BRITISH STANDARD

BS 7870-8.6:2003

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 8.6: Single wire or double steel tape armoured and non-halogenated sheathed multipair cable with copper conductors

(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 7870-8.6 implements HD 627:Part 7A2 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 multipair cables with halogen-free insulation and sheaths, having reduced fire propagation performance and low emission of smoke when affected by fire.

It specifies requirements for multipair cables (up to 200-pair) with copper conductors, a collective screen and armouring consisting of a single layer of steel wires or a double layer of steel tapes.

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 EN 50265-2-1:1999, *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 50265-2-2:1999, *Common test methods for cables under fire conditions — Test for resistance to vertical flame propagation for a single insulated conductor or cable — Part 2-2: Procedures — Diffusion 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 50268-2:2000, *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 60811-4-1:1995, *Insulating and sheathing materials for electric cables. Common test methods — Part 4-1: Methods specific to polythene and polypropylene compounds — Resistance to environmental stress cracking — Wrapping test after thermal ageing in air — Measurement of flow index — Carbon black and/or mineral content measurement in PE.*

BS EN 60811-4-2:2000, *Insulating and sheathing materials of electric cables — Common test methods — Methods specific to polyethylene and polypropylene compounds — Tensile strength and elongation at break after pre-conditioning — Wrapping test after thermal ageing in air — Measurement of mass increase — Long-term stability test — Test method for copper-catalysed oxidative degradation.*

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

IEC 60189-1:1986, *Low-frequency cables and wires with PVC insulation and PVC sheath — Part 1: General test and measuring methods.*

IEC 60189-2:1986, *Low-frequency cables and wires with PVC insulation and PVC sheath — Part 2: Cables in pairs, triples, quads and quintuples for inside installation.*

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 Rated voltage

The rated voltage of cables in this standard is 100 V a.c. or 150 V d.c.

4 Conductors

Conductors shall be of plain copper wire or tinned copper wire consisting of a single strand of 0.8 mm nominal diameter, conforming to the requirements of BS 6360.

Conformity shall be checked by visual examination as specified in **17.2**.

5 Insulation

The insulation for Type 1 cables shall be an extruded layer of PE compound conforming to the requirements given in Table 8. The insulation for Type 2 cables shall be an extruded layer of an aromatic based compound conforming to the requirements of this specification and meeting the requirements of BS EN 50265-2-2 in the core stage.

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 **17.3**.

6 Identification of cores

6.1 Cores

With the exception of 2-pair cables, the insulation of cores shall be colour coded in accordance with the code given in IEC 60189-2 and in Table 1 using cabling elements 1 to 20 inclusive, in sequence.

The cores of 2-pair cables shall be laid up as a quad in the sequence white, red, blue, orange.

Table 1 — Colour codes

Cabling element	Colour of insulation	
	Wire a	Wire b
1	White	Blue
2	White	Orange
3	White	Green
4	White	Brown
5	White	Grey
6	Red	Blue
7	Red	Orange
8	Red	Green
9	Red	Brown
10	Red	Grey
11	Black	Blue
12	Black	Orange
13	Black	Green
14	Black	Brown
15	Black	Grey
16	Yellow	Blue
17	Yellow	Orange
18	Yellow	Green
19	Yellow	Brown
20	Yellow	Grey

Conformity shall be checked by visual examination as specified in **17.5.1**.

6.2 Pairs, quads and units

The cores of 2-pair cables shall be colour coded as detailed in **6.1** and shall be laid up in quad formation and bound overall with non-hygroscopic tape binder as detailed below. 5-pair and 10-pair cables shall consist of cabling elements colour coded 1 to 5 and 1 to 10 respectively as detailed in Table 1, and shall be laid up to form a compact and symmetrical cable. The laid-up group shall be bound overall with a non-hygroscopic tape binder as detailed below. Non-hygroscopic fillers shall be used if necessary for 2-pair, 5-pair and 10-pair constructions in order to form a compact and symmetrical cable.

20-pair to 200-pair cables shall be constructed from the required number of cabling units. Each cabling unit shall consist of 20 cabling elements, colour coded 1 to 20 as detailed above, laid up in concentric layers to form a compact and symmetrical unit.

The cabling unit shall be bound overall with non-hygroscopic tape binder of minimum thickness 0.023 mm and shall be applied with a minimum overlap of 25 %. The required number of cabling units, individually identified as detailed below, shall be laid up in concentric layers to form a compact and symmetrical cable and shall be bound overall with a double layer of clear non-hygroscopic tape, the layers being applied in opposite directions. Open spiral inter-layer tapes shall be applied if necessary. The cable construction shall consist of the required number of cabling units, using non-hygroscopic fillers where necessary, to form a compact and symmetrical cable.

The cabling units in cables having 40 pairs or more shall be individually identified by printed numbers of a contrasting colour to the natural base.

The printed numbers shall be applied direct on to the tape forming the unit binder or on a separate longitudinal tape applied under a clear unit binder tape. The numbers shall run from one upwards in units of one. The height of the figures shall be not less than 2 mm and shall be spaced such that ready identification of all units is possible in any 50 mm of cable. The figures shall be applied with an ink that is capable of withstanding the effect of wiping with a dry or wet cloth, and that will remain identifiable after the removal of the cable bedding and collective screen.

Conformity shall be checked by visual examination as specified in **17.5.2**.

7 Assembly of cores, fillers and binders

Cable shall be twinned and where required formed into separate identifiable units, which shall then be laid up to form a compact and symmetrical cable using non-hygroscopic fillers and binders as required.

Conformity shall be checked by visual examination as specified in **17.6**.

8 Rip cord

A terylene rip cord shall be included to facilitate stripping.

9 Collective screen

2-pair cables with binding tape shall have a plain aluminium tape of minimum thickness 0.075 mm applied helically with a minimum 25 % overlap, in contact with which shall be a 1/0.8 mm tinned copper drain wire or stranded conductor of equivalent cross-sectional area.

5-pair and above cables shall have a collective aluminium screen with a backing which will ensure adhesion to the bedding. The laminated screen tape shall be applied longitudinally over the rip cord and drain wire, and shall be in electrical contact with the latter, which shall be a 1/0.8 mm diameter tinned copper wire. The laminated screen shall be a minimum thickness of 0.15 mm aluminium bonded to a suitable backing material.

Conformity shall be checked by measurement as specified in **17.8**.

10 Bedding layer

The bedding layer shall be an extruded layer of compound type ZM 1 for Type 1 cables and type ZM 2 for Type 2 cables.

11 Armouring

Cables shall be armoured either with a single layer of galvanized steel wires, applied with a direction of lay opposite to that of the pairs, or (in the case of Type 1 cables, 20-pair to 200-pair) with a double layer of galvanized steel tape each 0.5 mm thick. The tapes shall be applied helically with the outer tape covering the gap between the turns of the inner tape. Type 2 cables shall only be armoured with galvanized wires.

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.

Conformity shall be checked by visual examination as specified in **17.11**.

12 Oversheath

The oversheath shall be an extruded layer of compound type ZM 1 for Type 1 cable and type ZM 2 for Type 2 cable.

13 Marking

13.1 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	100 V
c) British Standard number[1] and cable type	BS 7870-8.6 Type 1 or BS 7870-8.6 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 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).

NOTE Identification of circuits by colour or printing may be provided if mutually agreed between supplier and user.

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

Conformity shall be checked by visual examination and measurement as specified in **16.6**.

13.2 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 **16.6**.

13.3 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 **16.6**.

[1] Marking BS 7870-8.6:2003 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 2 and Table 3.

13.4 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 **13.1**, **13.2** and **13.3**.

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 **16.6**.

14 Dimensions

The dimensions of the component layers shall be as specified in Table 2 and Table 3.

Table 2 — Multipair cables (Type 1)

Dimensions in millimetres

Cable type	Conductor		Thickness of insulation[a]	Thickness of bedding		Diameter		Thickness of double tape armour (each tape)	Thickness of oversheath		Max. overall diameter of completed cable[b]
	No. of wires	Diameter of wires[a]		Nominal	Min. at any point	Max. over bedding[b]	Armour wire		Nominal	Min. at any point	
2-pair	1	0.8	0.3	1.5	1.18	10	0.9	—	1.9	1.32	18
5-pair	1	0.8	0.3	1.5	1.18	15	0.9	—	2.0	1.40	22
10-pair	1	0.8	0.3	1.5	1.18	17	1.25	—	2.2	1.56	28
20-pair	1	0.8	0.3	1.5	1.18	20	1.25	0.5	2.4	1.72	30
40-pair	1	0.8	0.3	2.0	1.60	30	1.6	0.5	2.8	2.04	40
60-pair	1	0.8	0.3	2.6	2.11	40	1.6	0.5	3.1	2.28	50
100-pair	1	0.8	0.3	2.6	2.11	45	2.0	0.5	3.1	2.28	55
200-pair	1	0.8	0.3	3.0	2.45	55	2.5	0.5	3.8	2.84	70

[a] Nominal value.
[b] The minimum diameter should be compatible with the gland selected for the specified maximum diameter.

Table 3 — Multipair cables (Type 2)

Dimensions in millimetres

Cable type	Conductor		Thickness of insulation[a]	Thickness of bedding		Diameter		Thickness of oversheath		Max. overall diameter of completed cable[b]
	No. of wires	Diameter of wires[a]		Nominal	Min. at any point	Max. over bedding[b]	Armour wire	Nominal	Min. at any point	
2-pair	1	0.8	0.3	1.4	1.08	10	0.9	2.2	1.56	18
5-pair	1	0.8	0.3	1.6	1.26	15	0.9	2.2	1.56	22
10-pair	1	0.8	0.3	1.8	1.43	17	1.25	2.2	1.56	28
20-pair	1	0.8	0.3	1.8	1.43	20	1.25	2.4	1.72	30
40-pair	1	0.8	0.3	2.0	1.6	30	1.6	2.8	2.04	40
60-pair	1	0.8	0.3	2.0	1.6	40	1.6	2.8	2.04	50
100-pair	1	0.8	0.3	2.2	1.77	45	2.0	3.0	2.2	55
200-pair	1	0.8	0.3	2.4	1.94	55	2.5	3.3	2.46	70

[a] Nominal value.
[b] The minimum diameter should be compatible with the gland selected for the specified maximum diameter.

15 Tests

Testing shall be performed in accordance with the schedule of tests specified in Table 4.

Table 4 — 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**	**16.2**
Insulation resistance at 20 °C	R	BS 7870-2:1999, **3.3.2**	**16.3**
Voltage test	R	BS 7870-2:1999, **3.2.1.2**	**16.4**
Mutual capacitance	T	IEC 60189-1:1986, **5.4**	**18.3**
Capacitance unbalance	T and S	IEC 60189-1:1986, **5.5**	**18.4** and **17.4**
Mutual inductance	T	**18.5**	**18.5**
Voltage test after bending	T	BS 7870-2:1999, **2.4.1.1**	**18.6**
Spark test on oversheath	R	BS 7870-2:1999, **3.6.1**	**16.5**
Provisions covering constructional and dimensional characteristics			
Conductor material and construction	S	Visual examination	**17.2**
Insulation:			
— application	S	Visual examination	**17.3**
— thickness	S	BS 7870-2:1999, **2.1.1**	**17.3**
Core identification	S	Visual examination	**17.5.1**
Pair identification	S	Visual examination	**17.5.2**
Unit identification	S	Visual examination	**17.5.2**
Laid-up cores	S	Visual examination	**17.6**
Rip cord	S	Stripping sheath	**17.7**
Collective screen	S	Measurement	**17.8**
Bedding thickness	S	BS 7870-2:1999, **2.1.2**	**17.9**
Armour wire:			
— wire diameter	S	BS 7870-2:1999, **2.1.4.3**a)	**17.10**
— mass of zinc coating	T	BS 7870-2:1999, **2.5.1.1**	**18.7.1**
— wrapping test	T	BS 7870-2:1999, **2.3.2**	**18.7.2**
Armour tape:			
— application	S	Visual examination	**17.11**
— thickness	S	BS 7870-2:1999, **2.1.4.3**c)	**17.11**
— mass of zinc coating	T	BS 7870-2:1999, **2.5.1.1**	**18.7.3**
Oversheath thickness	S	BS 7870-2:1999, **2.1.2**	**17.12**
Cable marking	R	Visual examination	**16.6**
Overall dimensions	R	BS 7870-2:1999, **2.1.3**	**16.7**
Mechanical properties			
Insulation	T	Table 8 or Table 9	**18.8**
Extruded bedding	T	Table 10	**18.9**
Oversheath	T	Table 10	**18.10**
Abrasion resistance	T	BS 7870-2:1999, **2.4.5**	**18.11**
Electrical type approval	T	—	**18.2**
Special type tests (Type 2 only)	T	Table 11	**18.12**

Table 4 — Schedule of tests (*continued*)

Test	Category of test	Test method described in	Requirements given in
Tests under fire conditions			
Oxygen index	T and S	BS EN ISO 4589-3	**17.13.2** and **18.13.2**
Propagation:			
— single cable	S	BS EN 50265-2-1	**17.13.3**
— bunched cables	T	BS 7870-2:1999, **4.1.4**	**18.13.3**
— insulated core (Type 2 only)	T	BS EN 50265-2-2	**18.13.4**
Smoke emission:			
— Type 1 only	T	BS EN 50268-2	**18.13.5**
— Type 2 only	T	BS 7870-2:1999, **4.2.2**	**18.13.6**
Corrosive gas emission:			
— Type 1 only	T	BS EN 50267-2-1	**18.13.7**
— Type 2 only	T	BS 7870-2:1999, **4.3.1**	**18.13.8**

16 Routine tests

16.1 General

Routine tests shall be performed in accordance with the schedule of tests in Table 4 and **16.2** to **16.7**.

16.2 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.

16.3 Insulation resistance

When measured in accordance with BS 7870-2:1999, **3.3.2**, the insulation resistance shall be not less than 80 MΩ/km at 20 °C.

16.4 Voltage test

When the voltage test is carried out in accordance with BS 7870-2:1999, **3.2.1.2**, using either 2 kV a.c. or 3 kV d.c. for 1 min between the conductors of each pair, and between all the conductors and the screen or armouring, no breakdown of the insulation shall occur.

In addition, the insulation resistance between the screen and armour shall exceed 1 MΩ for 1 km at 20 °C after energizing at 500 V d.c. for 1 min.

16.5 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.

16.6 Cable markings

The cable markings shall be checked by visual examination and measurement and shall conform to the requirements of Clause **13**.

16.7 Diameters over bedding and overall

The diameter over the bedding, and the overall diameter, shall be measured on a sample taken from one end of each drum length of cable selected for the test. Three measurements shall be taken in accordance with BS 7870-2:1999, **2.1.3**, at three points 80 mm apart. Each measurement shall be at 60° angular displacement. No measurement shall fall outside the maximum and minimum values given in Table 2 or Table 3 as appropriate.

17 Sample tests

17.1 General

Sample tests shall be performed in accordance with the schedule of tests in Table 4 and **17.2** and **17.12**.

17.2 Conductor material and construction

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

17.3 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 on all cores up to 5-pair and, for larger pairages, on 10 cores.

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 thickness of the insulation shall be (0.3 ± 0.05) mm.

If any of the thicknesses measured does not conform to the requirements specified in Table 2 or Table 3, 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 requirements, the cable shall be deemed not to conform.

17.4 Capacitance unbalance

When tested in accordance with IEC 60189-1:1986, **5.5**, the capacitance unbalance shall not exceed the following:

a) 2-pair: 800 pF for 500 m at 1 kHz;

b) above 2-pair: 400 pF for 500 m at 1 kHz.

17.5 Identification

17.5.1 *Core identification*

The cable cores shall be checked by visual examination and shall conform to the requirements of **6.1**.

17.5.2 *Pair and unit identification*

The cable pairs and units shall be checked by visual examination and shall conform to the requirements of **6.2**.

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

17.6 Laid-up cores

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

17.7 Rip cord

The rip cord shall have a nominal breaking force of 150 N.

17.8 Collective screen

The collective screen shall be checked by measurement and shall conform to the requirements of Clause **9**.

17.9 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 thickness of the bedding layer shall conform to the value specified in Table 2 or Table 3, as appropriate. In determining the minimum bedding thickness, any indentation caused by the rip cord or identification tape shall be ignored.

If any of the thicknesses measured does not conform to the requirements specified in Table 2 or Table 3, 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.

17.10 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 5.

Table 5 — 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
2.5	2.37	2.63

17.11 Armour tape

The application of the armour tape shall be checked by visual examination and shall conform to the requirements of Clause **11**.

When measured in accordance with BS 7870-2:1999, **2.1.4.3**c), the thickness of the armour tape shall conform to the value specified in Table 2 or Table 3 as appropriate.

17.12 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 thickness of the oversheath shall conform to the value specified in Table 2 or Table 3, as appropriate.

If any of the thicknesses measured does not conform to the requirements specified in Table 2 or Table 3, 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.

17.13 Tests under fire conditions

17.13.1 *Sample selection*

Tests shall be carried out on the smallest size of the range being offered by the manufacturer.

17.13.2 *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.

17.13.3 *Flame propagation on single cable*

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

18 Type tests

18.1 General

Type tests shall be performed in accordance with the schedule of tests in Table 4 and **18.2** to **18.13**.

18.2 Type approval

The tests specified in Table 6 shall be undertaken on a minimum length of 100 m of the smallest and largest sizes being offered by the manufacturer.

Table 6 — Type approval tests

Parameter	Test to be carried out	
	Smallest pairage	Largest pairage
Cable dimensions	Yes	Yes
Insulation resistance	No	Yes
Conductor resistance	No	Yes
Mutual capacitance	Yes	Yes
Capacitance unbalance	No	Yes
Inductance	Yes	Yes
Bending and voltage	Yes	Yes

18.3 Mutual capacitance

When tested in accordance with IEC 60189-1:1986, **5.4**, the mutual capacitance shall be not less than 150 nF for 1 km at 1 kHz.

18.4 Capacitance unbalance

When tested in accordance with IEC 60189-1:1986, **5.5**, the capacitance unbalance shall not exceed the following values:

a) for 2-pair cables, 800 pF for 500 m at 1 kHz;

b) for cables above 2-pair, 400 pF for 500 m at 1 kHz.

18.5 Mutual inductance

The test shall be undertaken on the full length of the type approval test sample. The mutual inductance shall be measured on a sample basis using any two pairs. The mutual inductance shall be measured between the two conductors of each of the two pairs selected. The remaining pairs, collective screen and armour shall be earthed. The measurement shall be taken at a frequency of 1 kHz and corrected to 500 m and expressed in nanohenrys (nH).

The mutual inductance shall not exceed 915 μH for 500 m at 1 kHz.

18.6 Voltage test after bending

18.6.1 *Cold bend*

This test shall be carried out in accordance with BS 7870-2:1999, **2.4.1.1**, except that the diameter of the test drum shall be 15 times the cable overall diameter and the cable sample shall be cooled to 0 °C. After completing the test the sample shall be tested in accordance with **16.4**.

Following this a 1 m length shall be cut from the centre of the test sample and visually examined. There shall be no splits in the bedding or oversheath, no significant displacement of armouring and no damage to the collective screen.

18.6.2 *Ambient bend*

The bend test shall be carried out in accordance with BS 7870-2:1999, **2.4.1.1**, except that the diameter of the test drum shall be 15 times the cable overall diameter. After completing the test, the sample shall be tested in accordance with **16.4**.

18.7 Armour

18.7.1 *Mass of zinc coating of galvanized 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 given in Table 7.

Table 7 — 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
2.5	195

18.7.2 *Wrapping tests 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.

18.7.3 *Mass of zinc coating of armour tape*

When measured in accordance with BS 7870-2:1999, **2.5.1.1**, the mass of zinc coating of galvanized steel tape shall be not less than 112 g/m^2.

18.8 Insulation

The insulation shall be tested in accordance with Table 8 or Table 9 as appropriate, and shall conform to the requirements specified in Table 8 or Table 9 as appropriate.

Table 8 — Requirements for non-electrical tests on polyethylene

Test	Unit	Type of compound	Test method described in
		PE	
Density	g/cm^3	Record	BS EN 60811-1-3:1995, Clause **8**
Melt flow index		Record	BS EN 60811-4-1:1995, Clause **10**
Tensile strength, min.	N/mm^2	10	BS EN 60811-1-1:1995, Clause **9**
Elongation at break, min.	%	300	BS EN 60811-1-1:1995, Clause **9**
Resistance to oxidation (time)	h	1 000	BS EN 60811-4-2:2000, Annex A
Oxidative induction time	min	Record	BS EN 60811-4-2:2000, Annex B

Table 9 — Requirements for non-electrical tests on aromatic compound

Test	Unit	Type of compound	Test method described in
		Aromatic	
Tensile strength and elongation at break			
Properties in the state as delivered			BS EN 60811-1-1:1995, **9.1**
Values to be obtained for tensile strength:			
— median, min.	N/mm^2	25	
Values to be obtained for elongation at break:			
— median, min.	%	50	
Properties after ageing in air oven			BS EN 60811-1-2:1995, **8.1**
Ageing conditions:			
— temperature	°C	100	
— duration of treatment	h	168	
Value to be obtained for tensile strength:			
— median, min.	N/mm^2	25	
Value to be obtained for elongation at break:			
— median, min.	%	50	
Ozone resistance			BS EN 60811-2-1:1995, Clause **8**
Test conditions			
— temperature	°C	25 ± 2	
— duration	h	3	
— ozone concentration	ppm	250 to 300	
Requirement		No cracks	

18.9 Bedding

The bedding shall be tested in accordance with Table 10 and shall conform to the requirements specified in Table 10.

18.10 Oversheath

The oversheath shall be tested in accordance with Table 10 and shall conform to the requirements specified in Table 10.

Table 10 — Requirements for non-electrical tests for non-halogenated bedding and oversheath

Test	Unit	Type of compound		Test method described in
		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	10	8	
Values to be obtained for elongation at break:				
— median, min.	%	100	75	
Properties after ageing in air oven				BS EN 60811-1-2:1995, **8.1**
Ageing conditions:				
— temperature	°C	100	100	
— duration of treatment	h	168	168	
Value to be obtained for tensile strength:				
— median, min.	N/mm^2	10	8	
— variation[b], max.	%	±40	—	
Value to be obtained for elongation at break:				
— median, min.	%	100	75	
— variation[b], max.	%	±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	
Results to be obtained:				
— median of the depth of penetration, max.	%	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 afer ageing and the median value without ageing, expressed as a percentage of the latter.
[c] As specified in ASTM D5964-96:2001.

Table 10 — Requirements for non-electrical tests for non-halogenated bedding and oversheath (*continued*)

Test	Unit	Type of compound		Test method described in
		ZM 1	ZM 2[a]	
Impact at low temperature				BS EN 60811-1-4:1995, **8.5**
Test conditions:				
— temperature	°C	–15	–15	
— 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**		
Results to be obtained		See BS EN 60811-1-4: 1995, **8.5.6**		
Insulation resistance				BS 7870-2:1999, **3.3.4**
Constant min. at 20 °C	MΩ·km	0.0035		
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	
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	
Tensile strength maximum variation[b]	%	—	±20	
Elongation at break maximum variation[b]	%	—	±40	
Pulling lubricant resistance				BS 7870-2:1999, **5.2**
Test conditions				
— temperature	°C	—	20 ± 5	
— immersion period	h	—	2 016	
Tensile strength maximum variation[b]	%	—	±20	
Elongation at break maximum variation[b]	%	—	±40	

[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 afer ageing and the median value without ageing, expressed as a percentage of the latter.
[c] As specified in ASTM D5964-96:2001.

Table 10 — Requirements for non-electrical tests for non-halogenated bedding and oversheath (*continued*)

Test	Unit	Type of compound		Test method described in
		ZM 1	ZM 2[a]	
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}	
Water permeation after ageing				BS 7870-2:1999, **2.5.5**
Ageing condition:		—	As given in BS 7870-2: 1999, **5.1.1**	
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}	

[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 afer ageing and the median value without ageing, expressed as a percentage of the latter.
[c] As specified in ASTM D5964-96:2001.

18.11 Abrasion resistance

18.11.1 *Abrasion test (Type 1 only)*

When a sample of complete 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 or splits in the internal or external surfaces.

18.11.2 *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, examination of the sample without magnification reveals no cracks or splits in the internal or external surfaces. When tested in accordance with **15.5** the cable shall not fail.

18.12 Special type tests on completed cable (Type 2 only)

The tests given in Table 11 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 11. Ageing shall be in accordance with BS 7870-2:1999, **5.1.1** at a service temperature of 40 °C.

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 11.

Table 11 — Special type tests 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 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 the sample at 20 °C; — 1 000 N for the 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.

18.13 Tests under fire conditions

18.13.1 *Sample selection*

The tests given in **18.13.2**, **18.13.3**, **18.13.7** and **18.13.8** shall be carried out on the smallest cable of the range being offered.

The tests given in **18.13.5** and **18.13.6** shall be carried out on the smallest and largest cable of the range being offered.

NOTE A test covers only the particular materials and type of cable (Type 1 or Type 2) used in the tests.

18.13.2 *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.

18.13.3 *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 4 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 40 kg/m may be required.

18.13.4 ***Flame propagation test for core (Type 2 only)***

Core of Type 2 cable shall be tested in accordance with BS EN 50265-2-2 and shall conform to the requirements of BS EN 50265-2-2.

18.13.5 ***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 70 %.

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

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

18.13.7 ***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 %.

18.13.8 ***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 chlorine yield shall be:

a) $3.8 < pH < 10$;

b) conductivity < 80 μS/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 walls or metallic structures. The cables should not 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 controlled. They 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 operate up to 100 V a.c. or 150 V d.c. but should not be used for direct connection to low impedance sources, e.g. public mains electricity supply.

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 splinter.

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 *Environmental 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.*

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