

Specification for

**Thermosetting
insulated cables
(non-armoured) for
electric power and
lighting with low
emission of smoke and
corrosive gases when
affected by fire**

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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
- BEAMA Electrical Cable and Accessory Manufacturers' Association (BECCAMA)
- 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.)
- BEAMA Transmission and Distribution Association (BTDA)
- British Electrical Systems Association (BEAMA Ltd.)
- British Non-ferrous Metals Federation
- British Steel plc
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- Institution of Incorporated Executive Engineers
- Lighting Industry Federation Ltd.
- London Underground Ltd.
- National Association of Lift Makers
- Portable Electric Tool Manufacturers' Association

This British Standard, having been prepared under the direction of the Cables and Insulation Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 March 1994

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Foreword

This revision of BS 7211 has been prepared under the direction of the Cables and Insulation Standards Policy Committee at the request of the British Cable Makers Confederation in view of an increasing demand for cable with reduced emission of smoke and corrosive gases when affected by fire. This revised edition of the British Standard supersedes BS 7211:1989, which is withdrawn.

The improved performance under fire conditions is assessed on the basis of tests that measure the emission of smoke and corrosive gases under defined conditions.

This new edition aligns with CENELEC¹⁾ HD 22.9 S1 in respect of insulated non-sheathed single core cables. In addition, it includes insulated and sheathed cables for which there is currently no published European or International Standard.

The constructions closely follow those for similar cables made to BS 6004 and the new cables are for operation at voltages up to and including 450/750 V. However, the materials used may result in different installation characteristics from those of cables made to BS 6004.

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”).

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

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

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 22, 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 non-armoured cables with thermosetting insulation of rated voltage up to and including 450/750V which, when assessed by tests specified in the standard, produce lower levels of smoke and corrosive gases under exposure to fire compared with PVC cables made to BS 6004.

In this standard corrosive (and acid) gases are defined as those which are determined either as HCl or by measurement of pH and conductivity, as appropriate.

The standard specifies construction and test requirements, including tests relating to performance under fire conditions.

NOTE 1 The cautionary notes contained within the "scope" of each fire test method should be taken into account when assessing the suitability of cables conforming to this specification for use in a particular application.

The insulation and other components are suitable to permit operation of the cables at a maximum sustained conductor temperature of 90 °C.

NOTE 2 Limitation on the temperature of the cables may be imposed in situations where they may be touched, or where they may touch other materials.

NOTE 3 In installations that include cable joints and terminations, the performance of these accessories should be taken into account in deciding the maximum operating temperature of the cable.

Table 1 gives a schedule of tests and Table 2 gives the selection and arrangement of cables for the smoke emission test.

The types of cable included in the standard are:

Table 3 a) rigid Thermosetting insulated, copper conductor non-sheathed, single-core cable and b) flexible copper conductor

450/750 V

Table 4 a) rigid Thermosetting insulated, copper conductor non-sheathed, single-core cable and b) flexible copper conductor

300/500 V

Table 5 Thermosetting insulated, single-core sheathed cable

450/750 V

Table 6 Thermosetting insulated, twin, 3-core, 4-core and 5-core circular sheathed cables

450/750 V

Table 7

Thermosetting insulated, single-core, flat twin and flat 3-core sheathed cable with circuit protective conductor
300/500 V

A guide to the use of these cables for fixed installations is given in Annex A. Annex B to Annex D give test methods.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 21. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

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

3 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. metal covering of the cable or the surrounding medium;

U is the r.m.s. value between any two phase-conductors of a multi-core 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 system voltage (U) of the cable.

NOTE 1 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 purposes of this standard shall be 300/500 V and 450/750 V.

NOTE 2 Table 3 cables may be suitable for a rated voltage system (U) up to 1 000 V a.c. or 1.5 times higher for d.c. usage (see Annex A).

5 Conductor

5.1 The conductor shall be annealed copper conductor conforming to BS 6360. It shall be permissible for the wires to be tinned.

5.2 The class of the conductor shall be as given in Table 3 to Table 7 inclusive. Except for constructions in Table 3 b) and Table 4 b), conductors shall be circular solid, circular stranded or compacted circular stranded.

6 Insulation

6.1 Types of insulation

The insulation shall be a thermosetting type; either type GP 8 conforming to BS 7655-1.3 with the addition of a low temperature bending test as required for EI 5; or type EI 5 conforming to BS 7655-5.1, as specified in Table 3 to Table 7. Conformity shall be checked by carrying out the appropriate tests listed in Table 1. Where EI 5 insulation is used for Table 5, Table 6 and Table 7, measurement of corrosive and acid gas emission shall be in accordance with the requirements in 6.4.

The core insulation shall conform to the requirements for spark testing specified in BS 5099 when tested in accordance with that standard.

When subjected to the compatibility test in accordance with Annex D the insulation of cables to Table 5, Table 6 and Table 7 shall conform to the following requirements.

Median values after ageing:

	EI 5	GP 8
a) Tensile strength		
Minimum value (N/mm ²)	10	12.5
Maximum variation (%)	30	25
b) Elongation at break		
Minimum value (%)	125	200
Maximum variation (%)	30	25

NOTE Variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

6.2 Application

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

Conformity shall be checked by visual 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 cables in Table 3 to Table 7 inclusive. 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 + 10 % of the value specified.

Conformity shall be checked by the measurements described in 8.1 of BS 6469-1.1:1992. For each core to be tested, one sample of the 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 Corrosive and acid gas emission of insulation

When insulation from cables to Table 3 and Table 4 is tested in accordance with BS 6425-2 the resulting value of pH shall be not less than 4.3 and the conductivity shall not exceed 10 μ S/mm.

When insulation from cables to Table 5, Table 6 and Table 7 is tested in accordance with BS 6425-1, the level of HCl shall be not greater than 0.5 %.

7 Core identification

7.1 General

Each core shall be identified by its colour. The colour shall be either throughout the whole of the insulation or on the surface of the insulation.

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 3 to Table 7 as appropriate.

7.3 Harmonized code designations

Harmonized code designations are given in Table 3 and Table 4 for single-core non-sheathed cables; these cables are harmonized types, except where explicitly shown as national types, and shall be permitted to bear the Common Marking in accordance with 10.4, provided the colours conform to the following:

- a) the colours available shall include the combination green/yellow and the mono-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 conforming to Table 3 and Table 4 where harmonized code designations are given, but having core colours not in accordance with the above requirements, are not harmonized types and shall not bear the Common Marking.

NOTE 1 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.

NOTE 2 According to the use to which the cables are put, it may be necessary for the colour of the cables to conform to core colour requirements specified in BS 7671 and any other applicable British Standard. Attention is drawn to any appropriate regulations or statutory requirements.

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 not more than 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 BS 6469-99.1 for a test method to check conformity.

NOTE 2 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 the colour blue is 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. Conformity shall be checked by trying to remove the colours of the cores by rubbing the core 10 times with a piece of cotton wool or cloth soaked in water.

8 Fillers, tapes and extruded inner covering

8.1 General

The twisted cores in Table 6 shall be covered by either:

- a) an extruded inner covering of synthetic material;
- b) a separating tape of suitable material, which may be combined with separate synthetic fillers.

The extruded inner covering shall surround the twisted cores and penetrate the space between them, giving the assembly a practically circular shape. The extruded inner covering shall not adhere to the cores.

The approximate value of thickness of the extruded inner covering shall be as given in Table 6.

8.2 Compatibility

There shall be no harmful interaction between the inner covering and the insulation.

Conformity with the requirements given in 6.1 shall be checked by using the compatibility test given in Annex D.

8.3 Corrosive and acid gas emission

When the filler, tape or inner covering taken from the cable is tested in accordance with BS 6425-1 the level of HCl shall be not greater than 0.5 %.

9 Sheath

9.1 Types of sheath

The sheath shall be an extruded layer of synthetic material type LTS 1 or LTS 2 conforming to BS 7655-6.1 as given in Table 5 to Table 7 as appropriate.

Conformity shall be checked by carrying out the appropriate tests given in Table 1 and Table 8.

There shall be no harmful interaction between the sheath and insulation. Conformity with the requirements given in 6.1 shall be checked by using the compatibility test given in Annex D.

9.2 Application

The sheath shall be applied in a single layer:

- a) to the core of the single core cables;
- b) to the assembly of cores and inner covering (if any) in other cables.

The sheath shall be capable of being removed without damage to the core(s).

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 Table 5 to Table 7 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 $0.1 \text{ mm} + 15\%$ of the value specified.

Where the sheath fills the interstice between the cores of flat cables, the specified thickness shall apply at the place where the thickness of the sheath is at its minimum.

Conformity shall be checked using the method 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 to one decimal place as described 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.

9.4 Colour

The colour of the sheath shall be as specified in Table 5 to Table 7. Where the colour specified is light grey, it shall be a reasonable match to that given in BS 6746C; other colours shall be as given in the appropriate tables.

9.5 Corrosive and acid gas emission of sheath

When sheath taken from the cable is tested in accordance with BS 6425-1 the level of HCl shall be not greater than 0.5 %.

10 Marking

10.1 General

The cable shall be marked with the number of this British Standard, i.e. BS 7211³⁾, on the outer surface by printing, indenting or embossing.

10.2 Indication of origin

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

If coloured threads are used, the colours shall conform to those registered to 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.

10.3 Continuity of marking

Each specified mark including the marking of the manufacturer's name or trademark, if used, shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed:

- a) 550 mm if the marking is on the outer sheath of the cable;
- b) 275 mm if the marking is:
 - 1) on the insulation of an unsheathed cable;
 - 2) on the insulation of a sheathed cable;
 - 3) on a tape or thread within a sheathed cable.

NOTE A "specified mark" is any mandatory mark covered by this standard or the optional CENELEC Common Marking as specified in 10.4.

The marking shall be legible.

10.4 CENELEC "Common Marking"

It shall be permitted for a cable for which a Harmonized Code Designation is given in Table 3 and Table 4 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 cores. 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 alternative methods specified in 10.3.
- 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 sections shall conform to dimensions laid down by CENELEC for that Approvals Organization (see PD 2379).

Neither of these indications shall be used for a cable shown in Table 3 and Table 4 as a national type. The name CENELEC, in full or abbreviated, shall not be directly marked on, or in the cable.

³⁾ Marking BS 7211 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, which may also be desirable.

10.5 Durability

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

10.6 Indication of fire performance marking

In addition to the marking BS 7211, cables to Table 3 and Table 4 shall have a continuous marking in accordance with **10.3**, indicating fire performance. This shall be applied by printing, indenting or embossing on the insulation, using the symbol Z, indicating cable having low emission of smoke and acidic (corrosive) gases when burned⁴⁾.

11 Construction and overall dimensions

11.1 Construction

The construction of the cables shall be as given in Table 3 to Table 7 as appropriate.

Conformity shall be checked by visual examination and measurement.

11.2 Mean overall dimensions

The mean overall dimensions of the cables shall be within the limits given in Table 3 to Table 7 as appropriate.

Conformity shall be checked using the method given in **8.3** of BS 6469-1.1:1992.

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

For flat cable, the mean of the three determinations of each of the major and minor axes shall be taken as the mean overall dimension.

For other cable, the mean of the six values obtained shall be taken as the mean overall diameter.

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 Table 5 to Table 6, as appropriate, for the mean overall diameter.

Conformity shall be checked using the method described in **8.3** of BS 6469-1.1:1992.

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

Two measurements shall be taken at the same cross section of the cable covering the maximum and minimum values.

12 Schedule of tests

The range of tests applicable to the cables covered by this British Standard shall be as listed in Table 1 which refers to the relevant clauses of the standards specifying the requirements and test methods. The last column shows the category of each test, i.e. R, S and T.

The categories and corresponding designations are as follows:

a) Type tests (symbol T)

Tests required to be made before supplying a type of cable covered by this standard on a general commercial basis 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 materials or design which might change the performance characteristics.

b) Sample tests (symbol S)

Tests made on samples of completed cable, or components taken from a completed cable adequate to verify that the finished product meets the design specifications.

c) Routine tests (symbol R)

Tests made on all completed lengths of cable or as appropriate during manufacture.

⁴⁾ This is verified by tests specified in this British Standard.