BRITISH STANDARD

BS 7870-7.2:2003

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

Part 7: Specification for power cables having rated voltages of 3.8/6.6 kV and 6.35/11 kV with special fire performance for use in power stations —

Section 7.2: Single core and 3-core cables with halogen-free materials and with aluminium or steel wire armouring

(Implementation of HD 622)

ICS 29.060.20

BSI British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee GEL/20, Cables, to Subcommittee GEL/20/16, Medium/high voltage cables, upon which the following bodies were represented:

British Approval Service for Cables

British Cables Association

British Plastics Association

Electricity Association

ERA Technology

Co-opted members

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 17 June 2003

Amendments issued since publication

Amd. No.	Date	Comments

The following BSI references relate to the work on this British Standard:
Committee reference GEL/20/16
Draft for comment 99/244662 DC

ISBN 0 580 41549 X

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, 604, 605, 620, 622, 626 and 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 7870-7.1 specifies a range of PVC sheathed reduced fire propagation performance cables, and implements HD 622-3H.

BS 7870-7.2 specifies a range of halogen-free sheathed cables, having reduced fire propagation performance and low emission of smoke when affected by fire. It implements HD 622-4H 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.

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 25 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

1 Scope

This section of BS 7870 specifies requirements for the construction, dimensions and mechanical and physical properties of single core and 3-core cross-linked polyethylene (XLPE) or ethylene propylene rubber (EPR) insulated and halogen-free sheathed cables with aluminium or steel wire armouring, having reduced fire propagation performance and low emission of smoke when affected by fire.

It specifies requirements for the following categories of cable:

a) single core XLPE or EPR insulated aluminium wire armoured 3.8/6.6 kV;

b) 3-core XLPE or EPR insulated aluminium wire armoured or steel wire armoured 3.8/6.6 kV;

c) single core XLPE or EPR insulated aluminium wire armoured 6.35/11 kV;

d) 3-core XLPE or EPR insulated aluminium wire armoured or steel wire armoured 6.35/11 kV.

It specifies requirements for two different types of cable:

1) Type 1 — cable intended to be suitable for the installation and operating conditions prevailing in a conventional fossil-fuelled power station or equivalent location;

2) Type 2 — cable intended to be suitable for the installation and operating conditions prevailing in a pressurized water reactor (PWR) power station, but excluding locations in or around the containment area.

NOTE 1 Type 1 and Type 2 cables are both required to conform to the common constructional requirements of this section of BS 7870, but the performance requirements differ as indicated in the relevant clauses and test schedules. The more onerous type testing of Type 2 cables acknowledges the limited size range and voltage of cables currently used in certain PWR projects.

This section of BS 7870 is applicable to cables for fixed installations that are mainly intended for use in power generating plants and substations, and where the combination of ambient temperature and temperature rise due to loading current results in a conductor temperature not exceeding 90 °C.

NOTE 2 Annex A contains a "guide to use" for the cables specified in this section of BS 7870.

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 7870-7.1, *LV and MV polymeric insulated cables for use by distribution and generation utilities — Part 7: Specification for power cables having rated voltages of 3.8/6.6 kV and 6.35/11 kV with special fire performance for use in power stations — Section 7.1: Single and 3-core cables with halogenated materials and with aluminium or steel wire armouring.*

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: Procedures — Section 2.1: 1 kW pre-mixed flame.*

BS EN 60811-1-1:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 1: General application — Section 1.1: 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: General application — Section 1.2: Thermal ageing methods.*

BS EN 60811-1-3:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 1: General application — Section 1.3: Methods for determining the density — Water absorption tests — Shrinkage test.*

BS EN 60811-1-4:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 1: General application — Section 1.4: Test at low temperatures.*

BS EN 60811-2-1:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 2: Methods specific to elastomeric compounds — Section 2.1: Ozone resistance, hot set and mineral oil immersion tests.*

BS EN 60811-3-1:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 3: Methods specific to PVC compounds — Section 3.1: Pressure test at high temperature — Tests for resistance to cracking.*

BS EN 60811-3-2:1995, *Insulating and sheathing materials of electric cables — Common test methods — Part 3: Methods specific to PVC compounds — Section 3.2: Loss of mass test — Thermal stability test.*

BS ISO 4589-2:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-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 designations of cables in this standard are:

a) 3.8/6.6 (7.2) kV;

b) 6.35/11 (12) kV.

4 General requirements

4.1 Identification of cores in 3-core cables

The cores of 3-core cables shall be unmarked.

4.2 Thickness of insulation

The mean value of the thickness of insulation, excluding semi-conducting layers, shall be not less than the specified value for each type and size of cable shown in Table 1, Table 2, Table 3 and Table 4.

If the thickness at any place is less than the specified value, the difference shall not exceed 0.1 mm + 10 % of the specified value.

Conformity shall be checked by the test specified in BS 7870-2:1999, **2.1.1**.

4.3 Thickness of extruded bedding

The minimum thickness of extruded bedding shall not fall below the specified value for each type and size of cable shown in Table 1, Table 2, Table 3 and Table 4 by more than 15 % + 0.1 mm.

Conformity shall be checked by the test given in BS 7870-2:1999, **2.1.2**.

4.4 Thickness of oversheath

The minimum thickness at any point of the oversheath shall not fall below the specified value for each type and size of cable shown in Table 1, Table 2, Table 3 and Table 4 by more than 0.2 mm + 20 % of the specified value.

Conformity shall be checked by the test given in BS 7870-2:1999, **2.1.2**.

Table 1 — Single core 3 800/6 600 V cable with stranded aluminium or copper circular conductors

Nominal cross-sectional area of conductor[a] mm²	Thickness of insulation mm	Thickness of extruded bedding mm	Nominal armour wire diameter mm	Thickness of oversheath mm	Approximate overall diameter mm
50	2.5	1.2	1.6	1.8	26.7
70	2.5	1.2	1.6	1.8	28.4
95	2.5	1.2	1.6	1.9	30.3
120	2.5	1.2	1.6	1.9	31.9
150	2.5	1.2	1.6	2.0	33.5
185	2.5	1.2	2.0	2.0	36.1
240	2.6	1.2	2.0	2.1	38.9
300	2.8	1.2	2.0	2.2	41.8
400	3.0	1.2	2.0	2.3	45.5
500	3.2	1.3	2.5	2.5	50.5
630	3.2	1.4	2.5	2.6	54.6
800[b]	3.2	1.4	2.5	2.7	60.8
1 000[b]	3.2	1.5	2.5	2.9	65.9

[a] Circular compacted stranded conductor class 2.
[b] These sizes apply to cables with copper conductors only.

Table 2 — 3-core 3 800/6 600 V cable with stranded aluminium or copper circular conductors

Nominal cross-sectional area of conductor[a] mm²	Thickness of insulation mm	Thickness of extruded bedding mm	Nominal armour wire diameter[b] mm	Thickness of oversheath mm	Approximate overall diameter mm
50	2.5	1.3	2.5	2.5	50.3
70	2.5	1.3	2.5	2.6	54.2
95	2.5	1.4	2.5	2.7	58.3
120	2.5	1.5	2.5	2.8	62.1
150	2.5	1.5	2.5	2.9	65.3
185	2.5	1.6	2.5	3.0	69.6
240	2.6	1.7	2.3	3.2	75.8
300	2.8	1.8	3.15	3.5	83.8
400	3.0	2.0	3.15	3.7	92.1

[a] Circular compacted stranded conductor class 2.
[b] Armour wires may be of aluminium or galvanized steel.

Table 3 — Single core 6 350/11 000 V cable with stranded aluminium or copper circular conductors

Nominal cross-sectional area of conductor[a] mm²	Thickness of insulation mm	Thickness of extruded bedding mm	Nominal armour wire diameter[b] mm	Thickness of oversheath mm	Approximate overall diameter mm
50	3.4	1.2	1.6	1.8	28.5
70	3.4	1.2	1.6	1.9	30.4
95	3.4	1.2	1.6	1.9	32.1
120	3.4	1.2	1.6	2.0	33.9
150	3.4	1.2	2.0	2.1	36.3
185	3.4	1.2	2.0	2.1	38.1
240	3.4	1.2	2.0	2.2	40.7
300	3.4	1.2	2.0	2.2	43.0
400	3.4	1.2	2.0	2.4	46.5
500	3.4	1.3	2.5	2.5	50.9
630	3.4	1.4	2.5	2.6	55.0

[a] Circular compacted stranded conductor class 2.

Table 4 — 3-core 6 350/11 000 V cable with stranded aluminium or copper circular conductors

Nominal cross-sectional area of conductor[a] mm²	Thickness of insulation mm	Thickness of extruded bedding mm	Nominal armour wire diameter[b] mm	Thickness of oversheath mm	Approximate overall diameter mm
50	3.4	1.4	2.5	2.6	54.6
70	3.4	1.4	2.5	2.7	58.5
95	3.4	1.5	2.5	2.8	62.6
120	3.4	1.6	2.5	3.0	66.6
150	3.4	1.6	2.5	3.1	69.8
185	3.4	1.7	2.5	3.2	74.1
240	3.4	1.8	3.15	3.4	81.2
300	3.4	1.9	3.15	3.6	86.8

[a] Circular compacted stranded conductor class 2.
[b] Armour wires may be of aluminium or galvanized steel.

4.5 Marking

4.5.1 *External marking*

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

Element	Example of marking
a) Electric cable	ELECTRIC CABLE
b) Voltage designation	6 600 V or 11 000 V
c) British Standard number[1)]	BS 7870-7.2 Type 1 (or Type 2)
d) Manufacturer's identification	XYZ
e) The number of cores, type and nominal conductor area, e.g.	
1) Copper conductor cable	3 × 185
2) Aluminium conductor cable	1 × 400 AL

The marking of elements a) to d) shall be by embossing, by indenting on the oversheath, or by other durable means agreed with the purchaser.

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.

Elements d) and e) shall appear on at least one line.

NOTE Elements d) and e) may be on one of the primary lines or a secondary line or lines and need not be on the same line.

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 of marking shall be not greater than 550 mm for elements a), b) and c), and not greater than 1 100 mm for elements d) and e).

Conformity shall be checked by visual examination and measurement.

4.5.2 *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.

4.5.3 *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.

[1)] Marking BS 7870-7.2:2003 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.

4.5.4 *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 surface of the cable it shall not render illegible the marking specified in **4.5.1**, **4.5.2** and **4.5.3**.

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

Conformity shall be checked by visual examination and measurement.

4.6 Routine tests

4.6.1 *Voltage test (Type 1 and Type 2)*

The cable shall be tested in accordance with BS 7870-2:1999, **3.2.1**, using a voltage of $4U_0$, gradually imposed and held for a period of 15 min. No breakdown shall occur.

4.6.2 *D.C. test on oversheath of single core cables (Type 1 and Type 2)*

When tested in accordance with BS 7870-2:1999, **3.2.3.1**, the oversheath shall not break down during the application of 8 kV/mm of specified thickness of oversheath, subject to a maximum of 25 kV.

4.6.3 *Partial discharge test (Type 1 and Type 2)*

The cable shall be subjected to a partial discharge test in accordance with BS 7870-2:1999, **3.10.3**. The test voltage shall be raised to $2.25U_0$, held for not more than 1 min, and reduced to $2U_0$, at which voltage the discharge magnitude (q) shall not exceed 10 pC.

4.7 Sample tests

4.7.1 *Thickness measurement (Type 1 and Type 2)*

A sample shall be taken from one end of each drum length of cable selected for the test, and any portion of the cable that may have suffered damage shall be discarded. The thickness of insulation, extruded bedding and oversheath shall be measured in accordance with the tests specified in Table 5.

If any of the thicknesses measured does not conform to **6.3.2**, **6.3.5** and **6.3.7**, 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 sample does not meet the specified requirements, the cable shall be deemed not to conform.

4.7.2 *Strippability of extruded semi-conducting insulation screen (Type 1 and Type 2)*

The screen shall be capable of removal without impairing the performance of the insulation. When tested in accordance with BS 7870-2:1999, **2.2.8.6**, the force required to remove the screen shall be not less than 18 N and not more than 80 N.

Table 5 — Schedule of tests

Test	Category of test	Test method in accordance with BS 7870-2:1999 unless otherwise specified	Requirement given in clause	
			Single core cables	3-core cables
Electrical tests				
Conductor resistance	R	**3.1.1**	**6.3.1**	**6.3.1**
Voltage test:				
— cores	R	**3.2.1**	**4.6.1**	**4.6.1**
— oversheath	R	**3.2.3.1**	**4.6.2**	—
Spark test on oversheath	R	**3.6.1**	—	—
Resistance test on bedding and oversheath	T	**3.3.4**	**4.8.5**	—
Partial discharge test	R	**3.10.3**	**4.6.3**	**4.6.3**
Sequential type test:				
— Type 1	T	**4.8.7** in present section	**4.8.7**	**4.8.7**
— Type 2	T	**4.8.8** in present section	**4.8.8**	—

Table 5 — Schedule of tests (*continued*)

Test	Category of test	Test method in accordance with BS 7870-2:1999 unless otherwise specified	Requirement given in clause	
			Single core cables	3-core cables
Provision covering constructional and dimensional characteristics				
Conductor material and construction	S	BS 6360	**6.3.1**	**6.3.1**
Conductor screen resistivity	T	**3.9.3**	**4.8.2**	**4.8.2**
Insulation thickness	S	**2.1.1**	**4.2** and **6.3.2**	**4.2** and **6.3.2**
Insulation screen:				
a) non-metallic:				
— resistivity	T	**3.9.3**	**4.8.2**	**4.8.2**
— strippability	S	**2.2.8.6**	**4.7.2**	**4.7.2**
b) metallic:				
— fault capacity	T	Design	**6.3.3.2**	**6.3.3.2**
Assembly of cores	S	Visual	—	**6.3.4**
Bedding thickness	S	**2.1.2**	**4.3** and **6.3.5**	**4.3** and **6.3.5**
Armour:				
a) diameter	S	**2.1.4.3**	**6.3.6**	**6.3.6**
b) mass of zinc coating (steel)	T	**2.5.1.1**	—	**6.3.6**
c) wrapping test (steel)	T	**2.3.2**	—	**6.3.6**
d) tensile test (aluminium)	T	**2.3.1.1**	**6.3.6**	**6.3.6**
Oversheath thickness	S	**2.1.2**	**4.4** and **6.3.7**	**4.4** and **6.3.7**
Cable markings	R	Visual examination and measurement	**4.5**	**4.5**
Mechanical properties				
Insulation	T	Table 13	**6.3.2**	**6.3.2**
Extruded bedding	T	Table 14	Table 14	Table 14
Oversheath	T	Table 14	Table 14	Table 14
Abrasion resistance	T	**2.4.5**	**4.8.4**	**4.8.4**
Cold bend test	T	**2.4.1.1**	**4.8.6**	**4.8.6**
Compatibility test	T	**2.4.12.2**	**4.8.3** and Table 6	**4.8.3** and Table 6
Special type tests	T	Table 12 and **4.8.9** in present section	Table 12 and **4.8.9**	—
Tests under fire conditions				
Oxygen index: insulation, bedding and oversheath	T and S	BS ISO 4689-2	**4.9.4**	**4.9.4**
Flame propagation:				
a) single cable	S	BS EN 50265-2-1:1999, **4.1.1**	BS EN 50265-2-1:1999, Annex A	BS EN 50265-2-1:1999, Annex A
b) bunched cables	T	**4.1.4**	**4.9.3**	**4.9.3**
Smoke emission	T	**4.9.5** in present section	**4.9.5**	**4.9.5**
Corrosive gas emission	T	**4.9.6** in present section	**4.9.6**	**4.9.6**

4.8 Type tests

4.8.1 *General*

Satisfactory completion of all type tests on the following sizes shall be deemed to be sufficient to cover the full range of cables listed in Table 1, Table 2, Table 3 and Table 4, for the particular insulating material (XLPE or EPR) and the particular type of cable (Type 1 or Type 2):

a) for 3-core cables: 70 mm^2 or 95 mm^2 6.35/11 kV cable;

b) for single core cables: 500 mm^2 or 630 mm^2 6.35/11 kV cable.

NOTE The cables tested may have either copper or aluminium conductors, and either steel or aluminium wire armouring.

To cover the full range of 3.8/6.6 kV cables only, the same two sizes as above, but of 3.8/6.6 kV rating, shall be tested.

4.8.2 *Measurement of extruded semi-conducting screen resistivity (Type 1 and Type 2)*

When measured in accordance with BS 7870-2:1999, **3.9.3**, the resistivity shall not exceed 500 Ω·m at 90 °C.

4.8.3 *Compatibility test (Type 1 and Type 2)*

When tested in accordance with BS 7870-2:1999, **2.4.12.2**, the sample being aged for 7 days at (100 ± 2) °C, the performance shall conform to the values specified in Table 6.

Table 6 — Compatibility test

Component	Parameter	Requirements	
		XLPE	EPR
Insulation	Maximum % variation[a] of tensile strength	25	30
	Maximum % variation[a] of elongation at break	25	30
Conductor screen	Maximum resistivity at 90 °C, Ω·m	1 000	
Core screen	Maximum resistivity at 90 °C, Ω·m	1 000	
	Strippability force, N/13 mm	18 to 80	

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

4.8.4 *Abrasion test*

4.8.4.1 *Type 1*

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.

4.8.4.2 *Type 2*

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 and that, when the sample is subsequently tested in accordance with **4.6.2**, the oversheath does not break down.

4.8.5 *Bedding and oversheath resistance test (Type 1 and Type 2)*

This shall be measured on a single core cable between the insulation metal screen and the armour, and between the armour and the water as described in BS 7870-2:1999, **3.3.4**, except that the nominal voltage shall be not less than 500 V d.c.

The insulation resistance shall be not less than 1 MΩ·km when corrected to 20 °C.

4.8.6 *Cold bending test (Type 1 and Type 2)*

When tested in accordance with BS 7870-2:1999, **2.4.1.1**, the 11 kV cables shall be subjected to the conditions shown in Table 7.

Table 7 — Cold bending test

Temperature	Diameter of test cylinder		Parameter to be measured
	3-core cable	Single core cable	
0 °C	12 ($D + d$)	15 ($D + d$)	Partial discharge and freedom from cracks or splits
NOTE D is the approximate overall diameter in millimetres (mm); d is the diameter of the conductor in millimetres (mm).			

The partial discharge shall be measured in accordance with BS 7870-2:1999, **3.10.3**. The voltage shall be raised to $2.25U_0$, held for not more than 1 min, and reduced to $2U_0$ at which voltage the discharge magnitude (q) shall not exceed 5pC for Type 1 cables and 1 pC for Type 2 cables.

4.8.7 *Sequential type testing for 3.8/6.6 kV and 6.35/11 kV cables (Type 1)*

4.8.7.1 *General*

A cable length shall be subjected to the sequence of tests given in **4.8.7.2** to **4.8.7.8**. The cable length shall be not less than 10 m between terminations, excluding any joints which may be included in the test loop.

NOTE 1 Tests for power factor measurements may be carried out on separate lengths.

NOTE 2 Since the performance in these tests is not dependent on the type of bedding and oversheath, sequential type tests on the same sizes of PVC-sheathed cable to BS 7870-7.1 can be accepted in lieu of testing the cables above.

4.8.7.2 *Partial discharge test*

The partial discharge shall be measured in accordance with BS 7870-2:1999, **3.10.3**. The voltage shall be raised to $2.25U_0$, held for not more than 1 min, and reduced to $2U_0$ at which voltage the discharge magnitude (q) shall not exceed 5 pC.

4.8.7.3 *Bend test*

When tested in accordance with BS 7870-2:1999, **2.4.1.1**, the cables shall be subjected to the conditions shown in Table 8.

Table 8 — Bend test

Temperature	Diameter of test cylinder		Parameter to be measured
	3-core cable	Single core cable	
Ambient	12 ($D + d$)	15 ($D + d$)	Partial discharge
NOTE D is the approximate overall diameter in millimetres (mm); d is the diameter of the conductor in millimetres (mm).			

The partial discharge shall be measured in accordance with BS 7870-2:1999, **3.10.3**. The voltage shall be raised to $2.25U_0$, held for not more than 1 min, and reduced to $2U_0$ at which voltage the discharge magnitude (q) shall not exceed 5 pC.

4.8.7.4 *Power factor variation with voltage*

When the power factor of each core is measured at room temperature and at voltages of $0.5U_0$, $1.0U_0$ and $2.0U_0$, the measured values shall not exceed those specified in Table 9.

Table 9 — Power factor variation with voltage

Property	XLPE	EPR
Maximum tan δ at U_0	40×10^{-4}	200×10^{-4}
Maximum increase tan δ ($0.5U_0$ to $2.0U_0$)	20×10^{-4}	25×10^{-4}

4.8.7.5 *Power factor variation with temperature*

When the power factor of each core is measured in accordance with BS 7870-2:1999, **3.11.2**, at a minimum voltage of 2 kV, the measured values shall not exceed those specified in Table 10.

Table 10 — Power factor variation with temperature

Property	XLPE	EPR
Maximum tan δ at U_0	40×10^{-4}	200×10^{-4}
Maximum tan δ at elevated temperature 95 °C to 100 °C	80×10^{-4}	400×10^{-4}

4.8.7.6 *Heating cycle test*

The heating cycle test shall be carried out in accordance with BS 7870-2:1999, **3.8.1**. The partial discharge shall then be measured in accordance with BS 7870-2:1999, **3.10.3**. The voltage shall be raised to $2.25U_0$, held for not more than 1 min, and reduced to $2U_0$ at which voltage the discharge magnitude (q) shall not exceed 5 pC.

4.8.7.7 *Impulse testing*

When tested in accordance with BS 7870-2:1999, **3.2.4.1**, no breakdown of the insulation shall occur when the sample is subjected to 10 positive and 10 negative pulses at the appropriate level as specified in Table 11. The test shall be applied at a conductor temperature of 95 °C to 100 °C and for 3-core cables the three cores shall be tested in sequence.

Table 11 — Impulse testing

Rated voltage of cable (U) kV	Impulse voltage kV
6.6	75
11	95

4.8.7.8 *Four-hour voltage test*

When tested in accordance with BS 7870-2:1999, **3.2.1.1**, there shall be no failure when a power frequency voltage of $4U_0$ is applied for 4 h.

4.8.8 ***Sequential type testing for 6.35/11 kV cables (Type 2)***

The test procedures and requirements shall be as specified in **4.8.7** with the following exceptions:

a) the heating cycle test shall be carried out in accordance with BS 7870-2:1999, **3.8.4**;

b) all measurements of partial discharge shall give a discharge magnitude not exceeding 1 pC;

c) the tests shall be performed only on a single core, 500 mm^2, 6.35/11 kV cable.

NOTE Tests on a 500 mm^2 size cable are sufficient to prove acceptable performance of cables in the entire range of 6.35/11 kV Type 2 cables, i.e. 300 mm^2 to 630 mm^2.

4.8.9 ***Special type tests on complete cable (Type 2)***

The tests given in Table 12 shall be undertaken either on a sample taken from the cable or on a sample of complete single core 11 kV cable, as appropriate.

When specified in Table 12, tests shall be undertaken on aged and unaged samples. Ageing shall be carried out in accordance with BS 7870-2:1999, **5.1.1**.

The cables shall conform to the requirements specified in Table 12.

Table 12 — Special type tests for Type 2 cables

Test description	Sample conditions		Method	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: Unaged 500 N for sample at 20 °C 100 N for sample at 70 °C 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 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 specified in BS 7870-2:1999, **5.3.1**. There shall be no significant signs of corrosion of the armour wires and no presence of free water.
Sequential electrical tests on thermally aged cable:				
a) insulation resistance	Yes	Yes	BS 7870-2:1999, **3.3.2**	The value obtained on the aged sample shall be no lower than that obtained on the unaged sample.
b) impulse voltage test followed by a.c. voltage test	Yes	No	BS 7870-2:1999, **3.2.4.2**	No breakdown of the insulation shall occur following impulses at 50 kVp. No breakdown of the insulation shall occur following the application of 12 kV.
c) voltage test on bedding and oversheath	Yes	No	BS 7870-2:1999, **3.2.3.1**	No breakdown of the bedding or oversheath shall occur following the application of 2 kV for 5 min.
d) visual examination	Yes	No	Visual examination	Each component essential for the continued function of the cable shall not show evidence of excessive deterioration including melting or bonding or deterioration of the insulation due to contact with other components of the cable.

4.9 Fire performance tests

4.9.1 *Sample selection (Type 1)*

The flame propagation, smoke emission and oxygen index tests shall be performed on the following cable sizes:

a) For single core cables, test a single core 6.6 kV or 11 kV cable in the range 300 mm^2 to 500 mm^2.

b) For 3-core cables, test a 3-core 6.6 kV or 11 kV cable of size 70 mm^2 or 95 mm^2.

The cables tested may have copper or aluminium conductors and steel or aluminium wire armour, and satisfactory performance shall be deemed to be acceptable to the cover other conductor and armour materials. However, a test shall only be accepted as covering the particular insulating material (XLPE or EPR) used in the sample.

The corrosive and acid gas test shall be performed on a sufficient number of samples to ensure that each material type to be used has been tested.

4.9.2 *Sample selection (Type 2)*

For type tests, the flame propagation, smoke emission and oxygen index tests shall be performed on any size of single core 11 kV cable in the range 300 mm^2 to 630 mm^2.

A test shall only be accepted as covering the particular insulating material (XLPE or EPR) used in the sample.

The corrosive and acid gas test shall be performed on a sufficient number of samples to ensure that each material type to be used has been tested.

For sample tests, the finished cable shall be tested in accordance with and shall meet the requirements specified in BS EN 50265-2-1. After the test the cable shall conform to the performance recommendations given in BS EN 50265-2-1:1999, Annex A.

4.9.3 *Flame propagation test (Type 1 and Type 2)*

The cable shall be subjected to the test specified in BS 7870-2:1999, **4.1.4**, using the cable arrangement for Category 1 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) after the cables have been wiped clean, the charred portion 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 cables in the assembly.

4.9.4 *Oxygen index test (Type 1 and Type 2)*

During the fire performance tests, the absolute oxygen index of samples of insulation, bedding and oversheath, taken from the complete cable, shall be determined in accordance with the test method given in BS ISO 4589-2. The values obtained shall be used to enable a nominal value, together with suitable tolerances for sample tests, to be agreed between manufacturer and purchaser.

For sample tests, the oxygen index of the insulation, bedding and oversheath shall be determined in accordance with the test method given in BS ISO 4589-2. The values obtained shall fall within the agreed tolerances on the nominal value.

4.9.5 *Smoke emission test*

4.9.5.1 *Type 1*

When tested in accordance with BS EN 50268-2, the minimum level of light transmittance throughout the test shall be greater than 60 %.

4.9.5.2 *Type 2*

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

4.9.6 *Corrosive and acid gas emission test*

4.9.6.1 *Type 1*

When tested in accordance with BS EN 50267-2-1, the level of HCl in the material under test shall be not greater than 0.5 %.

4.9.6.2 *Type 2*

When tested in accordance with BS 7870-2:1999, **4.3.1**, the average pH shall be not less than 3.8 and not greater than 10, the conductivity shall be less than 80 μS/cm and the chloride yield shall be less than 0.5 mg/g.

4.10 Resistance to water (Type 1 and Type 2)

If cables are to be buried in the ground and it is considered necessary to show evidence of long-term water resistance testing, the cables shall be tested in accordance with and shall conform to the requirements specified in BS 7870-2:1999, **5.4.8**.

5 Cables without metallic coverings

Not applicable.

6 Cables with metallic coverings

6.1 Cable designation

(Under consideration by CENELEC TC20.)

6.2 Rated voltage

The rated voltages shall be 3.8/6.6 kV and 6.35/11 kV.

6.3 Construction

6.3.1 *Conductor*

The conductors shall be of the material and type detailed in Table 1, Table 2, Table 3 and Table 4 and shall conform to the requirements of BS 6360, class 2 for stranded conductors.

All conductors shall be circular stranded compacted copper or aluminium.

6.3.2 *Insulation*

The insulation shall be either cross-linked polyethylene (XLPE) or ethylene propylene rubber (EPR) conforming to the non-electrical requirements given in Table 13. The insulation thickness shall conform to the values specified in Table 1, Table 2, Table 3 and Table 4.

The corrosive and acid gas emission of the insulation shall meet the requirements given in Table 5 when tested in accordance with the test method given in Table 5.

6.3.3 *Screens*

6.3.3.1 *Non-metallic*

Non-metallic screens shall be applied to all cables in the form of extruded layers. The insulation and screens shall be applied in the same operation.

6.3.3.2 *Metallic*

Metallic screens shall be applied to all cables and shall be in the form of a helically applied copper tape having a fault capacity of at least 1 000 A for 1 s. The screens shall be in contact for 3-core cables.

6.3.4 *Assembly of cores*

For 3-core cables the cores shall be laid up with a right-hand direction of lay. Fillers shall be used if necessary to form a substantially compact and round cable. The filler shape shall not prevent electrical contact between the screens.

The corrosive and acid gas emission of fillers and binder tape shall meet the requirements given in Table 5 when tested in accordance with the test method given in Table 5.

6.3.5 *Extruded bedding*

The bedding for Type 1 cables shall consist of a compound conforming to the requirements for ZB1 given in Table 14. The bedding for Type 2 cables shall consist of a compound conforming to the requirements for ZB2 given in Table 14.

The thickness shall conform to the values given in Table 1, Table 2, Table 3 and Table 4.

The corrosive and acid gas emission of the bedding shall meet the requirements given in Table 5 when tested in accordance with the test method given in Table 5.

6.3.6 *Armour*

The armour shall consist of a single layer of wires applied helically with a left-hand direction of lay. For all single core cables the armour shall consist of aluminium wire. For 3-core cables the armour shall consist of aluminium or steel wire.

The armouring shall conform to the following requirements, as appropriate.

a) When measured in accordance with BS 7870-2:1999, **2.1.4.3**, the diameter of round armour wire shall fall within the minimum and maximum wire diameters specified in Table 15.

b) When measured in accordance with BS 7870-2:1999, **2.5.1.1**, the mass of zinc coating of galvanized steel armour wire shall be not less than that given in Table 16.

c) The wire shall be subjected to the wrapping test specified in BS 7870-2:1999, **2.3.2**, and shall not break.

d) When measured in accordance with BS 7870-2:1999, **2.3.1.1**, the tensile strength of aluminium armour wires shall be not less than 125 N/mm^2.

Joints in steel armour wire shall be brazed or welded and any surface irregularity shall be removed.

Joints in aluminium wires shall be made by cold pressure or fusion welding and all surface irregularities 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.

If tapes are applied under or over the armour wire, the corrosive and acid gas emission shall meet the requirements given in Table 5 when tested in accordance with the test method given in Table 5.

Table 13 — Requirements for non-electrical tests for 90 °C insulation

Test	Unit	Type of compound		Test method described in
		EPR	XLPE	
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 the tensile strength:				
— median, min.	N/mm^2	8.5	12.5	
Values to be obtained for the elongation at break:				
— median, min.	%	200	200	
Properties after ageing in air oven				BS EN 60811-1-2:1995, **8.1.3**
Ageing conditions:				
— temperature	°C	135	135	
— duration of treatment	h	168	168	
Values to be obtained for the tensile strength:				
— median, min.	N/mm^2	—	—	
— variation[a], max.	%	30	25	
Values to be obtained for the elongation at break:				
— median, min.	%	—	—	
— 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	—	
Value to be obtained for the tensile strength:				
— median, min.	N/mm^2	—	—	
— variation[a], max.	%	30	—	
Values to be obtained for the elongation at break:				
— median, min.	%	—	—	
— variation[a], max.	%	30	—	
Hot set test				BS EN 60811-2-1:1995, Clause **9**
— temperature	°C	250	200	
— time under load	min	15	15	
— mechanical stress	N/mm^2	0.2	0.2	
— max. elongation under load	%	175	175	
— max. elongation after unloading	%	15	15	
Ozone resistance test				BS EN 60811-2-1:1995, Clause **8**
— temperature	°C	25 ± 2	—	
— duration	h	30	—	
— ozone concentration	ppm	250 to 300	—	
Shrinkage test				BS EN 60811-1-3:1995, Clause **10**
— temperature	°C	—	130	
— duration	h	—	1	
— shrinkage, max.	%	—	4	
Water absorption				BS EN 60811-1-3:1995, **9.2**
— temperature	°C	85	85	
— duration	h	336	336	
— max. variation of mass	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.

Table 14 — Requirements for non-electrical tests for halogen-free bedding and oversheath

Test	Unit	Type of compound				Test method described in
		ZB1	ZB2	ZM1	ZM2[a]	
Test strength and elongation at break						
Properties in the state as delivered						BS EN 60811-1-1:1995, **9.2**
Values to be obtained for the 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 60811-1-2:1995, **8.1**
Ageing conditions:						
— temperature	°C	—	100	100	100	
— duration of treatment	h	—	168	168	168	
Value to be obtained for the tensile strength:						
— median, min.	N/mm^2	—	8	10	8	
— variation[b], max.	%	—	—	±40	—	
Value to be obtained for the elongation at break						
— median, min.	%	—	50	100	75	
— variation[b], max.	%	—	—	±40	—	
Pressure test at high temperature						BS EN 60811-3-1:1995, **8.2**
— force exerted by blade	—	—	[c]	[c]	[c]	
— duration of heating under load	—	—	[d]	[d]	[d]	
— temperature	°C	—	80	80	80	
— median of the depth of penetration, max.	%	—	50	50	50	
Elongation test at low temperature						BS EN 60811-1-4:1995, **8.4**
— temperature	°C	—	—	–15	–15	
— period of application of low temperature		—	—	[e]	[e]	
— elongation without break, min.	%	—	—	30	30	
Impact test at low temperature		N/A				
— temperature	°C	—	—	–15	–15	BS EN 60811-1-4:1995, **8.5**
— period of application of low temperature		—	—	[f]	[f]	
— mass of hammer		—	—	[g]	[g]	
Insulation resistance constant min. at 20 °C	MΩ·km	—	—	0.0035		BS 7870-2:1999, **3.3.4**
Water immersion test						BS 7870-2:1999, **2.2.12**
— 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	—	

[a] Where multilayer sheaths are provided, one of the component materials shall meet the requirement.
[b] The variation is the difference between the medium value after ageing and the median value without ageing, expressed as a percentage of the latter.
[c] See BS EN 60811-3-1:1995, **8.2.4**.
[d] See BS EN 60811-3-1:1995, **8.2.5**.
[e] See BS EN 60811-1-4:1995, **8.4.4**.
[f] See BS EN 60811-1-4:1995, **8.5.5**.
[g] See BS EN 60811-1-4:1995, **8.5.4**.
[h] For cable with steel wire armour.
[i] For cable with aluminium wire armour.

Table 14 — Requirements for non-electrical tests for halogen-free bedding and oversheath (*continued*)

Test	Unit	Type of compound				Test method described in
		ZB1	ZB2	ZM1	ZM2[a]	
Ozone resistance:						BS EN 60811-2-1:1995, Clause **8**
— temperature	°C	—	—	—	25 ± 5	
— 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)						
— temperature	°C	—	—	—	70	
— duration	h	—	—	—	4	
Tensile strength maximum variation	%	—	—	—	±20	
Elongation at break maximum	%	—	—	—	±40	
Pulling lubricant resistance:						BS 7870-2:1999, **5.2**
— temperature	°C	—	—	—	20 ± 5	
— immersion period	h	—	—	—	84 × 24	
Tensile strength maximum variation	%	—	—	—	±20	
Elongation at break maximum variation	%	—	—	—	±40	
Additional requirement		—	—	—	No removal of semi-conducting coating on single core cables	
Water permeation requirements:						BS 7870-2:1999, **2.5.5**
Max. value of the product of the median value of water vapour permeability and median value of sample thickness	g/m^2 per 24 h	—	8×10^{-3} [h]	—	8×10^{-3} [h]	
		—	5×10^{-3} [i]	—	5×10^{-3} [i]	
Water permeation after ageing						BS 7870-2:1999, **2.5.5**
Ageing condition:						
As given in BS 7870-2:1999, **5.1.1**						
Requirements:	g/m^2 per 24 h	—	8×10^{-3} [h]	—	8×10^{-3} [h]	
Max. value of the product of the median value of water vapour permeability and median value of sample thickness			5×10^{-3} [i]		5×10^{-3} [i]	
Tear resistance	N/mm	—	—	3.5	3.5	BS 7870-2:1999, **2.2.2.2**

[a] Where multilayer sheaths are provided, one of the component materials shall meet the requirement.
[b] The variation is the difference between the medium value after ageing and the median value without ageing, expressed as a percentage of the latter.
[c] See BS EN 60811-3-1:1995, **8.2.4**.
[d] See BS EN 60811-3-1:1995, **8.2.5**.
[e] See BS EN 60811-1-4:1995, **8.4.4**.
[f] See BS EN 60811-1-4:1995, **8.5.5**.
[g] See BS EN 60811-1-4:1995, **8.5.4**.
[h] For cable with steel wire armour.
[i] For cable with aluminium wire armour.

Table 15 — Diameter of round wire armour

Nominal diameter of wire mm	Wire diameter	
	Minimum mm	Maximum mm
1.25	1.18	1.32
1.6	1.51	1.69
2.0	1.90	2.10
2.5	2.37	2.63
3.15	2.99	3.31

Table 16 — Mass of zinc coating

Nominal diameter of armour wire mm	Minimum mass of zinc coating g/m^2
1.25	150
1.6	172
2.0	180
2.5	195
3.15	206

6.3.7 *Oversheath*

The oversheath for Type 1 cables shall consist of an extruded layer of black compound conforming to the requirements for ZM1 given in Table 14. The oversheath for Type 2 cables shall consist of an extruded layer of black compound conforming to the requirements for ZM2 given in Table 14.

The oversheath thickness shall conform to the specified value in Table 1, Table 2, Table 3 and Table 4.

The corrosive and acid gas emission of the oversheath shall meet the requirements given in Table 5 when tested in accordance with the test method given in Table 5.

If the resistance of the oversheath is to be determined after the cable has been installed, the oversheath for single core cables shall have a suitable semi-conducting coating. The coating shall be capable of withstanding the rigours of installation and shall adhere to the surface of the sheath when the cable is operating at maximum conductor temperature.

6.4 Tests

Conformity to the requirements of **6.3** shall be checked by inspection and by the tests specified in Table 5.

Annex A (informative)
Guide to use

A.1 General

This annex gives guidance on the use, storage, transport and disposal of the cables specified in this section of BS 7870.

A.2 Object

The object of this annex is to provide recommendations for the selection, storage, transportation, installation and disposal of the cables specified in this section of BS 7870.

A.3 Recommendations for use

A.3.1 *Permissible application*

The cables are intended for installation indoors or outdoors for fixed installations where low emission of smoke and corrosive fumes is required in the event of fire.

Where Type 1 cables are to be installed in ducts or directly buried in the ground, advice should be sought from the manufacturer with regard to their suitability.

Type 2 cables are assessed by the tests in this section of BS 7870 as being suitable for such installations.

A.3.2 *Maximum permissible voltage*

The maximum permissible voltages for the cables are shown in Table A.1.

Table A.1 — Maximum permissible voltage

System voltage		System category	Minimum rated voltage of cable
Nominal voltage kV	Maximum sustained voltage kV		kV
6.6 or 6	7.2	A or B	3.8/6.6
6.6 or 6	7.2	C	6.35/11
11 or 10	12.0	A or B	6.35/11

A.3.3 *Earth fault current*

The wire armouring on these cables possesses a substantial earth fault capacity. Further information should be obtained from the manufacturer.

For MV installations it is common practice to earth the copper tape screen at both ends of the cable, whilst earthing the wire armour at one end only, normally the supply end. In this situation, the earth fault magnitude should be limited by earthing the transformer neutral through an appropriate impedance, such that the earth fault level in the copper screen is kept at $\leqslant$1 000 A. Where the armour of MV cables is to be used as part of the earth fault circuit, values of gross cross-sectional areas and armour resistance are given, for information, in Table A.2, Table A.3, Table A.4 and Table A.5.

Table A.2 — Armour resistance for 3.8/6.6 kV cables

Nominal cross-sectional area of conductors	3-core cables				Single core cables	
	Steel wire armour		Aluminium wire armour		Aluminium wire armour	
	Cables with stranded copper conductors	Cables with stranded aluminium conductors	Cables with stranded copper conductors	Cables with stranded aluminium conductors	Cables with stranded copper conductors	Cables with stranded aluminium conductors
mm^2	Ω	Ω	Ω	Ω	Ω	Ω
50	0.68	0.68	0.14	0.14	0.43	0.43
70	0.63	0.63	0.13	0.13	0.40	0.40
95	0.58	0.58	0.12	0.12	0.38	0.38
120	0.54	0.54	0.12	0.12	0.36	0.36
150	0.52	0.52	0.11	0.11	0.34	0.34
185	0.48	0.48	0.097	0.097	0.25	0.25
240	0.44	0.44	0.089	0.089	0.23	0.23
300	0.32	0.32	0.064	0.064	0.22	0.22
400	0.29	0.29	0.058	0.058	0.20	0.20
500	—	—	—	—	0.14	0.14
630	—	—	—	—	0.13	0.13
800	—	—	—	—	0.12	—
1 000	—	—	—	—	0.11	—

Table A.3 — Armour resistance for 6.35/11 kV cables

Nominal cross-sectional area of conductors	3-core cables				Single core cables	
	Steel wire armour		Aluminium wire armour		Aluminium wire armour	
	Cables with stranded copper conductors	Cables with stranded aluminium conductors	Cables with stranded copper conductors	Cables with stranded aluminium conductors	Cables with stranded copper conductors	Cables with stranded aluminium conductors
mm^2	Ω	Ω	Ω	Ω	Ω	Ω
50	0.63	0.63	0.13	0.13	0.40	0.40
70	0.58	0.58	0.12	0.12	0.37	0.37
95	0.53	0.53	0.11	0.11	0.35	0.35
120	0.50	0.50	0.11	0.11	0.34	0.34
150	0.48	0.48	0.097	0.097	0.25	0.25
185	0.45	0.45	0.092	0.092	0.23	0.23
240	0.33	0.33	0.067	0.067	0.22	0.22
300	0.31	0.31	0.063	0.063	0.21	0.21
400	—	—	—	—	0.19	0.19
500	—	—	—	—	0.14	0.14
630	—	—	—	—	0.13	0.13

Table A.4 — Gross cross-sectional areas of armour wires for 3.8/6.6 kV cables

Nominal cross-sectional area of conductors	Cross-sectional area of armour wires	
	Single core cables with stranded conductors	3-core cables with stranded conductors
mm^2	mm^2	mm^2
50	74	230
70	80	250
95	84	269
120	90	289
150	96	304
185	128	328
240	141	358
300	150	498
400	166	553
500	230	—
630	250	—
800	284	—
1 000	309	—

Table A.5 — Gross cross-sectional areas of armour wires for 6.35/11 kV cables

Nominal cross-sectional area of conductors	Cross-sectional area of armour wires	
	Single core cables with stranded conductors	3-core cables with stranded conductors
mm^2	mm^2	mm^2
50	80	250
70	86	269
95	92	294
120	96	314
150	128	328
185	141	348
240	147	483
300	157	514
400	169	—
500	230	—
630	255	—

A.4 Recommendations for storage, transport and disposal

A.4.1 *Storage*

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

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

A.4.2 *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.4.3 *Incineration of scrap cable*

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

A.4.4 *Cable and 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.5 Recommendations for cable laying and installation

A.5.1 *General*

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

The latter should include:

a) the proximity of other cables and their mutual heating effect; the specific earth resistance; protection against solar radiation; the earth loop impedance, the capability of the cable to withstand the worst anticipated fault conditions of the system;

b) the leakage of stray currents;

c) potential attack from solvent substances;

d) soil subsidence and other forms of violent vibrations;

e) protection against mechanical damage during and after installation.

The following provisions should also be made.

1) When cables are laid in ducts, the correct size of duct should be used to avoid damage during installation and overheating.

2) Where cables are laid in surface troughs, there should be adequate ventilation which, however, will not permit the entry of debris.

3) The cable support system should be designed to avoid damage or danger under normal or fault conditions.

A.5.2 *Environmental conditions*

The lowest recommended temperature for installation is 0 °C for the preceding 24 h.

Loaded cables can have a surface temperature that requires protection against accidental contact.

A.5.3 *Pulling tensions*

The maximum pulling load should not exceed the following values:

a) for copper conductors, 50 N/mm^2 of CSA;

b) for aluminium conductors, 30 N/mm^2 of CSA.

CSA refers only to the conductor(s).

Where long lengths of cable are to be pulled along difficult routes, where the tension increases sharply due to bends, the values for maximum side wall pressure (tension divided by bending radius) recommended by the supplier should be taken into account.

A.5.4 *Bending radii*

During installation, no cable should be bent to a smaller radius than the following, where D is the tabulated overall diameter:

a) for armoured 3-core cables,12D;

b) for armoured single core cables, 20D.

A.5.5 *Cable installation*

There should be a significant measure of similarity between the way in which cables are installed for the test for fire propagation and the actual installations.

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

All bonds for earthing should have adequate conductance, be as short and straight as possible and be protected against corrosion, especially where dissimilar metals are involved.

A.6 Tests after installation

A.6.1 *General*

If tests are required after installation, they should consist of:

a) a d.c. test on the cable insulation;

b) a test on the oversheath.

A.6.2 *D.C. test on cable insulation*

The d.c. test should be carried out in accordance with Table A.6, with the voltage applied for 5 min.

Table A.6 — D.C. test on cable insulation

System voltage kV	D.C. voltage applied, core to earth kV
3.8/6.6	15
6.35/11	25

The manufacturer should be consulted before carrying out this test on cables that have been in service for more than 1 year.

A.6.3 *Test on oversheath*

Where an outer conductive layer is applied to the oversheath, a d.c. voltage equal to 4 kV/mm of tabulated thickness (10 kV maximum) should be applied for 1 min.

If the test is carried out after jointing, the joints should be suitably insulated from earth.

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 kV 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 up to and including 20.8/36 (42) kV.*

HD 622 S1:1996, *Power cables having rated voltage 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.*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL