12	0.57	0.72
13	0.62	0.74
14	0.66	0.77
15	0.71	0.80
16	0.76	0.82
17	0.81	0.85
18	0.87	0.89
19	0.93	0.94
20	1.00	1.00
21	1.07	1.06
22	1.15	1.13
23	1.23	1.20
24	1.32	1.27
25	1.42	1.35
26	1.52	1.44
27	1.62	1.54
28	1.74	1.65
29	1.87	1.77
30	2.00	1.90

B.2 Test on completed cable

B.2.1 *General.* Completed cables and flexible cables should be subjected to the tests described in **B.2.2** to **B.2.5**.

B.2.2 *Conductor resistance*

B.2.2.1 *Procedure.* Leave the cable in a test area, which is at a reasonably constant temperature, for sufficient time to ensure that the cable temperature is equal to the ambient temperature.

Measure the d.c. resistance of the conductor at room temperature.

B.2.2.2 *Recommended test criteria.* Calculate the resistance per unit length from the production length of the completed cable and not from the length of the individual cores or wires. In this respect cables of flat formation should be regarded as single core.

The d.c. resistance of the conductor corrected to 20 °C by the appropriate factor given in BS 6360 should comply with BS 6360.

B.2.3 *Voltage test*

B.2.3.1 *Procedure.* Subject completed twin and multicore cables to the voltage test without immersion in water. Apply the voltage between conductors.

NOTE. Completed single core sheathed cables may be tested in water.

Make the test at room temperature with an alternating voltage of approximately sine-wave form having a frequency in the range 49 Hz to 61 Hz. Increase the voltage gradually and maintain it at the full r.m.s. value shown in table 11 for 5 min.

B.2.3.2 *Recommended test criteria.* No breakdown of insulation should occur.

B.2.4 *Insulation resistance test.* Immediately after the completion of the voltage test described in **B.2.3**, carry out an insulation resistance test.

Follow the method described in **B.1.4** but make the measurement between conductors.

For multicore cables, cores may be grouped provided that cores adjacent to those being tested are connected to earth.

Where single core sheathed cables are tested in water, use the method described in **B.1.4.**

B.2.5 *Constructional and dimensional check.* A sample of completed cable should be checked for compliance with tables 1 to 6, as appropriate.

Appendix C

Solderability test for plain conductors

C.1 Principle. The test is intended to verify the effectiveness of the separator between the plain conductor and the insulation.

C.2 Reagents and materials

C.2.1 *Zinc chloride solution,* in water, the concentration of zinc chloride being 10 % (*m/m*).*

C.2.2 *Solder,* composed of tin, at a level of between 59.9 % (*m/m*) and 61.5 % (*m/m*), and lead and any impurities shall not exceed the following levels:

(a) antimony	0.50 % (*m/m*);
(b) bismuth	0.25 % (*m/m*);
(c) copper	0.08 % (*m/m*);
(d) iron	0.02 % (*m/m*);
(e) zinc	0.005 % (*m/m*);
(f) aluminium	0.005 % (*m/m*);
(g) other impurities	0.080 % (*m/m*).

C.3 Apparatus. The solder bath shall have a volume sufficient to ensure that the temperature of the solder (**C.2.2**) remains uniform at the moment when the conductor is introduced. It shall be provided with a device that maintains the temperature of the solder at 270 ± 10 °C.

The depth of the solder bath shall be at least 75 mm.

The visible surface area of the bath shall be reduced as far as possible, by using a perforated plate of heat-resisting material, in order to protect the core against direct radiation from the bath.

C.4 Sampling and preparation of test pieces

C.4.1 *Sampling.* Take one sample having a length suitable for the bending operation described in **C.4.2** at three points in the cable, and carefully separate the cores in each sample from all other components.

C.4.2 *Bending operation.* Wind each sample of core thus obtained in three turns on a mandrel, the diameter of which is three times that of the core.

Then unwind the sample and straighten it out and wind it again in such a way that the fibre that was compressed in the first case becomes the stretched fibre in the second.

Repeat this cycle of operations two more times, which means that the total operation represents three bending operations in one direction and three in the other.

C.4.3 *Conditioning.* From each sample of core which has been straightened out after the third cycle of bending operations, take a test piece having a length of about 150 mm from that part of the core which has actually been wound.

Subject each test piece to accelerated ageing in a hot-air oven for 240 h at a temperature of 70 ± 1 °C.

After accelerated ageing, leave the test pieces at ambient temperature for at least 16 h.

Then strip each test piece at one end over a length of 60 mm.

C.5 Procedure. Keep the surface of the solder bath clean and shining.

Immerse the bared end of each test piece for 10 s at ambient temperature in a pickling bath constituted by the solution of zinc chloride (**C.2.1**) and then immerse each end in the solder bath over a length of 50 mm in the direction of its longitudinal axis.

Immerse the test piece at a speed of 25 ± 5 mm/s and leave it immersed for 5 ± 0.5 s.

Withdraw the test piece at a speed of 25 ± 5 mm/s.

Observe an interval lasting 10 s from the start of one immersion to the start of a subsequent immersion and make three immersions.

*The symbol *m/m* is an abbreviation for proportion of total mass.

Appendix D

Measurement of thicknesses and overall dimensions

D.1 Measurement of insulation thickness

D.1.1 *Apparatus.* A measuring microscope or a profile projector shall be used, each instrument being capable of at least ×10 magnification. The equipment shall have an accuracy of 0.01 mm. A microscope allowing a reading of 0.01 mm or a profile projector of at least ×20 magnification shall be used in case of dispute.

D.1.2 *Sampling and preparation of test pieces*

D.1.2.1 *Sampling.* From each core to be tested take one sample of core from each of three places separated by at least 1 m.

D.1.2.2 *Preparation.* Remove any covering from the insulation and withdraw the conductor together with the separator, if any, taking care not to damage the insulation.

Cut each test piece, consisting of a thin slice of insulation, with a suitable device, sharp knife, razor blade, etc., along a plane perpendicular to the longitudinal axis of the conductor.

If the insulation carries an indented marking, take the test piece so as to include such marking.

D.1.3 *Procedure.* Place the test piece under the measuring equipment with the plane of the cut perpendicular to the optical axis.

Make six measurements of radial thickness on each piece of insulation at places where the insulation is thin, i.e. between the ridges caused by the strands, and as far as possible equally spaced around the circumference. Make the first measurement at the place where the insulation is thinnest (see figure 2).

If the outer surface is irregular, carry out measurements as shown in figure 5(a).

Take readings in millimetres to two decimal places.

D.1.4 *Expression of results.* Calculate the mean of all the values obtained on the three pieces of insulation, to two decimal places and then round them off to obtain the mean value of insulation thickness (see **5.3**).

If the calculation gives five or more for the second decimal figure, raise the first figure to the next number: thus, for example, 1.75 shall be rounded to 1.8 and 1.74 to 1.7.

Take the smallest of all the values obtained as the minimum thickness of insulation at any one place.

D.2 Measurement of sheath thickness

D.2.1 *Apparatus.* The apparatus shall be in accordance with **D.1.1**.

D.2.2 *Sampling and preparation of test pieces*

D.2.2.1 *Sampling.* Take one sample of cable from each of three places, separated by at least 1 m.

D.2.2.2 *Preparation.* Remove all the materials inside and outside the sheath. Cut each test piece, consisting of a thin slice of sheath, with a suitable device, sharp knife, razor blade, etc., along a plane perpendicular to the longitudinal axis of the cord.

If the sheath carries an indented marking, take the test piece so as to include such marking.

D.2.3 *Procedure.* Place the test piece under the measuring equipment with the plane of the cut perpendicular to the optical axis.

When the inner profile of the test piece is of substantially circular form, make measurements as shown in figure 1, as far as possible, equally spaced around the circumference. Make the first measurement at the place where the sheath is thinnest.

If the sheath shows grooves caused by the cores, make the measurements in as many places as there are cores, at places where the sheath is thin, i.e. at the deepest part of the grooves (see figure 4).

In the case of sheathed parallel twin cable, make three measurements at the position of each core, two on lines approximately parallel to the minor axis and one on the major axis (see figure 3).

Make the first of these measurements at the place where the sheath is thinnest, if necessary, instead of the positions indicated in figure 3.

If the outer surface is irregular, make measurements as shown in figure 5(b).

Take readings in millimetres to two decimal places.

D.2.4 *Expression of results.* Calculate the mean of all the values obtained on the three pieces of sheath, to two decimal places and then round them off as detailed in **D.1.4** to obtain the mean value of sheath thickness (see **9.3**).

Take the smallest of all the values obtained as the minimum thickness of sheath at any one place.

D.3 Measurement of overall dimensions

D.3.1 *Apparatus.* Measurements shall be made using a micrometer, a profile projector or similar apparatus.

D.3.2 *Sampling.* One sample of cable shall be taken from each of three places, separated by at least 1 m.

D.3.3 *Procedure.* For flat cable, make the measurements along the major and minor axes of the cross section.

For other cables, make the measurements in two directions perpendicular to each other.

Take the readings to two decimal places of a millimetre.

For checking the ovality of circular sheathed cable, take two measurements at the same cross section of the cable, covering the maximum and minimum values. (See **11.3**.)

D.3.4 *Expression of results.* For flat cable, take the mean of the three determinations of each of the major and minor axes as the mean overall dimensions.

For other cable, take the mean of the six values obtained as the mean overall diameter.

Appendix E

Electrical tests

E.1 Test conditions. Unless otherwise specified, make tests at ambient temperature with alternating voltages of approximately sine-wave form, having a frequency in the range of 49 Hz to 61 Hz, and of the r.m.s. values given in table 7. The ratio peak value/r.m.s. value shall be equal to $\sqrt{2}$ with a tolerance of ± 7 %.

E.2 Voltage test on complete cable

E.2.1 *Test sample.* Take a sample of cable, as delivered, of the length given in table 7.

E.2.2 *Procedure.* Immerse the sample of cable in water at the temperature given in table 7. Ensure that the ends of the cable protrude above the water by a distance sufficient to prevent excessive surface leakage when the test voltage is applied. Apply a voltage of the magnitude given in table 7 in turn between each conductor and all the others connected together and to the water, and between all conductors and the water for the time given in table 7.

E.3 Voltage test on cores

E.3.1 *Test sample.* Prepare a sample of the length given in table 7 by carefully removing the sheath and any other covering or filling from the complete cable.

E.3.2 *Procedure.* Immerse the sample in water at the temperature given in table 7. Ensure that the ends of the cores protrude above the water by a distance sufficient to prevent excessive surface leakage when the test voltage is applied. Apply a voltage of the magnitude given in table 7 between the conductors and the water for the time given in table 7.

E.4 Test to check the absence of faults in insulation

E.4.1 *Test during manufacturing.* Carry out this test on cable that is in the final stage of manufacture, either in delivery lengths or in manufacturing lengths prior to being cut into delivery lengths.

E.4.2 *Procedure*

E.4.2.1 *General.* Test single core cables by the spark test described in **E.4.2.2** and multicore cables and sheathed flat cable by the voltage test described in **E.4.2.3.**

E.4.2.2 *Spark test*

E.4.2.2.1 *Apparatus.* The spark test equipment shall provide a magnitude and presence of voltage that, together with the electrode system employed and speed of passage employed for the passage of the cable through the equipment, is capable of detecting a puncture in the insulation having a diameter equal to or greater than half of the specified thickness of the insulation.

NOTE. The voltage applied by the spark test equipment may be power-frequency a.c., d.c., high-frequency or other form.

In addition, the recovery time of the spark testing shall not be greater than 1 s.

When the spark test equipment is tested as described in appendix F all the faults shall be registered by the equipment. Manufacturer's instructions for production and control procedures shall provide that cable for which spark testing is required is effectively tested in practice.

E.4.2.2.2 *Procedure.* Test the cable at the voltage and speed of passage specified in **E.4.2.2.1.**

E.4.2.3 *Voltage test.* With the cable in the dry state and at room temperature, apply a voltage of the magnitude given in table 7 between each conductor and all the other conductors connected to earth. Increase the voltage gradually to the test value and maintain it for the time given in table 7. The voltage shall be derived either from an a.c. source or from a d.c. source.

E.5 Test to determine surface resistance of sheath

E.5.1 *Test samples.* Take three samples of complete cable, each about 250 mm in length.

E.5.2 *Procedure.* Clean the sheath of each of the samples with spirit and apply two electrodes consisting of wire helices applied at a distance of 100 ± 2 mm from each other. For the helices, use copper wire of between 0.2 mm and 0.6 mm diameter. After the wire has been applied, thoroughly clean the surface of the sheath again between the electrodes.

Then condition the samples at a temperature of 20 ± 2 °C and a relative humidity of 65 ± 5 % r.h. for 24 h.

Immediately after removal from the conditioning chamber, apply a d.c. voltage of between 100 V and 500 V between the wire electrodes and measure the resistance 1 min after application of the voltage.

E.5.3 *Expression of results.* Multiply the measured resistance for each sample, in ohms, by $a/100$, where a is the perimeter of the sheath of the sample in millimetres. Take the median of the three values so obtained as the surface resistance of the sheath.

Appendix F

Method for checking the efficacy of the method of spark testing

F.1 Principle. The principle of this method is to standardize the method by which manufacturers may demonstrate that their spark testing method is effective in detecting faults in the insulation as specified in **E.4.2.2.**

F.2 Selection and preparation of test pieces

F.2.1 *Sampling.* Prepare two test-lengths of core, one with the smallest insulation thickness for the relevant type of cable and the other core with the largest insulation thickness for the relevant type of cable.

F.2.2 *Preparation of punctures.* Prepare the punctures in the insulation as follows:

(a) Remove the insulation from the core for a length of about five times the nominal insulation thickness.

(b) From the piece of insulation which has been removed, remove a segment of about 30°. Then replace the remaining piece of the insulation on the conductor (see figure 6).

(c) Over the replaced piece of the insulation, place one layer of adhering tape, e.g. polyethylene terephthalate, with a length of at least ten times the nominal insulation thickness in the longitudinal direction, with an overlap. Situate this overlap on the opposite side of the core to the position where the insulation was removed (see figure 7).

(d) In this layer, in the middle of the place where the insulation has been removed, use a hot needle to punch a hole in the tape with a diameter equal to half of the allowed minimum insulation thickness.

Prepare the other test piece in the same way.

F.3 Procedure

F.3.1 *Efficacy of detecting.* Pass the prepared test-piece through the spark test equipment at the highest speed for which the equipment is intended, the voltage applied between the electrode and the conductor being that normally used.

F.3.2 *Recovery time.* Pass at least two faults through the spark-test equipment at its actual operating speed v, in metres per second, the distance in metres between two faults being not greater than the value of v.

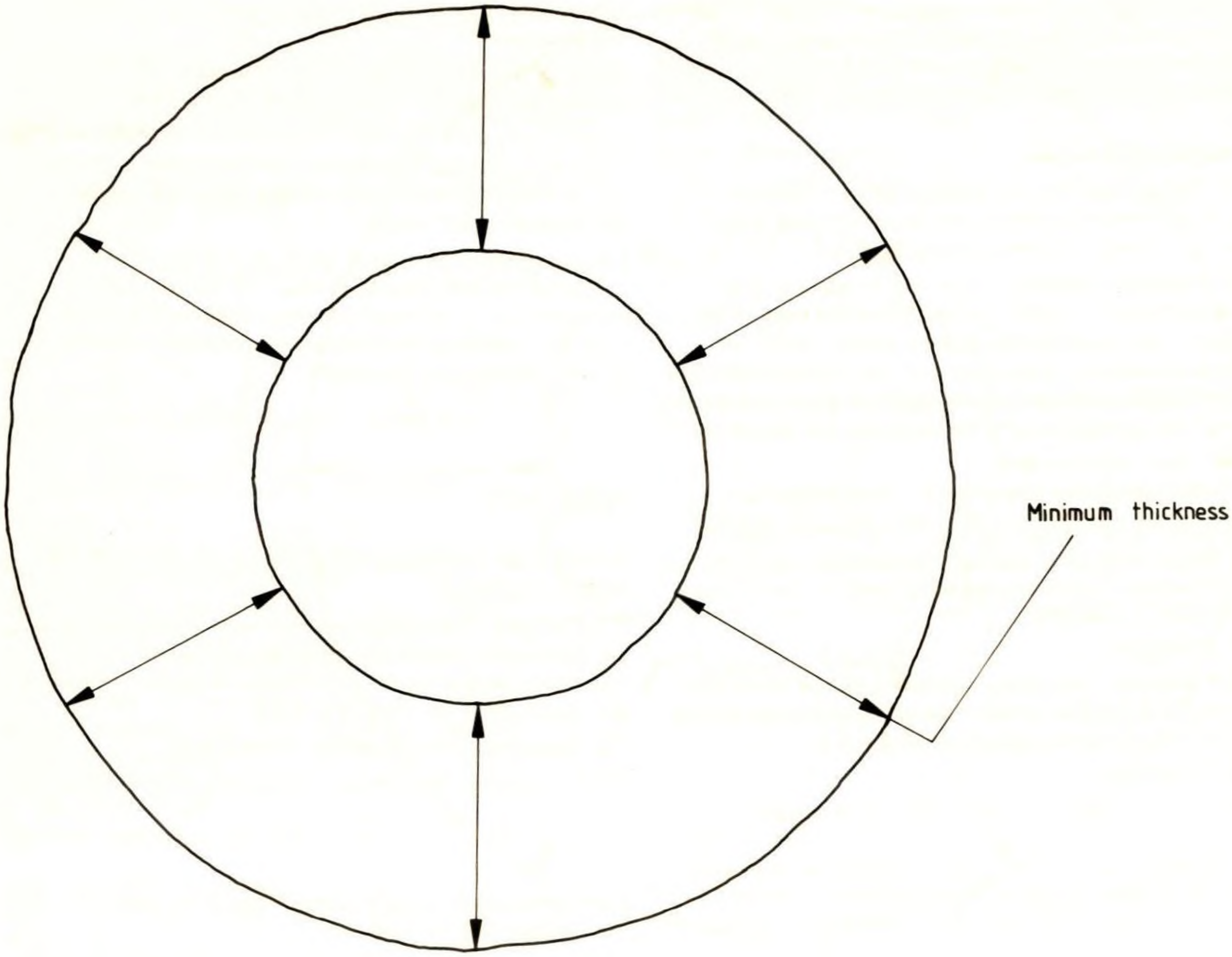


Figure 1. Positions for measurement of sheath thickness for circular profile

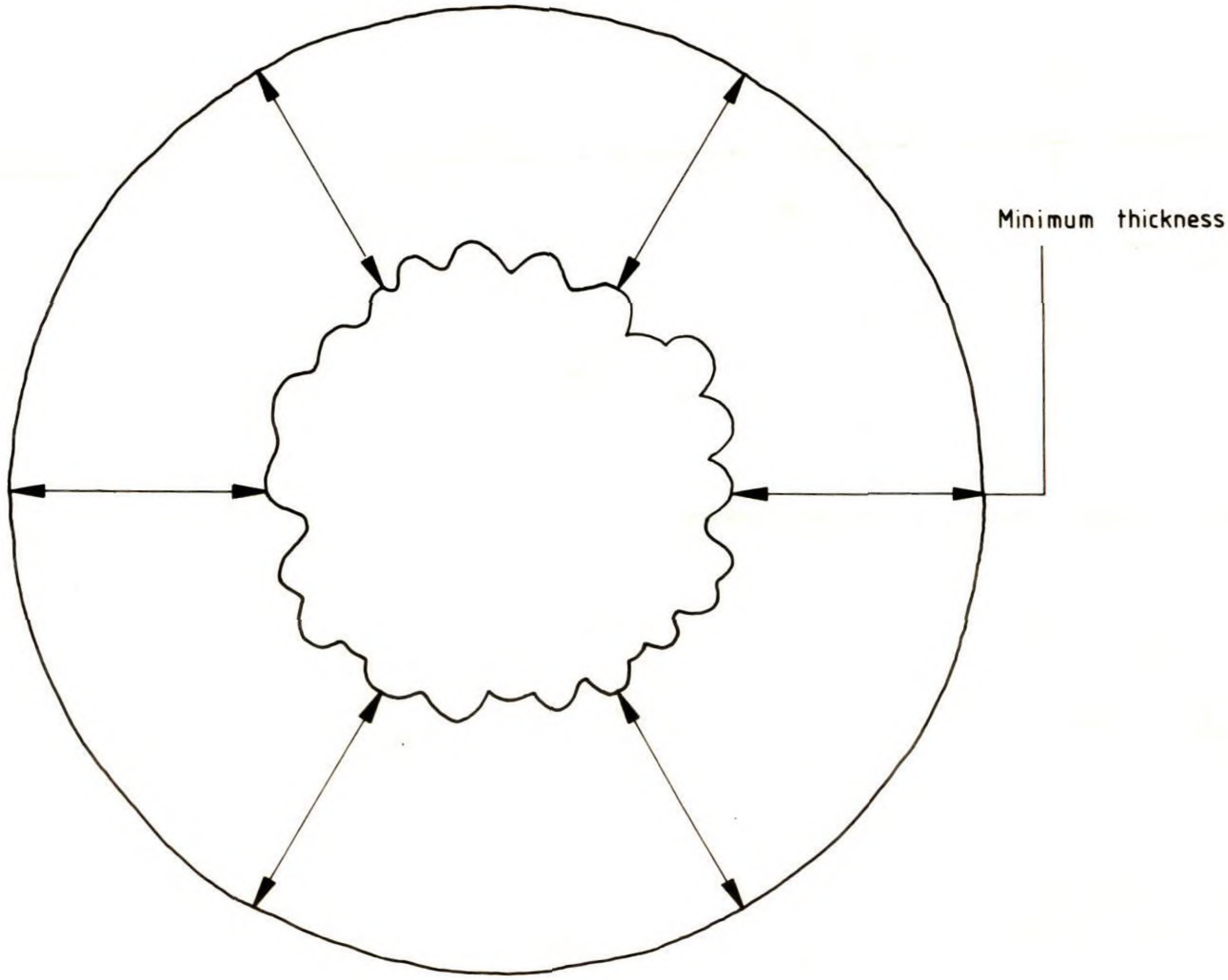


Figure 2. Positions for measurement of insulation thickness

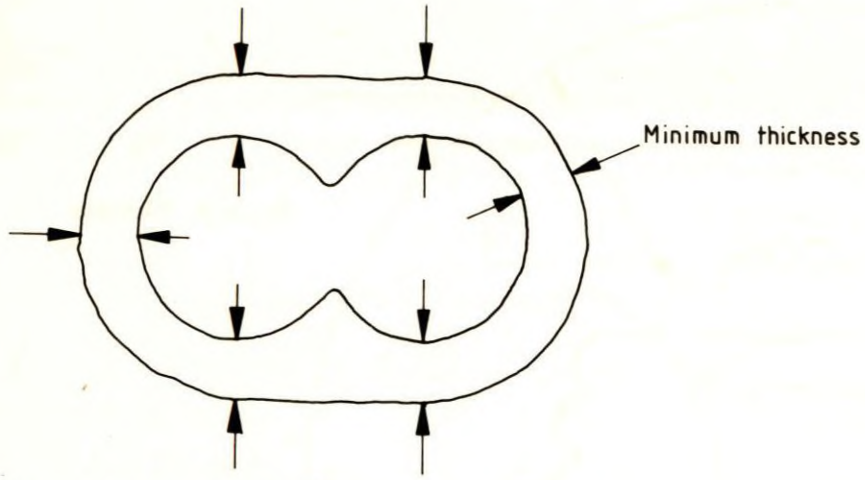


Figure 3. Positions for measurement of sheath thickness

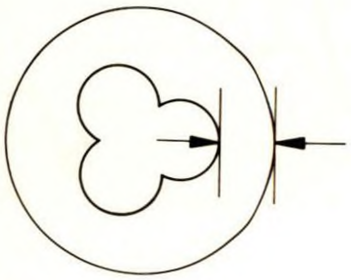
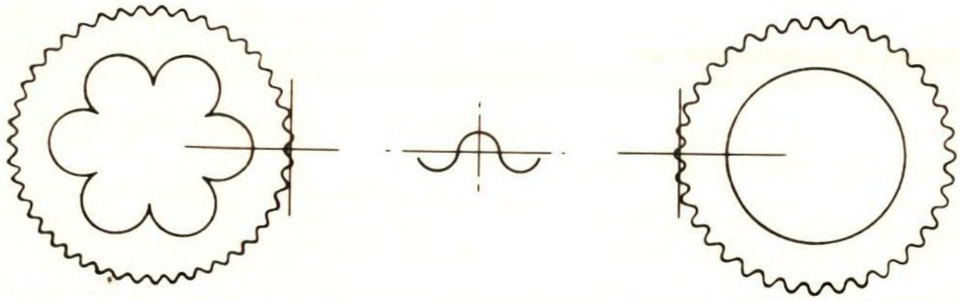


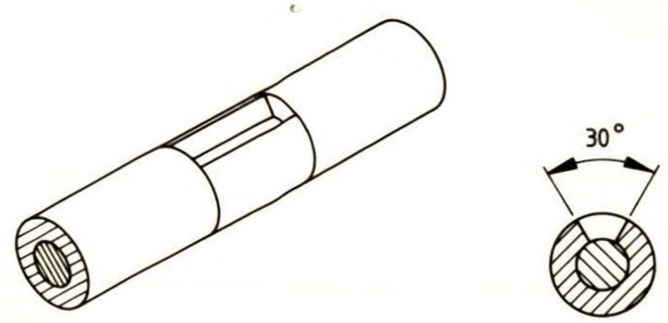
Figure 4. Position for measurement of sheath thickness



(a) Insulation

(b) Sheath

Figure 5. Position of thickness measurement for insulation and sheath



(a)

(b)

Figure 6. Spark test check: removal of insulation

Figure 7. Spark test check: covering with tape

Publications referred to

BS 4066 Tests on electric cables under fire conditions
Part 1 Method of test on a single vertical insulated wire or cable
BS 4727 Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms
BS 5099 Spark testing of electric cables
BS 6141 Specification for insulated cables and flexible cords for use in high temperature zones
BS 6360 Specification for conductors in insulated cables and cords
BS 6500 Insulated flexible cords
BS 6899 Specification for rubber insulation and sheath of electric cables
PD 2379 Register of colours of manufacturers' identification threads for electric cables and cords
HD 22 Rubber insulated cables of rated voltages up to and including 450/750 V
Part 1* General requirements
Part 2* Test methods
Part 3* Heat resistant silicone rubber insulated cables
Part 4* Cords and flexible cables

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Electricity Supply Industry in England and Wales
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