BRITISH STANDARD

BS 7870-8.5:2003

LV and MV polymeric insulated cables for use by distribution and generation utilities —

Part 8: Specification for multicore and multipair cables for installation above and below ground —

Section 8.5: Single wire armoured and unarmoured multicore cables with copper conductors and non-halogenated sheath

(Implementation of part of HD 627)

ICS 29.060.20

BSI British Standards

Committees responsible for this British Standard

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British Approval Service for Cables

British Cables Association

British Plastics Association

Electricity Association

ERA Technology

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Contents

Foreword

This section of BS 7870 has been prepared by Subcommittee GEL/20/16, under the direction of Technical Committee GEL/20.

BS 7870 implements the nationally applicable parts of Harmonization Documents HD 603, HD 604, HD 605, HD 620, HD 622, HD 626 and HD 627 published by the European Committee for Electrotechnical Standardization (CENELEC) in accordance with the decision of the CENELEC Technical Board.

BS 7870 applies to cables for fixed installations having a rated voltage U_0/U up to and including 19/33 kV, and is published as a series of separate parts and sections, as listed in the table in the foreword of BS 7870-1.

BS 7870-8.5 implements HD 627:Part 7A1 and is to be read in conjunction with BS 7870-1 and BS 7870-2.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard 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 23 and a back cover.

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1 Scope

This section of BS 7870 specifies requirements for the construction, dimensions and mechanical and physical properties of multicore cables with thermosetting insulation and non-halogenated sheaths, having reduced fire propagation performance, and low emission of smoke when affected by fire.

It specifies requirements for:

a) steel wire armoured multicore cables (2-core to 48-core) having copper conductors;

b) unarmoured multicore cables (2-core to 48-core) having copper conductors.

It specifies requirements for both Type 1 and Type 2 cables, which are defined as follows:

— Type 1: cable designed for the installation and operating conditions prevailing in a conventional fossil-fuelled power station or equivalent location;

— Type 2: cable designed for the installation and operating conditions prevailing in a PWR power station, but excluding location in or around the containment area.

The requirements specified in this section of BS 7870 are applicable to both Type 1 and Type 2 cables unless otherwise indicated.

This section of BS 7870 is applicable to cables for use in and around power stations and other installations having similar cable densities.

NOTE A "guide to use" is given in Annex A.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 6360, *Specification for conductors in insulated cables and cords.*

BS 7870-1, *LV and MV polymeric insulated cables for use by distribution and generation utilities — Part 1: General.*

BS 7870-2:1999, *LV and MV polymeric insulated cables for use by distribution and generation utilities — Part 2: Methods of test.*

BS 7870-6.3, *LV and MV polymeric insulated cables for use by distribution and generation utilities — Part 6: Specification for 0.6/1 kV and 1.9/3.3 kV power cables with special fire performance for use in power stations — Section 6.3: Cables with thermosetting insulation and non-halogenated sheath.*

BS EN 50265-2-1, *Common test methods for cables under fire conditions — Test for resistance to vertical flame propagation for a single insulated conductor or cable — Part 2-1: Procedures — 1 kW pre-mixed flame.*

BS EN 50267-2-1, *Common test methods for cables under fire conditions — Tests on gases evolved during combustion of materials from cables — Part 2-1: Procedures — Determination of amount of halogen gas.*

BS EN 50268-2, *Common test methods for cables under fire conditions — Measurement of smoke density of cables burning under defined conditions — Part 2: Procedure.*

BS EN 60811-1-1:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 1-1: General application — Measurement of thickness and overall dimensions — Tests for determining the mechanical properties.*

BS EN 60811-1-2:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 1-2: General application — Thermal ageing methods.*

BS EN 60811-1-3:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 1-3: General application — Methods for determining the density — Water absorption tests — Shrinkage test.*

BS EN 60811-1-4:1995, *Insulating and sheathing materials for electric cables — Common test methods — Part 1-4: General application — Test at low temperatures.*

BS EN 60811-2-1:1995, *Insulating and sheathing materials for electric cables — Common test methods — Part 2-1: Methods specific to elastomeric compounds — Ozone resistance, hot set and mineral oil immersion tests.*

BS EN 60811-3-1:1995, *Insulating and sheathing materials for electric cables — Common test methods — Part 3-1: Methods specific to PVC compounds — Pressure test at high temperature — Tests for resistance to cracking.*

BS EN ISO 4589-3, *Plastics — Determination of burning behaviour by oxygen index — Part 3: Elevated temperature test.*

ASTM D5964-96:2001, *Standard practice for rubber IRM 902 and IRM 903 replacement oils for ASTM No. 2 and ASTM No. 3 oils.*

3 Voltage designation

Cables shall be designated by the voltages U_0, U and U_m, expressed in the form U_0/U (U_m).

The voltage designation of cables in this standard is 0.6/1 (1.2) kV.

4 Conductors

Conductors shall be 1.5 mm^2, 2.5 mm^2 or 4 mm^2, of circular stranded copper (class 2), conforming to the requirements of BS 6360.

Conformity shall be checked by visual examination as specified in **15.2**.

NOTE A separator tape may be applied over the conductor.

5 Insulation

The insulation for Type 1 cables shall be a single extruded layer of XLPE or HEPR. The insulation for Type 2 cables shall be either a single extruded layer of thermosetting TI Z material, or two bonded layers of extruded thermosetting material, as a composite layer, conforming to the requirements for TI Z specified in Table 11.

The insulation shall be applied so that it fits closely on the conductor and it shall be possible to remove it without damage to the insulation itself or to the conductor.

The insulation shall be applied by a suitable extrusion process, cross-linked where required, and shall form a compact and homogenous body.

Conformity shall be checked by the test methods specified in **15.3**.

6 Identification of cores

The cores shall be black or white with printed numbers in a contrasting colour.

The cores shall be numbered in sequence inside to outside from 1 to 48.

Cores shall be clearly identifiable and the printing shall be durable.

Conformity shall be checked by visual examination as specified in **15.4**.

7 Assembly of cores, fillers and binders

The direction of lay shall alternate for each successive layer. Up to seven cores shall be laid up with either a right- or left-hand direction of lay or an alternating right- and left-hand direction of lay.

Conformity shall be checked by visual examination as specified in **15.5**.

NOTE 1 Where necessary, fillers of suitable synthetic material may be used.

NOTE 2 At the discretion of the manufacturer, a synthetic binder tape may be applied over the laid-up cores.

8 Bedding layer (optional for unarmoured cables)

The bedding for Type 1 cables shall consist of a compound conforming to the requirements for ZB 1 as specified in Table 12. The bedding for Type 2 cables shall consist of a compound conforming to the requirements for ZB 2 as specified in Table 12.

NOTE 1 A bedding layer is optional for unarmoured cables.

NOTE 2 Tapes may be applied over the bedding.

9 Armouring

Armoured cables shall have a single layer of galvanized steel wires. The wires shall be applied with a direction of lay opposite to that of the outer layer of cores.

Joints in the steel wire armour shall be brazed or welded and any surface irregularity shall be removed. Any joint in any wire shall be not less than 1 m from the nearest joint in any other armour wire in the complete cable.

NOTE Tapes may be applied over the armour wires.

10 Oversheath

The oversheath for Type 1 cables shall consist of an extruded layer of compound conforming to the requirements for ZM 1 as specified in Table 12. The oversheath for Type 2 cables shall consist of an extruded layer of black compound conforming to the requirements for ZM 2 as specified in Table 12.

11 Marking

11.1 External marking

The external surface of the cable shall be legibly marked with the following elements:

Element	Example of marking
a) Electric cable	ELECTRIC CABLE
b) Voltage designation	600/1 000 V AUX
c) British Standard number[1] and cable type	BS 7870-8.5 Type 1 or BS 7870-8.5 Type 2
d) Manufacturer's identification	XYZ

The marking shall be by indenting or embossing on the oversheath.

For cables with tabulated[2] approximate overall diameters greater than 15 mm, elements a), b) and c) shall appear, in any sequence that is deemed neither to confuse nor to conflict, on two or more primary lines along the axis of the cable, approximately equally spaced around the circumference of the cable. Element d) shall appear upon at least one line, which may be one of the primary lines or a secondary line.

For cables with tabulated[2] approximate overall diameters of 15 mm or less, the elements shall be arranged as for cables of greater than 15 mm diameter, except that the marking for elements a), b) and c) shall appear on one or more primary lines.

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

The distance between the end of one element of marking and the beginning of the next identical element shall be not greater than 550 mm for elements a), b) and c) and not greater than 1 100 mm for element d).

Conformity shall be checked by visual examination and measurement as specified in **14.6**.

11.2 Identification of year of manufacture

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

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

If the identification is by marking on the external surface, the distance between the end of one element of marking and the beginning of the next identical element shall be not greater than 1 100 mm.

Conformity shall be checked by visual examination and measurement as specified in **14.6**.

[1] Marking BS 7870-8.5:2003 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

[2] See Table 1 to Table 8.

11.3 Mark of an approval organization

If the mark of an approval organization is used, it shall be provided throughout the length of the cable, either as an identification thread or by marking on the external surface of the cable, as specified by the approval organization.

If the mark is on the external surface of the cable, it shall be in the form of the symbol(s) specified by the approval organization, and the distance between the end of one element of marking and the beginning of the next identical element shall be not greater than 1 100 mm.

Conformity shall be checked by visual examination and measurement as specified in **14.6**.

11.4 Additional marking

Where additional marking is made, it shall be throughout the length of the cable, and on the external surface of the cable, or by means of a tape or thread within the cable, or by a combination of these methods. If the additional marking is applied to the external surface of the cable, it shall not render illegible the marking specified in **11.1**, **11.2** and **11.3**.

The additional marking, however made, shall be repeated at intervals not exceeding 1 100 mm.

Conformity shall be checked by visual examination and measurement as specified in **14.6**.

12 Dimensions

The dimensions of the component layers shall be as specified in Table 1 to Table 8.

Table 1 — Construction of 1.5 mm² multicore XLPE or HEPR insulated armoured cables (Type 1 only)

Cable type	Conductor size mm²	Mean thickness of insulation mm	Mean thickness of bedding mm	Approximate diameter over bedding mm	Armour wire diameter mm	Mean thickness of oversheath mm	Approximate overall diameter mm
2-core	1.5	0.6	0.8	7.6	0.9	1.4	12.3
3-core	1.5	0.6	0.8	8.1	0.9	1.4	12.8
4-core	1.5	0.6	0.8	8.8	0.9	1.4	13.5
7-core	1.5	0.6	0.8	10.6	0.9	1.4	15.2
12-core	1.5	0.6	0.8	13.8	1.25	1.5	19.4
19-core	1.5	0.6	0.8	16.3	1.25	1.6	22.2
27-core	1.5	0.6	1.0	19.9	1.6	1.7	26.7
37-core	1.5	0.6	1.0	22.4	1.6	1.8	29.2
48-core	1.5	0.6	1.0	25.7	1.6	1.9	32.9

Table 2 — Construction of 2.5 mm² multicore XLPE or HEPR insulated armoured cable (Type 1 only)

Cable type	Conductor size mm²	Mean thickness of insulation mm	Mean thickness of bedding mm	Approximate diameter over bedding mm	Armour wire diameter mm	Mean thickness of oversheath mm	Approximate overall diameter mm
2-core	2.5	0.7	0.8	8.9	0.9	1.4	13.6
3-core	2.5	0.7	0.8	9.4	0.9	1.4	14.1
4-core	2.5	0.7	0.8	10.3	0.9	1.4	15.0
7-core	2.5	0.7	0.8	12.4	0.9	1.4	17.1
12-core	2.5	0.7	0.8	16.5	1.25	1.6	22.4
19-core	2.5	0.7	1.0	19.8	1.6	1.7	26.6
27-core	2.5	0.7	1.0	23.9	1.6	1.8	30.7
37-core	2.5	0.7	1.0	26.8	1.6	1.8	33.8
48-core	2.5	0.7	1.2	31.3	2.0	2.0	39.3

Table 3 — Construction of 4 mm² multicore XLPE or HEPR insulated armoured cable (Type 1 only)

Cable type	Conductor size mm²	Mean thickness of insulation mm	Mean thickness of bedding mm	Approximate diameter over bedding mm	Armour wire diameter mm	Mean thickness of oversheath mm	Approximate overall diameter mm
2-core	4	0.7	0.8	10.0	0.9	1.4	14.7
3-core	4	0.7	0.8	10.7	0.9	1.4	15.3
4-core	4	0.7	0.8	11.7	0.9	1.4	16.4
7-core	4	0.7	0.8	14.1	1.25	1.5	19.7
12-core	4	0.7	1.0	19.1	1.6	1.6	25.7
19-core	4	0.7	1.0	22.7	1.6	1.7	29.3
27-core	4	0.7	1.0	27.2	1.6	1.9	34.4
37-core	4	0.7	1.2	31.2	2.0	2.0	39.2
48-core	4	0.7	1.2	35.7	2.0	2.1	44.1

Table 4 — Construction of 1.5 mm^2 multicore XLPE or HEPR insulated unarmoured cable (Type 1 only)

Cable type	Conductor size	Mean thickness of insulation	Mean thickness of bedding	Approximate diameter over bedding	Mean thickness of oversheath	Approximate overall diameter
	mm^2	mm	mm	mm	mm	mm
2-core	1.5	0.6	1.0	8.0	1.8	11.7
3-core	1.5	0.6	1.0	8.5	1.8	12.2
4-core	1.5	0.6	1.0	9.2	1.8	12.9
7-core	1.5	0.6	1.0	11.0	1.8	14.6
12-core	1.5	0.6	1.0	14.2	1.8	17.9
19-core	1.5	0.6	1.0	16.3	1.8	20.0
27-core	1.5	0.6	1.0	19.9	1.8	23.7
37-core	1.5	0.6	1.0	22.4	1.8	26.0
48-core	1.5	0.6	1.0	25.7	1.8	29.3

Table 5 — Construction of 2.5 mm^2 multicore XLPE or HEPR insulated unarmoured cable (Type 1 only)

Cable type	Conductor size	Mean thickness of insulation	Mean thickness of bedding	Approximate diameter over bedding	Mean thickness of oversheath	Approximate overall diameter
	mm^2	mm	mm	mm	mm	mm
2-core	2.5	0.7	1.0	9.3	1.8	13.0
3-core	2.5	0.7	1.0	9.8	1.8	13.5
4-core	2.5	0.7	1.0	10.8	1.8	14.4
7-core	2.5	0.7	1.0	12.8	1.8	16.5
12-core	2.5	0.7	1.0	16.9	1.8	20.5
19-core	2.5	0.7	1.0	19.8	1.8	23.6
27-core	2.5	0.7	1.0	23.9	1.8	27.5
37-core	2.5	0.7	1.0	26.8	1.8	30.4
48-core	2.5	0.7	1.2	31.3	1.9	35.1

Table 6 — Construction of 4 mm^2 multicore XLPE or HEPR insulated unarmoured cable (Type 1 only)

Cable type	Conductor size	Mean thickness of insulation	Mean thickness of bedding	Approximate diameter over bedding	Mean thickness of oversheath	Approximate overall diameter
	mm^2	mm	mm	mm	mm	mm
2-core	4	0.7	1.0	10.4	1.8	14.1
3-core	4	0.7	1.0	11.1	1.8	14.7
4-core	4	0.7	1.0	12.1	1.8	15.8
7-core	4	0.7	1.0	14.5	1.8	18.2
12-core	4	0.7	1.0	19.1	1.8	22.9
19-core	4	0.7	1.0	22.7	1.8	26.3
27-core	4	0.7	1.0	27.2	1.8	30.8
37-core	4	0.7	1.2	31.2	1.9	35.0
48-core	4	0.7	1.2	35.7	2.1	39.9

Table 7 — Construction of 2.5 mm^2 multicore thermosetting insulated armoured cable (Type 2 only)

Cable type	Conductor size mm^2	Mean thickness of insulation mm	Mean thickness of bedding mm	Approximate diameter over bedding mm	Armour wire diameter mm	Mean thickness of oversheath mm	Approximate overall diameter mm
2-core	2.5	0.7	0.8	8.9	0.9	1.4	13.6
3-core	2.5	0.7	0.8	9.4	0.9	1.4	14.1
4-core	2.5	0.7	0.8	10.3	0.9	1.4	15.0
7-core	2.5	0.7	0.8	12.4	0.9	1.4	17.1
12-core	2.5	0.7	0.8	16.5	1.25	1.6	22.4
19-core	2.5	0.7	1.0	19.8	1.6	1.7	26.6
27-core	2.5	0.7	1.0	23.9	1.6	1.8	30.7
37-core	2.5	0.7	1.0	26.8	1.6	1.8	33.8

Table 8 — Construction of 2.5 mm^2 multicore thermosetting insulated unarmoured cable (Type 2 only)

Cable type	Conductor size mm^2	Mean thickness of insulation mm	Mean thickness of bedding mm	Approximate diameter over bedding mm	Mean thickness of oversheath mm	Approximate overall diameter mm
2-core	2.5	0.7	1.0	9.3	1.8	13.0
3-core	2.5	0.7	1.0	9.8	1.8	13.5
4-core	2.5	0.7	1.0	10.8	1.8	14.4
7-core	2.5	0.7	1.0	12.8	1.8	16.5
12-core	2.5	0.7	1.0	16.9	1.8	20.5
19-core	2.5	0.7	1.0	19.8	1.8	23.6
27-core	2.5	0.7	1.0	23.9	1.8	27.5
37-core	2.5	0.7	1.0	26.8	1.8	30.4

13 Tests

Testing shall be performed in accordance with the schedule of tests specified in Table 9.

Table 9 — Schedule of tests

Test	Category of test	Test method described in	Requirements given in
Electrical tests			
Conductor resistance	R	BS 7870-2:1999, **3.1.1**	**14.2**
Insulation resistance at 20 °C (Type 2 only)	R	BS 7870-2:1999, **3.3.2**	**14.3**
Voltage test	R	BS 7870-2:1999, **3.2.1.2**	**14.4**
Star capacitance	T	**16.3**	**16.3**
Spark test on oversheath	R	BS 7870-2:1999, **3.6.1**	**14.5**
Provisions covering constructional and dimensional characteristics			
Conductor material and construction	S	Visual examination	**15.2**
Insulation:			
— application	S	Visual examination	**15.3**
— thickness	S	BS 7870-2:1999, **2.1.1**	**15.3**
Core identification	S	Visual examination and BS 7870-2:1999, **2.5.4**	**15.4**
Laid-up cores	S	Visual examination	**15.5**
Bedding layer	S	BS 7870-2:1999, **2.1.2**	**15.6**
Armour wire:			
— wire diameter	S	BS 7870-2:1999, **2.1.4.3**a)	**15.7**
— mass of zinc coating	T	BS 7870-2:1999, **2.5.1.1**	**16.5**
— wrapping test	T	BS 7870-2:1999, **2.3.2**	**16.6**
Oversheath thickness	S	BS 7870-2:1999, **2.1.2**	**15.8**
Cable markings	R	Visual examination	**14.6**
Non-electrical tests on materials			
Insulation	T	Table 11	**16.2**
Extruded bedding	T	Table 12	**16.4**
Oversheath	T	Table 12	**16.7**
Tests on complete cable			
Compatibility test (Type 1 only)	T	BS 7870-2:1999, **2.4.12.2**	**16.8**
Abrasion resistance	T	BS 7870-2:1999, **2.4.5**	**16.9**
Special type tests (Type 2 only)	T	Table 15	**16.10**
Tests under fire conditions			
Oxygen index	T and S	BS EN ISO 4589-3	**15.9.2** and **16.11.2**
Propagation:			
— single cable	S	BS EN 50265-2-1	**15.9.3**
— bunched cables	T	BS 7870-2:1999, **4.1.4**	**16.11.3**
Smoke emission	T	BS EN 50268-2 or BS 7870-2:1999, **4.2.2**	**16.11.4** or **16.11.5**
Corrosive gas emission	T	BS EN 50267-2-1 or BS 7870-2:1999, **4.3.1**	**16.11.6** or **16.11.7**

14 Routine tests

14.1 General

Routine tests shall be performed in accordance with the schedule of tests in Table 9 and **14.2** to **14.6**.

14.2 Conductor resistance

When measured in accordance with BS 7870-2:1999, **3.1.1**, the resistance of each conductor at 20 °C shall be in accordance with the requirements of BS 6360 for the given class of conductor.

14.3 Insulation resistance (Type 2 only)

When measured in accordance with BS 7870-2:1999, **3.3.2**, the insulation resistance shall be not less than 9 MΩ/km at 20 °C.

14.4 Voltage test

When the voltage test is carried out in accordance with BS 7870-2:1999, **3.2.1.2**, using either 5 kV a.c. or 7.5 kV d.c. for 1 min between each conductor and the remaining conductors connected to the armour, if any, and earthed, no breakdown of the insulation shall occur.

14.5 Spark test on oversheath

Spark testing of the oversheath shall be carried out in accordance with BS 7870-2:1999, **3.6.1**. No failures shall occur.

14.6 Cable markings

The cable markings shall be checked by visual examination and measurement and shall conform to the requirements of Clause **11**.

15 Sample tests

15.1 General

Sample tests shall be performed in accordance with the schedule of tests in Table 9 and **15.2** to **15.9**.

15.2 Conductor material and construction

The conductor material and construction shall be checked by visual examination and shall conform to the requirements of Clause **4**.

15.3 Insulation

The application of the insulation shall be checked by visual examination and shall conform to the requirements of Clause **5**.

The thickness of the insulation shall be measured using a sample that has been taken from one end of each drum length of cable selected for the test, and from which any portion that may have suffered damage has been discarded.

When this sample is measured in accordance with BS 7870-2:1999, **2.1.1**, the mean thickness of the insulation shall conform to the value specified in Table 1 to Table 8, as appropriate, and the minimum thickness at any point shall not fall below the value specified in Table 1 to Table 8, as appropriate, by more than 0.1 mm + 10 % of the specified value.

If any of the thicknesses measured does not conform to the requirements specified in Table 1 to Table 8, as appropriate, then two further samples shall be checked for the non-conforming factors. If both the further samples meet the specified requirements, the cable shall be deemed to conform, but if either does not meet the specified requirements, the cable shall be deemed not to conform.

15.4 Core identification

The cable cores shall be checked by visual examination and shall conform to the requirements of Clause **6**.

Durability of marking shall be checked by the test given in BS 7870-2:1999, **2.5.4**.

15.5 Laid-up cores

The laid-up cores shall be checked by visual examination and shall conform to the requirements of Clause **7**.

15.6 Bedding layer

The thickness of the bedding layer shall be measured using a sample that has been taken from one end of each drum length of cable selected for the test, and from which any portion that may have suffered damage has been discarded.

When this sample is measured in accordance with BS 7870-2:1999, **2.1.2**, the mean thickness of the bedding layer shall conform to the value specified in Table 1 to Table 8, as appropriate, and the minimum thickness at any point shall not fall below the value specified in Table 1 to Table 8, as appropriate, by more than 0.1 mm + 15 % of the specified value.

If any of the thicknesses measured does not conform to the requirements specified in Table 1 to Table 8, as appropriate, then two further samples shall be checked for the non-conforming factors. If both the further samples meet the specified requirements, the cable shall be deemed to conform, but if either does not meet the specified requirements, the cable shall be deemed not to conform.

15.7 Armour wire

When measured in accordance with BS 7870-2:1999, **2.1.4.3**a), the diameter of round armour wire shall fall within the minimum and maximum diameters specified in Table 10.

Table 10 — Diameter of armour wire

Dimensions in millimetres

Nominal wire diameter	Wire diameter	
	Minimum	Maximum
0.9	0.85	0.95
1.25	1.18	1.32
1.6	1.51	1.69
2.0	1.90	2.10

15.8 Oversheath

The thickness of the oversheath shall be measured using a sample that has been taken from one end of each drum length of cable selected for the test, and from which any portion that may have suffered damage has been discarded.

When this sample is measured in accordance with BS 7870-2:1999, **2.1.2**, the mean thickness of the oversheath shall conform to the values specified in Table 1 to Table 8, as appropriate, and the minimum thickness at any point shall not fall below the value specified in Table 1 to Table 8, as appropriate, by more than 0.2 mm + 20 % of the specified value.

If any of the thicknesses measured does not conform to the requirements specified in Table 1 to Table 8, as appropriate, then two further samples shall be checked for the non-conforming factors. If both the further samples meet the specified requirements, the cable shall be deemed to conform, but if either does not meet the specified requirements, the cable shall be deemed not to conform.

15.9 Tests under fire conditions

15.9.1 *Sample selection*

The flame propagation and oxygen index tests shall be performed on a 2-core, 3-core or 4-core cable with 2.5 mm^2 cores.

NOTE A test covers only the particular insulating material used in the sample, and the particular construction (armoured or unarmoured).

15.9.2 *Oxygen index*

The value of oxygen index of the insulation, bedding and oversheath shall be determined using the test method given in BS EN ISO 4589-3. The value obtained shall fall within the agreed tolerance on the nominal value.

NOTE The tolerance should be agreed between the manufacturer and the purchaser.

15.9.3 *Flame propagation on single cable*

The finished cable shall conform to the requirements of BS EN 50265-2-1.

16 Type tests

16.1 General

Type tests shall be performed in accordance with the schedule of tests in Table 9 and **16.2** to **16.11**.

16.2 Insulation

The insulation shall be tested in accordance with Table 11 and shall conform to the requirements specified in Table 11.

Table 11 — Requirements for non-electrical tests for thermosetting insulation

Test	Unit	Type of compound			Test method described in
		TI Z	HEPR	XLPE	
Tensile strength and elongation at break					
Properties in the state as delivered					BS EN 60811-1-1:1995, **9.1**
Value to be obtained for tensile strength:					
— median, min.	N/mm^2	6.5	8.5	12.5	
Value to be obtained for elongation at break:					
— median, min.	%	100	200	200	
Properties after ageing in air oven					BS EN 60811-1-2:1995, **8.1.3**
Ageing conditions:					
— temperature	°C	135	135	135	
— duration of treatment	h	168	168	168	
Values to be obtained for tensile strength:					
— median, min.	N/mm^2	6.5	—	—	
— variation[a], max.	%	—	±30	±25	
Values to be obtained for elongation at break:					
— median, min.	N/mm^2	100	—	—	
— variation[a], max.	%	—	±30	±25	
Properties after ageing in air bomb at (55 ± 2) N/cm^2					BS EN 60811-1-2:1995, **8.2**
Ageing conditions:					
— temperature	°C	—	127	—	
— duration of treatment	h	—	40	—	
Values to be obtained for tensile strength:					
— median, min.	N/mm^2	—	—	—	
— variation[a], max.	%	—	30	—	
Values to be obtained for elongation at break:					
— median, min.	N/mm^2	—	—	—	
— variation[a], max.	%	—	30	—	
Hot set					BS EN 60811-2-1:1995, Clause **9**
Conditions of treatment:					
— temperature	°C	200	250 ± 3	200	
— time under load	min	15	15	15	
— mechanical stress	N/mm^2	0.2	0.2	0.2	
Result to be obtained:					
— elongation under load, max.	%	100	100	175	
— elongation after unloading, max.	%	15	25	15	

[a] The variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

Table 11 — Requirements for non-electrical tests for thermosetting insulation (*continued*)

Test	Unit	Type of compound			Test method described in
		TI Z	HEPR	XLPE	
Ozone resistance					BS EN 60811-2-1:1995, Clause **8**
Test conditions:					
— temperature	°C	25 ± 2	25 ± 2		
— duration	h	3	30	—	
— ozone concentration	ppm	250 to 300	250 to 300	—	
Shrinkage					BS EN 60811-1-3:1995, Clause **10**
Test conditions					
— temperature	°C	—	—	130	
— duration	h	—	—	1	
Result to be obtained:					
— shrinkage, max.	%	—	—	4	
Hardness					BS 7870-2:1999, **2.2.5**
— min.	IRHD	—	80	—	
Water absorption					BS EN 60811-1-3:1995, **9.2**
Test conditions:					
— temperature	°C	—	85	85	
— duration	h	—	336	336	
Result to be obtained:					
— variation on mass, max.	mg/cm^2	—	5	1	

[a] The variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter

16.3 Star capacitance

This test shall be undertaken on a complete drum length. The capacitance shall be measured between one core in each layer and all the other cores connected to the armouring, which shall be earthed. The average of these results shall be corrected to 1 km, multiplied by the factor of 1.2 and expressed in nanofarads (nF).

The star capacitance shall have a maximum value of 440 nF for 1 km.

16.4 Bedding

The bedding shall be tested in accordance with Table 12 and shall conform to the requirements specified in Table 12.

Table 12 — Requirements for non-electrical tests for non-halogenated bedding and oversheath

Test	Unit	Type of compound				Test method described in
		ZB 1	ZB 2	ZM 1	ZM 2[a]	
Tensile strength and elongation at break						
Properties in the state as delivered						BS EN 60811-1-1:1995, **9.2**
Values to be obtained for tensile strength:						
— median, min.	N/mm^2	4	8	10	8	
Values to be obtained for elongation at break:						
— median, min.	%	50	50	100	75	
Properties after ageing in air oven						BS EN 6081-1-2:1995, **8.1**
Ageing conditions:						
— temperature	°C	—	100	100	100	
— duration of treatment	h	—	168	168	168	
Value to be obtained for tensile strength:						
— median, min.	N/mm^2	—	8	10	8	
— variation[b], max.	%	—	—	±40	—	
Value to be obtained for elongation at break:						
— median, min.	%	—	50	100	75	
— variation at break:	%	—	—	±40	—	
Pressure at high temperature						BS EN 60811-3-1:1995, **8.2**
Test conditions:						
— force exerted by blade			See BS EN 60811-3-1:1995, **8.2.4**			
— duration of heating under load			See BS EN 60811-3-1:1995, **8.2.5**			
— temperature	°C	—	80	80	80	
Result to be obtained:						
— median of the depth of penetration, max.	%	—	50	50	50	
Elongation at low temperature						BS EN 60811-1-4:1995, **8.4**
Test conditions:						
— temperature	°C	—	—	–15	–15	
— period of application of low temperature				See BS EN 60811-1-4:1995, **8.4.4**		
Result to be obtained:						
— elongation without break, min.	%	—	—	30	30	

[a] Where multilayer sheaths are provided, one of the component materials shall meet the requirement.
[b] The variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.
[c] As specified in ASTM D5964-96:2001.

Table 12 — Requirements for non-electrical tests for non-halogenated bedding and oversheath (*continued*)

Test	Unit	Type of compound				Test method described in
		ZB 1	ZB 2	ZM 1	ZM 2[a]	
Impact at low temperature						BS EN 60811-1-4:1995, **8.5**
Test conditions:						
— temperature	°C	—	—	–15 ± 2	–15 ± 2	
— period of application of low temperature				See BS EN 60811-1-4:1995, **8.5.5**		
— mass of hammer				See BS EN 60811-1-4:1995. **8.5.4**		
Result to be obtained				See BS EN 60811-1-4:1995, **8.5.6**		
Insulation resistance						BS 7870-2:1999, **3.3.4**
Constant at 20 °C (min.)	MΩ·km			0.035		
Water immersion						BS 7870-2:1999, **2.2.12**
Test conditions:						
— temperature	°C	—	—	70	—	
— duration of treatment	h	—	—	168	—	
Values to be obtained for tensile strength:						
— variation[b], max.	%	—	—	±30	—	
Values to be obtained for elongation at break:						
— variation[b], max.	%	—	—	±30	—	
Tear resistance						BS 7870-2:1999, **2.2.2.2**
Result to be obtained	N/mm	—	—	3.5	3.5	
Ozone resistance						BS EN 60811-2-1:1995, Clause **8**
Test conditions:						
— temperature	°C	—	—	—	25	
— duration	h	—	—	—	3	
Ozone concentration:	ppm	—	—	—	250 to 300	
— requirement					No cracks	

[a] Where multilayer sheaths are provided, one of the component materials shall meet the requirement.
[b] The variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.
[c] As specified in ASTM D5964-96:2001.

Table 12 — Requirements for non-electrical tests for non-halogenated bedding and oversheath (*continued*)

Test	Unit	Type of compound				Test method described in
		ZB 1	ZB 2	ZM 1	ZM 2[a]	
Mineral oil resistance						BS EN 60811-2-1:1995, Clause **10**
Treatment:						
— type of oil: ASTM No.2 (IRM 902)[c]						
— temperature	°C	—	—	—	70	
— duration	h	—	—	—	4	
Values to be obtained for tensile strength:						
— variation[b], max.	%	—	—	—	±20	
Values to be obtained for elongation at break:						
— variation[b], max.	%	—	—	—	±40	
Pulling lubricant resistance						BS 7870-2:1999, **5.2**
— temperature	°C	—	—	—	20 ± 5	
— immersion period	h	—	—	—	2 016	
Values to be obtained for tensile strength:						
— variation[b], max.	%	—	—	—	±20	
Values to be obtained for elongation at break:						
— variation[b], max.	%	—	—	—	±40	
Water permeation						BS 7870-2:1999, **2.5.5**
Maximum value of the product of the median value of water vapour permeability and median value of sample thickness	g/m per 24 h		8×10^{-3}		8×10^{-3}	
Water permeation after ageing						BS 7870-2:1999, **2.5.5**
Ageing condition:			As given in BS 7870-2:1999, **5.1**		As given in BS 7870-2:1999, **5.1**	
Maximum value of the product of the median value of water vapour permeability and median value of sample thickness	g/m per 24 h	—	8×10^{-3}	—	8×10^{-3}	

[a] Where multilayer sheaths are provided, one of the component materials shall meet the requirement.
[b] The variation is the difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.
[c] As specified in ASTM D5964-96:2001.

16.5 Mass of zinc coating of galvanized steel armour wires

When measured in accordance with BS 7870-2:1999, **2.5.1.1**, the mass of zinc coating of galvanized steel armour wires shall be not less than that specified in Table 13.

Table 13 — Mass of zinc coating

Nominal wire diameter mm	Minimum mass of zinc coating g/m^2
0.9	112
1.25	150
1.6	172
2.0	180

16.6 Wrapping test for galvanized steel armour wires

The wires shall be subjected to the wrapping test specified in BS 7870-2:1999, **2.3.2**. The mechanical characteristics of the galvanized steel armour wires shall be such that none of the wires break.

16.7 Oversheath

The oversheath shall be tested in accordance with Table 12 and shall conform to the requirements specified in Table 12.

16.8 Compatibility test (Type 1 only)

When tested in accordance with BS 7870-2:1999, **2.4.12.2**, the sample being aged for 7 days at (80 ± 2) °C, the materials shall conform to the requirements specified in Table 14.

Table 14 — Requirements for compatibility of insulation and oversheath

Component	Test	Requirements		
		XLPE	HEPR	ZM 1
Insulation	Minimum tensile strength (in N/mm^2)	12.5	8.5	—
	Minimum percentage elongation at break	200	200	—
	Maximum percentage variation[a] of tensile strength	25	30	—
	Maximum percentage variation[a] of elongation at break	25	30	—
Oversheath	Minimum tensile strength (in N/mm^2)	—	—	10
	Minimum percentage elongation at break	—	—	100
	Maximum percentage variation[a] of tensile strength	—	—	40
	Maximum percentage variation[a] of elongation at break	—	—	40

[a] The variation is the difference between the respective values obtained prior to and after heat treatment, expressed as a percentage of the former.

16.9 Abrasion resistance

16.9.1 *Abrasion test (Type 1 only)*

When a sample of completed cable is tested in accordance with BS 7870-2:1999, **2.4.5**, the oversheath shall be deemed to conform provided that, following the test, examination of the sample without magnification reveals no cracks of splits in the internal or external surfaces.

16.9.2 *Abrasion test (Type 2 only)*

When a sample of completed cable is tested in accordance with BS 7870-2:1999, **2.4.5**, the oversheath shall be deemed to conform provided that, following the test:

a) the sheath withstands a voltage of 5 kV d.c. for 1 min. when tested in accordance with BS 7870-2:1999, **3.2.3.1**; and

b) examination of the sample without magnification reveals no cracks or splits in the internal and external surfaces.

16.10 Special type tests (Type 2 only)

The tests given in Table 15 shall be undertaken on a sample taken from the cable or on a sample of complete cable having undergone an ambient bend test. The tests shall be undertaken on aged or unaged samples as shown in Table 15. Ageing shall be in accordance with BS 7870-2:1999, **5.1.1**.

Tests shall be performed on the smallest and largest cables in the range being offered by the manufacturer.

Tests and requirements are given in Table 15.

Table 15 — Special type test for Type 2 cables

Test	Sample conditions		Test method described in	Requirement
	Aged	Unaged		
Sheath cut through	Yes	Yes	BS 7870-2:1999, **2.4.6**	The median force at which the cutting edge makes contact with the armour shall be not less than: a) Unaged: — 500 N for sample at 20 °C; — 100 N for sample at 70 °C. b) Aged: — 300 N for sample at 20 °C; — 80 N for sample at 70 °C.
Crush on a complete cable	Yes	Yes	BS 7870-2:1999, **2.4.7**	The median force at which the tester stops shall be not less than: — 5 000 N for sample at 20 °C; — 1 000 N for sample at 70 °C.
Retraction of sheath	No	Yes	BS 7870-2:1999, **2.4.4.2**	There shall be not more than 1 mm of movement between the outer sheath and gland body at each end.
Sheath penetration	No	Yes	BS 7870-2:1999, **2.4.3**	The sheath shall withstand the voltage test.
Long term water immersion test	No	Yes	BS 7870-2:1999, **5.3.1**	The cable shall meet the insulation resistance and voltage withstand requirements given in BS 7870-2:1999, **5.3.1**. There shall be no significant signs of corrosion of the armour wires nor presence of free water.

16.11 Tests under fire conditions

16.11.1 *Sample selection*

The flame propagation, oxygen index and corrosive gas emission tests shall be performed on a 2-core, 3-core or 4-core cable with 2.5 mm^2 cores.

NOTE A test covers only the particular insulating material used in the sample, and the particular construction (armoured or unarmoured).

The smoke emission tests shall be performed on the smallest and largest sizes in the range being offered by the manufacturer. Satisfactory testing of a power cable to BS 7870-6.3, having a tabulated diameter not greater than 15 mm, shall be accepted in lieu of testing cable to this specification, provided that the materials are identical and the constructional details are equivalent.

16.11.2 *Oxygen index*

During type tests the absolute oxygen index of samples of insulation, bedding and oversheath, taken from the complete cable, shall be determined using the test method given in BS EN ISO 4589-3. The values obtained shall be used to enable a nominal value, together with suitable tolerances for sample tests, to be agreed between the manufacturer and the purchaser.

16.11.3 ***Flame propagation test***

The cable shall be subjected to the test specified in BS 7870-2:1999, **4.1.4**, using the cable arrangement for Category 3 given in that clause.

The cable shall be deemed to conform if, after burning has ceased, or the flames have been extinguished:

a) penetration to the conductor has been achieved on one third or more of the total number of cables; and

b) the cables have been wiped clean and the charred position has not reached a height exceeding 2.5 m above the bottom edge of the burner, measured at the front and rear and, where applicable, between the cable assembly.

NOTE At the request of the user increased densities up to 30 kg/m may be required.

16.11.4 ***Smoke emission (Type 1 only)***

When tested in accordance with BS EN 50268-2, the minimum level of light transmittance throughout the test shall be greater than the following values:

a) armoured: 70 %;

b) unarmoured: 60 %.

16.11.5 ***Smoke emission (Type 2 only)***

When installed and tested in accordance with BS 7870-2:1999, **4.2.2**, the cable shall be deemed to conform if A_0 (OFF) does not exceed a value of 10.

16.11.6 ***Corrosive gas emission (Type 1 only)***

Every non-metallic material shall be tested in accordance with BS EN 50267-2-1. The level of HCl shall be not greater than 0.5 %.

16.11.7 ***Corrosive gas emission (Type 2 only)***

Every non-metallic material shall be tested in accordance with BS 7870-2:1999, **4.3.1**. The average pH, conductivity and chloride yield shall be:

a) $3.8 < pH < 10$;

b) conductivity < 80 S/cm;

c) chloride yield < 0.5 mg/g.

Annex A (informative)
Guide to use

A.1 General

This annex gives guidance on the selection, storage, transportation, installation and disposal of the cables specified in this section of BS 7870.

A.2 Recommendations for selection

A.2.1 *Permissible application*

These cables are primarily intended for use indoors for fixed installations on wall or metallic structures. They should be used where fire propagation is a risk and where the emission of corrosive fumes and smoke in the event of a fire is to be limited.

These cables may be used where there is a high risk of fire propagation along cable runs, especially where cabling density is high.

A.2.2 *Maximum permissible voltage*

These cables may be used on Category A, B and C systems as defined in IEC 60183.

A.3 Recommendations for storage, transport and disposal

A.3.1 *Storage*

Cable drums should be regularly inspected to assess their physical condition.

Battens, when supplied, should not be removed until the cable is required for installation.

A.3.2 *Transport*

Cable drums having a flange diameter exceeding 1 m and weighing more than 250 kg gross should be transported in an upright condition. The drums should be protected against movement. Loading and unloading should be facilitated by suitable devices to avoid damage to both cable and drum. When moving drums, due regard should be paid to the weight, method and direction of rolling, protruding nails and wood splinters.

A.3.3 *Incineration of scrap cable*

Incineration of scrap cable should be undertaken only by a licensed contractor. For further information, the Environment Agency should be contacted.

A.3.4 *Cable end sealing*

Both ends of every length of cable should be sealed in such a manner as to include the oversheath and to inhibit the ingress of moisture during storage, delivery and up to the time of jointing.

A.4 Recommendations for cable laying and installation

A.4.1 *General*

The choice of cable should take into account the cable route, method of laying and service conditions. The latter should include:

a) the adjacency of other cables and their mutual heating effect;

b) the leakage of stray currents and attack from solvent substances;

c) soil subsidence and other forms of violent vibrations;

d) protection against mechanical damage during and after installation.

A.4.2 *Environment conditions*

The lowest recommended temperature for installation is 0 °C, but care should be taken to ensure that the cable temperature has been above 0 °C for the preceding 24 h.

A.4.3 *Pulling tensions*

The maximum pulling load should not normally exceed 50 N/mm^2 of copper cross sectional area but for armoured cables, particularly small sizes, higher rates are permitted subject to the recommended side wall pressures not being exceeded and pulling on both armouring and conductors. Advice should be sought from the cable manufacturer.

A.4.4 *Bending radii*

During installation, no cable should be bent to a smaller radius than 12 times the cable overall diameter. A single bend executed around a template may be undertaken at a radius of 8 times the cable overall diameter.

A.4.5 *Cable installation*

There should be compatibility between jointing materials and components of the cable.

The insulation level of the joint and terminations should take into account any induced voltage.

Bibliography

Standards publications

HD 603 S1:1994, *Distribution cables of rated voltage 0.6/1 kV.*

HD 604 S1:1994, *0.6/1 kV and 1.9/3.3 power cables with special fire performance for use in power stations.*

HD 605 S1:1994, *Electric cables — Additional test methods.*

HD 620 S1:1996, *Distribution cables with extruded insulation for rated voltages from 3.6/6 (7.2) kV to 20.8/36 (42) kV.*

HD 622 S1:1996, *Power cables having rated voltages from 3.6/6 (7.2) kV up to and including 20.8/36 (42) kV with special fire performance for use in power stations.*

HD 626 S1:1996, *Overhead distribution cables of rated voltage U_0/U (U_m): 0.6/1 (1.2) kV.*

HD 627 S1:1996, *Multicore and multipair cable for installation above and below ground.*

IEC 60183, *Guide to the selection of high voltage cables.*

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