

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

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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 It supersedes BS 6883:1991 which is withdrawn.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

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 63 and a back cover.

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 360:1991, *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

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.

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/m².

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.

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;
- $7 \times 2 \times 1.0$ (i) indicates seven individually screened pairs with 1.0 mm^2 conductors;
- $7 \times 3 \times 1.0$ (c) indicates seven collectively screened triples with 1.0 mm^2 conductors;
- $7 \times 4 \times 1.0$ (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 $(20 \pm 15)^\circ\text{C}$ 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.

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.

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 M Ω -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 M Ω -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 M Ω -km at (20 ± 5) °C.

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
6.12.1	<i>Electrical tests</i>										
	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
5.1	<i>Constructional and dimensional tests</i>										
	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
	<i>Tests under fire conditions</i>										
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.

Table 3 — Schedule of tests

Test	Requirement given in clause	Test method	Test category
<i>Tests on components</i>			
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
<i>Tests on completed cables</i>			
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.

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 mm ²	Radial thickness of insulation mm	Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. 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 mm ²	Radial thickness of insulation mm	Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. 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.

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

Number of pairs	Nominal area of conductor mm ²	Radial thickness of insulation mm	Radial thickness of inner sheath mm	Diameter over inner sheath ^a		Wire braid		Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. mm	Nominal wire diameter mm	Maximum resistance Ω/km		Min. mm	Max. 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 mm ²	Radial thickness of insulation mm	Radial thickness of inner sheath mm	Diameter over inner sheath ^a		Wire braid		Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. mm	Nominal wire diameter mm	Maximum resistance Ω/km		Min. mm	Max. 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.

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

Number of triples	Nominal area of conductor mm ²	Radial thickness of insulation mm	Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. 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 mm ²	Radial thickness of insulation mm	Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. 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 mm ²	Radial thickness of insulation mm	Radial thickness of inner sheath mm	Diameter over inner sheath ^a		Wire braid		Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. mm	Nominal wire diameter mm	Maximum resistance Ω/km		Min. mm	Max. 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.

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

Number of triples	Nominal area of conductor mm ²	Radial thickness of insulation mm	Radial thickness of inner sheath mm	Diameter over inner sheath ^a		Wire braid		Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. mm	Nominal wire diameter mm	Maximum resistance Ω/km		Min. mm	Max. 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 mm ²	Radial thickness of insulation mm	Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. 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 mm ²	Radial thickness of insulation mm	Radial thickness of inner sheath mm	Diameter over inner sheath ^a		Wire braid		Radial thickness of outer sheath mm	Diameter over outer sheath ^a	
				Min. mm	Max. mm	Nominal wire diameter mm	Maximum resistance Ω/km		Min. mm	Max. 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.

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 mm² and 1.5 mm² and class 2 shall be used for all other conductor sizes. The conceptual construction of 25, 35, 95, 400 and 500 mm² 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:

- numbers printed on the insulation in a contrasting colour;
- numbered proofed tapes having black numerals on a white base;
- coloured proofed tapes;
- 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.

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 %.

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
7.8.1	<i>Electrical tests</i>																
7.8.2	Conductor resistance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.8.3	Voltage test on completed cable	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Insulation resistance of cores	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5.1	<i>Constructional and dimensional tests</i>																
7.2.3	Check on construction	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.5.2	Measurement of insulation thickness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.7.2	Measurement of inner sheath thickness	—	—	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	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
7.10.1	<i>Tests under fire conditions</i>																
7.10.2	Vertical burning test (single cable)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.10.3	Flame propagation (bunched cables)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.10.4	Smoke emission ^b	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	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.