BS 6883:1999

Elastomer insulated cables for fixed wiring in ships and on mobile and fixed offshore units — Requirements and test methods

ICS 47.020.60

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Committees responsible for this British Standard

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Foreword

This British Standard has been prepared by Subcommittee GEL/20/6. It supersedes BS 6883:1991 which is withdrawn.

This revision has been rationalized, for the 150/250 V cables (pairs, triples and quads) specified in clause **6** and the 600/1 000 V single and multi-core cables specified in clause **7**, to preclude certain cable types and conductor sizes in accordance with current industry practice.

The revision includes the additional use of class 5 conductors to ease the installation and termination of cables in confined spaces.

BS 6883 is now complemented by BS 7917 which specifies a range of cables having fire resistance (limited circuit integrity) in the event of fire.

The minimum and maximum diameters, both those over the inner sheath and those over the outer sheath, quoted in the relevant construction tables are indicative only and do not take into account any glanding requirements.

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 the use of substances and/or 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.

Annexes C, D, E, F, G, H, J, K, L, M, N P and Q are normative. Annexes A and B and annexes R and S are informative.

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

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

Summary of pages

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1 Scope

This British Standard specifies requirements for the construction, dimensions, and mechanical and electrical properties of cables for fixed wiring of lighting, power, control, instrumentation and propulsion circuits in ships and on mobile and fixed offshore units, having a rated voltage up to and including 8 700/15 000 V.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of the British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 358, *Method for the measurement of voltage with sphere gaps (one sphere earthed).*

BS 923-1, *Guide on high voltage testing techniques — Part 1: General.*

BS 4066-1, *Tests on electric cables under fire conditions — Part 1: Method of test on a single vertical insulated wire or cable.*

BS 4066-3:1994, *Tests on electric cables under fire conditions — Part 3: Tests on bunched wires or cables.*

BS 4109, *Specification for copper for electrical purposes. Wire for general electrical purposes and for insulated cables and flexible cords.*

BS 4608, *Specification for copper for electrical purposes. Rolled sheet, strip or foil.*

BS 4727-2:Group 08, *Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms — Part 2: Terms particular to power engineering — Group 08: Electric cables.*

BS 4828:1985, *Guide for partial discharge measurements.*

BS 6360:1991, *Specification for conductors in insulated cables and cords.*

BS 6425-1, *Tests on gases evolved during the combustion of materials taken from cables — Part 1: Method for determination of amount of halogen acid gas evolved during combustion of polymeric materials taken from cables.*

BS 7622-1, *Measurement of smoke density of electric cables burning under defined conditions — Part 1: Test apparatus.*

BS 7622-2:1993, *Measurement of smoke density of electric cables burning under defined conditions — Part 2: Test procedure and requirements.*

BS 7655-1.2:1997, *Specification for insulating and sheathing materials for cables — Part 1: Cross-linked elastomeric insulating compounds — Section 1.2: General 90 °C application.*

BS 7655-2.6:1993, *Specification for insulating and sheathing materials for cables — Part 2: Elastomeric sheathing compounds — Section 2.6: Sheathing compounds for ships wiring and offshore applications.*

BS EN 10257-1, *Zinc or zinc alloy coated non-alloy steel wire for armouring either power cables or telecommunication cables — Part 1: Land cables.*

BS EN 12166:1998, *Copper and copper alloys — Wire for general purposes.*

BS EN 60811-1-1, *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.*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 4727-2:Group 08 and the following apply.

3.1 voltages

3.1.1

rated voltage

reference voltage for which the cable is designed

NOTE This is expressed as a combination of the values U_0 and U.

3.1.2

rated voltage U_0

nominal power-frequency voltage between conductor(s) and armour or earth for which the cable is suitable

3.1.3

rated voltage U

nominal power-frequency voltage between phase conductors for which the cable is suitable

3.1.4

maximum voltage U_m

maximum sustained power-frequency voltage between phase conductors, for which the cable is suitable

NOTE The values of U_m for the relevant voltage range are given in Table A.1.

3.2 cable types

3.2.1

individually screened pair, triple or quad cable

cable in which each individual pair, triple or quad is surrounded by an earthed metallic layer to confine the electric field and to limit the external electrical influences

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3.2.2

collectively screened pair, triple or quad cable

cable in which all pairs, triples or quads are surrounded by an overall earthed metallic layer to confine the electric field and to limit the external electrical influences

3.2.3

radial field cable

cable in which each core is covered with an individual conducting layer (insulation or core screen) having the function of control of the electric field within the insulation

3.2.4

non-radial field cable

cable where insulation or core screens are omitted resulting in a non-uniform electric field and stresses within the insulation

3.3 values

3.3.1

nominal value

value by which a quantity is designated and which is often used in tables

NOTE In this standard, nominal values usually give rise to values to be checked by measurements taking into account specified tolerances.

3.3.2

approximate value

value which is only indicative

NOTE In this standard, values described as "approximate" do not constitute requirements to be checked by measurements.

3.4 tests

3.4.1

type tests (symbol T)

tests made before supplying, on a general commercial basis, a type of cable covered by this standard, in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE These tests are such that, after they have been made, they need not be repeated unless changes are made in the cable material, design or manufacturing process which might change the performance characteristics. Further information on type tests is given in annex R.

3.4.2

sample tests (symbol S)

tests made by the manufacturer on samples of completed cable, or components taken from a completed cable, so as to verify that the finished product meets the specified requirements

3.4.3

routine tests (symbol R)

tests made by the manufacturer on each manufactured length of cable to check that the whole of each length meets the specified requirements

3.4.4

tests after installation

tests intended to demonstrate the integrity of the cable and its accessories as installed

4 Designation of cables

4.1 Voltage designation

Every cable shall be designated by the rated voltages U_0 and U expressed in the form U_0/U.

The rated voltages recognized for the purposes of this standard shall be 150/250 V, 600/1 000 V, 1 900/3 300 V, 3 300/3 300 V, 3 800/6 600 V, 6 600/6 600 V, 6 350/11 000 V, and 8 700/15 000 V.

4.2 Cable designation

Cables shall be designated according to the type of outer sheath material used in their construction as follows.

— Type SW 2. Cables with an outer sheath material conforming to BS 7655-2.6:1993, type SW 2, heavy duty enhanced oil-resisting, flame retardant with reduced halogen gas emission.

— Type SW 3. Cables with an outer sheath material conforming to BS 7655-2.6:1993, type SW 3, ordinary duty oil-resisting with low emission of smoke and corrosive gases when affected by fire.

— Type SW 4. Cables with an outer sheath material conforming to BS 7655-2.6:1993, type SW 4, ordinary duty enhanced oil-resisting with low emission of smoke and gases when affected by fire.

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5 General requirements

5.1 Construction and dimensions

The construction and dimensions of the cables shall be as specified in the appropriate construction table (Tables 5 to 14, Tables 18 to 33, Tables 36 to 42 or Tables 46 to 57, as applicable).

NOTE The minimum and maximum diameters, both those over the inner sheath and those over the outer sheath, quoted in the construction tables are indicative only and do not take into account any glanding requirements.

5.2 Corrosive and acid gas emission of fillers

When tested in accordance with BS 6425-1, the level of corrosive and acid gas emission of any filler shall not exceed that specified for the sheath material of the cable in which it is used.

5.3 Inner sheath

5.3.1 *General*

When the cable has an inner sheath it shall be either SW 2, SW 3 or SW 4 conforming to BS 7655-2.6:1993 and shall conform to the selection limitations specified in **5.3.2**.

The inner sheath shall be applied by the extrusion process and cross-linked to form a compact and homogeneous layer.

5.3.2 *Material selection*

When an inner sheath is required, it shall be chosen by reference to the type of outer sheath specified for the particular cable, in accordance with the following list.

Outer sheath type	Inner sheath permissible type
SW 2	SW 2, SW 3, SW 4
SW 3	SW 3, SW 4
SW 4	SW 3, SW 4

5.4 Wire braid

5.4.1 *Material*

Wire braid shall consist of galvanized mild steel, tinned annealed copper or tinned bronze wires as indicated in the appropriate construction table (see **5.1**).

The steel wires shall conform to BS EN 10257-1. The mass of zinc coating shall be not less than 15 g/m^2.

The copper wires shall conform to BS 4109 and the bronze wires to BS EN 12166:1998, material designation CuSn5 (CW451K).

The braid on single-core cables intended for use on a.c. circuits shall consist of tinned annealed copper or tinned bronze wires.

5.4.2 *Diameter of braiding wires*

The diameter of braiding wires shall be not less than the minimum value given in Table 1 when determined by means of a suitable micrometer and by taking the mean of two measurements at right angles made at the same cross-section at least 5 mm from one end of a sample wire. The measurement shall be made prior to the application of the wire to the cable.

Table 1 — Diameter of braiding wires

Wire	Nominal diameter mm	Minimum diameter mm
Copper	0.2	0.196
	0.3	0.296
	0.4	0.396
Steel/bronze	0.3	0.285
	0.45	0.435

5.4.3 *Coverage*

The braid shall cover at least 82 % of the surface area.

NOTE 1 This requirement is equivalent to a minimum filling factor, F, of 0.573 when the percentage coverage, p, is calculated from the following formula:

$$p = (2F - F^2) \times 100$$

where

$$F = \frac{mnd_w}{2\pi D}\left(1 + \frac{\pi^2 D^2}{L^2}\right)^{1/2}$$

and where

D is the mean diameter of braid in millimetres (mm);
d_w is the diameter of braiding wire in millimetres (mm);
L is the lay length of braiding wire in millimetres (mm);
m is the total number of spindles;
n is the total number of ends per spindle.

NOTE 2 A suitable tape or tapes may be applied under and/or over the braid.

5.4.4 *Braid resistance*

The braid resistance shall be as specified in the relevant construction table (see **5.1**).

NOTE Unless the braid material is otherwise specified in the relevant construction tables the maximum resistances given in the tables are those for galvanized steel wire.

5.5 Outer sheath

5.5.1 *General*

The outer sheath shall be type SW 2, SW 3 or SW 4 as specified in BS 7655-2.6:1993 (see **4.2**).

The outer sheath shall be applied by the extrusion process to form a compact and homogenous layer.

5.5.2 *Outer sheath colours*

Unless otherwise requested by the purchaser in the order, the following outer sheath colours shall be used:

— instrumentation cables	150/250 V:	grey;
— single and multi-core cables	600/1 000 V:	black;
— high voltage cables	> 600/1 000 V:	red.

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5.6 Cable marking

5.6.1 *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	1 900/3 300 V
c)	The number of this British Standard, i.e. BS 6883[1)]	BS 6883
d)	Manufacturer's identification	XYZ
e)	Cable type	SW 2
f)	Number of cores, pairs, triples or quads and nominal area of conductor	
g)	Type of screen	(i) or (c)

NOTE Examples of items f) and g) are as follows.

— 27 × 1.5 indicates a twenty-seven core cable with 1.5 mm^2 conductors;

— 7 × 2 × 1.0 (i) indicates seven individually screened pairs with 1.0 mm^2 conductors;

— 7 × 3 × 1.0 (c) indicates seven collectively screened triples with 1.0 mm^2 conductors;

— 7 × 4 × 1.0 (i) indicates seven individually screened quads with 1.0 mm^2 conductors.

The marking of the items a) to g) shall be by embossing, indenting or printing on the outer sheath.

The letters and figures shall consist of upright block characters with 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 items a), b) and c) and not greater than 1 100 mm for items d), e), f) and g).

Conformity shall be checked by visual examination and measurement.

5.6.2 *Identification of year of manufacture*

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

If the identification is by internal marking, 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 surface, the maximum distance between marks shall be not greater than 1 100 mm.

5.6.3 *The 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 on the surface or as an identification thread.

If the mark is applied to the surface of the cable, it shall be in the form of symbol(s) specified by the approval organization, and the maximum distance between marks shall be not greater than 1 100 mm.

If the mark is in the form of an identification thread, it shall be as specified by the approval organization.

5.6.4 *Additional marking*

Any additional marking shall be throughout the length of the cable, and shall be either on the external surface, or by means of a tape or thread within the cable, or by a combination of these methods.

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

If the additional marking is applied to the surface of the cable, it shall not be such as to render illegible the marking specified in **5.6.1** to **5.6.3**.

NOTE Additional information may be marked on the cable by agreement between the manufacturer and the purchaser e.g. in accordance with the Cable Routing Programme for System 350 as used by the Engineering Contractors Association.

5.7 End sealing

Before dispatch, the manufacturer shall cap the ends of the cable in order to form a seal to prevent the ingress of water during transportation and storage.

5.8 Tests

5.8.1 *Schedule of tests*

The tests to be performed on cables specified in this standard shall be in accordance with the test schedules given in Tables 3, 16, 35 and 44, which refer to the relevant clauses of the standard specifying the requirements and test methods as well as the category of each test which applies, i.e. T, S or R (see **3.4.1**, **3.4.2** and **3.4.3**).

NOTE Tables 3, 16, 35 and 44 also indicate those tests which relate to completed cable, and those which relate to components.

5.8.2 *Test conditions*

5.8.2.1 *Ambient temperature*

Tests shall be performed at an ambient temperature of (20 ± 15) °C unless otherwise specified for a particular test.

5.8.2.2 *Frequency and waveform of power frequency test voltages*

Unless otherwise specified for a particular test, the frequency of the alternating test voltages shall be in the range of 49 Hz to 61 Hz. The waveform shall be substantially sinusoidal.

[1)] Marking BS 6883 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.

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6 Cables 150/250 V (pairs, triples and quads)

6.1 Conductors

The conductors shall be tinned annealed copper conforming to BS 6360:1991 class 2 or class 5, except that the maximum resistance shall be increased by 2 % above the values given in BS 6360:1991 for the relevant conductor class.

NOTE Class 5 conductors are included to aid installation and termination of cables in confined spaces. The use of class 5 conductors does not imply that these cables are suitable for applications where they will be subjected to frequent or repeated flexing (see **S.3.6.4**).

6.2 Insulation

6.2.1 *Material*

The insulation shall comprise of a layer of material of type GP 4 conforming to BS 7655-1.2:1997, and shall have a halogen acid gas emission level not exceeding the value specified in **6.14.4** for the relevant cable type.

6.2.2 *Application*

The insulation shall be applied by extrusion and vulcanized to form a compact and homogeneous layer. It shall be possible to remove the insulation easily, without damage to the remaining insulation or the tin coating on the conductor.

6.2.3 *Thickness*

The thickness of insulation, when determined by taking the average of a number of measurements as described in annex C, shall be not less than the value specified in the appropriate construction table (see Tables 5 to 14) and the smallest of the measured values shall not fall below the specified value by more than 10 % + 0.2 mm.

6.3 Core identification

Cores forming a pair shall be identified by having the same number printed in a contrasting colour on the insulation of each core.

Cores forming a triple shall be identified by having the same number printed in a contrasting colour on the insulation of each core.

Cores forming a quad shall be identified by having the same number printed in a contrasting colour on the insulation of each core.

NOTE Any colour combination may be used if specifically agreed between purchaser and manufacturer. Preferred colour combinations are black and white for the insulation of cores forming a pair, black, white and red for the insulation of cores forming a triple and black, white, red and blue for the insulation of cores forming a quad.

6.4 Forming pairs, triples and quads

Cores identified in accordance with **6.3** shall be twisted together to form a pair, triple or quad.

Each set of two similarly numbered cores shall be twisted into a pair. Triples shall consist of three similarly numbered cores. Quads shall consist of four similarly numbered cores. If the pairs, triples or quads are individually screened the lay length of the cores shall not exceed 200 mm.

NOTE 1 If the pairs, triples or quads are not individually screened, the lay length of the cores in the units should be selected so as to reduce inductive effect and cross-talk to a minimum.

NOTE 2 A polyester tape or tapes may be applied over each pair, triple or quad.

NOTE 3 It should be noted that two pair cables are not included as standard types. It is suggested that where collective screening is required a single quad cable is selected and when individual screening is required a three pair cable is selected.

6.5 Individually screened constructions

When individually screened construction is required, each pair, triple or quad shall have a laminated screening tape applied with the metallic side in electrical contact with a drain wire. The minimum overlap of the laminated tape shall be 25 % of its width.

The laminated tape shall be either aluminium bonded to polyester having a minimum thickness of aluminium of 0.008 mm and a minimum thickness of polyester of 0.010 mm or copper bonded to polyester having a maximum thickness of copper of 0.018 mm and a minimum thickness of polyester of 0.023 mm.

The drain wire shall be composed of a number of strands of tinned annealed copper wires conforming to BS 4109 and shall have a maximum resistance of 40.1 Ω/km.

A suitable polyester tape or tapes of either 0.023 mm or 0.050 mm nominal thickness shall be applied over the screen with a minimum overlap of 25 % of its width.

6.6 Laying-up pairs, triples or quads

6.6.1 *General*

The formation of a compact and reasonably circular cable shall be achieved, when required, by one or more of the following:

- — a centre filler;
- — the inner or outer sheath (as appropriate) penetrating the interstices between the laid-up pairs, triples or quads;
- — separate fillers to fill the interstices between the laid-up pairs, triples or quads;
- — binder tapes over the assembly of laid-up pairs, triples or quads and fillers, if any.

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Where centre or separate fillers are used, they shall be non-hygroscopic and made of an elastomeric compound, natural textiles, synthetic textiles or the like. The fillers shall be such that the cable conforms to **6.13.2**.

The sheaths and fillers shall be capable of being removed during termination without damage to the units.

6.6.2 ***Direction of lay***

It shall be permissible for the direction of lay of the pairs, triples or quads to be either left-hand or right-hand.

6.7 Collectively screened constructions

When a collectively screened construction is required, a laminated screening tape shall be applied with the metallic side in electrical contact with the drain wire. The minimum overlap of the laminated tape shall be 25 % of its width.

The laminated tape shall be either aluminium bonded to polyester having a minimum thickness of aluminium of 0.008 mm and a minimum thickness of polyester of 0.010 mm or copper bonded to polyester having a minimum thickness of copper of 0.018 mm and a minimum thickness of polyester of 0.023 mm.

The drain wire shall be composed of a number of strands of tinned, annealed copper wires conforming to BS 4109, and shall have a maximum resistance of 40.1 Ω/km.

NOTE A suitable tape or tapes may be applied over the collectively screened pairs, triples, or quads.

6.8 Inner sheath

6.8.1 ***Material***

The inner sheath shall conform to **5.3**.

6.8.2 ***Thickness of inner sheath***

The minimum thickness at any point of the inner sheath, when measured in accordance with annex C, shall be not less than 80 % of the design value given in Tables 5 to 14, as applicable.

NOTE Where the inner sheath fills the interstices between the laid-up pairs, triples or quads the specified thickness applies at the places where the thickness of the inner sheath is at its minimum.

6.9 Wire braid

The wire braid shall conform to **5.4**.

NOTE 1 A tinned copper wire braid may be used. If so, the braiding wires specified in Table 1 should be used for the relevant cables detailed in Tables 5 to 14 as follows:

— minimum diameter over the inner sheath ≤ 10 mm: braiding wires of 0.2 mm nominal diameter;

— minimum diameter over the inner sheath > 10 mm and ≤ 25 mm: braiding wires of 0.3 mm nominal diameter;

— minimum diameter over the inner sheath > 25 mm: braiding wires of 0.4 mm nominal diameter.

NOTE 2 A suitable tape or tapes may be applied under and/or over the braid.

6.10 Outer sheath

6.10.1 ***Material***

The outer sheath shall conform to **5.5**.

6.10.2 ***Thickness of outer sheath***

The thickness of the outer sheath, when determined by taking the average of a number of measurements in accordance with annex C, shall be not less than the value specified in Tables 5 to 14, as applicable, and the smallest of the measured values shall not fall below the specified value by more than 15 % + 0.1 mm.

NOTE Where the outer sheath fills the interstices between the units the specified thickness applies at the places where the thickness of sheath is at its minimum.

6.11 Non-standard numbers of pairs, triples or quads

If agreed between the purchaser and the manufacturer, it shall be permissible for cables to be made with numbers of pairs, triples or quads other than those specified in Tables 5 to 14. In such cases, the thickness of the insulation and sheath(s) and the diameter of the braid wire (if any) shall be those specified in the relevant table for the cable containing the next higher number of pairs, triples or quads.

6.12 Electrical tests

NOTE The electrical tests are listed in Table 2.

6.12.1 ***Conductor resistance***

The d.c. resistance of each conductor in the finished cable shall be measured in accordance with BS 6360. The results, when corrected to 20 °C in accordance with BS 6360, shall conform to that standard.

6.12.2 ***Voltage test on completed cable***

When completed cable is tested in accordance with annex M the insulation shall not break down.

6.12.3 ***Insulation resistance tests***

6.12.3.1 *Insulation resistance of cores*

The insulation resistance shall be measured immediately after the voltage test specified in **6.12.2** has been applied. When tested in accordance with **N.1** the calculated insulation resistance constant shall be not less than 2 400 MΩ·km at 20 °C.

6.12.3.2 *Insulation resistance between screens (individually screened pair, triple or quad cables)*

For cables with individually screened pair, triple or quad construction the insulation resistance between screens when tested in accordance with **N.2** shall be not less than 1 MΩ·km at (20 ± 5) °C.

6.12.3.3 *Insulation resistance screen(s) to braid [individually or collectively screened pair(s), triple(s) or quad(s) cables]*

For braided cables with individually or collectively screened pairs, triples or quads the insulation resistance between the screens and the braid when tested in accordance with **N.3** shall be not less than 0.25 MΩ·km at (20 ± 5) °C.

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6.13 Non-electrical tests

6.13.1 *General*

NOTE 1 The non-electrical tests are listed in Table 2.

NOTE 2 In some tests, the preparation and presentation of the test sample can have a critical effect on the result of the tests, so it is essential that test samples are always prepared carefully.

Test samples shall be examined for damage before testing. Test samples which have been damaged during preparation shall not be tested.

6.13.2 *Compatibility*

When a sample of completed cable is aged in accordance with **Q.2**, the insulation and outer sheath shall conform to the requirements specified in Table 4. In addition, at the end of the test period in the oven, the blotting paper shall be free of stains.

6.14 Tests under fire conditions

6.14.1 *Vertical burning test (single cable)*

All cables shall be tested in accordance with BS 4066-1 and shall conform to the requirements of that standard.

6.14.2 *Test for flame propagation (bunched cables)*

All cables shall be tested in accordance with Category A (designation F) of BS 4066-3:1994, except that the cables, irrespective of conductor sizes, shall be in a touching configuration on the front of the ladder not exceeding 300 mm width, and the performance of the cables shall conform to the requirements of that standard.

6.14.3 *Test for smoke emission*

The completed type SW 3 and SW 4 cables shall be tested, using the apparatus given in BS 7622-1, in accordance with the test procedure given in BS 7622-2:1993. The cables shall be tested as a flat horizontal unit. The number of cables shall be in accordance with BS 7622-2:1993, **4.2.1**. The smoke generated shall not result in transmittance values lower than 60 %.

6.14.4 *Corrosive and acid gas emission*

Each non-metallic element of type SW 2 cables when tested in accordance with BS 6425-1 shall have a level of HCl not greater than 5 %.

Each non-metallic element of type SW 3 and SW 4 cables when tested in accordance with BS 6425-1 shall have a level of HCl not greater than 0.5 %.

Table 2 — List of tests applicable to the cables specified in clause 6

Clause number	Test	Cable specified in table									
		5	6	7	8	9	10	11	12	13	14
	Electrical tests										
6.12.1	Conductor resistance	X	X	X	X	X	X	X	X	X	X
6.12.2	Voltage test on completed cable	X	X	X	X	X	X	X	X	X	X
6.12.3.1	Insulation resistance of cores	X	X	X	X	X	X	X	X	X	X
6.12.3.2	Insulation resistance (between screens)	X	—	X	—	X	—	X	—	X	X
6.12.3.3	Insulation resistance (screen to braid)	—	—	X	X	—	—	X	X	—	X
	Constructional and dimensional tests										
5.1	Check on construction	X	X	X	X	X	X	X	X	X	X
6.2.3	Measurement of insulation thickness	X	X	X	X	X	X	X	X	X	X
6.8.2	Measurement of inner sheath thickness	—	—	X	X	—	—	X	X	—	X
6.10.2	Measurement of outer sheath thickness	X	X	X	X	X	X	X	X	X	X
6.13.2	Compatibility test[a]	X	X	X	X	X	X	X	X	X	X
	Tests under fire conditions										
6.14.1	Vertical burning test (single cable)	X	X	X	X	X	X	X	X	X	X
6.14.2	Flame propagation (bunched cables)	X	X	X	X	X	X	X	X	X	X
6.14.3	Smoke emission[b]	X	X	X	X	X	X	X	X	X	X
6.14.4	Corrosive and acid gas emission	X	X	X	X	X	X	X	X	X	X

[a] To be performed on completed cables.
[b] Types SW 3 and SW 4 cables only.

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Table 3 — Schedule of tests

Test	Requirement given in clause	Test method	Test category
Tests on components			
Conductor construction	**6.1**	BS 6360	S
Insulation:			
material	**6.2.1**	BS 7655-1.2	T
application	**6.2.2**	Visual examination	S
thickness	**6.2.3**	Annex C	S
Core identification	**6.3**	Visual examination and measurement	S
Forming pairs, triples and quads	**6.4**	Visual examination and measurement	S
Screening pairs, triples and quads	**6.5**	Visual examination	S
Laying-up pairs, triples and quads:			
general	**6.6.1**	Visual examination	S
direction of lay	**6.6.2**	Visual examination	S
Collective screening	**6.7**	Visual examination	S
Inner sheath:			
material properties	**6.8.1**	**5.3**	T
thickness	**6.8.2**	Annex C	S
Braid	**6.9**	**5.4**	S
Outer sheath:			
material properties	**6.10.1**	**5.5**	T
thickness	**6.10.2**	Annex C	S
Tests on completed cables			
Cable markings	**5.6**	Visual examination and measurement	R
Conductor resistance test	**6.12.1**	BS 6360	R
Drain wire resistance	**6.5**, **6.7**	BS 6360	S
Voltage test on completed cables	**6.12.2**	Annex M	R
Insulation resistance test on cores	**6.12.3.1**	**N.1**	R
Insulation resistance between screens	**6.12.3.2**	**N.2**	R
Insulation resistance screen to braid	**6.12.3.3**	**N.3**	R
Compatibility	**6.13.2**	Annex Q	T
Tests under fire conditions:			
flame propagation test on single cable	**6.14.1**	BS 4066-1	S
flame propagation test on bunched cables	**6.14.2**	BS 4066-3	T
smoke emission	**6.14.3**	BS 7622	S
corrosive and acid gas emission	**6.14.4**	BS 6425-1	T
NOTE Tests classified as sample (S) or routine (R) may be required as part of a type approval scheme.			

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Table 4 — Compatibility requirements

Component	Test	Requirement			
		GP 4	SW 2	SW 3	SW 4
Insulation	Maximum percentage variation[a] of tensile strength	±30	—	—	—
	Maximum percentage variation[a] of elongation at break	±30	—	—	—
Outer sheath	Maximum percentage variation[a] of tensile strength	—	±30	±30	±30
	Maximum percentage variation[a] of elongation at break	—	±40	±30	±40

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

Table 5 — Elastomer insulated, individually screened pairs, sheathed 150/250 V

Number of pairs	Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.
	mm^2	mm	mm	mm	mm
1	0.75	0.8	1.0	7.3	9.0
	1.0	0.8	1.0	7.7	9.5
3	0.75	0.8	1.2	12.6	14.5
	1.0	0.8	1.3	13.5	15.5
7	0.75	0.8	1.4	16.9	19.0
	1.0	0.8	1.4	18.0	20.1
12	0.75	0.8	1.6	21.2	23.7
	1.0	0.8	1.7	22.8	25.4
20	0.75	0.8	1.9	27.0	29.8
	1.0	0.8	1.9	28.8	31.6
27	0.75	0.8	2.0	30.8	33.9
	1.0	0.8	2.1	32.8	36.0
37	0.75	0.8	2.2	35.9	39.3
	1.0	0.8	2.3	38.5	42.3

[a] See note to **5.1**.

Table 6 — Elastomer insulated, collectively screened pairs, sheathed 150/250 V

Number of pairs	Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.
	mm^2	mm	mm	mm	mm
3	0.75	0.8	1.2	12.6	14.5
	1.0	0.8	1.2	13.3	15.3
7	0.75	0.8	1.4	16.6	18.7
	1.0	0.8	1.4	17.6	19.8
12	0.75	0.8	1.6	21.7	24.2
	1.0	0.8	1.6	23.1	25.7
20	0.75	0.8	1.8	27.3	30.1
	1.0	0.8	1.8	29.1	31.9
27	0.75	0.8	1.9	31.1	34.2
	1.0	0.8	2.0	33.3	36.6
37	0.75	0.8	2.1	34.4	37.7
	1.0	0.8	2.2	36.9	40.3

[a] See note to **5.1**.

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Table 7 — Elastomer insulated, individually screened pairs, sheathed, steel or bronze wire braided, sheathed 150/250 V

Number of pairs	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.75	0.8	1.0	7.3	9.0	0.3	80.8	1.2	11.1	12.9
	1.0	0.8	1.0	7.7	9.5	0.3	76.8	1.2	11.5	13.4
3	0.75	0.8	1.2	12.6	14.5	0.3	48.9	1.4	16.7	19.0
	1.0	0.8	1.3	13.5	15.5	0.3	45.6	1.4	17.6	20.0
7	0.75	0.8	1.4	16.9	19.0	0.3	36.8	1.6	21.4	24.3
	1.0	0.8	1.4	18.0	20.1	0.3	34.7	1.6	22.5	25.4
12	0.75	0.8	1.6	21.3	23.7	0.3	29.6	1.8	26.1	29.2
	1.0	0.8	1.7	22.8	25.4	0.45	18.1	1.9	28.6	31.8
20	0.75	0.8	1.9	27.0	29.8	0.45	15.4	2.1	33.2	37.0
	1.0	0.8	1.9	28.8	31.6	0.45	14.5	2.2	35.2	39.0
27	0.75	0.8	2.0	30.8	33.9	0.45	13.6	2.3	37.3	41.3
	1.0	0.8	2.1	32.8	36.0	0.45	12.8	2.4	39.5	44.0
37	0.75	0.8	2.2	35.9	39.3	0.45	11.7	2.5	42.9	47.5
	1.0	0.8	2.3	38.5	42.3	0.45	10.9	2.6	45.7	50.4

[a] See note to **5.1**.

Table 8 — Elastomer insulated, collectively screened pairs, sheathed, steel or bronze wire braided, sheathed 150/250 V

Number of pairs	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
3	0.75	0.8	1.2	12.6	14.5	0.3	48.9	1.4	16.7	19.0
	1.0	0.8	1.2	13.3	15.3	0.3	46.3	1.4	17.4	19.8
7	0.75	0.8	1.4	16.6	18.7	0.3	37.5	1.5	20.9	23.8
	1.0	0.8	1.4	17.6	19.8	0.3	35.4	1.6	22.1	25.1
12	0.75	0.8	1.6	21.7	24.2	0.3	28.9	1.7	26.4	29.5
	1.0	0.8	1.6	23.1	25.7	0.3	27.2	1.8	28.0	31.2
20	0.75	0.8	1.8	27.3	30.1	0.45	15.3	2.0	33.3	37.1
	1.0	0.8	1.8	29.0	31.9	0.45	14.3	2.1	35.3	39.2
27	0.75	0.8	1.9	31.1	34.2	0.45	13.5	2.2	37.4	41.4
	1.0	0.8	2.0	33.3	36.6	0.45	12.6	2.2	39.7	44.2
37	0.75	0.8	2.1	34.4	37.7	0.45	12.2	2.3	41.0	45.5
	1.0	0.8	2.2	36.9	40.3	0.45	11.4	2.4	43.7	48.3

[a] See note to **5.1**.

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Table 9 — Elastomer insulated, individually screened triples, sheathed 150/250 V

Number of triples	Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.
	mm^2	mm	mm	mm	mm
1	0.75	0.8	1.0	7.7	9.4
	1.0	0.8	1.1	8.4	10.1
3	0.75	0.8	1.3	14.2	16.2
	1.0	0.8	1.3	15.0	17.2
7	0.75	0.8	1.5	19.7	22.1
	1.0	0.8	1.5	21.0	23.5
12	0.75	0.8	1.7	24.4	27.1
	1.0	0.8	1.8	26.2	28.9

[a] See note to **5.1**.

Table 10 — Elastomer insulated, collectively screened triples, sheathed 150/250 V

Number of triples	Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.
	mm^2	mm	mm	mm	mm
3	0.75	0.8	1.3	14.2	16.2
	1.0	0.8	1.3	15.1	17.1
7	0.75	0.8	1.4	19.4	21.9
	1.0	0.8	1.5	20.9	23.4
12	0.75	0.8	1.7	24.2	26.8
	1.0	0.8	1.7	25.8	28.5

[a] See note to **5.1**.

Table 11 — Elastomer insulated, individually screened triples, sheathed, steel or bronze wire braided, sheathed 150/250 V

Number of triples	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.75	0.8	1.0	7.7	9.4	0.3	77.0	1.2	11.5	13.3
	1.0	0.8	1.1	8.4	10.1	0.3	71.6	1.2	12.1	14.0
3	0.75	0.8	1.3	14.2	16.2	0.3	43.4	1.5	18.6	20.9
	1.0	0.8	1.3	15.0	17.2	0.3	41.0	1.5	19.4	22.3
7	0.75	0.8	1.5	19.7	22.1	0.3	31.8	1.7	24.4	27.4
	1.0	0.8	1.5	21.0	23.5	0.3	29.9	1.7	25.7	28.8
12	0.75	0.8	1.7	24.4	27.1	0.45	17.0	2.0	30.4	34.1
	1.0	0.8	1.8	26.2	28.9	0.45	15.9	2.0	32.2	36.0

[a] See note to **5.1**.

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Table 12 — Elastomer insulated, collectively screened triples, sheathed, steel or bronze wire braided, sheathed 150/250 V

Number of triples	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
3	0.75	0.8	1.3	14.2	16.2	0.3	43.5	1.4	18.3	20.7
	1.0	0.8	1.3	15.1	17.1	0.3	41.1	1.5	19.4	22.2
7	0.75	0.8	1.4	19.4	21.9	0.3	32.2	1.6	24.0	27.0
	1.0	0.8	1.5	20.9	23.4	0.3	30.1	1.7	25.6	28.7
12	0.75	0.8	1.7	24.2	26.8	0.45	17.0	1.9	29.3	32.9
	1.0	0.8	1.7	25.8	28.5	0.45	16.1	2.0	31.8	35.5

[a] See note to **5.1**.

Table 13 — Elastomer insulated, individually screened quads sheathed 150/250 V

Number of quads	Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.
	mm²	mm	mm	mm	mm
1	0.75	0.8	1.1	8.6	10.4
	1.0	0.8	1.1	9.1	10.9
3	0.75	0.8	1.4	16.4	18.5
	1.0	0.8	1.4	17.5	19.6
7	0.75	0.8	1.6	22.1	24.7
	1.0	0.8	1.6	23.6	26.2

[a] See note to **5.1**.

Table 14 — Elastomer insulated, individually screened quads, sheathed, steel or bronze wire braided, sheathed 150/250 V

Number of quads	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.75	0.8	1.1	8.6	10.4	0.3	69.5	1.2	12.4	14.3
	1.0	0.8	1.1	9.10	10.9	0.3	66.0	1.2	12.9	14.8
3	0.75	0.8	1.4	16.4	18.5	0.3	37.9	1.5	20.9	23.8
	1.0	0.8	1.4	17.5	19.6	0.3	35.7	1.6	22.0	24.9
7	0.75	0.8	1.6	22.1	24.7	0.3	28.4	1.7	27.0	30.2
	1.0	0.8	1.6	23.6	26.2	0.45	17.6	1.8	29.4	32.0

[a] See note to **5.1**.

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7 Single-core and multicore cables 600/1 000 V, 1 900/3 300 V and 3 300/3 300 V

7.1 Conductors

The conductors shall be tinned annealed circular or circular compacted copper conforming to BS 6360:1991. Class 2 or class 5 conductors shall be used for conductor sizes of 1 mm^2 and 1.5 mm^2 and class 2 shall be used for all other conductor sizes. The conceptual construction of 25, 35, 95, 400 and 500 mm^2 conductor sizes shall be 19/1.35 mm, 19/1.53 mm, 37/1.78 mm, 91/2.36 mm and 91/2.65 mm, respectively.

NOTE 1 Class 5 conductors are included to aid installation and termination of cables in confined spaces. The use of class 5 conductors does not imply that these cables are suitable for applications where they will be subjected to frequent or repeated flexing (see **S.3.6.4**).

NOTE 2 A suitable tape may be applied over the conductor.

7.2 Insulation

7.2.1 ***Material***

The insulation shall conform to the requirements of BS 7655-1.2:1997, type GP 4 for 600/1 000 V cables and GP 5 for 1 900/3 300 V and 3 300/3 300 V cables, and shall have a halogen acid gas emission level not exceeding that specified in **7.10.4** for the relevant cable type.

7.2.2 ***Application***

The insulation shall be applied by extrusion and vulcanized to form a compact and homogeneous layer. It shall be possible to remove the insulation easily, without damaging the remaining insulation or the tin coating on the conductor.

7.2.3 ***Thickness***

The thickness of insulation, when determined by taking the average of a number of measurements as described in annex C, shall be not less than the value specified in the appropriate construction table (see Tables 18 to 33) and the smallest of the measured values shall not fall below the specified value by more than 10 % + 0.1 mm.

7.2.4 ***Proofed tape***

NOTE 1 The use of a proofed textile tape over the insulation is optional.

If a proofed textile tape is used, it shall be of closely woven textile, without selvedge, proofed on one side with a rubber like material compatible with the insulation.

NOTE 2 The thickness of the tape should be approximately 0.15 mm.

The tape shall be applied helically with a minimum overlap of 1 mm. In the completed cable it shall be possible to remove the proofed tape without damage to the insulation. Some transfer of the proofing from the tape shall be permissible.

7.3 Core identification

The cores of all cables shall be identified either by colour or by numbers using one of the following methods:

a) numbers printed on the insulation in a contrasting colour;

b) numbered proofed tapes having black numerals on a white base;

c) coloured proofed tapes;

d) coloured cores.

Colour coding shall be in accordance with the following sequence.

Number of cores	Identification
Single-core	Red or black
Two-core	Red, black
Three-core	Red, yellow, blue
Four-core	Red, yellow, blue, black

The colour shall be applied either throughout the insulation or on its external surface.

If a cable contains more than four cores, the cores shall be numbered sequentially, starting with the number 1 printed in a colour contrasting with that of the insulation.

The height of each individual number shall be not less than 1.5 mm and the spacing shall be such that each number is repeated at intervals not greater than 70 mm.

7.4 Laying-up multicores

7.4.1 ***General***

The formation of a compact and reasonably circular cable shall be achieved, when required, by one or more of the following:

— a centre filler;

— the inner or outer sheath (as appropriate) penetrating the interstices between the laid-up cores;

— separate fillers to fill the interstices between the laid-up cores;

— binder tape over the assembly of laid-up cores.

Where centre or separate fillers are used, they shall be non-hygroscopic and made of elastomeric compound, natural textiles, synthetic textiles or the like. The fillers shall be such that the cable conforms to **7.9.2**.

The sheaths and fillers shall be capable of being removed during termination without damage to the units.

7.4.2 ***Direction of lay***

The cores of cables having two or more cores up to and including seven cores shall be laid-up with a right-hand direction of lay.

NOTE For multicore cables having more than seven cores the direction of lay is not specified.

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7.5 Inner sheath

7.5.1 *Material*

The inner sheath shall conform to **5.3**.

7.5.2 *Thickness of inner sheath*

The minimum thickness at any point of the inner sheath when measured in accordance with annex C, shall be not less than 80 % of the design value given in Tables 18 to 33, as applicable.

NOTE Where the inner sheath fills the interstices between the cores, the specified thickness applies at the places where the thickness of the inner sheath is at its minimum.

7.6 Wire braid

The wire braid shall conform to **5.4**.

NOTE A suitable tape or tapes may be applied under and/or over the braid.

7.7 Outer sheath

7.7.1 *Material*

The outer sheath shall conform to **5.5**.

7.7.2 *Thickness of outer sheath*

The minimum thickness of the outer sheath, when determined by taking the average of a number of measurements as described in annex C, shall be not less than the value specified in Tables 18 to 34, as applicable, and the smallest of the measured values shall not fall below the specified value by more than 15 % + 0.1 mm.

NOTE Where the outer sheath fills the interstices between the cores the specified thickness applies at the places where the thickness of outer sheath is at its minimum.

7.8 Electrical tests

NOTE The electrical tests are listed in Table 15.

7.8.1 *Conductor resistance*

The d.c. resistance of each conductor in the finished cable shall be measured in accordance with BS 6360. The results, when corrected to 20 °C in accordance with BS 6360, shall conform to that standard.

7.8.2 *Voltage test on completed cable*

When the completed cable is tested in accordance with annex M the insulation shall not break down.

7.8.3 *Insulation resistance test*

The insulation resistance shall be measured immediately after the voltage test specified in **7.8.2** has been applied. When tested in accordance with **N.1** the calculated insulation resistance constant shall be not less than 2 400 MΩ·km at 20 °C for type GP 4 and not less than 4 800 MΩ·km at 20 °C for type GP 5.

7.9 Non-electrical tests

7.9.1 *General*

NOTE 1 The non-electrical tests are listed in Table 15.

NOTE 2 In some tests, the preparation and presentation of the test sample can have a critical effect on the result of the tests, so it is essential that test samples are always prepared carefully.

Test samples shall be examined for damage before testing. Test samples which have been damaged during preparation shall not be tested.

7.9.2 *Compatibility*

When a sample of completed cable is aged in accordance with **Q.2**, the insulation and outer sheath shall conform to the requirements specified in Table 17. In addition, at the end of the test period in the oven, the blotting paper shall be free of stains.

7.10 Tests under fire conditions

7.10.1 *Vertical burning test (single cable)*

All cables shall be tested in accordance with BS 4066-1, and shall conform to the requirements of that standard.

7.10.2 *Test for flame propagation (bunched cables)*

All cables shall be tested in accordance with Category A (designation F) of BS 4066-3:1994 except that the cables, irrespective of conductor sizes, shall be installed in a touching configuration on the front of the ladder not exceeding 300 mm width, and the performance of the cables shall conform to the requirements of that standard.

7.10.3 *Test for smoke emission*

The completed type SW 3 and SW 4 cables shall be tested, using the apparatus given in BS 7622-1, in accordance with the test procedure given in BS 7622-2:1993. The cables shall be tested as a flat horizontal unit. The number of cables shall be in accordance with BS 7622-2:1993, **4.2.1**. The smoke generated shall not result in transmittance values lower than 60 %.

7.10.4 *Corrosive and acid gas emission*

Each non-metallic element of type SW 2 cables when tested in accordance with BS 6425-1 shall have a level of HCl not greater than 5 %.

Each non-metallic element of type SW 3 and SW 4 cables when tested in accordance with BS 6425-1 shall have a level of HCl not greater than 0.5 %.

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Table 15 — List of tests applicable to the cables specified in clause 7

Clause number	Test	Cable specified in table															
		18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	Electrical tests																
7.8.1	Conductor resistance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.8.2	Voltage test on completed cable	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.8.3	Insulation resistance of cores	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Constructional and dimensional tests																
5.1	Check on construction	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.2.3	Measurement of insulation thickness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.5.2	Measurement of inner sheath thickness	—	—	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.7.2	Measurement of outer sheath thickness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.9.2	Compatibility test[a]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Tests under fire conditions																
7.10.1	Vertical burning test (single cable)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.10.2	Flame propagation (bunched cables)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.10.3	Smoke emission[b]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.10.4	Corrosive and acid gas emission	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

[a] Test to be performed on completed cables.
[b] Types SW 3 and SW 4 cables only.

Table 16 — Schedule of tests

Test	Requirement given in clause	Test method	Test category
Tests on components			
Conductor construction	**7.1**	BS 6360	S
Insulation:			
material	**7.2.1**	BS 7655-1.2	T
application	**7.2.2**	Visual examination	S
thickness	**7.2.3**	Annex C	S
Core identification	**7.3**	Visual examination and measurement	S
Laying-up multicores:			
general	**7.4.1**	Visual examination	S
direction of lay	**7.4.2**	Visual examination	S
Inner sheath:			
material properties	**7.5.1**	**5.3**	T
thickness	**7.5.2**	Annex C	S
Braid	**7.6**	**5.4**	S
Outer sheath:			
material properties	**7.7.1**	**5.5**	T
thickness	**7.7.2**	Annex C	S
Tests on completed cables			
Cable markings	**5.6**	Visual examination and measurement	R
Conductor resistance test	**7.8.1**	BS 6360	R
Voltage test on completed cables	**7.8.2**	Annex M	R
Insulation resistance test on cores	**7.8.4**	**N.1**	R
Compatibility	**7.9.2**	Annex Q	T
Tests under fire conditions:			
flame propagation test on single cable	**7.10.1**	BS 4066-1	S
flame propagation test on bunched cables	**7.10.2**	BS 4066-3	T
smoke emission	**7.10.3**	BS 7622	S
corrosive and acid gas emission	**7.10.4**	BS 6425-1	T

NOTE Tests classified as sample (S) or routine (R) may be required as part of a type approval scheme.

Table 17 — Compatibility requirements

Component	Test	Requirement				
		GP 4	GP 5	SW 2	SW 3	SW 4
Insulation	Maximum percentage variation[a] of tensile strength	±30	±30	—	—	—
	Maximum percentage variation[a] of elongation at break	±30	±30	—	—	—
Outer sheath	Maximum percentage variation[a] of tensile strength	—	—	±30	±30	±30
	Maximum percentage variation[a] of elongation at break	—	—	±40	±30	±40

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

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Table 18 — Elastomer insulated, sheathed, single-core, two-core, three-core and four-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath				Diameter over outer sheath[a]							
		Single-core	Two-core	Three-core	Four-core	Single-core		Two-core		Three-core		Four-core	
						Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
mm^2	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
1.0	0.8	1.0	1.0	1.1	1.1	4.7	5.8	7.5	8.8	8.2	9.5	8.9	10.3
1.5	0.8	1.0	1.1	1.1	1.1	5.0	6.2	8.2	9.6	8.7	10.1	9.5	10.9
2.5	0.8	1.0	1.1	1.1	1.1	5.4	6.6	9.0	10.4	9.6	11.0	10.5	12.1
4	1.0	1.0	1.2	1.2	1.2	6.3	7.6	11.0	12.7	11.7	13.4	12.9	14.6
6	1.0	1.0	1.2	1.2	1.3	6.8	8.1	12.1	13.8	12.9	14.7	14.4	16.2
10	1.0	1.0	1.3	1.3	1.4	7.7	9.1	14.1	15.9	15.0	17.0	16.7	18.7
16	1.0	1.1	1.4	1.4	1.5	8.9	10.3	16.3	18.3	17.4	19.4	19.4	21.8
25	1.2	1.2	1.5	1.6	1.7	11.1	12.8	20.4	22.9	22.0	24.6	24.5	27.1
35	1.2	1.2	1.6	1.7	1.8	12.0	13.7	22.4	24.9	24.1	26.7	26.8	29.5
50	1.4	1.3	1.7	1.8	1.9	13.7	15.5	25.7	28.4	27.7	30.5	30.8	34.0
70	1.4	1.3	1.9	2.0	2.1	15.5	17.4	29.6	32.7	31.8	35.1	35.4	38.8
95	1.6	1.4	2.1	2.2	2.3	17.7	19.8	34.1	37.4	36.7	40.1	40.8	44.7
120	1.6	1.5	2.2	2.3	2.5	19.6	22.0	37.7	41.1	40.5	44.4	45.2	49.3
150	1.8	1.6	2.3	2.5	2.7	21.6	24.2	41.8	45.7	44.9	49.0	50.1	54.7
185	2.0	1.7	2.5	2.7	2.9	24.0	26.6	46.3	50.5	50.1	54.6	55.8	60.7
240	2.2	1.8	2.8	2.9	3.2	27.1	29.9	52.7	57.4	56.7	61.5	63.4	68.9
300	2.4	1.9	3.0	3.2	3.5	30.0	33.2	58.5	63.5	63.1	68.6	70.6	76.6
400	2.6	2.0	—	—	—	33.8	37.1	—	—	—	—	—	—
500	2.8	2.2	—	—	—	37.6	41.1	—	—	—	—	—	—
630	2.8	2.3	—	—	—	41.2	45.2	—	—	—	—	—	—

[a] See note to **5.1**.

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Table 19 — Elastomer insulated, sheathed, 5, 7, 12, 19, 27 and 37-core cables 600/1 000 V

Number of cores	Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.
	mm^2	mm	mm	mm	mm
5	1.5	0.8	1.1	10.4	12.0
	2.5	0.8	1.2	11.7	13.3
7	1.5	0.8	1.2	11.5	13.2
	2.5	0.8	1.2	12.7	14.4
12	1.5	0.8	1.3	15.2	17.2
	2.5	0.8	1.4	17.1	19.1
19	1.5	0.8	1.4	18.0	20.1
	2.5	0.8	1.5	20.2	22.7
27	1.5	0.8	1.6	21.9	24.5
37	1.5	0.8	1.7	24.7	27.3

[a] See note to **5.1**.

Table 20 — Elastomer insulated, sheathed, bronze wire braided, sheathed, single-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.0	4.7	5.8	0.3	99.5	1.1	8.3	9.8
1.5	0.8	1.0	5.0	6.2	0.3	94.9	1.1	8.5	10.1
2.5	0.8	1.0	5.4	6.6	0.3	88.7	1.1	8.9	10.5
4	1.0	1.0	6.3	7.6	0.3	77.3	1.1	9.8	11.7
6	1.0	1.0	6.8	8.1	0.3	71.7	1.1	10.4	12.2
10	1.0	1.0	7.7	9.1	0.3	64.1	1.2	11.5	13.4
16	1.0	1.1	8.9	10.3	0.3	56.1	1.2	12.7	14.6
25	1.2	1.2	11.1	12.8	0.3	45.9	1.3	15.0	17.3
35	1.2	1.2	12.0	13.7	0.3	42.7	1.4	16.1	18.4
50	1.4	1.3	13.7	15.5	0.3	37.5	1.4	17.9	20.2
70	1.4	1.3	15.5	17.4	0.3	33.5	1.5	19.8	22.6
95	1.6	1.4	17.7	19.8	0.3	29.4	1.6	22.2	25.2
120	1.6	1.5	19.6	22.0	0.3	26.7	1.7	24.3	27.3
150	1.8	1.6	21.6	24.2	0.3	24.2	1.8	26.5	29.7
185	2.0	1.7	24.0	26.6	0.45	14.4	1.9	29.8	33.5
240	2.2	1.8	27.1	29.9	0.45	12.8	2.0	33.1	36.9
300	2.4	1.9	30.0	33.2	0.45	11.6	2.1	36.2	40.1
400	2.6	2.0	33.8	37.1	0.45	10.4	2.3	40.3	44.8
500	2.8	2.2	37.6	41.1	0.45	9.4	2.5	44.5	49.2
630	2.8	2.3	41.2	45.2	0.45	8.5	2.6	48.4	53.6

[a] See note to **5.1**.

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Table 21 — Elastomer insulated, sheathed, steel or bronze wire braided, sheathed, two-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.0	7.5	8.8	0.3	78.8	1.2	11.3	13.1
1.5	0.8	1.1	8.2	9.6	0.3	72.5	1.2	12.0	13.9
2.5	0.8	1.1	9.0	10.4	0.3	66.5	1.2	12.8	14.7
4	1.0	1.2	11.0	12.7	0.3	55.2	1.3	15.0	17.2
6	1.0	1.2	12.1	13.8	0.3	50.5	1.4	16.3	18.5
10	1.0	1.3	14.1	15.9	0.3	43.8	1.4	18.2	20.6
16	1.0	1.4	16.3	18.3	0.3	38.1	1.5	20.6	23.5
25	1.2	1.5	20.4	22.9	0.3	30.7	1.7	25.2	28.2
35	1.2	1.6	22.4	24.9	0.3	28.1	1.8	27.3	30.4
50	1.4	1.7	25.7	28.4	0.45	16.2	2.0	31.7	35.5
70	1.4	1.9	29.6	32.7	0.45	14.1	2.1	35.8	39.7
95	1.6	2.1	34.1	37.4	0.45	12.3	2.3	40.7	45.2
120	1.6	2.2	37.7	41.1	0.45	11.2	2.5	44.6	49.3
150	1.8	2.3	41.8	45.7	0.45	10.1	2.6	48.9	54.2
185	2.0	2.5	46.3	50.5	0.45	9.1	2.8	53.9	59.3
240	2.2	2.8	52.7	57.4	0.45	8.1	3.1	60.8	67.0
300	2.4	3.0	58.5	63.5	0.45	7.3	3.3	67.0	73.4

[a] See note to **5.1**.

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Table 22 — Elastomer insulated, sheathed, steel or bronze wire braided, sheathed, three-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.1	8.2	9.5	0.3	73.1	1.2	11.9	13.8
1.5	0.8	1.1	8.7	10.1	0.3	68.8	1.2	12.5	14.4
2.5	0.8	1.1	9.6	11.0	0.3	63.0	1.3	13.5	15.5
4	1.0	1.2	11.7	13.4	0.3	52.1	1.3	15.7	17.9
6	1.0	1.2	12.9	14.7	0.3	47.6	1.4	17.0	19.4
10	1.0	1.3	15.0	17.0	0.3	41.2	1.5	19.4	22.2
16	1.0	1.4	17.4	19.4	0.3	35.8	1.6	21.9	24.8
25	1.2	1.6	22.0	24.6	0.3	28.5	1.8	26.9	30.1
35	1.2	1.7	24.1	26.7	0.45	17.2	1.9	29.9	33.6
50	1.4	1.8	27.7	30.5	0.45	15.0	2.0	33.7	37.5
70	1.4	2.0	31.8	35.1	0.45	13.2	2.2	38.2	42.2
95	1.6	2.2	36.7	40.1	0.45	11.5	2.4	43.5	48.1
120	1.6	2.3	40.5	44.4	0.45	10.4	2.6	47.7	52.5
150	1.8	2.5	44.9	49.0	0.45	9.4	2.8	52.5	57.8
185	2.0	2.7	50.1	54.6	0.45	8.5	3.0	58.0	64.0
240	2.2	2.9	56.7	61.5	0.45	7.5	3.2	65.0	71.3
300	2.4	3.2	63.1	68.6	0.45	6.7	3.5	72.0	79.0

[a] See note to **5.1**.

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Table 23 — Elastomer insulated, sheathed, steel or bronze wire braided, sheathed, four-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.1	8.9	10.3	0.3	67.6	1.2	12.6	14.6
1.5	0.8	1.1	9.5	10.9	0.3	63.4	1.3	13.5	15.4
2.5	0.8	1.1	10.5	12.1	0.3	57.9	1.3	14.4	16.4
4	1.0	1.2	12.9	14.6	0.3	47.8	1.4	17.0	19.3
6	1.0	1.3	14.4	16.2	0.3	43.0	1.5	18.7	21.1
10	1.0	1.4	16.7	18.7	0.3	37.2	1.6	21.3	24.1
16	1.0	1.5	19.4	21.8	0.3	32.3	1.7	24.1	27.1
25	1.2	1.7	24.5	27.1	0.45	16.9	1.9	30.3	34.0
35	1.2	1.8	26.8	29.5	0.45	15.5	2.0	32.8	36.6
50	1.4	1.9	30.8	34.0	0.45	13.6	2.2	37.2	41.2
70	1.4	2.1	35.4	38.8	0.45	11.9	2.4	42.2	46.7
95	1.6	2.3	40.8	44.7	0.45	10.3	2.6	47.9	52.7
120	1.6	2.5	45.2	49.3	0.45	9.3	2.8	52.8	58.2
150	1.8	2.7	50.1	54.7	0.45	8.5	3.0	58.1	64.1
185	2.0	2.9	55.8	60.7	0.45	7.6	3.2	64.1	70.4
240	2.2	3.2	63.4	68.9	0.45	6.7	3.5	72.3	79.3
300	2.4	3.5	70.6	76.6	0.45	6.0	3.8	80.0	87.8

[a] See note to **5.1**.

Table 24 — Elastomer insulated, sheathed, steel or bronze wire braided, sheathed, 5, 7, 12, 19, 27 and 37-core cables 600/1 000 V

Number of cores	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
5	1.5	0.8	1.1	10.4	12.0	0.3	58.5	1.3	14.3	16.3
	2.5	0.8	1.2	11.7	13.3	0.3	52.5	1.3	15.6	17.8
7	1.5	0.8	1.2	11.5	13.2	0.3	53.2	1.3	15.4	17.7
	2.5	0.8	1.2	12.7	14.4	0.3	48.4	1.4	16.8	19.1
12	1.5	0.8	1.3	15.2	17.2	0.3	40.7	1.5	19.6	22.4
	2.5	0.8	1.4	17.1	19.1	0.3	36.5	1.6	21.6	24.5
19	1.5	0.8	1.4	18.0	20.1	0.3	34.7	1.6	22.5	25.5
	2.5	0.8	1.5	20.2	22.7	0.3	31.0	1.7	24.9	28.0
27	1.5	0.8	1.6	21.9	24.5	0.3	28.7	1.8	26.8	30.0
37	1.5	0.8	1.7	24.7	27.3	0.45	16.8	1.9	30.5	34.2

[a] See note to **5.1**.

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Table 25 — Elastomer insulated, sheathed, copper wire braided, sheathed, single-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.0	4.7	5.8	0.2	23.5	1.0	7.6	9.1
1.5	0.8	1.0	5.0	6.2	0.2	22.4	1.0	7.9	9.4
2.5	0.8	1.0	5.4	6.6	0.2	20.8	1.1	8.5	10.0
4	1.0	1.0	6.3	7.6	0.2	18.0	1.1	9.4	11.0
6	1.0	1.0	6.8	8.1	0.2	16.7	1.1	9.9	11.7
10	1.0	1.0	7.7	9.1	0.2	14.9	1.2	11.0	12.9
16	1.0	1.1	8.9	10.3	0.2	13.0	1.2	12.2	14.1
25	1.2	1.2	11.1	12.8	0.3	6.9	1.3	15.0	17.3
35	1.2	1.2	12.0	13.7	0.3	6.4	1.4	16.1	18.4
50	1.4	1.3	13.7	15.5	0.3	5.6	1.4	17.9	20.2
70	1.4	1.3	15.5	17.4	0.3	5.0	1.5	19.8	22.6
95	1.6	1.4	17.7	19.8	0.3	4.4	1.6	22.2	25.2
120	1.6	1.5	19.6	22.0	0.3	4.0	1.7	24.3	27.3
150	1.8	1.6	21.6	24.2	0.3	3.6	1.8	26.5	29.7
185	2.0	1.7	24.0	26.6	0.4	2.4	1.9	29.6	33.2
240	2.2	1.8	27.1	29.9	0.4	2.2	2.0	32.9	36.7
300	2.4	1.9	30.0	32.2	0.4	2.0	2.1	36.0	39.9
400	2.6	2.0	33.8	37.1	0.4	1.8	2.3	40.1	44.6
500	2.8	2.2	37.6	41.1	0.4	1.6	2.4	44.1	48.8
630	2.8	2.3	41.2	45.2	0.4	1.4	2.6	48.2	53.0

[a] See note to **5.1**.

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Table 26 — Elastomer insulated, sheathed, copper wire braided, sheathed, two-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.0	7.5	8.8	0.2	15.3	1.2	10.8	12.6
1.5	0.8	1.1	8.2	9.6	0.2	14.0	1.2	11.5	13.4
2.5	0.8	1.1	9.0	10.4	0.2	12.8	1.2	12.3	14.2
4	1.0	1.2	11.0	12.7	0.3	6.9	1.3	15.0	17.2
6	1.0	1.2	12.1	13.8	0.3	6.3	1.4	16.3	18.5
10	1.0	1.3	14.1	15.9	0.3	5.5	1.4	18.2	20.6
16	1.0	1.4	16.3	18.3	0.3	4.8	1.5	20.6	23.5
25	1.2	1.5	20.4	22.9	0.3	3.8	1.7	25.2	28.2
35	1.2	1.6	22.4	24.9	0.3	3.5	1.8	27.3	30.4
50	1.4	1.7	25.7	28.4	0.4	2.3	1.9	31.3	35.0
70	1.4	1.9	29.6	32.7	0.4	2.0	2.1	35.5	39.4
95	1.6	2.1	34.1	37.4	0.4	1.7	2.3	40.4	44.9
120	1.6	2.2	37.7	41.1	0.4	1.6	2.4	44.2	48.8
150	1.8	2.3	41.8	45.7	0.4	1.4	2.6	48.7	53.9
185	2.0	2.5	46.3	50.5	0.4	1.3	2.8	53.6	59.1
240	2.2	2.8	52.7	57.4	0.4	1.1	3.1	60.6	66.7
300	2.4	3.0	58.5	63.5	0.4	1.0	3.3	66.8	73.2

[a] See note to **5.1**.

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Table 27 — Elastomer insulated, sheathed, copper wire braided, sheathed, three-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.1	8.2	9.5	0.2	14.1	1.2	11.4	13.3
1.5	0.8	1.1	8.7	10.1	0.2	13.3	1.2	12.0	13.9
2.5	0.8	1.1	9.6	11.0	0.2	12.1	1.2	12.9	14.8
4	1.0	1.2	11.7	13.4	0.3	6.5	1.3	15.7	17.9
6	1.0	1.2	12.9	14.7	0.3	6.0	1.4	17.0	19.4
10	1.0	1.3	15.0	17.0	0.3	5.2	1.5	19.4	21.8
16	1.0	1.4	17.4	19.4	0.3	4.5	1.6	21.9	24.8
25	1.2	1.6	22.0	24.6	0.3	3.6	1.8	26.9	30.1
35	1.2	1.7	24.1	26.7	0.4	2.4	1.9	29.7	33.3
50	1.4	1.8	27.7	30.5	0.4	2.1	2.0	33.5	37.3
70	1.4	2.0	31.8	35.1	0.4	1.9	2.2	38.0	42.0
95	1.6	2.2	36.7	40.1	0.4	1.6	2.4	43.2	47.8
120	1.6	2.3	40.5	44.4	0.4	1.5	2.6	47.4	52.2
150	1.8	2.5	44.9	49.0	0.4	1.3	2.7	52.0	57.4
185	2.0	2.7	50.1	54.6	0.4	1.2	3.0	57.7	63.3
240	2.2	2.9	56.7	61.5	0.4	1.1	3.2	64.7	71.0
300	2.4	3.2	63.1	68.6	0.4	1.0	3.5	71.8	78.8

[a] See note to **5.1**.

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Table 28 — Elastomer insulated, sheathed, copper wire braided, sheathed, four-core cables 600/1 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
1	0.8	1.1	8.9	10.3	0.2	13.0	1.2	12.2	14.1
1.5	0.8	1.1	9.5	10.9	0.2	12.2	1.2	12.8	14.7
2.5	0.8	1.1	10.5	12.1	0.3	7.2	1.3	14.4	16.4
4	1.0	1.2	12.9	14.6	0.3	6.0	1.4	17.0	19.3
6	1.0	1.3	14.4	16.2	0.3	5.4	1.5	18.7	21.1
10	1.0	1.4	16.7	18.7	0.3	4.7	1.6	21.3	24.1
16	1.0	1.5	19.4	21.8	0.3	4.0	1.7	24.1	27.1
25	1.2	1.7	24.5	27.1	0.4	2.4	1.9	30.1	33.7
35	1.2	1.8	26.8	29.5	0.4	2.2	2.0	32.6	36.3
50	1.4	1.9	30.8	34.0	0.4	1.9	2.2	37.0	40.9
70	1.4	2.1	35.4	38.8	0.4	1.7	2.4	41.9	46.5
95	1.6	2.3	40.8	44.7	0.4	1.5	2.6	47.7	52.5
120	1.6	2.5	45.2	49.3	0.4	1.3	2.8	52.5	57.9
150	1.8	2.7	50.1	54.7	0.4	1.2	3.0	57.8	63.4
185	2.0	2.9	55.8	60.7	0.4	1.1	3.2	63.9	70.2
240	2.2	3.2	63.4	68.9	0.4	0.9	3.5	72.1	79.1
300	2.4	3.5	70.6	76.6	0.4	0.9	3.8	79.8	87.5

[a] See note to **5.1**.

Table 29 — Elastomer insulated and sheathed, copper wire braided, sheathed, 5, 7, 12, 19, 27 and 37-core cables 600/1 000 V

Number of cores	Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
				Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
	mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
5	1.5	0.8	1.1	10.4	12.0	0.3	7.3	1.3	14.3	46.3
	2.5	0.8	1.2	11.7	13.3	0.3	6.6	1.3	15.6	17.8
7	1.5	0.8	1.2	11.5	13.2	0.3	6.7	1.3	15.4	17.7
	2.5	0.8	1.2	12.7	14.4	0.3	6.1	1.4	16.8	19.1
12	1.5	0.8	1.3	15.2	17.2	0.3	5.1	1.5	19.6	22.0
	2.5	0.8	1.4	17.1	19.1	0.3	4.6	1.6	21.6	24.5
19	1.5	0.8	1.4	18.0	20.1	0.3	4.3	1.6	22.5	25.5
	2.5	0.8	1.5	20.2	22.7	0.3	3.9	1.7	24.9	28.0
27	1.5	0.8	1.6	21.9	24.5	0.3	3.6	1.8	26.8	30.0
37	1.5	0.8	1.7	24.7	27.3	0.4	2.4	1.9	30.3	33.9

[a] See note to **5.1**.

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Table 30 — Elastomer insulated and sheathed, bronze wire braided, sheathed, single-core cables 1 900/3 300 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
10	2.2	1.1	10.2	11.9	0.3	49.5	1.3	14.2	16.2
16	2.2	1.2	11.4	13.1	0.3	44.6	1.3	15.4	17.6
25	2.2	1.2	13.0	14.8	0.3	39.4	1.4	17.1	19.5
35	2.2	1.3	14.1	15.9	0.3	36.6	1.4	18.2	20.6
50	2.2	1.3	15.3	17.2	0.3	33.9	1.5	19.6	22.4
70	2.2	1.4	17.2	19.2	0.3	30.2	1.6	21.7	24.6
95	2.4	1.5	19.4	21.9	0.3	26.8	1.7	24.2	27.2
120	2.4	1.6	21.3	23.8	0.3	24.6	1.7	26.0	29.1
150	2.4	1.6	22.8	25.4	0.45	15.1	1.8	28.4	31.6
185	2.4	1.7	24.8	27.4	0.45	14.0	1.9	30.6	34.3
240	2.4	1.8	27.5	30.3	0.45	12.7	2.0	33.5	37.3
300	2.4	1.9	30.0	33.2	0.45	11.6	2.1	36.2	40.1
400	2.6	2.0	33.8	37.1	0.45	10.4	2.3	40.3	44.8
500	2.8	2.2	37.6	41.1	0.45	9.4	2.5	44.5	49.2
630	2.8	2.3	41.2	45.2	0.45	8.5	2.6	48.4	53.6

[a] See note to **5.1**.

Table 31 — Elastomer insulated and sheathed, steel or bronze wire braided, sheathed, three-core cables 1 900/3 300 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
10	2.2	1.5	20.4	22.9	0.3	30.8	1.7	25.1	28.2
16	2.2	1.6	22.8	25.3	0.3	27.7	1.8	27.7	30.8
25	2.2	1.8	26.6	29.3	0.45	15.7	2.0	32.6	36.3
35	2.2	1.8	28.4	31.2	0.45	14.7	2.1	34.6	38.5
50	2.2	1.9	31.2	34.4	0.45	13.4	2.2	37.6	41.6
70	2.2	2.1	35.3	38.7	0.45	11.9	2.4	42.1	46.7
95	2.4	2.3	40.2	44.1	0.45	10.5	2.6	47.4	52.1
120	2.4	2.4	44.0	48.1	0.45	9.6	2.7	51.4	56.7
150	2.4	2.6	47.6	51.8	0.45	8.9	2.9	55.3	60.8
185	2.4	2.7	51.7	56.4	0.45	8.2	3.0	59.6	65.7
240	2.4	3.0	57.7	62.9	0.45	7.4	3.3	66.2	72.6
300	2.4	3.2	63.1	68.6	0.45	6.7	3.5	72.0	79.0

[a] See note to **5.1**.

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Table 32 — Elastomer insulated and sheathed, bronze wire braided, sheathed, single-core cables 3 300/3 300 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
10	3.0	1.2	12.0	13.7	0.3	42.7	1.4	16.1	18.4
16	3.0	1.2	13.0	14.7	0.3	39.6	1.4	17.1	19.4
25	3.0	1.3	14.7	16.7	0.3	35.0	1.5	19.1	21.5
35	3.0	1.3	15.6	17.6	0.3	33.2	1.5	19.9	22.8
50	3.0	1.4	17.0	19.0	0.3	30.6	1.6	21.5	24.4
70	3.0	1.5	18.9	21.0	0.3	27.6	1.6	23.4	26.4
95	3.0	1.5	20.6	23.1	0.3	25.4	1.7	25.3	28.4
120	3.0	1.6	22.5	25.0	0.3	23.3	1.8	27.4	30.5
150	3.0	1.7	24.1	26.8	0.45	14.3	1.9	30.0	33.6
185	3.0	1.7	26.0	28.6	0.45	13.4	2.0	32.0	35.7
240	3.0	1.8	28.7	31.8	0.45	12.2	2.1	34.8	38.7
300	3.0	1.9	31.2	34.4	0.45	11.2	2.2	37.6	41.5
400	3.0	2.1	34.7	38.1	0.45	10.1	2.3	41.3	45.8
500	3.2	2.2	38.4	41.9	0.45	9.2	2.5	45.3	50.0
630	3.2	2.4	42.2	46.2	0.45	8.4	2.6	49.4	54.6

[a] See note to **5.1**.

Table 33 — Elastomer insulated and sheathed, steel or bronze wire braided, sheathed, three-core cables 3 300/3 300 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
10	3.0	1.7	24.1	26.7	0.45	17.2	1.9	29.9	33.6
16	3.0	1.8	26.5	29.2	0.45	15.7	2.0	32.5	36.2
25	3.0	1.9	30.1	33.2	0.45	13.9	2.1	36.3	40.2
35	3.0	2.0	32.1	35.4	0.45	13.0	2.2	38.5	42.9
50	3.0	2.1	34.9	38.3	0.45	12.0	2.3	41.5	46.0
70	3.0	2.2	38.9	42.7	0.45	10.8	2.5	45.8	50.5
95	3.0	2.4	42.9	46.9	0.45	9.9	2.7	50.2	55.5
120	3.0	2.5	46.7	50.9	0.45	9.1	2.8	54.2	59.7
150	3.0	2.7	50.3	54.9	0.45	8.4	3.0	58.2	64.2
185	3.0	2.8	54.4	59.2	0.45	7.8	3.2	62.7	68.9
240	3.0	3.1	60.4	65.7	0.45	7.0	3.4	69.1	76.0
300	3.0	3.3	65.8	71.3	0.45	6.5	3.6	74.9	82.0

[a] See note to **5.1**.

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8 Single-core and three-core (non-radial field) cables 3 800/6 600 V, 6 600/6 600 V and 6 350/11 000 V

8.1 Conductors

The conductors shall be tinned annealed circular or circular compacted copper conforming to BS 6360:1991, class 2. The conceptual construction of 25, 35, 95, 400 and 500 mm^2 conductors shall be 19/1.35 mm, 9/1.53 mm, 37/1.78 mm, 91/2.36 mm and 91/2.65 mm respectively.

8.2 Conductor screen

8.2.1 ***Material***

A semi-conducting tape screen shall be applied over the conductor. The tape shall consist of textile fabric proofed with a suitable semi-conducting compound and shall have a surface resistivity not exceeding 100 000 Ω/square when measured in accordance with annex P.

8.2.2 ***Application***

The tape shall be applied over the conductor with a minimum overlap of 25 % of its width.

8.3 Insulation

8.3.1 ***Material***

The insulation shall comprise a layer of material of type GP 5 conforming to BS 7655-1.2:1997, and shall have a halogen acid gas emission level not exceeding the level specified in **8.11.4** for the relevant cable type.

8.3.2 ***Application***

The insulation shall be applied by extrusion and vulcanized to form a compact and homogenous layer. It shall be possible to remove the insulation easily, without damage to the remaining insulation or the tin coating on the conductor.

8.3.3 ***Thickness***

The thickness of insulation, when determined by taking the average of a number of measurements as described in annex C, shall be not less than the value specified in the appropriate construction table (see Tables 37 to 42) and the smallest of the measured values shall not fall below the specified value by more than 10 % + 0.1 mm.

8.3.4 ***Proofed tape***

NOTE 1 The use of proofed textile tape over the insulation is optional.

If proofed textile tape is used, it shall be of closely woven textile, without selvedge, proofed on one side with a rubber like material compatible with the insulation.

NOTE 2 The thickness of the tape should be approximately 0.15 mm.

The tape shall be applied helically with a minimum overlap of 1 mm. In the completed cable it shall be possible to remove the proofed tape without damage to the insulation. Some transfer of the proofing from the tape shall be permissible.

8.4 Core identification

The cores of all three-core cables shall be identified either by colour or by numbers using one of the following methods:

a) numbers printed on the insulation in a contrasting colour;

b) numbered proofed tapes having black numerals on a white base;

c) coloured proofed tapes;

d) coloured cores.

NOTE There is no requirement for the identification by colour or number of the core of a single-core cable.

The coding shall be as follows:

1) colours: red, yellow, blue;

2) numbers: 1, 2, 3.

The colour shall be applied either throughout the insulation or on its external surface.

The height of each individual number shall be not less than 1.5 mm and the spacing shall be such that each number is repeated at intervals not greater than 70 mm.

Conformity shall be checked by visual examination and measurement.

8.5 Laying-up multicores

8.5.1 ***General***

The formation of a compact and reasonably circular cable shall be achieved, when required, by one or more of the following:

— a centre filler;

— the inner sheath penetrating the interstices between the laid-up cores;

— separate fillers to fill the interstices between the laid-up cores;

— binder tape(s) over the assembly of laid-up cores.

Where centre or separate fillers are used, they shall be non-hygroscopic and made of elastomeric compound, natural textiles, synthetic textiles or the like. The fillers shall be such that the cable conforms to **8.10.2**.

The sheaths and fillers shall be capable of being removed during termination without damage to the units.

8.5.2 ***Direction of lay***

The cores of three-core cables shall be laid-up with a right-hand direction of lay.

8.6 Inner sheath

8.6.1 ***Material***

The inner sheath shall conform to **5.3**.

8.6.2 ***Thickness of inner sheath***

The minimum thickness at any point of the inner sheath, when measured in accordance with annex C, shall not be less than 80 % of the design value given in Tables 37 to 42 as applicable.

NOTE Where the sheath fills the interstices between the cores, the specified thickness applies at the places where the thickness of the sheath is at its minimum.

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8.7 Wire braid

Wire braid shall conform to **5.4**.

NOTE A tape or tapes may be applied under and/or over the braid.

8.8 Outer sheath

8.8.1 *Material*

The outer sheath shall conform to **5.5**.

8.8.2 *Thickness of outer sheath*

The minimum thickness of the outer sheath, when determined by taking the average of a number of measurements in accordance with annex C, shall be not less than the value specified in Tables 37 to 42, as applicable, and the smallest of the measured values shall not fall below the specified value by more than 15 % + 0.1 mm.

NOTE Where the outer sheath fills the interstices between the cores the specified thickness applies at the places where the thickness of the sheath is at its minimum.

8.9 Electrical tests

NOTE The electrical tests are listed in Table 34.

8.9.1 *Conductor resistance*

The d.c. resistance of each conductor in the finished cable shall be measured in accordance with BS 6360. The results, when corrected to 20 °C in accordance with BS 6360, shall conform to that standard.

8.9.2 *Voltage test on completed cable*

When the completed cable is tested in accordance with annex M the insulation shall not break down.

8.9.3 *Insulation resistance test*

The insulation resistance shall be measured immediately after the voltage test specified in **8.9.2** has been applied. When tested in accordance with **N.1** the calculated insulation resistance constant shall be not less than 4 800 MΩ·km at 20 °C.

8.10 Non-electrical tests

8.10.1 *General*

NOTE 1 The non-electrical tests are listed in Table 34.

NOTE 2 In some tests, the preparation and presentation of the test sample can have a critical effect on the result of the tests, so it is essential that test samples are always prepared carefully.

Test samples shall be examined for damage before testing. Test samples which have been damaged during preparation shall not be tested.

8.10.2 *Compatibility*

When a sample of completed cable is aged in accordance with **Q.2** the insulation and outer sheath shall conform to the requirements specified in Table 36. In addition, at the end of the test period in the oven, the blotting paper shall be free of stains.

8.11 Tests under fire conditions

8.11.1 *Vertical burning test (single cable)*

Cables shall be tested in accordance with BS 4066-1, and shall conform to the requirements of that standard.

8.11.2 *Test for flame propagation (bunched cables)*

Cables shall be tested in accordance with Category A (designation F) of BS 4066-3 except that the cables, irrespective of conductor sizes, shall be installed in a spaced formation at 20 mm spacing, and the performance of the cables shall conform to the requirements of that standard.

8.11.3 *Test for smoke emission*

The completed type SW 3 and SW 4 cables shall be tested, using the apparatus given in BS 7622-1 in accordance with the test procedure given in BS 7622-2:1993. The cables shall be tested as a flat horizontal unit. The number of cables shall be in accordance with BS 7622-2:1993, **4.2.1**. The smoke generated shall not result in transmittance values lower than 60 %.

8.11.4 *Corrosive and acid gas emission*

Each non-metallic element of type SW 2 cables when tested in accordance with BS 6425-1 shall have a level of HCl not greater than 5 %.

Each non-metallic element of type SW 3 and SW 4 cables when tested in accordance with BS 6425-1 shall have a level of HCl not greater than 0.5 %.

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Table 34 — List of tests applicable to the cables specified in clause 8

Clause number	Test	Cable specified in table					
		37	38	39	40	41	42
	Electrical tests						
8.9.1	Conductor resistance	X	X	X	X	X	X
8.9.2	Voltage test on completed cable	X	X	X	X	X	X
8.9.3	Insulation resistance of cores	X	X	X	X	X	X
	Constructional and dimensional tests						
5.1	Check on construction	X	X	X	X	X	X
8.3.3	Measurement of insulation thickness	X	X	X	X	X	X
8.6.2	Measurement of inner sheath thickness	X	X	X	X	X	X
8.8.2	Measurement of outer sheath thickness	X	X	X	X	X	X
8.10.2	Compatibility[a]	X	X	X	X	X	X
	Tests under fire conditions						
8.11.1	Vertical burning test (single cable)	X	X	X	X	X	X
8.11.2	Flame propagation (bunched cables)	X	X	X	X	X	X
8.11.3	Smoke emission[b]	X	X	X	X	X	X
8.11.4	Corrosive and acid gas emission	X	X	X	X	X	X

[a] Test to be performed on completed cables.
[b] Type SW 3 and SW 4 cables only.

Table 35 — Schedule of tests

Test	Requirement given in clause	Test method	Test category
Tests on components			
Conductor construction	**8.1**	BS 6360	S
Conductor screen:			
material	**8.2.1**	Annex P	S
application	**8.2.2**	Visual examination	S
Insulation:			
material	**8.3.1**	BS 7655-1.2	T
application	**8.3.2**	Visual examination	S
thickness	**8.3.3**	Annex C	S
Proofed tape:			
application	**8.3.4**	Visual examination	S
Core identification	**8.4**	Visual examination and measurement	S
Laying-up:			
general	**8.5.1**	Visual examination	S
direction of lay	**8.5.2**	Visual examination	S
Inner sheath:			
material properties	**8.6.1**	**5.3**	T
thickness	**8.6.2**	Annex C	S
Braid	**8.7**	**5.4**	S
Outer sheath:			
material properties	**8.8.1**	**5.5**	T
thickness	**8.8.2**	Annex C	S

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Table 35 — Schedule of tests *(continued)*

Test	Requirement given in clause	Test method	Test category
Tests on completed cables			
Cable markings	**5.6**	Visual examination and measurement	R
Conductor resistance test	**8.9.1**	BS 6360	R
Voltage test on completed cables	**8.9.2**	Annex M	R
Insulation resistance test on cores	**8.9.3**	**N.1**	R
Compatibility	**8.10.2**	Annex Q	T
Tests under fire conditions:			
flame propagation test on single cable	**8.11.1**	BS 4066-1	S
flame propagation test on bunched cables	**8.11.2**	BS 4066-3	T
smoke emission	**8.11.3**	BS 7622	S
corrosive and acid gas emission	**8.11.4**	BS 6425-1	T

NOTE Tests classified as sample (S) or routine (R) may be required as part of a type approval scheme.

Table 36 — Compatibility requirements

Component	Test	Requirement			
		GP 5	SW 2	SW 3	SW 4
Insulation	Maximum percentage variation[a] of tensile strength	±30	—	—	—
	Maximum percentage variation[a] of elongation at break	±30	—	—	—
Outer sheath	Maximum percentage variation[a] of tensile strength	—	±30	±30	±30
	Maximum percentage variation[a] of elongation at break	—	±40	±30	±40

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

Table 37 — Elastomer insulated (non-radial field) and sheathed, bronze wire braided, sheathed single-core cables 3 800/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
16	3.4	1.3	13.9	15.7	0.3	37.0	1.4	18.0	20.4
25	3.4	1.3	15.5	17.5	0.3	33.4	1.5	19.8	22.7
35	3.4	1.4	16.6	18.6	0.3	31.3	1.5	20.9	23.8
50	3.4	1.4	17.8	19.8	0.3	29.3	1.6	22.3	25.2
70	3.4	1.5	19.7	22.1	0.3	26.5	1.7	24.4	27.4
95	3.4	1.6	21.6	24.1	0.3	24.3	1.8	26.5	29.6
120	3.4	1.6	23.2	25.8	0.3	22.6	1.8	28.1	31.3
150	3.4	1.7	24.9	27.6	0.45	13.9	1.9	30.7	34.4
185	3.4	1.8	26.9	29.6	0.45	12.9	2.0	32.9	36.7
240	3.4	1.9	29.6	32.8	0.45	11.8	2.1	35.8	39.7
300	3.4	2.0	32.1	35.4	0.45	10.9	2.2	38.5	42.9
400	3.4	2.1	35.5	38.9	0.45	9.9	2.4	42.2	46.8
500	3.4	2.2	38.7	42.6	0.45	9.1	2.5	45.7	50.4
630	3.4	2.4	42.6	46.6	0.45	8.3	2.7	49.9	55.2

[a] See note to **5.1**.

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Table 38 — Elastomer insulated (non-radial field) and sheathed, steel or bronze wire braided, sheathed, three-core cables 3 800/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
16	3.4	1.8	28.1	30.9	0.45	14.8	2.1	34.3	38.2
25	3.4	2.0	31.9	35.2	0.45	13.1	2.2	38.3	42.3
35	3.4	2.0	33.8	37.1	0.45	12.4	2.3	40.4	44.9
50	3.4	2.2	36.8	40.2	0.45	11.4	2.4	43.5	48.2
70	3.4	2.3	40.7	44.6	0.45	10.4	2.6	47.9	52.7
95	3.4	2.5	44.7	48.8	0.45	9.5	2.8	52.3	57.7
120	3.4	2.6	48.6	53.1	0.45	8.7	2.9	56.3	61.8
150	3.4	2.7	51.9	56.6	0.45	8.2	3.1	60.1	66.2
185	3.4	2.9	56.2	61.1	0.45	7.6	3.2	64.6	70.8
240	3.4	3.1	62.0	67.4	0.45	6.9	3.5	70.9	77.9
300	3.4	3.3	67.5	73.4	0.45	6.3	3.7	76.7	83.9

[a] See note to **5.1**.

Table 39 — Elastomer insulated (non-radial field) and sheathed, bronze wire braided, sheathed, single-core cables 6 600/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
25	5.5	1.5	19.9	22.4	0.3	26.2	1.7	24.6	27.7
35	5.5	1.5	20.8	23.3	0.3	25.2	1.7	25.5	28.6
50	5.5	1.6	22.2	24.7	0.3	23.6	1.8	27.1	30.2
70	5.5	1.7	24.1	26.7	0.45	14.4	1.9	29.9	33.6
95	5.5	1.7	25.8	28.5	0.45	13.5	2.0	31.8	35.5
120	5.5	1.8	27.7	30.4	0.45	12.6	2.0	33.7	37.5
150	5.5	1.9	29.3	32.5	0.45	11.9	2.1	35.5	39.4
185	5.5	1.9	31.1	34.3	0.45	11.2	2.2	37.5	41.5
240	5.5	2.0	33.8	37.2	0.45	10.4	2.3	40.4	44.9
300	5.5	2.1	36.4	39.8	0.45	9.7	2.4	43.1	47.7
400	5.5	2.3	39.9	43.8	0.45	8.8	2.6	47.0	51.8
500	5.5	2.4	43.2	47.2	0.45	8.2	2.7	50.5	55.8
630	5.5	2.5	46.8	51.0	0.45	7.6	2.8	54.3	59.8

[a] See note to **5.1**.

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Table 40 — Elastomer insulated (non-radial field) and sheathed, steel or bronze wire braided, sheathed, three-core cables 6 600/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
25	5.5	2.3	41.2	45.1	0.45	10.2	2.6	48.4	53.6
35	5.5	2.4	43.3	47.3	0.45	9.8	2.7	50.6	55.9
50	5.5	2.5	46.1	50.2	0.45	9.2	2.8	53.6	59.0
70	5.5	2.7	50.2	54.8	0.45	8.4	3.0	58.1	64.1
95	5.5	2.8	54.0	58.8	0.45	7.9	3.1	62.1	68.3
120	5.5	3.0	58.0	63.0	0.45	7.3	3.3	66.5	72.9
150	5.5	3.1	61.4	66.8	0.45	6.9	3.4	70.1	77.0
185	5.5	3.3	65.7	71.3	0.45	6.5	3.6	74.8	81.9
240	5.5	3.5	71.5	77.6	0.45	6.0	3.9	81.2	89.0
300	5.5	3.7	76.9	83.2	0.45	5.6	4.1	87.0	95.4

[a] See note to **5.1**.

Table 41 — Elastomer insulated (non-radial field) and sheathed, bronze wire braided, sheathed, single-core cables 6 350/11 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
35	6.5	1.6	22.9	25.5	0.3	22.9	1.8	27.8	31.0
50	6.5	1.7	24.3	26.9	0.45	14.3	1.9	30.1	33.8
70	6.5	1.7	26.0	28.7	0.45	13.3	2.0	32.0	35.8
95	6.5	1.8	27.9	30.7	0.45	12.5	2.1	34.1	37.9
120	6.5	1.9	29.8	32.9	0.45	11.7	2.1	36.0	39.9
150	6.5	1.9	31.2	34.5	0.45	11.2	2.2	37.6	41.6
185	6.5	2.0	33.3	36.5	0.45	10.5	2.3	39.8	44.3
240	6.5	2.1	36.0	39.4	0.45	9.8	2.4	42.7	47.3
300	6.5	2.2	38.5	42.3	0.45	9.1	2.5	45.4	50.1
400	6.5	2.4	42.0	46.0	0.45	8.4	2.6	49.2	54.4
500	6.5	2.5	45.3	49.4	0.45	7.8	2.8	52.8	58.2
630	6.5	2.6	48.9	53.5	0.45	7.2	2.9	56.6	62.2

[a] See note to **5.1**.

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Table 42 — Elastomer insulated (non-radial field) and sheathed, steel or bronze wire braided, sheathed, three-core cables 6 350/11 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm^2	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
35	6.5	2.6	47.8	52.0	0.45	8.9	2.9	55.5	61.1
50	6.5	2.7	50.6	55.2	0.45	8.4	3.0	58.5	64.6
70	6.5	2.8	54.5	59.3	0.45	7.8	3.2	62.8	69.0
95	6.5	3.0	58.6	63.5	0.45	7.3	3.3	67.0	73.4
120	6.5	3.1	62.4	67.8	0.45	6.8	3.5	71.3	78.2
150	6.5	3.3	66.0	71.5	0.45	6.5	3.6	75.0	82.2
185	6.5	3.4	70.1	76.1	0.45	6.1	3.8	79.5	87.2
240	6.5	3.7	76.1	82.3	0.45	5.6	4.1	86.1	94.1
300	6.5	3.9	81.5	88.0	0.45	5.2	4.3	91.9	100.5

[a] See note to **5.1**.

9 Single-core and three-core (radial field) cables 3 800/6 600 V, 6 350/11 000 V and 8 700/15 000 V

9.1 Conductors

The conductors shall be tinned annealed circular or circular compacted copper conforming to BS 6360:1991, class 2. The conceptual construction of 25, 35, 95, 400 and 500 mm^2 conductors shall be 19/1.35 mm, 19/1.53 mm, 37/1.78 mm, 91/2.36 mm and 91/2.65 mm, respectively.

9.2 Conductor screen

9.2.1 *Material*

The screen shall be applied over the conductor. The screen shall consist of either a semi-conducting tape or an extruded layer of semi-conducting compound or a combination of a tape and an extruded layer in which case the semi-conducting tape shall be applied prior to the extruded layer. The tape shall consist of textile fabric proofed with a suitable semi-conducting compound and shall have a surface resistivity not exceeding 100 000 Ω/square when measured in accordance with annex P.

9.2.2 *Application*

The screen shall be continuous and shall completely cover the surface of the conductor. The extruded screen shall be applied and vulcanized simultaneously with the insulation. The tape shall be applied directly over the conductor with a minimum overlap of 25 % of its width.

9.2.3 *Thickness*

The nominal thickness of the extruded screen shall be 0.8 mm.

9.3 Insulation

9.3.1 *Material*

The insulation shall comprise a layer of material of type GP 5 conforming to BS 7655-1.2:1997 and shall have a halogen acid gas emission level not exceeding the value specified in **9.12.4** for the relevant cable type.

9.3.2 *Application*

The insulation shall be applied by extrusion and vulcanized to form a compact and homogeneous layer.

9.3.3 *Thickness*

The thickness of insulation, when determined by taking the average of a number of measurements in accordance with annex C, shall be not less than the value given in Tables 46 to 57, as applicable, and the smallest of the measured values shall not fall below the specified value by more than 10 % + 0.1 mm. The thickness of any tape or extruded screen shall not be included in the measured insulation thickness.

9.4 Insulation screen

9.4.1 *General*

A screen shall be applied over the insulation of each core and shall consist of a semi-conducting layer in combination with a copper tape.

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9.4.2 ***Semi-conducting layer***

The semi-conducting layer shall consist of one of the following.

a) *Semi-conducting taped screens comprising a semi-conducting tape applied over a semi-conducting coating*

When this taped form of screening is used, the semi-conducting coating shall be applied to completely cover the surface of the insulation and this coating shall be followed by a semi-conducting tape applied helically with an overlap. This tape shall consist of textile fabric proofed with a suitable semi-conducting compound and shall have a surface resistivity not exceeding 100 000 Ω/square, when measured in accordance with annex P.

b) *Semi-conducting extruded screens comprising an extruded layer of semi-conducting compound*

Extruded screens shall consist of semi-conducting compound, which shall be vulcanized during the manufacture of the cable. The semi-conducting layer shall be continuous and shall cover the surface of the core completely. The extruded layer shall be applied in the same operation as the insulation. The resistivity of the extruded insulation screen shall not exceed 500 Ω·m at 90 °C, when measured in accordance with annex E.

The insulation screen shall be capable of removal without impairing the performance of the insulation. If the screen is required to be cold strippable the force required to remove the screen, when tested in accordance with annex D, shall be not less than 18 N and not more than 80 N.

9.4.3 ***Copper tape screen***

9.4.3.1 *Material*

The copper tape shall conform to BS 4608.

NOTE The tape may be tinned or plain.

9.4.3.2 *Application*

One to two copper tape(s) shall be applied directly over the semi-conducting insulation screen. In either case, the tape or tapes shall be applied in such a manner that they will not be distorted by normal installation bending (see **B.2**). In three-core cables the copper tape screen on each core shall be in electrical contact with the tape on the adjacent cores.

9.4.3.3 *Thickness*

The nominal thickness of the tape shall be 0.075 mm, with a minimum thickness of 0.065 mm.

NOTE System requirements may necessitate the use of a thicker tape.

9.5 Core identification

The cores of three-core cables shall be identified by one of the following methods:

a) printing 1, 2, 3 on the semi-conducting insulation screen tape;

b) coloured insulation (red, yellow, blue);

c) coloured tapes (red, yellow, blue);

d) numbered tapes;

e) printing colours (red, yellow, blue) on the semi-conducting insulation screen tape.

9.6 Laying-up multicores

9.6.1 ***General***

The formation of a compact and reasonably circular cable shall be achieved, when required, by one or more of the following:

— a centre filler;

— the inner sheath penetrating the interstices between the laid-up cores;

— separate fillers to fill the interstices between the laid-up cores;

— binder tape(s) over the assembly of laid-up cores.

Where centre or separate fillers are used, they shall be non-hygroscopic and made of elastomeric compound, natural textiles, synthetic textiles or the like. The fillers shall be such that the cable conforms to **9.11.2**.

The sheaths and fillers shall be capable of being removed during termination without damage to the units.

9.6.2 ***Direction of lay***

The cores of three-core cables shall be laid-up with a right-hand direction of lay.

9.7 Inner sheath

9.7.1 ***Material***

The inner sheath shall conform to **5.3**.

9.7.2 ***Thickness of the inner sheath***

The minimum thickness of any point of the inner sheath, when measured in accordance with annex C, shall be not less than 80 % of the design value given in Tables 46 to 57, as applicable.

NOTE Where the sheath fills the interstices between the cores, the specified thickness applies at the place where the thickness of the sheath is at its minimum.

9.8 Wire braid

Wire braid shall conform to **5.4**.

NOTE A tape or tapes may be applied under and/or over the braid.

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9.9 Outer sheath

9.9.1 *Material*

The outer sheath shall conform to **5.5**.

9.9.2 *Thickness of outer sheath*

The thickness of the outer sheath, when determined by taking the average of a number of measurements in accordance with annex C, shall be not less than the value given in Tables 46 to 57, as applicable, and the smallest of the measured values shall not fall below the specified value by more than 15 % + 0.1 mm.

NOTE Where the sheath fills the interstices between the cores the specified thickness applies at the places where the thickness of the sheath is at its minimum.

9.10 Electrical tests

NOTE The electrical tests are listed in Table 43.

9.10.1 *Conductor resistance*

The d.c. resistance of each conductor in the finished cable shall be measured in accordance with BS 6360. The results, when corrected to 20 °C in accordance with BS 6360, shall conform to that standard.

9.10.2 *Voltage test on completed cable*

When the completed cable is tested in accordance with annex M the insulation shall not break down.

9.10.3 *Insulation resistance test*

The insulation resistance shall be measured immediately after the voltage test specified in **9.10.2** has been applied. When tested in accordance with **N.1** the calculated insulation resistance constant shall be not less than 4 800 MΩ·km at 20 °C.

9.10.4 *Partial discharge test*

When tested in accordance with annex F the magnitude of the discharge shall not exceed 20 pC at a test voltage of 5.7 kV r.m.s. for a rated voltage U_0 of 3.8 kV, at a test voltage of 9.6 kV r.m.s. for a rated voltage U_0 of 6.35 kV and at a test voltage of 13.1 kV r.m.s. for a rated voltage U_0 of 8.7 kV.

9.10.5 *Sequential type tests*

9.10.5.1 *General*

9.10.5.1.1 With the exceptions detailed in **9.10.5.1.2**, the tests specified in **9.10.5.2** to **9.10.5.8** shall be carried out on a sample of cable not less than 10 m in length between terminations (excluding accessories, if any) in the sequence as specified.

9.10.5.1.2 The manufacturer shall be permitted the option of carrying out the power factor tests (see **9.10.5.4** and **9.10.5.5**) on a different sample of similar length. The option shall also be permitted of carrying out the 4 h voltage test (see **9.10.5.8**) on a different cable sample provided that the sample has been previously submitted to the bending test (see **9.10.5.3**) and the heating cycle test (see **9.10.5.6**).

9.10.5.2 *Partial discharge test*

When tested in accordance with annex F, the magnitude of the discharge on each core at the voltage given in **9.10.4** shall not exceed 20 pC.

9.10.5.3 *Bending test*

After having been subjected to the bending routine given in annex G, the cable shall show no cracks when examined with normal or corrected vision, without magnification, and shall conform to the partial discharge requirement specified in **9.10.5.2**.

9.10.5.4 *Power factor (tan δ) test in relation to voltage*

When the power factor of each core of the sample is measured at room temperature with a.c. voltages equal to $0.5U_0$ to $2.0U_0$, the measured values shall not exceed the following limits.

Maximum tan δ at U_0:	200×10^{-4}
Maximum increase in tan δ ($0.5U_0$ to $2.0U_0$):	25×10^{-4}

9.10.5.5 *Power factor (tan δ) test in relation to temperature*

When tested in accordance with annex H, the power factor for cables rated at 6 350/1 100 V and 8 700/150 000 V shall not exceed the following limits.

Maximum tan δ at ambient temperature:	200×10^{-4}
Maximum tan δ at elevated temperature (i.e. 90 °C to 100 °C, see annex H):	400×10^{-4}

9.10.5.6 *Heating cycle test*

When tested in accordance with annex J, the discharge magnitude for each of the measurements taken shall not exceed 20 pC at the voltages given in annex F.

9.10.5.7 *Impulse voltage withstand test*

When tested in accordance with annex K, no breakdown of the insulation shall occur when the sample is subjected to 10 positive and 10 negative impulses of 75 kV for a rated voltage U_0 of 3.8 kV, of 95 kV for a rated voltage U_0 of 6.35 kV and of 112 kV for a rated voltage U_0 of 8.7 kV.

The impulse voltage shall be applied at a conductor temperature of 90 °C to 95 °C. For three-core cables, all three cores shall be tested in sequence.

9.10.5.8 *Four hour voltage test*

No breakdown of the insulation shall occur when the sample of cable is tested at ambient temperature in the following way. A power frequency voltage shall be applied for 4 h to the cable sample between the conductor(s) and the screen(s).

The test voltage shall be 11 kV r.m.s. for a rated voltage U_0 of 3.8 kV, 18 kV r.m.s. for a rated voltage of 6.35 kV and 26 kV r.m.s. for a rated voltage U_0 of 8.7 kV.

The voltage shall be increased gradually to the specified value.

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9.10.6 ***Adherence of screens at short circuit temperature***

NOTE This is an optional test which may be requested by the purchaser in the enquiry or order.

When tested in accordance with annex L the discharge magnitude, q, for both tests shall not exceed 20 pC at $1.5U_0$.

9.11 Non-electrical tests

9.11.1 ***General***

NOTE 1 The non-electrical tests are listed in Table 43.

NOTE 2 In some tests, the preparation and presentation of the test sample can have a critical effect on the result of the tests, so it is essential that test samples are always prepared carefully.

Test samples shall be examined for damage before testing. Test samples which have been damaged during preparation shall not be tested.

9.11.2 ***Compatibility***

When a sample of completed cable is aged in accordance with **Q.2**, the insulation and outer sheath shall conform to the requirements specified in Table 45. In addition, at the end of the test period in the oven, the blotting paper shall be free of stains.

9.12 Tests under fire conditions

9.12.1 ***Vertical burning test (single cable)***

All cables shall be tested in accordance with BS 4066-1, and shall conform to the requirements of that standard.

9.12.2 ***Test for flame propagation (bunched cables)***

All cables shall be tested in accordance with Category A (designation F) of BS 4066-3:1994, except that the cables, irrespective of conductor sizes, shall be installed in spaced formation at 20 mm spacing, and the performance of the cables shall conform to the requirements of that standard.

9.12.3 ***Test for smoke emission***

The completed type SW 3 and SW 4 cables shall be tested, using the apparatus given in BS 7622-1, in accordance with the test procedure given in BS 7622-2:1993. The cables shall be tested as a flat horizontal unit. The number of cables shall be in accordance with BS 7622-2:1993, **4.2.1**. The smoke generated shall not result in transmittance values lower than 60 %.

9.12.4 ***Corrosive and acid gas emission***

Each non-metallic element of type SW 2 cables, when tested in accordance with BS 6425-1, shall have a level of HCl not greater than 5 %.

Each non-metallic element of type SW 3 and SW 4 cables, when tested in accordance with BS 6425-1, shall have a level of HCl not greater than 0.5 %.

Table 43 — List of tests applicable to the cables specified in clause 9

Clause number	Test	Cable specified in table											
		46	47	48	49	50	51	52	53	54	55	56	57
	Electrical tests												
9.10.1	Conductor resistance	X	X	X	X	X	X	X	X	X	X	X	X
9.10.2	Voltage test on completed cable	X	X	X	X	X	X	X	X	X	X	X	X
9.10.3	Insulation resistance of cores	X	X	X	X	X	X	X	X	X	X	X	X
9.10.4	Partial discharge test	X	X	X	X	X	X	X	X	X	X	X	X
9.10.5	Sequential type tests	X	X	X	X	X	X	X	X	X	X	X	X
9.10.6	Adherence of screens at short circuit temperature	X	X	X	X	X	X	X	X	X	X	X	X
	Constructional and dimensional tests												
5.1	Check on construction	X	X	X	X	X	X	X	X	X	X	X	X
9.3.3	Measurement of insulation thickness	X	X	X	X	X	X	X	X	X	X	X	X
9.7.2	Measurement of inner sheath thickness	—	X	X	X	—	X	X	X	—	X	X	X
9.9.2	Measurement of outer sheath thickness	X	X	X	X	X	X	X	X	X	X	X	X
9.11.2	Compatibility[a]	X	X	X	X	X	X	X	X	X	X	X	X
	Tests under fire conditions												
9.12.1	Vertical burning test (single cable)	X	X	X	X	X	X	X	X	X	X	X	X
9.12.2	Flame propagation (bunched cables)	X	X	X	X	X	X	X	X	X	X	X	X
9.12.3	Smoke emission[b]	X	X	X	X	X	X	X	X	X	X	X	X
9.12.4	Corrosive and acid gas emission	X	X	X	X	X	X	X	X	X	X	X	X

[a] Test to be performed on completed cable.
[b] Type SW 3 and SW 4 cables only.

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Table 44 — Schedule of tests

Test	Requirement given in clause	Test method	Test category
Tests on components			
Conductor construction	**9.1**	Visual examination	S
Conductor screen:			
material	**9.2.1**	**8.2**	S
application	**9.2.2**	Visual application	S
Insulation:			
material	**9.3.1**	BS 7655-1.2	T
application	**9.3.2**	Visual examination	S
thickness	**9.3.3**	Annex C	S
Insulation screen:			
taped application	**9.4.2**a)	Visual examination	S
extruded application	**9.4.2**b)	Visual examination	S
Copper tape screen:			
application	**9.4.3.2**	Visual examination	S
thickness	**9.4.3.3**	Visual examination and measurement	S
Core identification	**9.5**	Visual examination and measurement	S
Laying-up:			
general	**9.6.1**	Visual examination	S
direction of lay	**9.6.2**	Visual examination	S
Inner sheath:			
material properties	**9.7.1**	**5.3**	T
thickness	**9.7.2**	Annex C	S
Braid	**9.8**	**5.4**	S
Outer sheath:			
material properties	**9.9.1**	**5.5**	T
thickness	**9.9.2**	Annex C	S
Tests on completed cables			
Cable markings	**5.6**	Visual examination and measurement	R
Conductor resistance test	**9.10.1**	BS 6360	R
Voltage test on completed cables	**9.10.2**	Annex M	R
Insulation resistance test on cores	**9.10.3**	**N.1**	R
Partial discharge	**9.10.4**	Annex F	R
Sequential type tests	**9.10.5**	**9.10.5**, annexes F, G, H, and K	T
Adherence of screen at short circuit temperature	**9.10.6**	Annex L	T
Compatibility	**9.11.2**	Annex Q	T
Tests under fire conditions:			
flame propagation test on single cable	**9.12.1**	BS 4066-1	S
flame propagation test on bunched cables	**9.12.2**	BS 4066-3	T
smoke emission	**9.12.3**	BS 7622	S
corrosive and acid gas emission	**9.12.4**	BS 6425-1	T
NOTE Tests classified as sample (S) or routine (R) may be required as part of a type approval scheme.			

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Table 45 — Compatibility requirements

Component	Test	Requirement			
		GP 5	SW 2	SW 3	SW 4
Insulation	Maximum percentage variation[a] of tensile strength	±30	—	—	—
	Maximum percentage variation[a] of elongation at break	±30	—	—	—
Outer sheath	Maximum percentage variation[a] of tensile strength	—	±30	±30	±30
	Maximum percentage variation[a] of elongation at break	—	±40	±30	±40

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

Table 46 — Elastomer insulated (radial field) and sheathed, single-core cables 3 800/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.
mm^2	mm	mm	mm	mm
16	3.0	1.3	16.0	18.0
25	3.0	1.3	17.6	19.7
35	3.0	1.4	18.7	20.8
50	3.0	1.4	19.9	22.3
70	3.0	1.5	21.8	24.3
95	3.0	1.6	23.7	26.3
120	3.0	1.6	25.4	28.0
150	3.0	1.7	27.0	29.8
185	3.0	1.8	29.0	32.1
240	3.0	1.9	31.7	35.0
300	3.0	2.0	34.3	37.6
400	3.0	2.1	37.6	41.1
500	3.2	2.3	41.4	45.4
630	3.2	2.4	45.1	49.2

[a] See note to **5.1**.

Table 47 — Elastomer insulated (radial field) and sheathed, three-core cables 3 800/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.
mm^2	mm	mm	mm	mm
16	3.0	1.8	32.7	36.0
25	3.0	2.0	36.5	39.9
35	3.0	2.0	38.4	41.9
50	3.0	2.2	41.3	45.3
70	3.0	2.3	45.3	49.4
95	3.0	2.5	49.3	53.9
120	3.0	2.6	53.1	57.8
150	3.0	2.7	56.5	61.4
185	3.0	2.9	60.8	66.1
240	3.0	3.1	66.6	72.2
300	3.0	3.3	72.0	78.1

[a] See note to **5.1**.

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Table 48 — Elastomer insulated (radial field) and sheathed, bronze wire braided, sheathed, single-core 3 800/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
16	3.0	1.3	16.0	18.0	0.3	32.3	1.4	20.2	23.0
25	3.0	1.3	17.6	19.7	0.3	29.5	1.5	21.9	24.9
35	3.0	1.4	18.7	20.8	0.3	27.9	1.5	23.0	26.0
50	3.0	1.4	19.9	22.3	0.3	26.3	1.6	24.4	27.4
70	3.0	1.5	21.8	24.3	0.3	24.1	1.7	26.5	29.6
95	3.0	1.6	23.7	26.3	0.3	22.2	1.8	28.6	31.8
120	3.0	1.6	25.4	28.0	0.3	20.8	1.8	30.2	33.9
150	3.0	1.7	27.0	29.8	0.45	12.9	1.9	32.8	36.6
185	3.0	1.8	29.0	32.1	0.45	12.0	2.0	35.0	38.9
240	3.0	1.9	31.7	35.0	0.45	11.0	2.1	37.9	41.9
300	3.0	2.0	34.3	37.6	0.45	10.2	2.2	40.6	45.1
400	3.0	2.1	37.6	41.1	0.45	9.4	2.4	44.4	49.0
500	3.2	2.3	41.4	45.4	0.45	8.5	2.5	48.4	53.6
630	3.2	2.4	45.1	49.2	0.45	7.8	2.7	52.4	57.8

[a] See note to **5.1**.

Table 49 — Elastomer insulated (radial field) and sheathed, steel or bronze wire braided, sheathed, three-core cables 3 800/6 600 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
16	3.0	1.8	32.7	36.0	0.45	12.8	2.1	38.9	43.3
25	3.0	2.0	36.5	39.9	0.45	11.5	2.2	42.9	47.5
35	3.0	2.0	38.4	41.9	0.45	11.0	2.3	44.9	49.6
50	3.0	2.2	41.3	45.3	0.45	10.2	2.4	48.1	53.3
70	3.0	2.3	45.3	49.4	0.45	9.3	2.6	52.4	57.4
95	3.0	2.5	49.3	53.9	0.45	8.6	2.8	56.8	62.4
120	3.0	2.6	53.1	57.8	0.45	8.0	2.9	60.8	67.0
150	3.0	2.7	56.5	61.4	0.45	7.5	3.1	64.6	70.9
185	3.0	2.9	60.8	66.1	0.45	7.0	3.2	69.1	76.0
240	3.0	3.1	66.6	72.2	0.45	6.4	3.5	75.5	82.6
300	3.0	3.3	72.0	78.1	0.45	5.9	3.7	81.3	89.1

[a] See note to **5.1**.

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Table 50 — Elastomer insulated (radial field) and sheathed, single-core cables 6 350/11 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.
mm^2	mm	mm	mm	mm
16	3.4	1.3	16.8	18.8
25	3.4	1.4	18.6	20.7
35	3.4	1.4	19.4	21.9
50	3.4	1.5	20.8	23.3
70	3.4	1.5	22.6	25.1
95	3.4	1.6	24.4	27.1
120	3.4	1.7	26.3	29.0
150	3.4	1.7	27.8	30.6
185	3.4	1.8	29.8	32.9
240	3.4	1.9	32.5	35.8
300	3.4	2.0	35.0	38.4
400	3.4	2.1	38.4	41.9
500	3.4	2.3	41.8	45.8
630	3.4	2.4	45.5	49.6

[a] See note to **5.1**.

Table 51 — Elastomer insulated (radial field) and sheathed, three-core cables 6 350/11 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.
mm^2	mm	mm	mm	mm
16	3.4	1.9	34.5	37.9
25	3.4	2.0	38.2	41.6
35	3.4	2.1	40.2	44.1
50	3.4	2.2	43.0	47.0
70	3.4	2.4	47.1	51.3
95	3.4	2.5	51.0	55.6
120	3.4	2.7	55.0	59.8
150	3.4	2.8	58.4	63.3
185	3.4	3.0	62.7	68.1
240	3.4	3.2	68.5	74.1
300	3.4	3.4	73.9	80.1

[a] See note to **5.1**.

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Table 52 — Elastomer insulated (radial field) and sheathed, bronze wire braided, sheathed, single-core cables 6 350/11 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
16	3.4	1.3	16.8	18.8	0.3	30.9	1.5	21.1	24.0
25	3.4	1.4	18.6	20.7	0.3	28.1	1.5	22.9	25.9
35	3.4	1.4	19.4	21.9	0.3	26.9	1.6	24.0	27.0
50	3.4	1.5	20.8	23.3	0.3	25.1	1.6	25.3	28.4
70	3.4	1.5	22.6	25.1	0.3	23.3	1.7	27.3	30.4
95	3.4	1.6	24.4	27.1	0.3	21.5	1.8	29.3	33.0
120	3.4	1.7	26.3	29.0	0.45	13.2	1.9	32.1	35.9
150	3.4	1.7	27.8	30.6	0.45	12.5	2.0	33.8	37.6
185	3.4	1.8	29.8	32.9	0.45	11.7	2.0	35.8	39.7
240	3.4	1.9	32.5	35.8	0.45	10.8	2.2	38.9	43.3
300	3.4	2.0	35.0	38.4	0.45	10.0	2.3	41.6	46.1
400	3.4	2.1	38.4	41.9	0.45	9.2	2.4	45.1	49.8
500	3.4	2.3	41.8	45.8	0.45	8.4	2.5	48.8	54.0
630	3.4	2.4	45.5	49.6	0.45	7.8	2.7	52.8	58.2

[a] See note to **5.1**.

Table 53 — Elastomer insulated (radial field) and sheathed, steel or bronze wire braided, sheathed, three-core cables 6 350/11 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
16	3.4	1.9	34.5	37.9	0.45	12.2	2.1	40.7	45.2
25	3.4	2.0	38.2	41.6	0.45	11.0	2.3	44.7	49.4
35	3.4	2.1	40.2	44.1	0.45	10.5	2.4	47.0	51.7
50	3.4	2.2	43.0	47.0	0.45	9.8	2.5	50.0	55.2
70	3.4	2.4	47.1	51.3	0.45	9.0	2.7	54.5	59.9
95	3.4	2.5	51.0	55.6	0.45	8.3	2.8	58.5	64.5
120	3.4	2.7	55.0	59.8	0.45	7.7	3.0	62.9	69.1
150	3.4	2.8	58.4	63.3	0.45	7.3	3.1	66.5	72.8
185	3.4	3.0	62.7	68.1	0.45	6.8	3.3	71.2	78.1
240	3.4	3.2	68.5	74.1	0.45	6.2	3.6	77.5	85.2
300	3.4	3.4	73.9	80.1	0.45	5.8	3.8	83.3	91.2

[a] See note to **5.1**.

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Table 54 — Elastomer insulated (radial field) and sheathed, single-core cables 8 700/15 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.
mm^2	mm	mm	mm	mm
25	4.5	1.5	20.9	23.4
35	4.5	1.5	21.7	24.3
50	4.5	1.5	22.9	25.5
70	4.5	1.6	24.9	27.5
95	4.5	1.7	26.7	29.5
120	4.5	1.8	28.6	31.4
150	4.5	1.8	30.1	33.3
185	4.5	1.9	32.1	35.3
240	4.5	2.0	34.8	38.2
300	4.5	2.1	37.3	40.8
400	4.5	2.2	40.7	44.6
500	4.5	2.4	44.1	48.2
630	4.5	2.5	47.8	52.0

[a] See note to **5.1**.

Table 55 — Elastomer insulated (radial field) and sheathed, three-core cables 8 700/15 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.
mm^2	mm	mm	mm	mm
25	4.5	2.2	43.1	47.1
35	4.5	2.3	45.2	49.2
50	4.5	2.4	47.9	52.1
70	4.5	2.6	52.1	56.7
95	4.5	2.7	55.9	60.7
120	4.5	2.9	59.9	64.9
150	4.5	3.0	63.3	68.7
185	4.5	3.2	67.6	73.2
240	4.5	3.4	73.4	79.6
300	4.5	3.6	78.8	85.2

[a] See note to **5.1**.

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Table 56 — Elastomer insulated (radial field) and sheathed, bronze wire braided, sheathed, single-core cables 8 700/15 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
25	4.5	1.5	20.9	23.4	0.3	25.1	1.6	25.4	28.5
35	4.5	1.5	21.7	24.3	0.3	24.1	1.7	26.4	29.6
50	4.5	1.5	22.9	25.5	0.3	22.9	1.7	27.6	30.8
70	4.5	1.6	24.9	27.5	0.3	21.2	1.8	29.8	33.4
95	4.5	1.7	26.7	29.5	0.45	13.0	1.9	32.6	36.3
120	4.5	1.8	28.6	31.4	0.45	12.2	2.0	34.6	38.5
150	4.5	1.8	30.1	33.3	0.45	11.6	2.1	36.3	40.2
185	4.5	1.9	32.1	35.3	0.45	10.9	2.1	38.3	42.3
240	4.5	2.0	34.8	38.2	0.45	10.1	2.2	41.2	45.7
300	4.5	2.1	37.3	40.8	0.45	9.4	2.4	44.1	48.7
400	4.5	2.2	40.7	44.6	0.45	8.7	2.5	47.6	52.4
500	4.5	2.4	44.1	48.2	0.45	8.0	2.6	51.3	56.6
630	4.5	2.5	47.8	52.0	0.45	7.4	2.8	55.3	60.8

[a] See note to **5.1**.

Table 57 — Elastomer insulated (radial field) and sheathed, steel or bronze wire braided, sheathed, three-core cables 8 700/15 000 V

Nominal area of conductor	Radial thickness of insulation	Radial thickness of inner sheath	Diameter over inner sheath[a]		Wire braid		Radial thickness of outer sheath	Diameter over outer sheath[a]	
			Min.	Max.	Nominal wire diameter	Maximum resistance		Min.	Max.
mm²	mm	mm	mm	mm	mm	Ω/km	mm	mm	mm
25	4.5	2.2	43.1	47.1	0.45	9.8	2.5	50.1	55.4
35	4.5	2.3	45.2	49.2	0.45	9.4	2.6	52.3	57.7
50	4.5	2.4	47.9	52.1	0.45	8.8	2.7	55.3	60.8
70	4.5	2.6	52.1	56.7	0.45	8.2	2.9	59.8	65.9
95	4.5	2.7	55.9	60.7	0.45	7.6	3.0	63.8	70.1
120	4.5	2.9	59.9	64.9	0.45	7.1	3.2	68.2	75.1
150	4.5	3.0	63.3	68.7	0.45	6.7	3.3	71.8	78.8
185	4.5	3.2	67.6	73.2	0.45	6.3	3.5	76.5	83.7
240	4.5	3.4	73.4	79.6	0.45	5.8	3.8	82.9	90.7
300	4.5	3.6	78.8	85.2	0.45	5.4	4.0	88.7	96.8

[a] See note to **5.1**.

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Annex A (informative) Recommendations for the selection of cables, and information on cable operating temperatures

A.1 Voltage rating

The selection of standard cables of appropriate voltage designations for particular supply systems depends on the system voltage and the system earthing arrangements.

To facilitate the selection of the cable, systems are divided into the following three categories.

a) *Category A.* This category comprises those systems in which any phase conductor that comes in contact with earth or an earth conductor is automatically disconnected from the system.

b) *Category B.* This category comprises those systems that, under fault conditions, are operated for a short time, not exceeding 8 h on any occasion, with one phase earthed.

NOTE In a system where an earth fault is not automatically and promptly eliminated, the increased stresses on the insulation of cables during the earth fault are likely to affect the life of the cables to a certain degree. If the system is expected to be operated fairly often with a sustained earth fault, it may be preferable to use cables suitable for category C. In any case, for a system to be classified as category B the expected total duration of earth faults in any year should not exceed 125 h.

c) *Category C.* This category comprises all systems that do not fall into categories A and B.

Table A.1 gives the lowest rated voltage of cable which should be used for an a.c. system according to the system voltage and category. The nominal system voltage, U, given in Table A.1, is the power frequency voltage between phase conductors.

The maximum system voltage, U_m is the highest power frequency voltage between phase conductors which may be sustained under normal operating conditions at any time and at any point in the system. It excludes transient voltage variations, due, for example, to lightning impulses, fault conditions and rapid disconnection of loads.

The nominal system voltages from 3.3 kV to 15 kV shown in Table A.1 are generally in accordance with series 1 in IEC 60038. For nominal system voltages intermediate between these standard voltages and also between 1 kV and 3.3 kV, the cables should be selected with a rated voltage not less than the next higher value. For example, for a 13.8 kV system of category A or B, the cable should have a rated voltage not less than 8.7/15 kV.

The 600/1 000 V cables are suitable for d.c. systems up to 1 500 V and the 1 900/3 300 V cables for d.c. systems up to 3 000 V to earth. However, consideration should be given to the peak value when determining the voltage of a d.c. system derived from rectifiers, bearing in mind that smoothing does not modify the peak value when the rectifiers are operating on an open circuit.

A.2 Maximum operating temperature

A.2.1 The materials used in the construction of cables given in this standard will tolerate operation at a sustained conductor temperature of 90 °C.

A.2.2 Current ratings for the cables covered by this standard are indicated in the Institution of Electrical Engineers *Regulations for the electrical and electronic equipment of ships with recommended practice for their implementation* [1] and in their *Recommendations for the electrical and electronic equipment of mobile and fixed offshore installations* [2] and also in some ship classification society rules.

It should however, be noted that, in certain cases, the permitted conductor operating temperature may be less than 90 °C and that the listed current ratings are based accordingly or they require an appropriate correction factor to be applied.

A.2.3 Under short circuit conditions the conductor temperature should not exceed 250 °C, and the duration of the fault current should not be longer than 5 s.

NOTE 1 Caution should be exercised in selecting duration which produces very large calculated currents since, in practice, these may result in damaging mechanical forces.

NOTE 2 A limiting temperature lower than 250 °C may be imposed by joints, terminations and bending radii.

Table A.1 — Selection of cables for a.c. systems

System voltage		System category	Minimum rated voltage of cable, U_0/U	
Nominal voltage, U kV	Maximum sustained voltage, U_m kV		Unscreened[a] kV	Single-core or screened[a] kV
Up to 0.25	0.28	A, B or C	0.15/0.25	—
1.0	1.1	A, B or C	0.6/1	0.6/1
3.3	3.6	A or B	1.9/3.3	1.9/3.3
3.3	3.6	C	3.3/3.3	3.8/6.6
6.6	7.2	A or B	3.8/6.6	3.8/6.6
6.6	7.2	C	6.6/6.6	6.35/11
11	12.0	A or B	6.35/11	6.35/11
11	12.0	C	—	8.7/15
15	17.5	A or B	—	8.7/15

[a] Not applicable to screens as defined in **3.2.1** and **3.2.2**.

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Annex B (informative)

Recommendations for the installation of cables

B.1 Minimum temperature during installation

The cables specified in this standard should not be installed if the ambient temperature is below −15 °C.

B.2 Minimum installation radius

The cables specified in this standard should not be bent to an internal radius smaller than that given in Table B.1.

Wherever possible, larger installation radii should be used.

In the case of the radial field cables, the internal bending radii in Table B.1 are applicable to bends made without the use of a former. Where the bend is carefully controlled using a former, the minimum radii may be reduced to 12*D* in the case of three-core cables and to 15*D* for single-core cables.

B.3 Voltage test after installation

Voltage tests after installation are not a requirement of this standard. If performed, the test should be made with direct current at the voltage given in Table B.2 after all terminating and jointing has been carried out but before connection to the system.

The voltage should be increased gradually to the full value and maintained continuously for 15 min between either:

a) the conductor and the screen in the case of screened cores; or

b) each conductor and all the other conductors and braid, if any, in the case of unscreened cores.

If the insulation breaks down, the cable should be deemed to have failed the test.

These test voltages are intended for cables immediately after installation and not for cables that have been in service. When testing is required after cables have been in service, regardless of service duration, the manufacturer should be consulted for the appropriate test conditions which depend on the individual circumstances.

B.4 Further guidance

For further guidance reference should be made to *Regulations for the electrical and electronic equipment of ships with recommended practice for their implementation* [1] and *Recommendations for electrical and electronic equipment of mobile and fixed offshore installations* [2]. (See also annex S.)

Table B.1 — Minimum internal bending radius

Type of cable	Overall diameter	Minimum internal bending radius[a]
Screened multipair, triple and quad	Any	8*D*
Multicore unarmoured (unbraided) 600/1 000 V	≤ 10 mm > 10 mm ≤ 25 mm > 25 mm	3*D* 4*D* 6*D*
Multicore wire braided 600/1 000 V	≤ 25 mm > 25 mm	4*D* 6*D*
Wire braided 1 900/3 300 V, 3 300/3 300 V	Any	6*D*
Non-radial field wire braided 3 800/6 600 V, 6 600/6 600 V and 6 350/1 100 V	Any	12*D*
Radial field wire braided 3 800/6 600 V, 6 350/11 000 V and 8 700/15 000 V	All single-core cables	20*D*
	All three-core cables	15*D*

[a] *D* is the overall diameter of the cable.

Table B.2 — Voltage test after installation

Rated voltage, U_0 kV	Test voltage d.c. kV
0.15	2.5
0.6	6
1.9	11
3.3	18
3.8	18
6.35	25
6.6	25
8.7	37

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Annex C (normative)

Measurement of thickness

C.1 Sampling

Measurement of the thickness of insulation, inner sheath and outer sheath specified in Tables 3, 16, 35 and 44 shall be made on a sample from one end of each drum length of cable selected for the test, after having discarded any portion which may have suffered damage.

C.2 Procedure

Make measurements of thickness of insulation, inner sheath and outer sheath either by the method described in BS EN 60811-1-1 or by use of a calibrated hand lens or micrometer. In case of dispute, use the equipment specified in BS EN 60811-1-1.

For multicore cables, take measurements of insulation thickness on each core up to a maximum of five cores.

When determining an average thickness from several measurements, round the resultant value to the nearest 0.1 mm (0.05 mm is rounded upwards).

If any of the thicknesses measured does not conform to **6.8.2**, **6.10.2**, **7.5.2**, **7.7.2**, **8.6.2**, **8.8.2**, **9.7.2** or **9.9.2**, as applicable, measure two further samples in respect of the non-conforming dimensions. If both of the further samples conform to the specified requirements, the cable shall be deemed to conform, but if either does not conform to the requirements the cable shall be deemed not to conform.

Annex D (normative)

Insulation screen strippability test

Take a core sample of approximate length 400 mm from the cable to be tested.

Make two parallel cuts separated by (13 ± 1) mm in the semi-conducting insulation screen material, down to the insulation and longitudinally from end to end of the core sample. Remove approximately 50 mm length of the 13 mm wide strip from each end of the core by manually pulling it away from the core.

Mount the sample in a tensile test machine, with one end of the strip clamped in the upper jaws, and with the sample held horizontally at approximately 90° to the clamped strip. Measure the force required to separate the 13 mm strip, whilst maintaining the strip at approximately 90° to the sample, using a pulling speed of approximately 13 mm/s. Continue until approximately the midpoint of the sample.

Repeat the test from the other end of the sample.

Annex E (normative)

Method of measuring resistivity of extruded semi-conducting conductor and insulation screens

E.1 Preparation of test pieces

Prepare test pieces from 150 mm lengths of core taken from completed cable.

Prepare the conductor screen test pieces by cutting a sample in half longitudinally and then removing the conductor (see Figure E.1). Prepare the insulation screen test pieces by removing all the coverings from the sample of core (see Figure E.2).

E.2 Procedure

Apply four silver painted electrodes A, B, C and D to the semi-conducting surfaces (see Figures E.1 and E.2). Ensure that the two potential electrodes B and C are 50 mm apart and the two current electrodes A and D are each placed at least 25 mm beyond the potential electrodes. Make connections to the electrodes by means of suitable clips, avoiding damage to the screen. Place the assembly in an oven pre-heated to (90 ± 2) °C and after an interval of 30 min, measure the resistance between the electrodes B and C by means of a circuit with the power not exceeding 100 mW.

After the electrical measurements, measure optically the diameter over the conductor and insulation (see Figures E.1 and E.2) and the thickness of the conductor screen and insulation screen (see Figures E.1 and E.2), in all cases taking the average of six measurements.

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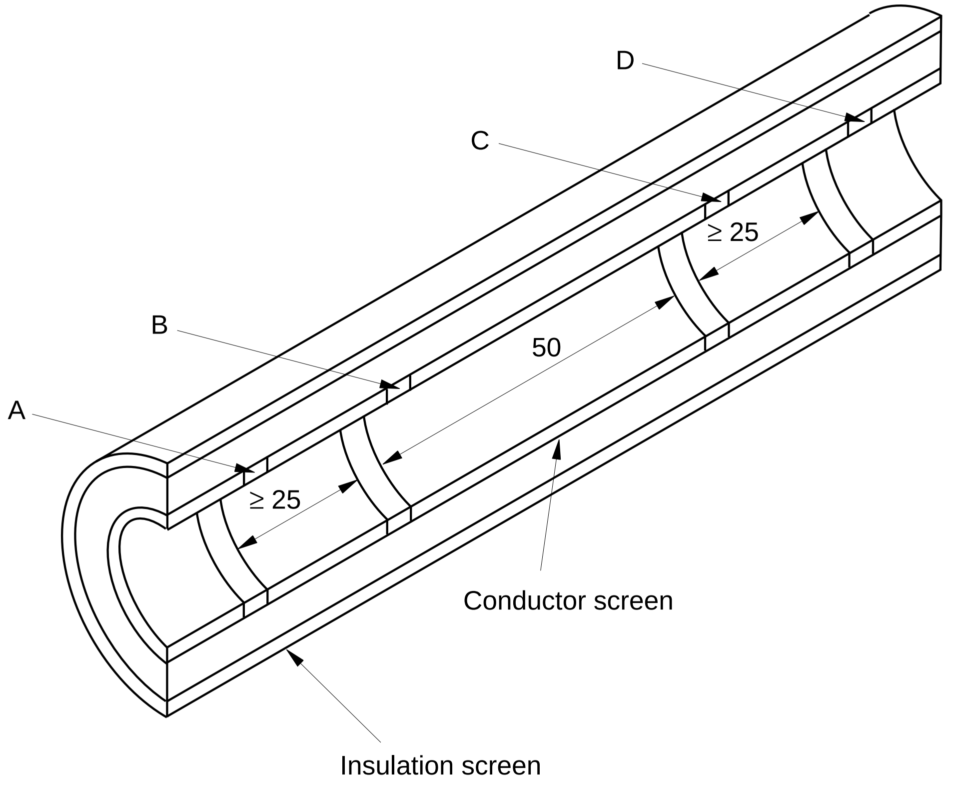
All dimensions are in millimetres



B and C are potential electrodes
A and D are current electrodes

Figure E.1 — Test piece and arrangement of electrodes for measurement of resistivity of conductor screen

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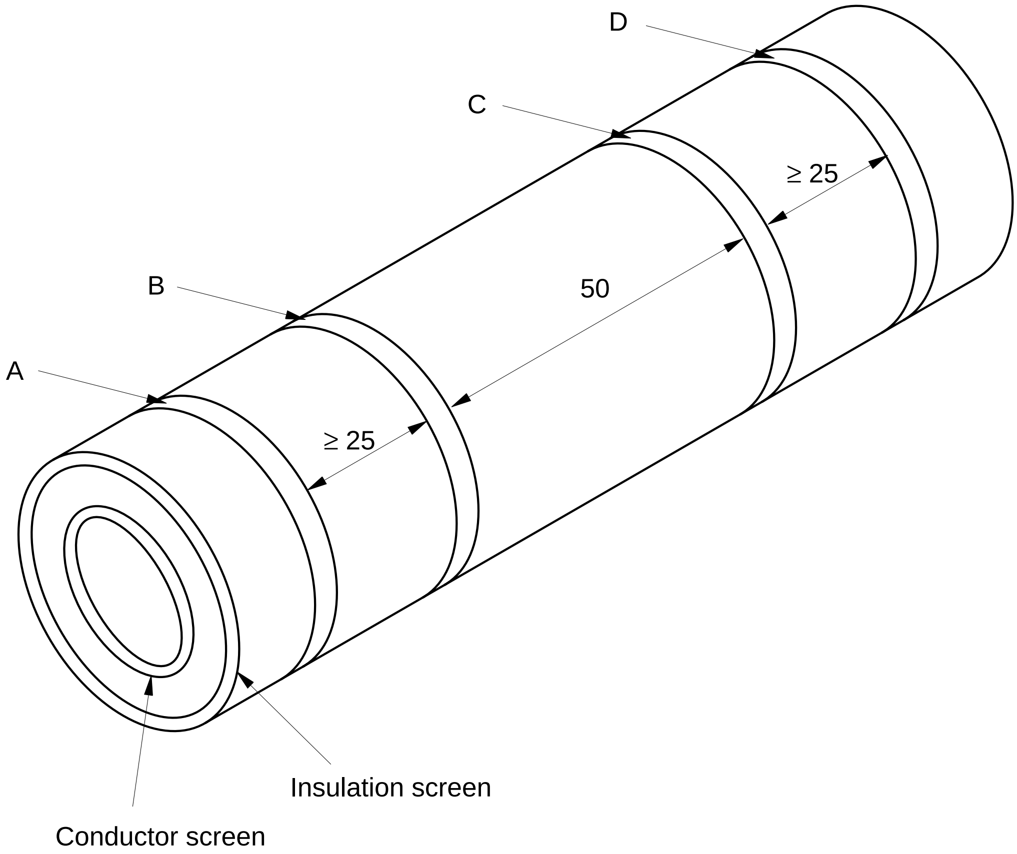
All dimensions are in millimetres



B and C are potential electrodes
A and D are current electrodes

Figure E.2 — Test piece and arrangement of electrodes for measurement of resistivity of insulation screen

E.3 Calculations

E.3.1 *Conductor screen*

Calculate the resistivity, ρ, expressed in ohm metres ($\Omega \cdot m$) of the conductor screen of a circular core (see Figure E.1) from the following equation:

$$\rho = \frac{\pi(D - T)TR}{2L}$$

where

- D is the diameter over the conductor screen, in metres (m);
- T is the average thickness of the conductor screen, in metres (m);
- R is the measured resistance between the potential electrodes, in ohms (Ω);
- L is the distance between the potential electrodes, in metres (m).

E.3.2 *Insulation screen*

Calculate the resistivity, ρ, expressed in ohm metres ($\Omega \cdot m$), of the insulation screen of a circular core (see Figure E.2) from the following equation:

$$\rho = \frac{\pi(D + T)TR}{L}$$

where

- D is the diameter over the insulation, in metres (m);
- T is the average thickness of the insulation screen, in metres (m);
- R is the measured resistance between the potential electrodes, in ohms (Ω);
- L is the distance between the potential electrodes, in metres (m).

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Annex F (normative)
Partial discharge test

F.1 Test equipment

F.1.1 *High voltage supply transformer*, of adequate capacity.

F.1.2 *Voltmeter*.

F.1.3 *Calibrator*.

F.1.4 *Discharge free capacitor*, and a terminating impedance or reflection suppressor (when required).

F.1.5 *Partial discharge measuring device*, consisting of a test circuit (see BS 4828), an oscilloscope and, if desired, an indicating instrument in conjunction with a suitable amplifier to detect individual discharge pulses.

For routine and type tests the minimum detectable discharge should be not more than 20 pC. The minimum detectable discharge (often referred to as the "sensitivity" of the equipment) is taken to be twice the level of the background noise. Therefore the equipment, during tests with the cable connected should have a noise level not greater than 10 pC.

NOTE Individual clearly distinguished interference pulses may be disregarded.

F.2 Calibration

Carry out the charge transfer method of calibration in accordance with BS 4828:1985, **5.2.1**.

NOTE 1 Further guidance on discharge calibration is given in appendix III of CIGRE Report 1968-21-01 [3], and IEEE Paper No. 69, CP88-PWR [4].

Connect the calibrator and detection circuit to the cable under tests and inject predetermined charges.

NOTE 2 The calibration discharge, q_0, is equal to the product of the calibration pulse amplitude U[2)] (in volts) and the coupling capacitance C_0 (in farads) of the calibration, so long as this capacitance is small compared with the capacitance of the cable under test.

If an instrument incorporating a picocoulomb meter is used, adjust the amplifier gain so that the ratio of the injected signal to the value indicated by the meter is unity. When an oscilloscope is used for the measurement, ensure that the response ratio of the test circuit is better than 0.5 pC/mm. The response ratio is the magnitude in picocoulombs of the calibrating pulse per millimetre deflection on the oscilloscope screen.

It is essential that the amplifier gain is not re-adjusted after the calibration has been completed unless a means is provided for a continuous display of a calibrating signal throughout the test.

The means of providing the continuous display of a calibrating signal can be either:

a) the coupling capacitor of the primary calibration circuit being full rated voltage and then not disconnected before the high voltage test transformer is energized; or

b) a secondary calibrator connected to the input of the detector. In this case the amplitude of the secondary pulse to produce a given response is pre-calibrated against the primary calibration circuit before the latter circuit is disconnected and the high voltage test transformer is energized.

When tests are to be made on full drum lengths of cable, as in routine tests, an attenuation factor, F, to compensate for the loss of signal amplitude in the cable and coupling capacitor, shall be determined. One method is as follows.

With the cable under test connected to the detection circuit, inject a calibration pulse into the detector terminals, noting its voltage (e_1) and the response at the detector. Then connect the calibrator to each end of the cable in turn and adjust the step wave voltage to produce the same response at the detector as e_1. Record these voltages, e_2 and e_3. Obtain the attenuation factor, F, from these three voltages using the following equation:

$$F = \sqrt{\left(\frac{e_3 \times e_2}{{e_1}^2}\right)}$$

Correction for attenuation is generally not necessary for type tests on relatively short lengths of cable. For routine tests, if it is only required to check that the magnitude for any discharge in the cable is not greater than the specified limit, the calibration may be carried out with the calibrator at the opposite end of the cable from the detector. Then, provided that the cable is terminated with its characteristic impedance, attenuation of the calibrator pulse will indicate a higher level of discharge than the true value. Provided the apparent discharge under these calibration conditions does not exceed the specified maximum value, there is no need to correct for attenuation.

Correction for attenuation may be required, however, to establish the level of discharge in the cable as closely as possible or if it affects the results sufficiently to influence conformity to the specified limits.

F.3 Procedure

Apply a test voltage of frequency between 40 Hz and 62 Hz between the conductor and the metallic screen for each core to be tested in sequence. Raise the voltage to $1.75U_0$ and hold for not more than 1 min. Reduce the voltage slowly to $1.5U_0$ and measure the discharge magnitude at this voltage.

[2)] U has been used for the calibration pulse amplitude in place of U_0 which is used in BS 4828 to avoid confusion with the rated voltage U_0 defined in **3.1.1**.

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For routine tests on drum lengths correction for attenuation may be made. For this purpose repeat the test with the detector connected to the other end of the cable under test. If the values of discharge magnitude measured at the two ends of the length are q_1 and q_2, the corrected discharge magnitude, q, can be calculated from the following equation:

$$q = F\sqrt{(q_1 \times q_2)}$$

where

F is the attenuation factor obtained from **F.2**.

Annex G (normative)
Bending test

Bend the cable sample around a test cylinder at room temperature for at least one complete turn. Unwind and repeat the process but this time bend the sample in the reverse direction.

Perform this cycle of operations a total of three times.

The diameter of the test cylinder shall be not greater than the value given in Table G.1.

Table G.1 — Diameter of test cylinder

Cable type	Diameter of test cylinder[a] mm
Single-core unbraided	20(D + d)
Single-core braided	15(D + d)
Three-core unbraided	15(D + d)
Three-core braided	12(D + d)

[a] D is the overall diameter (in millimetres) given in the appropriate construction table.

d is the diameter of the conductor (in millimetres) as given in BS 6360:1991, appendix E.

After completion of the bending test, examine the sample with normal or corrected vision, without magnification, and then subject it to the partial discharge test described in annex F.

Annex H (normative)
Power factor test in relation to temperature

Heat the sample of the cable by external means or by passing current through the metallic screen or by current loading of the conductor(s).

Measure the power factor at a conductor temperature of (90 ± 3) °C if the heating is effected by external means or by passing current through the metallic screen; or at a conductor temperature of not less than 90 °C, and not greater than 100 °C, if the heating is carried out by means of current loading of the conductor(s).

Measure the power factor with an a.c. voltage of not less than 2 kV at power frequency.

NOTE This measurement may be carried out during the heating cycle test described in annex J.

Annex J (normative)
Heating cycle test

Install the cable sample indoors in a draught-free environment at a steady ambient temperature and away from direct sunlight.

Place thermocouples at intervals not exceeding 2 m along the length of the cable to measure the temperature of the metallic screen.

Carry out 20 heating cycles, each cycle consisting of at least 2 h with conductor current loading, followed by at least 4 h of natural cooling in air. At the end of the heating period ensure that the conductor temperature has reached a steady temperature of not less than 95 °C and not greater than 100 °C.

Confirm that the screen temperature accurately reflects the required conductor temperature by making suitable measurements of phase conductor resistance, or by other means.

During the heating cycles, take at least four measurements of partial discharge in accordance with annex F at approximately equal intervals at the end of a cooling cycle, including one measurement at the completion of the test (i.e. after the last heating cycle).

Annex K (normative)
Impulse voltage test

K.1 Test assembly

The assembly shall be situated indoors in reasonably still air and away from direct sunlight. No arcing horns shall be fitted to the sealing ends.

The main components of the test assembly are an impulse generator, a voltage divider, an impulse wave monitor and the cable sample to be tested.

K.2 Procedure

Connect one core of the cable sample under test to the impulse generator and its associated voltage divider and oscillograph system. Adjust the circuit values of the impulse generator to produce an impulse wave conforming to BS 923-1 except that the wavefront may have any duration from 0.5 µs to 5.0 µs. Make oscillographs on short and long time sweeps to record the wavefront and wavetail duration of the test impulse wave. Leave the circuit values of the impulse generator unaltered for the remainder of the test period. Apply a loading current of a value estimated to produce the required maximum conductor temperature to the test assembly. Maintain this current constant until the cable sheath temperatures have been steady (i.e. variation not greater than 2 °C after due allowance has been made for ambient temperature variations) for 2 h. Calculate the maximum conductor temperature from a consideration of the conductor current and resistance, the maximum sheath temperature and the design value of cable thermal resistance. Ensure that the calculated conductor temperature is within the range 90 °C to 95 °C.

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During the above mentioned 2 h steady temperature period, carry out impulse generator calibration in the following way. Connect a sphere gap across the test assembly. For any given setting of the sphere gap, adjust the impulse generator charging voltage to give 50 % sparkover of the gap, and make oscillograms of the impulse voltage.

Carry out this procedure for at least three different gap settings at positive polarity of impulse voltage and select the settings so that their 50 % sparkover voltages, as given in BS 358, are about 55 %, 75 % and 95 % of the required impulse withstand voltage.

Draw a curve relating charge voltage to sphere gap sparkover voltage and extrapolate this curve to determine the charging voltage necessary to obtain the specified withstand voltage level with positive polarity.

Calculate the voltage divider ratio by consideration of the maximum sphere gap sparkover voltage and the corresponding impulse voltage oscillogram. Use this value of the voltage divider ratio for all the oscillograms made in the course of the series of tests under this polarity.

With the sphere gap setting increased and the cable maintained at the required temperature, subject one core of the cable sample under test to a series of 10 positive impulses at the voltage specified in **9.10.5.7**. Ensure that the time interval between successive impulses is just sufficient to fully charge the impulse generator.

Immediately after the application of the 10 positive impulses, recalibrate the generator for negative polarity under the conditions already described, and then apply a series of 10 negative impulses of the same specified voltage to one core of the cable sample.

Make oscillograms of at least the first and tenth in each sequence of 10 impulses, including base and voltage calibration lines and a timing wave.

Annex L (normative)

Test for adherence of screens at short circuit temperature

Subject a separate sample of cable having a conductor cross-sectional area not greater than 185 mm^2 and at least 5 m in length to the partial discharge test described in annex F and then subject it to a current, *I*, derived from the following equation:

$$I^2t = 11.77 \times 10^4 A^2 \log_{10} \frac{(234 + T_2)}{(234 + T_1)}$$

where

- I is the r.m.s. value of short circuit current in amps (A);
- t is the duration of short circuit current in seconds (s), maximum 30 s;
- A is the cross-sectional area of copper conductor in square millimetres (mm^2);
- T_2 is 250 °C (final conductor temperature);
- T_1 is the initial conductor temperature in degrees Celsius (°C).

An acceptable alternative procedure for this test is to use the facilities of a short circuit testing station. If this alternative is used, a signed certificate from the testing station is acceptable in lieu of a witness.

Upon completion of the test allow the sample to cool to ambient temperature and again subject it to the partial discharge test described in annex F.

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Annex M (normative) Voltage test

M.1 Test voltage

The test shall be made with either an a.c. or d.c. voltage. Values of single-phase test voltage in relation to the rated voltage of the cable shall be as given in Table M.1.

If, for three-core cables, the voltage test is carried out with a three-phase transformer, the test voltage between the phases shall be 1.73 times the values given in Table M.1. When d.c. test voltage is used, the applied voltage shall be 2.4 times the r.m.s. test voltage given in Table M.1. In all cases, the test voltage shall be increased gradually to the specified value.

Table M.1 — Test voltage on completed cable

Rated voltage (U_0) kV	**Test voltage** (r.m.s) kV
0.15	1.5
0.6	3.5
1.9	6.5
3.3	11
3.8	11
6.35	15
6.6	15
8.7	22

M.2 Cables with pairs, triples or quads

Apply the voltage in the following ways:

a) between one group and the other group connected to earth if the cable consists of pair(s), a group being all conductors “a” connected together, or all conductors “b” connected together, the drain wires being connected in turn to the earthed group;

NOTE 1 Conductors “a” and conductors “b” for pairs are the black and white cores respectively, referred to in **6.3**.

b) between any group and the other two groups connected to earth if the cable consists of triple(s), a group being all conductors “a” connected together, or all conductors “b” connected together, or all conductors “c” connected together, the drain wires being connected to the two interconnected earth groups;

NOTE 2 Conductors “a”, conductors “b” and conductors “c” for triples are the black, white and red cores respectively, referred to in **6.3**.

c) between one group and the other group(s) connected to earth if the cable consists of quad(s), a group being all conductors “a” connected together, or all conductors “b” connected together, or all conductors “c” connected together, or all conductors “d” connected together, the drain wires being connected in turn to the earthed group(s).

NOTE 3 Conductors “a”, “b”, “c” and “d” for quads are the black, white, red and blue cores respectively, referred to in **6.3**.

M.3 Single-core and multicore unscreened cables

M.3.1 *Single-core cables*

For single-core cables with a braid, apply the voltage between the conductor and the earthed braid. For single-core cables without a braid immerse the cable in water for 1 h and then apply the voltage between the conductor and the water with the water earthed.

M.3.2 *Multicore cables having two to five cores*

Apply the voltage in turn between each conductor and all other conductors connected together to earth and to the braid, if any.

M.3.3 *Multicore cables having more than five cores*

Apply the voltage in the following ways:

a) between all conductors of uneven number in all layers and all conductors of even numbers in all layers;

b) between all conductors of even layers and all conductors of uneven layers;

c) between the first and last conductor of each layer having an uneven number of conductors.

M.4 Single-core and multicore cables with a metallic screen

Apply the voltage between the conductor(s) and the metallic screen with the screen earthed.

Annex N (normative) Insulation resistance tests

N.1 Insulation resistance of cores

Immediately after completion of the voltage tests described in annex M apply a d.c. voltage of 300 V to 500 V for 1 min. Proceed with the electrification in a regular manner, steadily decreasing the deflection of the galvanometer, if used, during the period of application. Measure the insulation resistance.

Calculate the insulation resistance constant, K, at 20 °C, in MΩ·km, using the following equation:

$$K = \frac{R_{1\,000}}{\log_{10}(D/d)}$$

where

$R_{1\,000}$ is the measured insulation resistance at 20 °C, expressed in relation to 1 000 m of cable (in MΩ·km);

D is the diameter over the insulation, in millimetres (mm);

d is the diameter over the conductor, in millimetres (mm).

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Note the temperature of the air or the water in which the cable is immersed, and, if necessary, multiply the test result by the appropriate correction factor given in Table N.1 to obtain the true insulation resistance at 20 °C.

NOTE Cores may be grouped in accordance with annex M.

N.2 Insulation resistance between screens (individually screened pairs, triples or quads)

Carry out this test at a temperature of (20 ± 5) °C. Apply a d.c. voltage of 300 V to 500 V for 1 min between screens. Proceed with the electrification in a regular manner, steadily decreasing the deflection of the galvanometer, if used, during the period of application. Measure the insulation resistance. Express the result in relation to 1 000 m of cable.

N.3 Insulation resistance between screen(s) and braid

Carry out this test at a temperature of (20 ± 5) °C. Apply a d.c. voltage of 80 V to 500 V for 1 min between the screen(s) and the braid. Proceed with the electrification in a regular manner, steadily decreasing the deflection of the galvanometer, if used, during the period of application. Measure the insulation resistance. Express the result in relation to 1 000 m of cable.

Table N.1 — Temperature correction factors for insulation resistance

Temperature °C	Correction factor
10	0.50
11	0.54
12	0.57
13	0.62
14	0.66
15	0.71
16	0.76
17	0.81
18	0.87
19	0.93
20	1.00
21	1.07
22	1.15
23	1.23
24	1.32
25	1.42
26	1.52
27	1.62
28	1.74
29	1.87
30	2.00

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Annex P (normative)
Method of measuring the surface resistivity of semi-conducting tape

P.1 Test sample

This test shall be carried out on a clean unused sample of semi-conducting tape.

P.2 Procedure

Clamp a length of tape between the electrodes of the test apparatus (see Figure P.1) ensuring that the tape is connected at right angles to the electrodes with just enough tension to prevent a sag in the tape. Adjust the d.c. power supply to produce a reading of approximately 1 mA on the ammeter and record the voltage indicated on the voltmeter.

Using a graduated scale, measure the width of the tape and its length between the electrodes.

P.3 Calculation

Calculate the surface resistivity, ρ, in ohms per square, of the semi-conducting tape from the following equation:

$$\rho = \frac{V}{10^{-3}I} \times \frac{w}{L}$$

where

- V is the indicated voltage, in volts (V);
- I is the indicated current, in milli-amps (mA);
- w is the measured width of the tape, in millimetres (mm);
- L is the measured length of the tape, in millimetres (mm).

All dimensions in millimetres

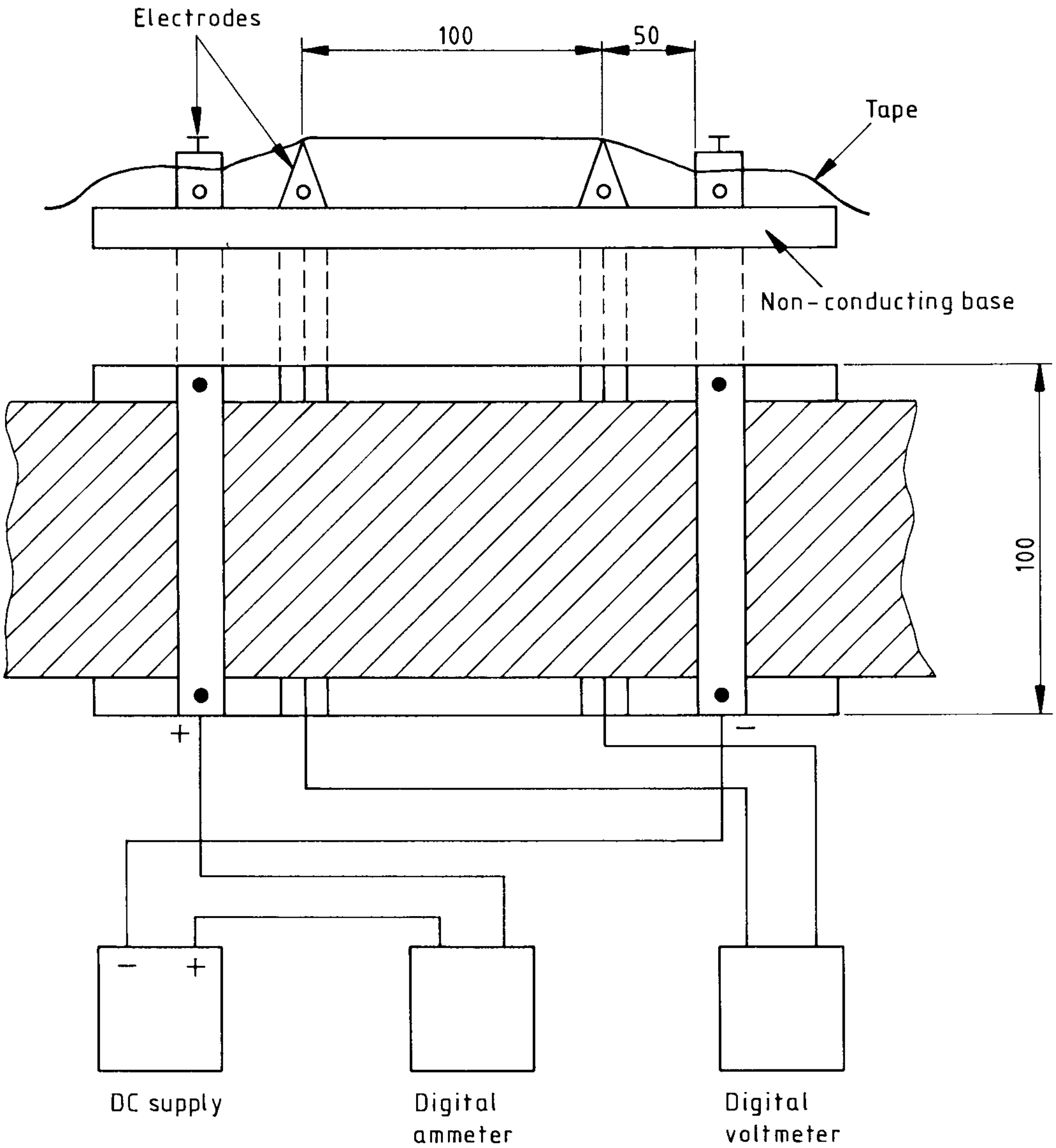

Figure P.1 — Method of measuring the surface resistivity of semi-conducting tape

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Annex Q (normative)
Compatibility test

Q.1 General

This test is intended to indicate whether the insulation and outer sheath are likely to deteriorate due to contact with other components in the cable.

Q.2 Procedure

Age the sample for 7 days at (80 ± 2) °C in an air oven in accordance with BS EN 60811-1-2:1995, **8.1.4**.

Place a sheet of clean white blotting paper under each test piece in the oven to detect any exudation which may drip from the cable.

After completion of the ageing test, measure the tensile strength and the elongation at break of the insulation and outer sheath in accordance with BS EN 60811-1-1.

Annex R (informative)
Guidance on type tests

R.1 General

Type tests, after they have been completed, need not be repeated unless changes have been made that affect conformity to the specified requirements. This means that type tests should not normally be required on cables for individual contracts provided that such type tests have already been successfully performed by the manufacturer.

If the relevant type tests have been successfully performed for conformity to BS 7917, for approvals with respect to instrumentation cables specified in clause **6** and power cables specified in clause **7** of that standard, the repetition of these tests is not necessary except for those tests which are affected by the use of inner sheath material SB 1.

Guidance is given in **R.2** to **R.4** regarding the level of type testing that may reasonably be required subject to agreement between manufacturer and purchaser.

R.2 Sample selection for type tests

Tables 3, 16, 35 and 44 indicate which tests relate to completed cable and which relate to components.

Type tests for components may be carried out on any one cable sample.

NOTE The results of these type tests are not determined by the cable size or construction.

For the type tests on finished cable, conformity to the requirements can be confirmed for the complete range of cables specified in this standard by selecting samples as detailed in the relevant sub-clauses of **R.3**.

NOTE Type testing alone is not sufficient for a claim of conformity to this standard. Sample and routine tests as listed in Tables 3, 16, 35 and 44 are also required.

R.3 Type tests

R.3.1 ***Compatibility test*** (see **6.13**, **7.9**, **8.10** and **9.11**)

One test should be carried out on each of the cable types selected.

R.3.2 ***Corrosive and acid gas emission test*** (see **6.14**, **7.10**, **8.11** and **9.12**)

As this is a test on cable components, and therefore generally independent of size or number of cores, only one test is necessary on each of the cable types selected.

R.3.3 ***Test for flame propagation on a single cable*** (see **6.14**, **7.10**, **8.11** and **9.12**)

NOTE This test is classified as a sample test. The guidance given below applies when it is used for type approval testing.

The following cables should be tested.

a) Cables specified in clause **6**: 150/250 V pairs, triples and quads.

Approximately the smallest unbraided cable and the largest braided cable of the range offered should be tested.

b) Cables specified in clause **7**: 600/1 000 V, 1 900/3 300 V and 3 300/3 300 V single-core and multicore.

1) For cables up to and including 35 mm^2 conductor size, one braided or unbraided multicore cable should be tested.

2) For cables above 35 mm^2 conductor size, one braided or unbraided multicore cable should be tested.

3) If cables in both size ranges are being offered, two cables, one from each range, should be selected and tested.

c) Cables specified in clause **8**: 3 800/6 600 V, 6 600/6 600 V and 6 350/11 000 V single-core and three-core (non-radial field) and cables specified in clause **9**: 3 800/6 600 V, 6 350/11 000 V and 8 700/15 000 V single-core and three-core (radial field).

One cable, in the range 70 mm^2 to 300 mm^2 conductor size should be tested.

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R.3.4 ***Test for flame propagation on bunched cables*** (see **6.14**, **7.10**, **8.11** and **9.12**)

To test for conformity to the requirements of Category A (designation F), cables should be selected from the range of cables to be approved such that all of the following conditions are satisfied by a series of tests for each sheathing material.

NOTE 1 A number of different conditions may be satisfied simultaneously by any one selection.

a) At least one cable should be tested from those specified in each of the following clauses (where applicable):

1) instrumentation cables (clause **6**);

2) power and control cables (clause **7**);

3) non-radial and radial field cables (clauses **8** and **9**).

b) Cables representing (approximately) the lowest and highest volume ratio of combustible material should be tested. This ratio may be calculated to within 0.2, from volumes based on design data.

c) At least two cables from each of the following types should be tested (where applicable):

1) braided;

2) unbraided.

d) At least one test should be carried out at each of the following loading conditions:

1) one layer of cable;

2) two layers of cable;

3) > 250 mm width of cable array;

4) < 100 mm width of cable array.

NOTE 2 For approval of a limited range of products only the relevant conditions should be selected e.g. for instrumentation cables conditions a)2) and a)3) would not apply.

For example, the chart given in Table R.1 shows how the conditions may be satisfied from a selection of cables.

R.3.5 ***Smoke emission test*** (see **6.14**, **7.10**, **8.11** and **9.12**)

NOTE This test is classified as a sample test. The guidance given below applies when it is used for type approval testing.

The loss of light transmittance during the 3 m cube test is a function of cable size. Therefore, although a range of cables may have identical components, tests on different sizes of each cable type should be carried out, in accordance with the following.

a) Cables specified in clause **6**: 150/250 V pairs, triples and quads.

Two cables should be tested.

b) Cables specified in clause **7**: 600/1 000 V, 1 900/3 300 V and 3 300/3 300 V single-core and multicore.

1) For cables up to and including 35 mm^2 conductor size, two braided or unbraided multicore cables should be tested.

2) For cables above 35 mm^2 conductor size, two braided or unbraided multicore cables should be tested.

3) If cables in both size ranges are being offered, two cables, one from each range, should be selected and tested.

c) Cables specified in clause **8**: 3 800/6 600 V, 6 600/6 600 V and 6 350/11 000 V single-core and three-core (non-radial field) and cables specified in clause **9**: 3 800/6 600 V, 6 350/11 000 V and 8 700/15 000 V single-core and three-core (radial field).

Two cables should be tested. One should always be in the range 70 mm^2 to 300 mm^2 conductor size.

Table R.1 — Sample selection chart

Condition	Cable selection					
					High voltage	High voltage
	1 pair unbraided	37 pair unbraided	4 × 2.5 unbraided	3 × 120 unbraided	1 × 50 radial field	3 × 185 radial field
a)	1)	1)	2)	2)	3)	3)
b)	High ratio	—	—	Low ratio	—	—
c)	2)	1)	2)	1)	—	—
d)	4)	1)	—	—	3)	4)

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R.3.6 ***Sequential type tests*** (see **9.10**)

NOTE These tests are applicable only to cables specified in clause **9**.

The sequential type tests, which are primarily electrical tests, are intended to assess the performance of a type of cable. Cables are generally regarded as being of the same type if they are of the same voltage rating and of similar construction.

In the context of the sequential type tests, cables of similar construction are generally regarded as those having the same number of cores (single-core or three-core), the same form of conductor (i.e. stranded), the same insulating material and the same form of semi-conducting screens (see **9.4.2**).

Repetition of the sequential type tests is not necessary on account of differences in the protective layers applied over the screened cores, unless these would be likely to have a significant effect on the results of the tests, taking into account that the prime purpose is to test the electrical performance of the insulating system. One type of cable embraces a range of different conductor sizes and, if the sequential type tests have been carried out successfully on cable(s) of particular conductor size(s), the results should be regarded as valid for cables of the same type having other conductor sizes. The results of tests on cables of one conductor size in the range 70 mm^2 to 300 mm^2 should be accepted as valid for cables of other conductor sizes in that range. For cables of conductor sizes outside that range, successful tests on cables of two conductor sizes should be accepted as valid for the same type of cable for all conductor sizes lying between the two sizes tested. They should also be accepted for the same type of cable for the two next standard smaller sizes below the smaller size tested, and the two next standard larger sizes above the larger size tested.

Successful tests on three-core cables should be accepted as valid for single-core cables, of the same type, for the same range of conductor sizes. However, as the manufacture of three-core cable may impose greater demands on the insulating system than for single-core cable, tests on single-core cable should not be regarded as demonstrating the performance of three-core cable.

Tests carried out successfully on cables of one voltage rating should be accepted as demonstrating the manufacturer's ability to produce satisfactory cables of lower voltage rating utilizing the same materials and processing method, without additional type testing.

R.4 Change of material

For the tests referred to in **R.3** it has been assumed that the materials are consistent throughout the range of cables for which conformity is to be assessed. Where a change occurs, it is necessary to include additional testing to ensure that such changes are adequately examined.

R.5 Evidence of type testing

A certificate of type testing signed by the representative of a competent witnessing body, or a report by the manufacturer giving the test results and signed by the appropriate personnel in his organization, should be accepted as evidence of type testing.

When evidence of type testing is required, this should be stated at the enquiry stage. Because of the possible variations in cable designs it should not be assumed that full type test information will be available for the size and type of cable detailed in a particular enquiry.

Annex S (informative)
Guide to use

S.1 Introduction

The aim of this annex is to inform users of characteristics and limitations of electric cables and thereby to minimize their misuse.

It is assumed that the design of installation and the specification, purchase and installation of cables in accordance with this British Standard is entrusted to suitable skilled and competent people.

In cases of doubt as to the suitability of cables specified in this British Standard for a particular use, further specific information should be obtained from the manufacturer.

S.2 Safety

S.2.1 ***Fundamental considerations***

S.2.1.1 Safety of a cable means that the product does not present an unacceptable risk of danger to life or property whilst being used in its intended manner.

S.2.1.2 Cables should not be used for any other purpose than the transmission and distribution of electricity.

S.2.1.3 The test methods, test parameters and requirements specified in this British Standard are only for the purposes of checking design and construction with respect to safety and quality assurance. They should not be regarded as providing evidence that the cables are suitable for service under conditions equivalent to the test conditions.

S.2.2 ***General***

S.2.2.1 All conductors and cables should be selected so as to be suitable for the voltages and currents likely to occur, under all conditions which are anticipated, in the equipment or installations or those parts thereof in which the cables are to be used.

It is essential that the rated voltage of any cable is not lower than the nominal voltage of the circuit for which it is used. See annex A for detailed guidance.

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S.2.2.2 Cables should be so constructed, installed, protected, used and maintained as to prevent danger so far as is reasonably practical.

S.2.2.3 The limiting conditions under which the cables can reasonably be expected to operate safely under normal circumstances are given in **S.3**.

These conditions are those considered capable of ensuring a length of life in service which has been accepted as reasonable by experience of the particular type of cable and the particular conditions of use. The duration of acceptable performance of a particular type of cable depends upon the type of use, the installation in which the cable is used or the electrical apparatus to which it is connected, and the particular combination of influences relating thereto.

For example, the duration of acceptable performance considered as reasonable for a cable used in a fixed internal installation in a ship is more than that for a cable installed externally.

S.2.2.4 Cables should be selected so that they are suitable for the operating conditions.

Examples of operating conditions are as follows:

a) voltage;

b) current;

c) protective measures (electrical);

d) grouping of cables;

e) method of installation;

f) ambient temperature.

Cables should be selected so that they are suitable for any external influences which may exist.

Examples of external influences are:

1) presence of rain, steam or accumulation of water;

2) presence of corrosive, chemical or polluting substances;

3) mechanical stresses (such as through holes or sharp edges in metalwork);

4) fauna (such as rodents);

5) flora (such as mould);

6) radiation (such as sunlight).

NOTE In respect of item 6) it should be noted that colour is important, black giving a higher degree of protection.

Cables should not be installed under any of these conditions unless they are of a type specifically designed to withstand such conditions.

S.2.2.5 Cables should not be installed in contact with, or close to, hot surfaces.

S.2.2.6 Cables should be supported adequately. Recommended maximum spacing of supports for wire braided and unbraided cables is given in Table S.1. In deciding the actual spacing, the weight of the cable between the supports should be taken into account so that the limiting value of tension recommended in **S.3.6.3** is not exceeded.

Table S.1 — Recommended maximum spacing of supports

Overall diameter of cable	Spacing of supports mm
Up to an including 8 mm	200
Over 8 mm up to and including 13 mm	250
Over 13 mm up to and including 20 mm	300
Over 20 mm up to and including 30 mm	350
Over 30 mm	400

The spacings given in Table S.1 are applicable to horizontal runs. For vertical runs the recommended spacings may be increased by 25 %.

NOTE When designing a cable support system for single-core cables, consideration should be given to the effects of the electrodynamic forces which develop on the occurrence of a short-circuit. The distances between cable supports recommended in Table S.1 may not be adequate for these cables.

S.3 Limiting conditions

S.3.1 *General*

The influence of all the factors outlined in **S.3.2** to **S.3.8** should be considered in combination, not separately.

S.3.2 *Voltage*

NOTE See **3.1**.

S.3.2.1 In an alternating current system, the rated voltage of a cable should be at least equal to the values U_0 and U of the system.

S.3.2.2 In a direct current system, the nominal voltage of the system should be not higher than 1.5 times the r.m.s. rated voltage of the cable.

NOTE 1 The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %.

NOTE 2 See annex A for detailed guidance.

S.3.2.3 Careful consideration should be given to cables subjected to voltage surges associated with highly inductive circuits to ensure that they are of a suitable voltage rating.

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S.3.3 *Current rating*

NOTE See also **A.2**.

S.3.3.1 The cross-sectional area of every conductor should be such that its current rating is not less than the maximum sustained current which will normally flow through it.

S.3.3.2 A.C. wiring should be carried out as far as is reasonably practical, using twin or multicored cables. Where it is necessary to use single-core cables in a.c. circuits or in d.c. circuits having a high ripple current, special precautions may be required.

S.3.3.3 Where crimped joints or terminations are used the limiting temperature for the conductor under short circuit conditions is 250 °C (see **A.2.3**).

In the case of soft soldered joints or terminations the limiting temperature for the conductor under short circuit conditions is reduced to 160 °C. Account of this limitation should be taken in selecting and operating cables.

S.3.3.4 If cables are operated for any prolonged periods at temperatures above those given in **A.2**, they could be seriously damaged leading to a premature failure, or their properties could be significantly reduced.

S.3.3.5 The selection of the cross-sectional area of any conductor should not be based on current rating alone. Account should be taken of the need to protect against the following:

a) electric shock;

b) thermal effects;

c) overload and short circuit current;

d) voltage drop.

The mechanical strength of the cable also needs to be taken into account.

Examples of particular factors which should be taken into account are as follows:

1) limiting temperatures for terminals of equipment, busbars or bare conductors;

2) the carrying of current by the neutral conductor, resulting for example, from the presence of significant harmonic current in a three phase circuit;

3) electromagnetic effects;

4) inhibition of heat dissipation;

5) requirements determining the size of the circuit protective conductor;

6) solar or infra-red radiation.

S.3.4 *Thermal effects*

S.3.4.1 The maximum limiting temperatures of the types of cables covered by this standard are given in **A.2**. The values given should not be exceeded by any combination of the heating effect of current in the conductors and the ambient conditions. Particular account should be taken of the following.

a) Cables in free air should be so installed that the natural air convection is not impeded. When cables are covered or embedded in thermal insulation or when the heat dissipation is impeded by other means, it is essential that the corresponding reduction of the current rating be observed.

b) The temperature of cable sheaths can be significantly higher than the ambient temperature where the cables are subjected to radiation, e.g. solar or infra-red. Where these situations cannot be avoided their effect should be taken into account in assessing the current rating or the temperature of the cable relative to the limiting temperature and its service life.

c) Account should be taken of the temperatures occurring within equipment, appliances and luminaires, and at their terminals.

S.3.4.2 The minimum limiting ambient temperature for which the fixed cables specified in this standard are considered suitable is −30 °C. All insulation and sheath materials used for cables become progressively stiffer as their temperature is lowered below the normal ambient temperature to the point where they become brittle. This behaviour has been taken into account in establishing this value. See also **B.1**.

S.3.4.3 The limiting temperature given in **A.2** is such that the temperature of the surface of the cable is liable to exceed 50 °C, so the cable should be so located or guarded as to prevent contact of persons or animals therewith. Cable surface temperatures above 50 °C can cause involuntary reactions in the event of contact with exposed skin. Account should be taken of these possibilities in the selection and use of cables.

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S.3.5 ***Cables and fire***

Cables should be selected, located and installed so that their intended heat dissipation is not inhibited and they do not present a fire hazard to adjacent materials. Particular account should be taken of the following.

a) In the case of fire initiated elsewhere, cables can provide a source of fuel and a means of propagating a fire along their length.

In these circumstances the insulation and sheath materials of cables in burning can give rise to smoke, and toxic and corrosive fumes.

b) Where a particular hazard exists or is likely to exist in the presence of explosive flammable atmospheres, specific regulations apply. It is essential that the requirements of these regulations be taken into account in selecting the type, current carrying capacity and constructional features of the cable involved to assure safety as influenced by the cable.

NOTE The types of cables permitted for service in hazardous areas are referred to in BS EN 60079-14:1997, clause **9**.

S.3.6 ***Mechanical stress***

S.3.6.1 *General*

In assessing the risks of mechanical damage to cables, account should be taken of any mechanical strains likely to be imposed during the normal process of installation of cables.

Cables should be so installed that the stress applied to them either by reason of their own weight or for any other reason is minimized. These precautions are particularly important for cables of small cross-section and for cables on vertical runs, or in vertical pipes. Such cables should be suitably supported (see **S.2.2.6**).

S.3.6.2 *Mechanical protection*

The following recommendations are applicable.

a) In situations where there could be a risk of mechanical damage, cables should be enclosed in suitable conduits or casing, unless the cable covering, e.g. wire braid or sheath, provides adequate protection.

b) In situations where there would be an exceptional risk of mechanical damage, cables should be protected by steel casing, trunking or conduits, even when wire braided, if the structure of the installation or attached parts do not afford sufficient protection to the cables. Any metal casing used should be protected against corrosion.

S.3.6.3 *Tension*

The tension applied to a cable should not exceed the values of tensile stress per conductor given below. This is subject to a total maximum tensile force of 1 000 N unless otherwise agreed by the cable manufacturer.

— 50 N/mm^2 during installation;

— 15 N/mm^2 for static tensile stress.

S.3.6.4 *Bending*

The internal radius of every bend in a cable should be such as not to cause damage to the cable.

The minimum internal bending radii for different types of cable are given in **B.2**. Any decision to use lower values than those recommended in **B.2** should be taken in consultation with the manufacturer of the cable.

Care should be taken when stripping the insulation to ensure that no damage occurs to the conductor since this will severely affect the bending radii.

The bending radii recommended are for ambient temperatures of (20 ± 10) °C. For temperatures outside these limits, the cable manufacturer's recommendations should be obtained.

Class 5 conductors are included in this standard as an aid to the installation and termination of cables in confined spaces. The use of class 5 conductors does not imply that these cables are suitable for applications where they will be subjected to frequent or repeated flexing.

S.3.6.5 *Compression*

A cable should not be compressed to such an extent as to cause damage.

S.3.7 ***Compatibility***

S.3.7.1 In selecting and installing cables account should be taken of the guidance given in **S.3.7.2** to **S.3.7.5**.

S.3.7.2 The possibility of interference between adjacent circuits either mechanical or electrical should be avoided.

S.3.7.3 Consideration should be given to the effect of heat given out by cables, and the chemical and/or physical effect of materials used in their construction, on adjacent materials, e.g. construction materials, decorative materials, cable enclosures and supports.

S.3.7.4 The interaction of adjacent materials with the materials used in the construction of cables should also be taken into account.

S.3.7.5 Cables having insulating materials with different maximum permissible conductor, temperatures should not be bunched in a common clip, support, gland, conduit, trunking or duct.

Where this is impractical, those cables with higher permissible conductor temperatures should be derated to ensure that their operating temperature is not greater than that of the lowest temperature rated cable in the bunch.

Cables for control circuits may, however, be bunched with power cables having higher permissible conductor temperatures, providing that the temperature within the bunch does not exceed the permissible temperature of the control cable sheath.

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S.3.8 *Dynamic stress*

The possibility of damage to cables and their supports due to the disruptive effects of the electromechanical forces caused by any current which the cables may have to carry in service, including short circuit currents, should be taken into account.

S.4 Initial and periodic verifications

Cables liable to be touched should be inspected along their route and, if necessary, checked by measurements at the end of the installation and periodically during operation.

Cables for fixed installations or for fixed equipment should be inspected periodically, and every time it is feared that the cable has been damaged by internal stresses (overvoltage, overcurrents) or external stresses. If the cable shows a visible change of external appearance it should either be repaired, by skilled persons using suitable devices, or replaced.

S.5 Packaging, storage, handling and transportation of cables

S.5.1 *Packaging*

Cables within the scope of this British Standard are normally delivered to the user either on drums, or reels. They are normally labelled to identify the cable type and size.

S.5.2 *Storage*

S.5.2.1 It is essential that all exposed cable ends are sealed if the cable is to be stored outdoors.

S.5.2.2 During storage, account should be taken of the recommended minimum temperature for installation given in **B.1**.

S.5.3 *Handling and transportation*

If the temperature of the cable falls below that recommended in **B.1**, care should be taken to minimize any mechanical stress, in particular vibration, impact, shock, bending and torsion.

S.6 Storage and handling of drums

S.6.1 Cable drums should be regularly inspected during storage to assess their physical condition.

S.6.2 Battens, where applied, should not be removed from drums until the cable is about to be installed.

S.6.3 When handling drums, precautions should be taken to avoid injury. Due regard should be paid to the weight of the drums, the method and direction of rolling, the method of lifting, and the possible presence of protruding nails and splinters.

S.6.4 Care should be taken to avoid deterioration of drums or their becoming a hazard to the general public.

S.6.5 For further information, a detailed guide to the safe handling of cable drums should be obtained from the cable manufacturer.

S.7 Incineration of scrap cable

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

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Bibiography

Standards publications

BS 7917:1999, *Specification for elastomer insulated fire resistant (limited circuit integrity) cables for fixed wiring in ships and on mobile and fixed offshore units.*

BS EN 60079-14:1997, *Electrical apparatus for explosive gas atmospheres — Part 14: Electrical installations for hazardous areas (other than mines).*

IEC 60038:1983, *IEC Standard voltages.*

Other publications

[1] INSTITUTION OF ELECTRICAL ENGINEERS. *Regulations for the electrical and electronic equipment of ships with recommended practice for their implementation.* Sixth Edition 1990, Supplement 1994[3].

[2] INSTITUTION OF ELECTRICAL ENGINEERS. *Recommendations for the electrical and electronic equipment of mobile and fixed offshore installations.* Second Edition 1992, Supplement 1995[3].

[3] Conférence Internationale des Grandes Réseaux Electriques. Report 1968-21-01[4].

[4] INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS. Paper No. 69, CP88-PWR[5].

[3] Obtainable from the Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.

[4] Published by, and obtainable from Conference Internationale des Grands Reseaux Electriques (à haute tension), 112 Boulevard Haussmann, 75008, Paris, France.

[5] Published by, and obtainable from, Institute of Electrical and Electronic Engineers Inc., 345 East 47th Street, New York NY 10017, USA.

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