BRITISH STANDARD

BS 7870-8.2:2003

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 8.2: Single wire armoured and PVC 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

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 16 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 37568 4

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 7870-8.2 implements HD 627-3A2 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 19 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 polyethylene insulated, PVC sheathed cables. It specifies requirements for multipair cables (4 pairs to 61 pairs) having copper conductors with filled and unfilled interstices, normal and increased insulation and bedding thicknesses and either steel or aluminium wire armour.

This section of BS 7870 is applicable to cables for use underground in wet conditions and also for withstanding high levels of induced voltage.

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 EN 60811-4-2:2000, *Insulating and sheathing materials of electric and optical fibre cables — Common test methods — Part 4-2: 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 7655-4.1, *Specification for insulating and sheathing materials for cables — Part 4: PVC sheathing compounds — Section 4.1: Harmonized types.*

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 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 60811-1-3:1995, *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 60811-4-1:1995, *Insulating and sheathing materials for electric cables — Common test methods — Part 4-1: Methods specific to polyethylene and polypropylene compounds — Resistance to environmental stress cracking — Wrapping test after thermal ageing in air — Measurement of the flow index — Carbon black and/or mineral content measurement in PE.*

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

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 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 **15.2**.

5 Insulation

The insulation shall be polyethylene type TI Y conforming to the requirements specified in Table 7.

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 and shall form a compact and homogenous body.

The thickness of the insulation shall conform to the requirements specified in Table 1, Table 2 and Table 3.

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

6 Identification of pairs

The pairs shall be identified by colours in the following sequence.

a) 4-pair cable:
- — black/violet;
- — red/yellow;
- — green/brown;
- — blue/white;

b) 7-pair cable:

1) centre pair: red/yellow;

2) outer layer:
- — black/violet;
- — orange/grey[1)];
- — green/brown;
- — orange/blue[1)];
- — green/brown;
- — orange/white[1)];

c) 19-pair cable:

1) centre pair and first layer: as 7-pair above;

2) outer layer:
- — black/violet;
- — odd pairs: red/yellow;
- — even pairs: green/brown;
- — blue/white;

d) 37-pair cable:

1) centre pair, first and second layers: as 19-pair above;

2) outer layer:
- — black/violet;
- — odd pairs: red/yellow;
- — even pairs: green/brown;
- — blue/white;

e) 61-pair cable:

1) centre pair, first, second and third layers: as 37-pair above;

2) outer layers:
- — black/violet;
- — odd pairs: red/yellow;
- — even pairs: green/brown;
- — blue/white.

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

[1)] Nominated pairs designed for use at carrier frequencies in the range 12 kHz to 108 kHz.

7 Assembly of pairs, fillers and binders

Cables shall be twinned with a maximum lay length of 150 mm. The lengths of lay of adjacent pairs shall meet all the electrical requirements.

All laid-up assemblies shall be bound with a suitable tape or tapes applied with an overlap. Where cables are required to be filled, a suitable compound having a nominal drop point of not less than 55 °C shall be used.

8 Bedding layer

The bedding shall be an extruded layer of polyethylene compounds type TM Y, conforming to the requirements specified in Table 1, Table 2 and Table 3.

9 Armouring

The armouring shall consist of a single layer of galvanized steel or aluminium wires, conforming to the requirements specified in Table 1, Table 2 and Table 3, applied in the opposite direction to the outer layer of pairs.

Joints in aluminium wire armour shall be cold pressure or fusion welded.

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

NOTE A layer of waterproof compound may be applied over the wires by agreement between the manufacturer and the purchaser.

10 Oversheath

The oversheath shall be an extruded layer of black PVC compound type TM 1, conforming to the requirements of BS 7655-4.1.

When required by the purchaser an outer semi-conducting coating shall be applied to serve as an electrode for a voltage test on the oversheath.

11 Marking

11.1 External marking

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

Element	Example of marking
a) Electric cable	ELECTRIC CABLE
b) Voltage designation	
1) For unfilled cables	TELE
2) For filled cables	TELE F
c) British Standard number[2)]	BS 7870-8.2
d) Manufacturer's identification	XYZ

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

For cables with tabulated[3)] 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[3)] approximate overall diameters of 15 mm or less, the elements shall be arranged as for cables of greater than 15 mm diameter, except that the marking for elements a), b) and c) shall appear on one or more primary lines.

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

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

Conformity shall be checked by visual examination and measurement as specified in **14.7**.

11.2 Identification of year of manufacture

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

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

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

Conformity shall be checked by visual examination and measurement as specified in **14.7**.

11.3 Mark of an approval organization

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

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

Conformity shall be checked by visual examination and measurement as specified in **14.7**.

[2)] Marking BS 7870-8.2:2003 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.

[3)] See Table 1.

11.4 Additional marking

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

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

Conformity shall be checked by visual examination and measurement as specified in **14.7**.

12 Dimensions

The dimensions of the component layers shall be as specified in Table 1, Table 2 and Table 3.

Table 1 — Multipair cables with steel wire armouring where induced voltage does not exceed 5 kV

Dimensions in millimetres

Cable type	Conductor		Thickness of insulation		Thickness of bedding		Diameter			Thickness of PVC oversheath				Overall diameter[a]	
	No. of wires	Diameter of wires[a]	Min. average	Min. at any point	Nominal	Min. at any point	Under bedding[a]	Over bedding[a]	Armour wire[a]	Without graphite coating		With graphite coating		Without graphite coating	With graphite coating
										Nominal	Min. at any point	Nominal	Min. at any point		
4-pair	1	0.8	0.5	0.38	0.8	0.58	7.9	9.5	0.9	1.4	0.92	1.8	1.24	14.1	14.9
7-pair	1	0.8	0.5	0.38	0.8	0.58	9.7	11.4	0.9	1.5	1.00	1.8	1.24	16.3	16.9
19-pair	1	0.8	0.5	0.38	1.0	0.75	16.0	18.0	1.6	1.7	1.16	1.8	1.24	24.8	25.0
37-pair	1	0.8	0.5	0.38	1.0	0.75	22.3	24.3	1.6	1.9	1.32	2.0	1.40	31.5	31.7
61-pair	1	0.8	0.5	0.38	1.2	0.92	28.4	31.0	2.0	2.1	1.48	2.3	1.64	40.4	40.8

[a] Nominal value.

Table 2 — Multipair cables with steel wire armouring where induced voltage does not exceed 15 kV

Dimensions in millimetres

Cable type	Conductor		Thickness of insulation		Thickness of bedding		Diameter			Thickness of PVC oversheath				Overall diameter[a]	
	No. of wires	Diameter of wires[a]	Min. average	Min. at any point	Nominal	Min. at any point	Under bedding[a]	Over bedding[a]	Armour wire[a]	Without graphite coating		With graphite coating		Without graphite coating	With graphite coating
										Nominal	Min. at any point	Nominal	Min. at any point		
4-pair	1	0.8	0.8	0.66	1.8	1.43	10.4	14.0	1.25	1.6	1.08	1.8	1.24	19.8	20.2
7-pair	1	0.8	0.8	0.66	1.8	1.43	12.9	16.6	1.25	1.6	1.08	1.8	1.24	22.5	22.9
19-pair	1	0.8	0.8	0.66	1.8	1.43	21.3	24.9	1.6	1.9	1.32	2.0	1.40	32.1	32.3
37-pair	1	0.8	0.8	0.66	1.8	1.43	29.5	33.3	2.0	2.1	1.48	2.4	1.72	41.7	42.3
61-pair	1	0.8	0.8	0.66	1.8	1.43	37.8	41.6	2.5	2.4	1.72	2.7	1.96	51.6	52.2

[a] Nominal value

Table 3 — Polyethylene-insulated, multipair cables for use where the induced voltage would otherwise exceed 15 kV (aluminium wire armoured)

Dimensions in millimetres

Cable type	Conductor		Thickness of insulation		Thickness of bedding		Diameter			Thickness of PVC oversheath with graphite coating		Overall diameter[a]
	No. of wires	Diameter of wires[a]	Min. average	Min. at any point	Nominal	Min. at any point	Under bedding[a]	Over bedding[a]	Armour wire[a]	Nominal	Min. at any point	
4-pair	1	0.8	0.8	0.66	1.8	1.43	10.4	14.0	2.0	1.8	1.24	21.7
7-pair	1	0.8	0.8	0.66	1.8	1.43	12.9	16.6	2.0	1.8	1.24	24.4
19-pair	1	0.8	0.8	0.66	1.8	1.43	21.3	24.9	2.0	2.0	1.40	33.1
37-pair	1	0.8	0.8	0.66	1.8	1.43	29.5	33.3	2.0	2.3	1.64	42.1
61-pair	1	0.8	0.8	0.66	1.8	1.43	37.8	41.6	2.0	2.7	1.96	52.3

[a] Nominal value.

13 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**	**14.2**
Insulation resistance at 20 °C	R	BS 7870-2:1999, **3.3.2**	**14.3**
Insulation resistance at 70 °C	S	**15.10**	**15.10**
Voltage	R	BS 7870-2:1999, **3.2.1.2**	**14.4**
Mutual capacitance	T	IEC 60189-1:1986, **5.4**	**16.8**
Capacitance unbalance	S	IEC 60189-1:1986, **5.5**	**15.4**
Inductance	T	**16.9.1**	**16.9.2**
Spark test on oversheath	R	BS 7870-2:1999, **3.6.1**	**14.5**
Voltage test on oversheath	R	BS 7870-2:1999, **3.2.3.1**	**14.6**
Provisions covering constructional and dimensional characteristics			
Conductor material and construction	S	Visual examination	**15.2**
Insulation:			
— application	S	Visual examination	**15.3**
— thickness	S	BS 7870-2:1999, **2.1.1**	**15.3**
Pair identification	S	Visual examination	**15.5**
Laid-up pairs	S	Visual examination	**15.6**
Compatibility of filling medium	T	Annex B	**16.10**
Water penetration	S	Annex C	**15.11**
Bedding layer thickness	S	BS 7870-2:1999, **2.1.2**	**15.7**
Armour wire:			
— wire diameter	S	BS 7870-2:1999, **2.1.4.3**a)	**15.8**
— mass of zinc coating	T	BS 7870-2:1999, **2.5.1.1**	**16.4**
— wrapping test	T	BS 7870-2:1999, **2.3.2**	**16.5**
— tensile strength of aluminium wire	T	BS 7870-2:1999, **2.3.1.1**	**16.6**
Oversheath thickness	S	BS 7870-2:1999, **2.1.2**	**15.9**
Cable markings	R	Visual examination	**14.7**
Non-electrical tests on materials			
Insulation	T	Table 7	**16.2**
Bedding	T	Table 7	**16.3**
Oversheath	T	BS 7655-4.1	**16.7**

14 Routine tests

14.1 General

Routine tests shall be performed in accordance with the schedule of tests in Table 4 and **14.2** to **14.7**.

14.2 Conductor resistance

When measured in accordance with BS 7870-2:1999, **3.1.1**, the conductor resistance shall not exceed 73.6 Ω for 1 km loop at 20 °C.

14.3 Insulation resistance

When measured in accordance with BS 7870-2:1999, **3.3.2**, the insulation resistance shall be not less than the following values at 20 °C:

a) for filled cable, 5 000 MΩ/km;

b) for unfilled cable, 40 000 MΩ/km.

NOTE An appropriate group test procedure may be adopted to facilitate testing. The measured value should not be less than the appropriate value given in Table 5. Should the measured group insulation resistance be less than specified, then the individual cores should be tested as given above.

Table 5 — Group insulation resistance

Number of wires in group	Insulation resistance for 1 000 m of cable at 20 °C	
	Unfilled MΩ	Filled MΩ
1 to 5	40 000	5 000
6 to 10	27 000	3 400
11 to 15	20 000	2 500
16 to 20	16 000	2 000
21 to 25	12 500	1 550

14.4 Voltage test

When the voltage test is carried out in accordance with BS 7870-2:1999, **3.2.1.2**, using one of the following voltages for 1 min, no breakdown of the insulation shall occur.

a) for induced voltage levels up to 5 kV (Table 1):
5 kV a.c. between each conductor and the remaining conductors connected to the armour and earthed;

b) for induced voltage levels up to 15 kV (Table 2):
10 kV a.c. between each conductor and the remaining conductors connected to the armour and earthed;

c) for induced voltage levels above 15 kV (aluminium wire armoured) (Table 3):
15 kV a.c. or 22.5 kV d.c. between all conductors bunched and armour, which shall be earthed.

14.5 Spark test on oversheath

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

14.6 Voltage test on oversheath

When the PVC oversheath is graphite coated a d.c. voltage shall be applied between the armour and the graphite layer for 1 min in accordance with BS 7870-2:1999, **3.2.3.1**.

The oversheath shall withstand a voltage equal to 8 kV/mm of tabulated oversheath thickness in the relevant table.

14.7 Cable markings

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

15 Sample tests

15.1 General

Sample tests shall be performed in accordance with the schedule of tests in Table 4 and **15.2** to **15.11**.

15.2 Conductor material and construction

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

15.3 Insulation

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

The thickness of the insulation shall be measured on all cores up to 5-pair, and for larger pairages, on any 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 conform to the value specified in Table 1, Table 2 and Table 3, as appropriate.

If any of the thicknesses measured does not conform to the requirements specified in Table 1, Table 2 and 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.

15.4 Capacitance unbalance

When measured in accordance with IEC 60189-1:1986, **5.5**, and corrected to 500 m by using the following equation, the capacitance unbalance value shall not exceed 500 pF, except for carrier pairs where the value shall not exceed 50 pF.

$$\frac{1}{2}\left[\frac{L}{500}+\left(\frac{L}{500}\right)^{1/2}\right]$$

where L is the drum length.

15.5 Pair identification

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

15.6 Laid-up pairs

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

15.7 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 1, Table 2 and Table 3, as appropriate.

If any of the thicknesses measured does not conform to the requirements specified in Table 1, Table 2 and 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.

15.8 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 6.

Table 6 — 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

15.9 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 1, Table 2 and Table 3, as appropriate.

If any of the thicknesses measured does not conform to the requirements specified in Table 1, Table 2 and 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.

15.10 Insulation resistance

When measured on a sample length of 20 m after 24 h immersion in water at 70 °C and corrected to 1 km, the insulation resistance shall be not less than the following values:

a) for unfilled cable, 350 MΩ;

b) for filled cable, 100 MΩ.

15.11 Water penetration test for filled cables

When tested in accordance with Annex C, there shall be no moisture detected at the far end of the cable when examined by a UV light source.

16 Type tests

16.1 General

Type tests shall be performed in accordance with the schedule of tests in Table 4 and **16.2** to **16.10**.

16.2 Insulation

The insulation shall be tested in accordance with Table 7 and shall conform to the requirements for type TI Y.

Table 7 — Requirements for non-electrical tests on polyethylene

Parameter	Unit	Type of compound		Test method described in
		TI Y	TM Y	
Density	g/cm^3	Record	Record	BS EN 60811-1-3:1995, Clause **8**
Melt flow index		Record	Record	BS EN 60811-4-1:1995, Clause **10**
Tensile strength at yield, min.	N/mm^2	—	8	BS EN 60811-1-1:1995, Clause **9**
Tensile strength, min.	N/mm^2	10	10	BS EN 60811-1-1:1995, Clause **9**
Elongation at break, min.	%	300	300	BS EN 60811-1-1:1995, Clause **9**
Environmental stress crack resistance				BS EN 60811-4-1:1995, Clause **8**
— failures compound (max.)		—	2	
— failures sheath (max.)		—	0	
Filling compound absorption, max.	%	15	15	BS EN 60811-4-2:2000, Clause **11**
Change of tensile strength after absorption				BS EN 60811-1-1:1995, Clause **9**
— min.	N/mm^2	7.5	7	
— variation (max.)	%	–25	–15	
Change in elongation at break after absorption				BS EN 60811-1-1:1995, Clause **9**
— min.	%	200	—	
— variation (max.)	%	–50	—	
Resistance to oxidation (time)	h	1 000	—	BS EN 60811-4-2:2000, Annex A
Oxidative induction time	min	Record	Record	BS EN 60811-4-2:2000, Annex B
Carbon black content	%	—	2.5 ± 0.5	BS EN 60811-4-1:1995, Clause **11**

16.3 Bedding

The bedding shall be tested in accordance with the test methods specified in Table 7 and shall conform to the requirements for type TM Y.

16.4 Mass of zinc coating of galvanized steel armour wires

When measured in accordance with BS 7870-2:1999, **2.5.1.1**, the mass of zinc coating of galvanized steel armour wires shall be not less than that specified in Table 8.

Table 8 — 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

16.5 Wrapping test for galvanized steel armour wires

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

16.6 Tensile strength of aluminium wire

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.

16.7 Oversheath

The oversheath shall be tested in accordance with BS 7655-4.1 and shall conform to the requirements for type TM 1.

16.8 Mutual capacitance

When measured in accordance with IEC 60189-1:1986, **5.4**, but on a full drum length, the average value of all the measurements for 1 km of cable shall not exceed the values given in Table 9.

Table 9 — Requirements for capacitance

Insulation thickness	Cable type	
	Unfilled	Filled
mm	nF	nF
0.5	50	60
0.8	40	50

16.9 Inductance

16.9.1 *Method*

This 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 5 kHz, corrected to 500 m and expressed in nanohenrys (nH).

16.9.2 *Requirement*

When measured in accordance with **16.9.1** on a full drum length and at a frequency of 5 kHz between carrier pairs, and corrected to 500 m using the following equation, the inductance value shall not exceed 0.5 mH.

$$\frac{1}{2}\left[\frac{L}{500}+\left(\frac{L}{500}\right)^{1/2}\right]$$

where L is the drum length.

16.10 Compatibility of materials test for filled cables

When tested in accordance with Annex B:

a) the test piece on the glass mandrel shall show no cracks or splits in the insulation visible to the naked eye;

b) the test piece shall be removed from the mandrel and three 400 mm long specimens shall be cut from its central portion. One end of each specimen shall be tightly wound manually over the other end to give at least 20 continuous turns. There shall be no cracks or splits in the insulation visible to the naked eye.

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 underground in wet conditions provided the "filled" option is used. They may also be installed alongside high voltage cables provided the appropriate design is selected after considering any possible induced voltage arising from a fault in the adjacent power cable.

These cables may be used indoors but they should not be installed where fire propagation is a risk or where the emission of corrosive fumes and excessive smoke in the event of a fire is forbidden.

These cables are suitable to operate in an environmental temperature not exceeding 70 °C, taking into account any heat generated by adjacent power cables.

A.2.2 *Maximum permissible voltage*

These cables may operate up to 110 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*

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

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

A.3.2 *Transport*

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

A.3.3 *Incineration of scrap cable*

The 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 and any induced voltage likely to arise in the event of a fault upon the adjacent cable;

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.

A.5 Tests after installation (before jointing)

When required, the following tests should be carried out.

a) Confirm continuity of all conductors.

b) Measure the insulation resistance of each length after applying 500 V d.c. for 1 min and confirm that it is not lower than the following values:

— for unfilled cable, 40 000 MΩ/km;

— for filled cable, 5 000 MΩ/km.

c) Apply a d.c. voltage of 4 kV/mm of nominal oversheath thickness for 1 min without failure between the armour and the outer conducting surface of the oversheath.

A.6 Tests after installation (after jointing)

When required, the following tests should be carried out.

a) For induced voltages not exceeding 5 kV:

Apply 7.5 kV d.c. for 1 min without failure between each conductor and the remaining conductors connected to the armour and earthed.

b) For induced voltages not exceeding 15 kV:

Apply 15 kV d.c. for 1 min without failure between each conductor and the remaining conductors connected to the armour and earthed and 22.5 kV d.c. for 1 min without failure between all conductors bonded and the armour which should be earthed.

Where transmission tests are required, these should consist of attenuation, cross talk and impedance using test methods agreed between the customer and the manufacturer.

Annex B (normative)
Compatibility of filling materials

B.1 General

The purpose of this test is to ascertain that the insulation and the filling compound are compatible.

B.2 Samples

Tests shall be carried out on samples of single core cables in all the specified colours, having 0.5 mm thick insulation and 0.8 mm conductor diameter, either as manufactured or as taken from the finished cable, at the discretion of the manufacturer.

B.3 Procedure

B.3.1 Each 6 m length of insulated core shall be maintained fully immersed (except for 100 mm core ends) in the filling compound under test. The core shall not be excessively bent or twisted.

NOTE A convenient procedure is to wind the core on to a glass beaker 70 mm to 80 mm in diameter, which is then placed into a cylindrical glass container 90 mm to 100 mm in diameter. The annular space is filled with the compound at a temperature that should not exceed the maximum temperature at which the filling compound is applied to the cable during manufacture.

B.3.2 The temperature of the filling compound shall be maintained at (70 ± 2) °C for 336 h.

B.3.3 The core shall then be removed from the filling compound while still hot, allowed to cool to room temperature and wiped with a soft cloth to remove the filling compound from the surface. The 150 mm ends of the core shall be cut off and the remainder divided into three test pieces of equal length.

B.3.4 Each test piece shall be loosely wound on to a separate glass tube mandrel 40 mm to 50 mm in diameter and about 200 mm long to produce a helical coil with 3 mm to 5 mm separation between the turns. The free ends of the core shall be secured to the mandrel (without introducing any twists or sharp bends in the core ends). The mandrel shall then be placed in an ageing cell in the form of a glass tube, 65 mm to 70 mm in diameter and 300 mm long, sealed at one end. The cell shall be covered with a well-fitting but not airtight lid. The ageing cells, each containing one test piece only, shall be maintained at (105 ± 3) °C in air circulating ovens for 3 000 h.

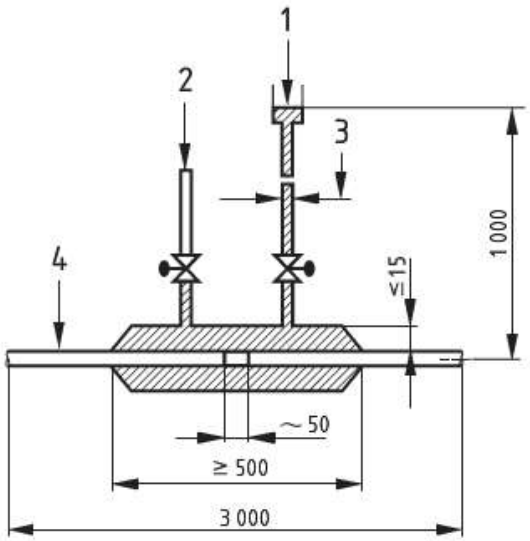
B.3.5 At the end of this period the test pieces shall be removed from the ageing cells, or cooled to room temperature.

Annex C (normative)
Water penetration test

A circumferential portion of sheath and wrapping 25 mm wide shall be removed 3 m from one end of a sample length of cable and a water tight gland shall be applied over the exposed cores so as to bridge the gap in the sheath. The cable shall be supported horizontally and a 1 m head of water containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied to the core for 24 h at a temperature of (20 ± 5) °C.

NOTE The test arrangement is shown in Figure C.1.

Dimensions in millimetres



Key

1 Water header tank
2 Vent
3 Nominal internal diameter of pipe, 10 mm
4 Cable

Figure C.1 — Water penetration test arrangement

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