

Specification for

Rubber-insulated cables for electric power and lighting

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:

- Association of Consulting Engineers
- Association of Manufacturers of Domestic Electrical Appliances
- BECCAMA (Beama Electrical Cable Connector and Accessories Manufacturers' Association)
- British Approvals Service for Cables
- British Cable Makers Confederation
- British Plastics Federation
- British Steel Industry
- Department of the Environment (Property Services Agency)
- Department of Trade and Industry (Consumer Safety Unit, CA Division)
- Electricity Association
- Engineering Equipment and Materials Users' Association
- Institution of Electrical Engineers
- London Regional Transport

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

- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Electrical Systems Association (BEAMA Ltd.)
- British Non-Ferrous Metals Federation
- British Steel plc
- Chartered Institution of Building Services Engineers
- ERA Technology Ltd.
- Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
- Engineering Industries Association
- GAMBICA (BEAMA Ltd.)
- Institution of Incorporated Executive Engineers
- Lighting Industry Federation Ltd.
- London Underground Ltd.
- National Association of Lift Makers
- Portable Electric Tool Manufacturers' Association
- Transmission and Distribution Association (BEAMA Ltd.)

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Foreword

This edition of BS 6007 has been prepared under the direction of the Cables and Insulation Standards Policy Committee and it supersedes BS 6007:1991 which is withdrawn.

This edition includes alterations introduced by Amendment No. 1 to BS 6007:1991 (published in May 1993) together with some further technical changes to bring the standard up to date but it does not reflect a full review of the standard which will be undertaken in due course.

This new edition is aligned with Amendments 8, 9, 10 and 11 to HD 22.1 S2, Amendment 3 to HD 22.2 S2 and Amendment 5 to HD 22.4 S2.

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 CENELEC¹⁾. 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 with CENELEC have been included in Table 1 to Table 8, as appropriate.

Differences in the text between this edition and BS 6007:1991 are indicated by a sideline in the margin.

Certification. Attention is drawn to the certification services (see inside back cover) of the British Approvals Service for Cables (BASEC)²⁾. 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”).

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

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 24, an inside back cover and a back cover.

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

¹⁾ European Committee for Electrotechnical Standardization.

²⁾ British Approvals Service for Cables, Silbury Court, 360 Silbury Boulevard, Milton Keynes, Buckinghamshire MK9 2AF.

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 compound 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;
- d1) Table 4A. Rubber-insulated and sheathed flexible cable, having more than 5-core (multicore cables) 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;
- g) Table 7. Heat-resistant, rubber-insulated, single core cables for internal wiring 450/750 V;
- g1) Table 7A. Heat-resistant, rubber-insulated, single core cables for internal wiring 300/500 V;
- h) Table 8. Unbraided, silicone-rubber-insulated cables for internal wiring 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.

2 References

2.1 Normative references

This British Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed on page 24. For dated references, subsequent amendments to or revisions of any of these publications apply to this British Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publications referred to applies.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on page 24, but reference should be made to the latest editions.

3 Definitions

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

3.1

rated voltage U_0

the power-frequency voltage to earth for which the cable is designed

3.2

rated voltage U

the power-frequency voltage between conductors for which the cable is designed

4 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.

5 Conductors

5.1 Construction

The conductors shall be annealed copper conductors complying with BS 6360. Unless otherwise given in Table 1 to Table 8, as appropriate, the individual wires of conductors shall be plain or covered with an effective layer of commercial tin.

For cables specified in Table 7 and Table 7A, where the wires are plain, a separator tape made of suitable material shall be placed between the conductor and the insulation.

NOTE For cables specified in tables other than Table 7 and Table 7A, a separator tape made of suitable material may be applied around each conductor. 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.

5.2 Class

The class of the conductor shall be as given in Table 1 to Table 8, inclusive.

6 Insulation

6.1 Type of insulation

The insulation shall be one of the following types, as given in Table 1 to Table 8, as appropriate:

- a) type GP 1 rubber insulation complying with BS 6899;
- b) types EI 2, EI 3 and EI 4 rubber insulation complying with BS 7655-1.1.

Compliance shall be checked by carrying out the appropriate tests listed in Table 10.

6.2 Application

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

- a) types EI 3 and GP 1: unless applied by the extrusion process, the insulation shall consist of at least two layers;
- b) types EI 2 and EI 4: 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.

6.3 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 Table 1 to Table 8, as appropriate. However, it shall be permissible for the thickness at any place to be less than the value specified provided that the difference does not exceed $0.1 \text{ mm} + 10 \%$ of the value specified.

Compliance shall be checked by the measurements described in 8.1 of BS 6469-1.1:1992.

From each core to be tested, one sample of core shall be taken from each of three places separated by at least 1 m.

The mean of all the values obtained on the three pieces of insulation shall be calculated to two decimal places and then rounded off to obtain the mean value of insulation thickness. If the calculation gives 5 or more for the second decimal figure, the first figure shall be raised to the next number: thus, for example, 1.75 shall be rounded to 1.8 and 1.74 to 1.7.

The smallest of all the values obtained shall be taken as the minimum thickness of insulation at any place.

6.4 Addition of tape

Where stated in Table 1 to Table 8, 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.

7 Core identification

7.1 General

NOTE The methods of core identification depend on the number of cores, as shown in 7.1.1 and 7.1.2.

7.1.1 Cables having 1 to 5 cores

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 Table 1 to Table 8 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.

7.1.2 *Multicore cables* (having more than 5 cores)

Multicore cables (having more than 5 cores) shall be identified in accordance with the requirements of Table 4A.

If the cores are identified by inscription, this shall be in accordance with the method stated in Appendix F.

7.2 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 Table 1 to Table 8, as appropriate.

7.3 Harmonized code designations

Harmonized code designations are given in Table 6, Table 7, Table 7A and Table 8 for single core non-sheathed cables. These cables shall be permitted to bear the Common Marking in accordance with 11.2, 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 shall not be considered harmonized.

Single-core non-sheathed cables complying with the properties given in Table 1 to Table 8 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 1 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 BS 7671, any other British or other standard applicable, or any appropriate regulations or statutory requirements.

NOTE 2 In addition to the combination green/yellow, and the mono-colour blue, the following other mono-colours are recognized as harmonized: black, brown, grey, orange, pink, red, turquoise, violet and white.

7.4 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 In case of dispute and where appropriate to the method of colour marking of the insulation, see clause 8 of BS 6469-99.1:1992 for a test method to check compliance.

NOTE 2 *Information on the use of the colours green/yellow and 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 as earth connection or similar protection and that the colour blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, blue can be used to identify any core except for earthing or protective conductor.

7.5 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.

8 Filler

8.1 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.

8.2 Application

Whether the cable includes fillers or whether the sheath may penetrate between the cores thus forming a filling, shall be as given in Table 1 to Table 8, 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 8.1.

9 Braid

9.1 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.

9.2 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.

10 Sheath

10.1 Type of sheath

The sheath shall be one of the following types complying with BS 7655-2.1 or BS 7655-2.3 as given in Table 1 to Table 8, as appropriate:

- a) type EM 1 ordinary duty rubber sheath for inner sheath only;
- b) type EM 3 ordinary duty rubber sheath;
- c) type EM 2 ordinary duty oil-resisting and flame-retardant sheath;
- d) type RS 4 heavy duty oil-resisting and flame-retardant sheath.

Compliance shall be checked by carrying out the appropriate tests given in Table 10.

10.2 Construction

10.2.1 General

The protective sheath shall be extruded and shall consist of a single layer or of two layers, as given in Table 1 to Table 8, as appropriate, complying with 10.2.2 or 10.2.3.

10.2.2 Single layer

The sheath shall be applied as an homogeneous 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 Table 1 to Table 8, the sheath shall penetrate into the space between the cores, thus forming a filler.

10.2.3 Sheath in two separate homogeneous layers

The two layers shall be as follows.

- a) *Inner layer.* The inner sheath shall be applied as specified in 10.2.2.

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 layer of the sheath shall be applied over the inner layer, or over the tape or separator if any. The outer layer shall be applied as an homogeneous layer.

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.

10.3 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 Table 2, Table 3, Table 4 and Table 5, as appropriate. However, it shall be permissible for the thickness at any 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 measurements described in 8.2 of BS 6469-1.1:1992.

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

The mean of all the values obtained on the three pieces of sheath shall be calculated to two decimal places and rounded off as detailed in 6.3 to obtain the mean value of sheath thickness.

The smallest of all the values obtained shall be taken as the minimum thickness of sheath at any place.

10.4 Colour

10.4.1 General

The colour of the sheath is specified only for the cable the properties of which are given in Table 5, and shall be as given in Table 5.

10.4.2 Black sheaths

For cables specified in Table 5, or where a black sheath is applied to a cable where colour is not specified, the colour shall be throughout the whole of the sheath (or the whole of the outer layer in a two layer construction).

10.4.3 Other coloured sheaths

For all coloured sheaths other than those specified in 10.4.2, the colour shall be throughout the whole of the sheath (or the whole of the outer layer in two layer construction) or on its surface. Where surface colouring is applied, the surface colour shall be of essentially the same material as the underlying material and shall be applied as part of the extrusion process. The surface colour shall not be separable from the underlying material and shall be durable.