BS 4553-1:1998

Specification for 600 / 1 000 V single-phase split concentric electric cables —

Part 1: Cables having PVC insulation

ICS 29.060.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee GEL/20, Electric cables, to Subcommittee GEL/20/2, Mains cables, 1 kV and above, upon which the following bodies were represented:

Association of Consulting Engineers
British Approvals Service for Cables
British Cable Makers Confederation
British Plastics Federation
Electricity Association
ERA Technology Ltd.
London Underground Ltd.
UK Steel Association

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Contents

Foreword

This British Standard has been prepared by Subcommittee GEL/20/2. It is one of three parts of a full technical revision of BS 4553:1992, which is withdrawn.

BS 4553-1 specifies the range of PVC insulated split concentric cables originally incorporated in BS 4553:1992. In addition, the standard now contains the option of solid aluminium conductors or stranded copper conductors, as well as the option of using a separate extruded bedding to build up the core to a diameter suitable for applying the split concentric layer.

BS 4553-2 specifies a similar range of split concentric cables but which have thermosetting insulation.

BS 4553-3 specifies a similar range of split concentric cables, but which have thermosetting insulation and non-halogenated sheaths and a low emission of smoke and acid gas when affected by fire.

Certification. Attention is drawn to the certification services of the British Approvals Service for Cables (BASEC)[1]. These services include licensing of manufacturers to use BASEC certification trade marks as independent assurance that cables or cords have been designed and manufactured to appropriate British Standards.

Annexes D, E, F and G are normative. Annexes A, B, C, H and J are informative.

A British Standard does not purport to include all 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 and ii, pages 1 to 10, an inside back cover and a back cover.

[1] British Approvals Service for Cables, Silbury Court, 360 Silbury Boulevard, Milton Keynes, MK9 2AF.

1 Scope

This British Standard specifies requirements for construction and gives methods of test for PVC-insulated single-phase split concentric cables for operation on an earthed neutral system at nominal voltages up to and including 1 000 V between phases and 600 V to earth.

The cables specified in this part of BS 4553 have a central phase conductor insulated with PVC and a concentric layer comprising bare copper wires (earth continuity conductor) and copper wires covered with extruded polymer (neutral conductor). The cables are intended for use in fixed installations in industrial areas, buildings and similar applications. They are suitable for use in situations where the combination of ambient temperature and temperature rise due to loading current results in a conductor temperature not exceeding 70 °C, and for a maximum short-circuit conductor temperature of 160 °C.

Guidance concerning selection, installation and usage is given in annexes A, B, and J respectively.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this 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 4066-1, *Tests on electric cables under fire conditions — Part 1: Method of test on a single vertical insulated wire or cable.*

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

BS 5099, *Specification for spark testing of electric cables.*

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

BS 7655-3.1, *Specification for insulating and sheathing materials for cables — Part 3: PVC insulating and sheathing materials for cables — Section 3.1: Harmonized types.*

BS 7655-4.1, *Specification for insulating and sheathing materials for cables — Part 4: PVC sheathing compound — Section 4.1: Harmonized types.*

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 Definitions

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

3.1

rated voltage U_0

nominal power-frequency voltage between phase conductor and earth, for which the cable is suitable

3.2

rated voltage U

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

3.3

maximum voltage U_m

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

3.4

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 taki g into account specified tolerances.

3.5

approximate value

value which is only indicative

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

3.6

type tests (symbol T)

tests required to be 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 of such a nature that, after they have been made, they need not be repeated unless changes are made in the cable material, design or type of manufacturing process which might change the performance characteristics.

3.7

sample tests (symbol S)

tests made on samples of completed cable, or components taken from a completed cable, adequate to verify that the finished product meets the design specifications

3.8

routine tests (symbol R)

tests made on all production lengths to demonstrate their integrity

3.9

tests after installation

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

4 Voltage designation

The cables shall be designated by the rated voltages U_0 and U, expressed in the form U_0/U.

The rated voltage recognized for the purposes of this standard is 600/1 000 V.

The maximum designated voltage (U_m) for the purposes of this standard is 1 200 V.

NOTE Guidance on the selection and operation of cables is given in annex A.

5 Phase conductor

The phase conductor shall be either annealed copper or solid aluminium, as given in Tables 3 or 4, and shall conform to the requirements detailed in Table 1 and to BS 6360.

Where the manufacturer deems it necessary to use tinned copper conductors, they shall conform to the requirements of BS 6360 for metal coated conductors.

The phase conductor shall be either circular or circular compacted stranded copper (class 2), or circular solid aluminium (class 1), as specified in Tables 3 or 4.

6 Insulation

6.1 General

The insulation shall be PVC compound type TI 1 conforming to BS 7655-3.1. The insulation shall be applied by the extrusion process to form a compact and homogeneous layer.

6.2 Thickness of insulation

The thickness of insulation, when determined by taking the average of a number of measurements in accordance with annex D, shall be not less than the value given in Tables 3 or 4, as appropriate, and the smallest of the measured values shall not fall below the value given in Tables 3 or 4, as appropriate, by more than 10 % + 0.1 mm.

6.3 Spark testing of insulation

The core insulation shall conform to the requirements for spark testing specified in BS 5099 when tested in accordance with the a.c. or d.c. test methods specified in that standard. The voltage levels shall be determined by reference to the value of insulation thickness given in Tables 3 or 4.

7 Identification of phase core

7.1 General

The phase core shall be identified by the colour red either throughout the insulation or on its external surface.

Conformity shall be checked by visual examination.

7.2 Clarity and durability

The colour used for core identification shall be clearly identifiable and durable such that it cannot be removed when rubbed 10 times with a piece of cotton wool or cloth soaked in water.

8 Bedding

NOTE In order to fit the layer of concentric wires around the core, the diameter of the core may be built up by applying an extruded layer of bedding material. As an alternative to applying a separate bedding, the insulation thickness may be increased appropriately such that the concentric wires fit around the insulated core.

Any bedding shall be an extruded polymeric compound, which, when tested in accordance with BS EN 60811-1-1, shall have a tensile strength of not less than 4 N/mm^2 and an elongation at break of not less than 50 %.

The manufacturer shall, where necessary, apply a suitable tape under the extruded bedding or, in the absence of a bedding, over the insulation.

It shall be possible to remove the bedding without damaging the insulation of the core.

9 Concentric layer

9.1 Neutral conductor

The neutral conductor shall be manufactured from plain annealed solid copper wires. The number of wires and the resistance of the neutral conductor, when measured in accordance with **16.2**, shall conform to the values given in Tables 3 or 4.

To distinguish the neutral conductor from the earth continuity conductor, each wire shall be covered by extrusion with a black polymeric compound to a diameter approximately the same as that of the individual wires in the earth continuity conductor.

The extruded polymeric compound, when tested in accordance with BS EN 60811-1-1, shall have a tensile strength of not less than 4 N/mm^2 and an elongation at break of not less than 50 %.

NOTE The covering should not be regarded as insulation.

9.2 Earth continuity conductor

The earth continuity conductor shall be manufactured from bare plain annealed solid copper wires. The number of wires and the resistance of the earth continuity conductor when measured in accordance with **16.2**, shall conform to the values given in Tables 3 or 4.

9.3 String separators

Non-hygroscopic string separators shall be approximately the same diameter as the individual bare wires forming the earth continuity conductor.

9.4 Application of concentric layer

The concentric layer shall be applied with either a right hand or left hand direction of lay. The wires forming the neutral conductor and earth continuity conductor shall be applied in individual groups over the insulation or bedding with string separators.

Either one or two string separator(s) shall be located on either side of the group of bare copper wires to separate it from the group of covered wires.

10 Binders

One or more overlapped synthetic binder tape(s) shall be applied directly over the concentric layer.

11 Oversheath

11.1 General

The oversheath shall be an extruded layer of PVC compound conforming to the requirements for TM 1 material specified in BS 7655-4.1.

NOTE Oversheaths are normally black, but colours other than black may be provided by agreement between the manufacturer and purchaser, subject to their suitability for the particular exposure conditions under which the cables are to be used.

11.2 Thickness of oversheath

The minimum thickness of the oversheath, when measured in accordance with annex D, shall not fall below the value given in Tables 3 or 4, as appropriate, by an amount more than 15 % + 0.1 mm.

11.3 Spark testing of oversheath

The oversheath shall conform to the requirements for spark testing specified in BS 5099 when tested in accordance with a.c. or d.c. test methods specified in that standard.

12 Cable marking

12.1 External marking

The external surface of all cables conforming to this British Standard shall be legibly marked with the following elements of marking.

Element	Example of marking
a) Electric cable	ELECTRIC CABLE
b) Voltage designation	600/1 000 V
c) British Standard number	BS 4553-1
d) Manufacturer's identification	XYZ
e) Number of cores, type and nominal area of phase/ neutral/earth conductors	1 × 35/35/25 1 × 25/16/16 AL

NOTE 1 If there are no letters after the size, this indicates that the phase conductor is copper.

The marking of the items a) to d) shall be by embossing or indenting on the oversheath.

For cables with tabulated approximate overall diameters greater than 15 mm, items a), b) and c) shall appear, in any sequence that is deemed neither to confuse nor conflict, on two or more primary lines along the axis of the cables, approximately equally spaced around the circumference of the cable.

Items d) and e) shall appear either on one of the primary lines, or on a secondary line or lines, in any sequence that is deemed neither to confuse nor conflict.

NOTE 2 Items d) and e) need not both appear on the same line.

For cables with tabulated approximate overall diameters up to and including 15 mm, the elements of the marking shall be disposed as for cables of greater than 15 mm diameter except that the marking for items a), b) and c) shall appear on one or more primary lines.

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) and e).

Conformity shall be checked by visual examination and measurement.

12.2 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.

12.3 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.

12.4 Additional marking

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

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 markings specified in **12.1** to **12.3**.

13 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.

14 Schedule of tests

The tests to be performed on cables specified in this standard shall be as scheduled in Table 1, which refers to the relevant clauses of the standard specifying the requirements and to the appropriate test methods, as well as the category of each test which applies, i.e. T, S or R (as defined in clause 3).

NOTE Table 1 also indicates which tests relate to complete cable, and which relate to components.

15 Test conditions

15.1 Ambient temperature

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

15.2 Frequency and waveform of power frequency test voltages

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

16 Routine tests

16.1 General

Routine tests shall be performed as indicated in Table 1 by the symbol R.

NOTE Those requirements for which routine testing is specified, and which are not fully covered by earlier clauses, are detailed in **16.2**, **16.3** and **16.4**.

16.2 Conductor resistance

The d.c. resistances of the central phase, covered neutral and bare earth continuity conductors shall be measured, and when corrected to 20 °C in accordance with BS 6360, shall be not greater than the values given in Tables 3 or 4.

16.3 Voltage tests on completed cables

When the completed cable is tested in accordance with annex E, the insulation and neutral covering shall not break down.

16.4 Insulation resistance

When the completed cable is tested in accordance with annex F, the insulation resistance shall be not less than 5 MΩ/1 000 m at 20 °C.

17 Sample tests

17.1 General

Sample tests shall be performed as indicated in Table 1 by the symbol S.

NOTE Those requirements for which sample testing is specified, and which are not fully covered by earlier clauses, are detailed in **17.2**.

17.2 Flame propagation on single cable

The finished cable shall conform to the requirements of BS 4066-1.

18 Type tests

18.1 General

Type tests shall be performed as indicated in Table 1 by the symbol T (see also annex H).

NOTE Those requirements for which type testing is specified, and which are not fully covered by earlier clauses, are detailed in **18.2**.

18.2 Compatibility

When a sample of complete cable is aged in accordance with **G.2**, the insulation and oversheath shall conform to the requirements given in Table 2. In addition, at the end of the test period in the oven, the blotting paper shall be free of stains.

Table 1 — Schedule of tests

Test	Requirement given in clause	Test method	Category
Tests on components			
Phase conductor material and construction	**5**	BS 6360	S
Insulation:			
material	**6.1**	BS 7655-3.1	T
thickness	**6.2**	Annex D	S
spark test	**6.3**	BS 5099	R
Core identification:			
colour	**7.1**	Visual examination	R
durability	**7.2**	**7.2**	R
Bedding:			
material	**8**	BS EN 60811-1-1	T
Concentric layer:			
neutral conductor	**9.1**	Visual examination	R
neutral covering material	**9.1**	BS EN 60811-1-1	T
earth continuity conductor	**9.2**	Visual examination	R
application	**9.4**	Visual examination	R
Binders:			
application	**10**	Visual examination	R
Oversheath:			
material	**11.1**	BS 7655-4.1	T
thickness	**11.2**	Annex D	S
spark test	**11.3**	BS 5099	R
Tests on complete cables			
Concentric construction	**9** and **10**	Visual examination	S
Cable markings	**12**	Visual examination and measurement	R
Phase conductor resistance	**16.2**	BS 6360	R
Neutral conductor resistance	**16.2**	BS 6360	R
Earth continuity conductor resistance	**16.2**	BS 6360	R
Voltage tests	**16.3**	Annex E	R
Insulation resistance	**16.4**	Annex F	R
Test under fire conditions:			
flame propagation on single cable	**17.2**	BS 4066-1	S
Compatibility test	**18.2**	Annex G and BS EN 60811-1-1 and BS EN 60811-1-2	T

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

Table 2 — Compatibility requirements

Component	Test	Requirement	
		T11	TM 1
Insulation	Minimum tensile strength (N/mm^2)	12.5	—
	Minimum percentage elongation at break	125	—
	Maximum percentage variation[a] of tensile strength	20	—
	Maximum percentage variation[a] of elongation at break	20	—
Oversheath	Minimum tensile strength (N/mm^2)	—	12.5
	Minimum percentage elongation at break	—	125
	Maximum percentage variation[a] of tensile strength	—	20
	Maximum percentage variation[a] of elongation at break	—	20

[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 3 — 600 / 1 000 V PVC-insulated single-phase split concentric cables with stranded copper phase conductors

Phase conductor	Thickness of insulation on phase conductor	Concentric conductors		Thickness of oversheath	Approximate overall diameter	Maximum d.c. conductor resistance per 1000 m of cable at 20 °C		
Nominal area[a]		Number and approximate diameter of wires				Phase	Neutral	Earth continuity conductor
		Neutral	Earth continuity					
mm^2	mm	mm	mm	mm	mm	Ω	Ω	Ω
4	0.8	7/0.85	3/1.35	1.4	9.8	4.61	4.8	4.8
6	0.8	7/1.04	4/1.53	1.4	11.2	3.08	3.2	3.2
10	1.0	7/1.35	4/1.78	1.4	12.6	1.83	1.9	1.9
16	1.0	7/1.70	4/2.25	1.4	15.0	1.15	1.2	1.2
25	1.2	11/1.70	4/2.25	1.5	18.3	0.727	0.76	1.2
35	1.2	15/1.70	6/2.25	1.6	23.2	0.524	0.55	0.76

[a] Circular stranded or compacted circular (class 2)

Table 4 — 600 / 1 000 V PVC-insulated single-phase split concentric cables with solid aluminium phase conductors

Phase conductor	Thickness of insulation on phase conductor	Concentric conductors		Thickness of oversheath	Approximate overall diameter	Maximum d.c. conductor resistance per 1000 m of cable at 20 °C		
Nominal area[a]		Number and approximate diameter of wires				Phase	Neutral	Earth continuity conductor
		Neutral	Earth continuity					
mm^2	mm	mm	mm	mm	mm	Ω	Ω	Ω
10	1.0	7/1.04	4/1.53	1.4	11.6	3.08	3.2	3.2
16	1.0	7/1.35	4/1.78	1.4	13.0	1.91	1.9	1.9
25	1.2	7/1.70	4/2.25	1.4	15.6	1.20	1.2	1.2
35	1.2	11/1.70	4/2.25	1.5	18.4	0.868	0.76	1.2

[a] Circular solid (class 1)

Annex A (informative)

Recommendations for the selection and operation of cables

A.1 General

The cables specified in this standard are designed to be installed in air, or for burial in free draining soil conditions.

Where the cables are to be laid in any other environment, reference should be made to the cable manufacturer.

A.2 Voltage rating

The cables specified in this standard are rated at 600/1 000 V.

The rated voltage of the cable for a given application should be suitable for the operating conditions in the system in which the cable is used. To facilitate the selection of the cable, systems are divided into three categories as follows:

a) *Category A*

This category comprises those systems in which any phase conductor that comes into contact with earth or an earth conductor is disconnected from the system within 1 min.

b) *Category B*

This category comprises those systems which, under fault conditions, are operated for a short time with one phase earthed. This period, according to IEC 60183, should not exceed 1 h. The total duration of earth faults in any year should not exceed 125 h.

c) *Category C*

This category comprises all systems which do not fall into categories A or B.

NOTE It should be realized that, in a system where an earth fault is not automatically and promptly isolated, the extra stresses on the insulation of cables during the earth fault reduce the life of the cables to a certain degree. If the system is expected to be operated fairly often with a permanent earth fault, it may be advisable to classify the system into a higher category.

The cables specified in this standard are only suitable for use in category A systems.

The maximum values of the system voltages U and U_m for these cables are 1.0 kV and 1.2 kV respectively.

The maximum sustained system voltage, U_m, is the highest voltage between phases that can 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.

A.3 Current rating

Reference should be made to the manufacturer's publications to obtain the current ratings of the selected cable sizes.

Annex B (informative)

Recommendations for installation of cables

B.1 General

Cables should be installed and used in association with other equipment in accordance with BS 7671 and/or the Electricity Supply Regulations, as appropriate.

NOTE In countries outside the UK, corresponding national regulations may apply.

In special environments, the appropriate regulations and codes of practice should be observed.

B.2 Minimum temperature during installation

It is recommended that the cables specified in this standard be installed only when both the cable and ambient temperatures are above 0 °C and have been so for the previous 24 h, or where special precautions have been taken to maintain the cable above this temperature.

B.3 Minimum installation radius

None of the cables specified in this standard should be bent during installation to a radius smaller than eight times the overall diameter given in Tables 3 and 4.

B.4 Prevention of moisture ingress

Care should be exercised during installation to avoid any damage to cable coverings. This is important in wet or other aggressive environments. The protective cap should not be removed from the ends of the cable until immediately prior to termination or jointing. When the caps have been removed the unprotected ends of the cable should not be exposed to moisture.

The possibility of damage to moisture seals during handling and installation or during storage of the cable should be borne in mind. Where such damage may have occurred, the seals should be inspected and remade if necessary.

B.5 Compound filling

For compound filled joints, the design of the box and the composition of the filling compound should provide an effective seal to prevent moisture gaining access to the conductor ferrules and connections. The filling compound should be compatible with the materials of the cable components with which it comes into contact. Account should be taken of the pouring temperatures or the temperatures resulting from exothermic reaction.

Compound filling is not necessary for terminations, provided that adequate clearances are maintained between phases and between each phase and earth. The minimum clearances should be related to the voltage and category of systems and environmental conditions. Guidance on minimum clearances can be obtained from the appropriate standards for equipment.

Where the required clearances cannot be achieved, it is necessary to provide some other effective means of insulation.

B.6 Tests after installation

A voltage test after installation is not a requirement of this standard, but if a test is made it should be performed with direct current, as follows.

The voltage should be increased gradually to the full value of 3 500 V d.c. and maintained continuously for 15 min. The test should be made between phase conductor and the concentric conductors, the neutral and earth conductors being connected together.

No breakdown should occur.

This test voltage is 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.

Annex C (informative)

Information to be provided with enquiry or order

The following information should be given with an enquiry or order:

a) the number of this British Standard, i.e. BS 4553-1;

b) length of cable required and individual drum lengths, if important;

c) size of conductor;

d) type of conductor (i.e. copper or aluminium);

e) whether cable is liable to be exposed to any potentially aggressive environments (e.g. water, oil or acid).

NOTE See annex A for recommendations for selection of cables.

Annex D (normative)

Measurement of thickness

D.1 Sampling

For measurements of the thickness of insulation and oversheath listed in Table 1, take a sample from one end of each drum length of cable selected for the test, discarding any portion which may have suffered damage.

D.2 Test procedure

Make measurements for thickness of insulation and oversheath 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.

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

If any of the thicknesses measured does not conform to **6.2** and **11.2**, check two further samples in respect of the non-conforming dimensions. If both of the further pieces meet the specified requirements, the cable is deemed to conform, but if either does not meet the requirements the cable is deemed not to conform.

Annex E (normative)

Voltage tests on completed cables

Earth all the wires that comprise the concentric layer. Apply a test voltage of 3.5 kV r.m.s between the central phase conductor and the concentric layer. Perform the test at room temperature increasing the voltage gradually and maintaining it for 5 min at the full value specified.

After completion of this test, perform an additional test by applying a voltage of 500 V d.c. for 1 min between the bare earth continuity wires and the covered neutral wires in the concentric neutral layer.

Annex F (normative)

Insulation resistance test

After completion of the voltage test given in **16.3**, measure the insulation resistance between the central phase conductor and all the wires comprising the concentric layer, after applying a minimum voltage of 500 V d.c. for 1 min.

Annex G (normative)

Compatibility test

G.1 General

This test is intended to demonstrate that the insulation and oversheath are not likely to deteriorate due to contact with the other components in the cable.

G.2 Test method

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

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 for insulation and sheath in accordance with BS EN 60811-1-1.

Annex H (informative)

Notes on type tests

H.1 General

Type tests, after they have been completed, need not be repeated unless changes have been made that affect conformity to the test 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.

H.2 to **H.4** give guidance as to the amount of type testing that may reasonably be required.

H.2 Sample selection for type tests

Table 1 indicates which tests relate to complete cable and which relate to components.

Type tests for components may be performed 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 in this standard by selecting samples for test as follows:

— any one sample of cable having a copper conductor; plus

— any one sample of cable having a solid aluminium conductor.

In addition, where manufacturers wish to demonstrate conformity to this standard, the cable samples should be subjected to full dimensional checks and to all other sample (S) and routine (R) tests given in Table 1.

H.3 Type tests

H.3.1 ***Compatibility test*** (see **18.2**)

One test should be performed on each sample selected.

H.4 Change of material

The test referred to in **H.3** assumes that the materials are consistent throughout the range of cables for which conformity is to be confirmed. Where a change occurs, it is necessary to include additional testing to ensure that such changes are adequately examined.

H.5 Evidence of type testing

A certificate of type test signed by the representative of a competent witnessing body, or a properly authorized report by the manufacturer giving the test results, should be acceptable 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 of a particular enquiry.

Annex J (informative)

Guide to use

J.1 Aim

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 installations and the specification, purchase and installation of cables specified in this British Standard is entrusted to suitably skilled and competent people.

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

J.2 Cable selection and design

J.2.1 The products specified in this British Standard are intended to be used for the supply of electrical energy up to the rated voltage indicated on the cable. **A.2** classifies the voltage rating of cables manufactured in accordance with this specification. This rating should not be exceeded.

J.2.2 These cables are intended for use within a nominal power frequency range of 49 Hz to 61 Hz.

J.2.3 In addition to the current ratings, due regard should be given to:

a) the capability of the cable to withstand the worst anticipated fault condition of the system;

b) the earth loop impedance;

c) the operating characteristics of the connected equipment;

d) the voltage drop requirements during normal load or motor starting conditions.

J.2.4 The possible effects of transient over-voltages should be recognized as they can be detrimental to cables.

J.3 Environment/application

J.3.1 Reasonable protection, appropriate to the choice of cable and the installation conditions, should be provided against mechanical damage.

J.3.2 Cables specified in this British Standard contain PVC and when exposed to the effects of external fire will produce harmful smoke and fumes, and where bundled together may propagate fire. When circumstances dictate, consideration may be given to the use of cables in accordance with BS 4553-3.

J.3.3 Cables may be harmed by exposure to corrosive products or solvent substances, especially petroleum based chemicals or their vapours.

J.3.4 Special precautions are required when cables are to be installed in areas classified as hazardous, and reference should be made to BS EN 60079-14.

J.3.5 Cables specified in this British Standard are not specifically designed for use:

a) as self supporting aerial cables;

b) as submarine cable or for laying in water-logged conditions;

c) where subsidence is likely, unless special precautions are taken to minimize damage;

d) where any exposure to excessive heat is involved;

e) where the oversheath is subjected to a voltage test after installation.

J.3.6 If cables in accordance with this specification are exposed to localized heat, solar radiation or high temperature ambient conditions, or there is a possibility of higher soil thermal resistivity, the current carrying capacity will be reduced.

J.3.7 The standard sheathing compounds supplied on these cables do not provide protection against damage by rodents, termites, etc.

J.3.8 Loaded cables may have surface temperatures which require protection against accidental contact.

J.4 Installation

J.4.1 Precautions should be taken to avoid mechanical damage to the cables before and during installation.

J.4.2 Exceeding the manufacturer's recommended maximum pulling tensions may result in damage to the cable.

J.4.3 If cables are to be installed in ducts, reference should be made to the cable manufacturer for a duct size corresponding to the current rating quoted.

J.4.4 The type of jointing and filling compounds employed should be chemically compatible with the cable materials.

J.4.5 The cable support system should be such as to avoid damage or danger under normal or fault conditions.

J.4.6 Cables specified in this British Standard are designed for fixed installations only, e.g. they are not for use as trailing or reeling cables.

J.4.7 Repeated over-voltage testing can lead to premature failure of the cable.

J.4.8 The selection of cable glands, accessories and any associated tools should take account of all aspects of intended use.

J.5 Storage and handling of drums

J.5.1 Cable drums should be regularly inspected during storage to assess their physical condition.

J.5.2 Battens, where applied, should not be removed from drums until the cable is about to be installed.

J.5.3 When handling drums, reasonable precautions should be taken to avoid injury. Due regard should be paid to the weight, method and direction of rolling, lifting, protruding nails and splinters.

J.5.4 Care should be taken to avoid deterioration of the drums or their becoming a hazard to the general public.

J.5.5 The cable manufacturer should be consulted for detailed guidance as to the safe handling of cable drums.

J.6 Scrap cable incineration

Incineration of scrap cable should only be undertaken by a licensed contractor. The Environment Agency should be contacted for further information.

Bibliography

BS 7671, *Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition.*

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

IEC 60183, *Guide to the selection of high-voltage cables.*

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