BRITISH STANDARD

BS 6469 :
Section 3.2 :
1992

Insulating and sheathing materials of electric cables

Part 3. Methods of test specific to PVC compounds

Section 3.2 Loss of mass test — Thermal stability test

(Implementation of HD 505.3.2 S1)

BSI
STANDARDS

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cables and Insulation Standards Policy Committee (CIL/-) to Technical Committee CIL/20, upon which the following bodies were represented:

Aluminium Federation
Association of Consulting Engineers
Association of Manufacturers of Domestic Electrical Appliances
British Approvals Service for Cables
British Cable Makers' Confederation
British Plastics Federation
British Steel Industry
British Telecommunications plc
Department of the Environment (Property Services Agency)
Department of Trade and Industry (Consumer Safety Unit, CA Division)
Electricity Association
Engineering Equipment and Materials Users' Association
Institution of Electrical Engineers
London Regional Transport

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Railways Board
British Rubber Manufacturers' Association Ltd.
ERA Technology Ltd.
GAMBICA (BEAMA Ltd.)
Institution of Incorporated Executive Engineers
London Underground Ltd.
Queen Mary and Westfield College
Telecommunications Cables Group of BCMC

This British Standard, having been prepared under the direction of the Cables and Insulation Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on
15 August 1992

The following BSI references relate to the work on this standard:
Committee reference CIL/20
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Amendments issued since publication

Amd. No.	Date	Text affected

Contents

National foreword

This Section of BS 6469 has been prepared under the direction of the Cables and Insulation Standards Policy Committee. BS 6469 : Parts 1 to 5 and Part 99 supersede BS 6469 : 1990 which is withdrawn.

Parts 1 to 5 implement CENELEC HD 505 : Parts 1 to 5 which were derived from IEC 811 : Parts 1 to 5. Part 99 describes test methods having national applicability only.

The International Electrotechnical Commission has completed its comprehensive update of the test methods previously given in IEC 538, IEC 538A and IEC 540, which are now largely brought together in IEC 811. Electrical tests from IEC 540 have been incorporated into IEC 885. The technical changes introduced during this update, and endorsed by CENELEC in HD 505, are now included in BS 6469.

BS 6469 : Section 4.2 includes a number of test methods described in BS 6234. Other test methods from BS 6234, from BS 6746 and from BS 6899 have been incorporated in BS 6469 : Part 99. The status of these test methods in BS 6234, BS 6746 and BS 6899 will be reviewed separately.

BS 6469 describes methods of test, but does not specify requirements for products or materials. These will be specified in the relevant cable standards or cable material standards.

This Section of BS 6469 implements CENELEC Harmonization Document HD 505.3.2 S1 : 1988, which is identical with IEC 811-3-2 : 1985 plus Corrigendum 1986.

Definitions of terms relating to electric cables are given in BS 4727 : Part 2 : Group 08.

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. The methods of test described in this British Standard do not necessarily detail all precautions necessary to meet the requirements of the Health and Safety at Work etc. Act 1974. Attention should be paid to any appropriate safety precautions and the tests should be carried out only by trained personnel.

The complete IEC standard (IEC 811) will eventually replace IEC Publications 538 and 540. To enable users to compare the relevant clauses in all three publications, a table of cross-references is given in appendix A.

Cross-references between the relevant clauses in BS 6469 : 1990 and those in BS 6469 : Parts 1 to 5 and Part 99 are given in table NB.1. Tests included in BS 6469 : Sections 1.3 and 5.1 which were not given in BS 6469 : 1990 are listed in table NC.1.

References to page numbers in the text relate to the IEC page numbers and should be ignored.

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

HARMONIZATION DOCUMENT
DOCUMENT D'HARMONISATION
HARMONISIERUNGSDOKUMENT

HD 505.3.2 S1

March 1988

UDC 621.315.6 : 621.315.2 : 620.193.94

Descriptors: Electric cable, insulated cable, electrical insulation, sheath, test, loss of mass by heating, thermal stability

English version

Common test methods for insulating and sheathing materials of electric cables

Part 3. Methods specific to PVC compounds
Section two — Loss of mass test — Thermal stability test

(IEC 811-3-2 : 1985)

Méthodes d'essais communes pour les matériaux d'isolation et de gainage des câbles électriques
Troisième partie: Méthodes spécifiques pour les mélanges PVC
Section deux: Essai de perte de masse — Essai de stabilité thermique
(CEI 811-3-2 : 1985)

Allgemeine Prüfungen für Isolier- und Mantelwerkstoffe für Kabel und isolierte Leitungen
Teil 3: Methoden für PVC-Compounds
Hauptabschnitt 2: Masseverlust — Prüfung der thermischen Stabilität
(IEC 811-3-2: 1985)

This Harmonization Document was approved by CENELEC on 1988-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

Up-to-date lists and bibliographical references concerning national implementation may be obtained on application to the Central Secretariat or to any CENELEC member.

This Harmonization Document exists in three official versions (English, French, German).

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The English and French versions of this Harmonization Document are provided by the text of the IEC publication and the German version is the official translation of the IEC text.

According to the CENELEC Internal Regulations the CENELEC member National Committees are bound:

to announce the existence of this Harmonization Document at national level by or before 1988-09-01

to publish their new harmonized national standard by or before 1989-03-01

to withdraw all conflicting national standards by or before 1989-03-01.

Harmonized national standards are listed on the HD information sheet, which is available from the CENELEC National Committees or from the CENELEC Central Secretariat.

CONTENTS

COMMON TEST METHODS FOR INSULATING AND SHEATHING MATERIALS OF ELECTRIC CABLES

Part 3: Methods specific to PVC compounds
Section Two — Loss of mass test — Thermal stability test

1. Scope

This standard specifies the test methods to be used for testing polymeric insulating and sheathing materials of electric cables for power distribution and telecommunications including cables used on ships.

This Section Two of Part 3 gives the methods for loss of mass test and thermal stability test, which apply to PVC compounds.

2. Test values

Full test conditions (such as temperatures, durations, etc.) and full test requirements are not specified in this standard; it is intended that they should be specified by the standard dealing with the relevant type of cable.

Any test requirements which are given in this standard may be modified by the relevant cable standard to suit the needs of a particular type of cable.

3. Applicability

Conditioning values and testing parameters are specified for the most common types of insulating and sheathing compounds, and of cables, wires and cords.

4. Type tests and other tests

The test methods described in this standard are intended, in the first instance, to be used for type tests. In certain tests, where there are essential differences between the conditions for type tests and those for more frequent tests, such as routine tests, these differences are indicated.

Note. – For multicore cables and cords, not more than three cores (of different colours, if any) need be tested unless otherwise specified in the relevant cable standard.

5. Pre-conditioning

All the tests shall be carried out not less than 16 h after the extrusion of the insulating or sheathing compounds.

6. Test temperature

Unless otherwise specified, tests shall be made at ambient temperature.

Note. – In the UK room temperature is defined as 20 ± 5 °C.

7. Median value

When several test results have been obtained and ordered in an increasing or decreasing succession, the median value is the middle value if the number of available values is odd, and is the mean of the two middle values if the number is even.

8. Loss of mass test for insulations and sheaths

8.1 *Loss of mass test for insulation*

8.1.1 *Test equipment*

a) An oven with natural air flow or air flow by pressure. The air shall enter the oven in such a way that it flows over the surface of the test pieces and leaves near the top of the oven. The oven shall have not less than 8 and not more than 20 complete air changes per hour at the specified ageing temperature. In case of dispute, an oven with natural air circulation shall be used.

A rotating fan shall not be used inside the oven.

b) An analytical balance with a sensitivity of 0.1 mg.

c) Punching dies for dumb-bell test pieces (see test method in Clause 9 of I E C Publication 811-1-1: Common Test Methods for Insulating and Sheathing Materials of Electric Cables, Part 1: Methods for General Application, Section One — Measurement of Thickness and Overall Dimensions. Tests for Determining the Mechanical Properties).

d) A desiccator with silica gel or similar material.

8.1.2 *Sampling*

If the loss of mass test is combined (see Item *c)* of Sub-clause 8.1.1 of I E C Publication 811-1-2: Section Two: Thermal Ageing Methods) with the mechanical test (Clause 9 of I E C Publication 811-1-1), the test pieces shall be three of those subjected to the ageing in the air oven specified in Sub-clause 8.1.3 of Publication 811-1-2, one from each sample of core.

Alternatively, three of the other test pieces prepared from each core in accordance with Clause 9 of Publication 811-1-1 may be used, if they are not required for other purposes and if their thickness complies with Item *c)* of Sub-clause 8.1.3 below.

Otherwise, three samples, each about 100 mm long, of each core or the insulation from each core to be tested shall be taken, and a test piece prepared from each one in the same way as specified in Sub-clause 8.1.3 below.

8.1.3 *Preparation of test pieces*

a) Any coverings shall be removed. The conductor shall be removed and semiconducting layers on the insulation, if any, shall be removed mechanically, i.e. without using solvent.

b) The test shall be made on:

1) Dumb-bell test pieces illustrated in Figure 1, page 16, whenever practicable.

2) Dumb-bell test pieces illustrated in Figure 2, page 16, if the core dimensions are too small to permit dumb-bells according to Figure 1 to be used.

3) Tubular test pieces, as an alternative to dumb-bells, for inner diameters not exceeding 12.5 mm, provided that there is not an adherent semiconducting layer on the inside of the insulation.

The ends of tubular test pieces shall not be closed.

c) Dumb-bell test pieces shall be prepared as specified in Item *a)* of Sub-clause 9.1.3 of I E C Publication 811-1-1, except that the test pieces shall have two parallel surfaces over the whole length, their thickness shall be 1.0 ± 0.2 mm, and marker lines are not required.

Tubular test pieces shall be prepared as specified in Item *b)* of Sub-clause 9.1.3 of I E C Publication 811-1-1, without applying marker lines. The total surface area of each test piece (see Item *a)* of Sub-clause 8.1.4) shall be not less than 5 cm².

d) Flat twin flexible cords provided with a groove on both sides between the cores shall be tested without separation of the cores. For calculation of its surface of evaporation, the twin cord may be considered as being two separated tubular pieces.

8.1.4 *Calculation of the evaporation area A*

The surface area A, in square centimetres, of each test piece shall be determined before conducting the loss of mass test using the following formulae:

a) For tubular specimens

Surface A = outer surface + inner surface + cut surface

$$A = \frac{2\pi (D - \delta) \times (l + \delta)}{100} \text{ cm}^2$$

where:

δ = average thickness of the test piece, in millimetres, to two decimal places if $\delta \leqslant 0.4$ mm, and to one decimal place above this limit

D = mean outer diameter of the test piece, in millimetres, to two decimal places if $D \leqslant 2$ mm, and to one decimal place above this limit

l = length of the test piece, in millimetres, to one decimal place

both δ and D being measured as specified in the test method in Clause 8 of I E C Publication 811-1-1 (Sub-clauses 8.1 and 8.3) on a thin slice cut from the end of each tubular test piece.

The formula may be applied also to a tubular test piece having a cross-section as shown in Figure 3, page 17

b) For dumb-bell test piece size of Figure 2, page 16

$$A = \frac{624 + (118\ \delta)}{100} \text{ cm}^2$$

c) For dumb-bell test piece size of Figure 1, page 16

$$A = \frac{1\,256 + (180\ \delta)}{100} \text{ cm}^2$$

Wherein δ is the mean thickness of the strips, in millimetres, to two decimal places, determined as specified in Item *a)* of Sub-clause 9.1.4 of I E C Publication 811-1-1.

8.1.5 *Test procedure*

a) The prepared test pieces shall be placed for at least 20 h at ambient temperature in a desiccator. Immediately after removal from the desiccator, each test piece shall be weighed accurately, in milligrams, to one decimal place.

b) Thereafter, the three test pieces shall be maintained in the oven (see Sub-clause 8.1.1), in air at atmospheric pressure for 7 × 24 h at 80 ± 2 °C, unless otherwise specified, under the following conditions:

— compounds of obviously different compositions shall not be tested at the same time in the same oven;

— test pieces shall be suspended vertically in the middle of the oven so that each piece is at least 20 mm from any other piece;

— not more than 0.5% of the oven volume shall be occupied by the test pieces.

c) After this heat treatment, the test pieces shall again be placed for 20 h in a desiccator at ambient temperature and each test piece shall then be re-weighed accurately, in milligrams, to one decimal place.

The difference between the weights determined in Items *a)* and *c)*, for each test piece, shall be calculated and rounded off to the nearest milligram.

8.1.6 *Expression of results*

The loss of mass of each test piece shall be determined by dividing its "weight difference" (see Item *c)* of Sub-clause 8.1.5) in milligrams, by its surface area (see Sub-clause 8.1.4) in square centimetres.

The median value of the results for the three test pieces from each core, expressed in milligrams per square centimetre, shall be taken as the loss of mass of the core.

8.2 *Loss of mass test for sheaths*

8.2.1 *Test equipment*

(See Sub-clause 8.1.1.)

8.2.2 *Sampling*

Three samples of the sheath shall be taken in accordance with Sub-clause 8.1.2.

8.2.3 *Preparation of test pieces*

All constructional elements arranged under (and, if any, over) the sheath shall be removed, taking care not to damage the sheath, and the test pieces prepared in accordance with Sub-clause 8.1.3.

8.2.4 *Calculation of the evaporation area A*

The surface of evaporation shall be calculated by the formulae given in Sub-clause 8.1.4, with the following modifications:

The formula given for tubular specimens is only applicable in the case of the cross-sections shown in Figures 4 and 5 (page 17). The inner and outer surfaces of evaporation of sheaths of flat cords and cables shall be calculated from the dimensions of the cross-section of the sheath. These dimensions shall be determined in millimetres to two decimal places.

The inner side of flat sheaths, having a wedge-shaped ridge, may be considered as being flat.

8.2.5 *Test procedure*

In accordance with Sub-clause 8.1.5.

8.2.6 *Expression of results*

In accordance with Sub-clause 8.1.6.

9. Thermal stability test for insulations and sheaths

9.1 *Test equipment*

a) Glass tubes closed at one end (e.g. by melting), 110 mm long with an outer diameter of approximately 5 mm and an inner diameter of 4.0 ± 0.5 mm.

b) Universal indicating paper with a pH range of 1 to 10.

c) Thermostatically controlled heating apparatus for a temperature specified in the standard for the type of cable, or, if the temperature is not specified in the cable standard, at 200 ± 0.5 °C.

d) Thermometer calibrated in divisions of 0.1 °C.

e) Stop-watch or a suitable time meter.

9.2 *Test procedure*

a) From the insulation of each core to be tested or from the sheath to be tested, three samples, each of 50 ± 5 mg, shall be taken in the form of a strip, if possible. For small thicknesses the sample may consist of two or more strips. Each sample shall be inserted into a glass tube as specified in Item *a)* of Sub-clause 9.1. The sample shall occupy the bottom of the tube and not project more than 30 mm above the bottom.

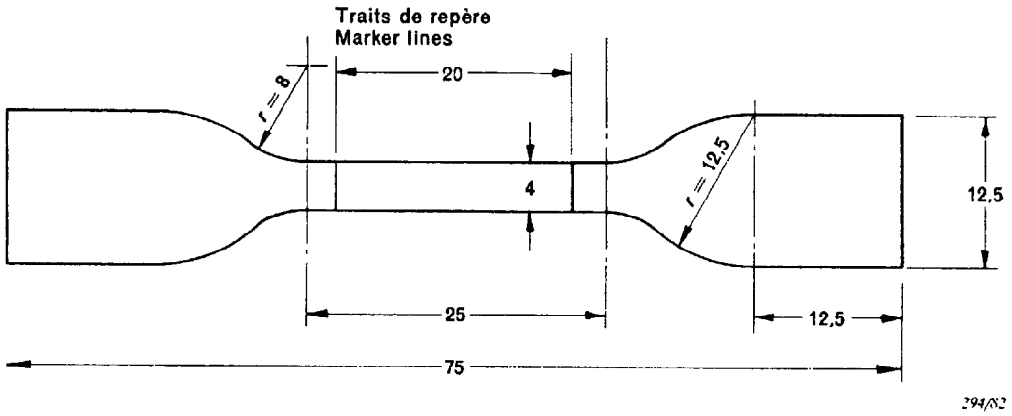
b) A strip of dry universal indicating paper, as specified in Item *b)* of Sub-clause 9.1, about 15 mm long and 3 mm wide, shall be inserted into the open end (top) of the glass tube so that the strip protrudes about 5 mm out of the tube and can be bent to keep it in position.

c) The glass tube shall be placed into the heating apparatus, as specified in Item *c)* of Sub-clause 9.1, which has already attained the test temperature specified. The glass tube shall be inserted into the heating apparatus to a depth of 60 mm.

d) The time taken for the universal indicating paper to change colour from a pH value of 5 to a pH value of 3 shall be measured, or the test continued for the specified duration without the colour change occurring. The colour change point shall be considered to have been reached when the red colouring of the universal indicating paper characteristic of a pH value of 3 is just becoming visible. The universal indicating paper shall be renewed (especially for long duration stabilities) towards the end of the expected test time every 5 to 10 min, so that the change point is better visible.

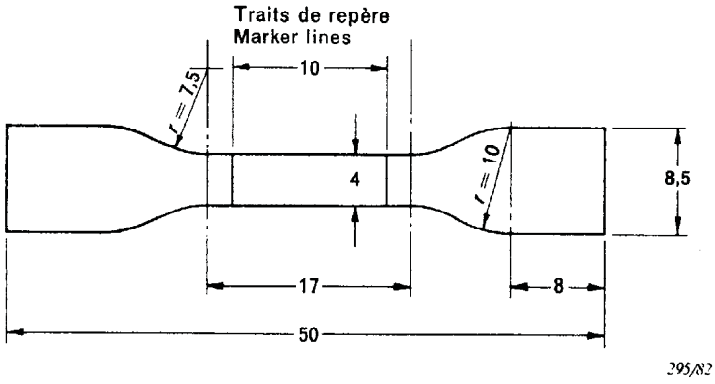
9.3 *Evaluation of results*

The average value of the thermal stability times of the three samples shall not be lower than the value specified in the standard for the type of cable.



Dimensions en millimètres *Dimensions in millimetres*

FIG. 1. — Eprouvette en forme d'haltère.
Dumb-bell test piece.



Dimensions en millimètres *Dimensions in millimetres*

FIG. 2. — Petite éprouvette en forme d'haltère.
Small dumb-bell test piece.

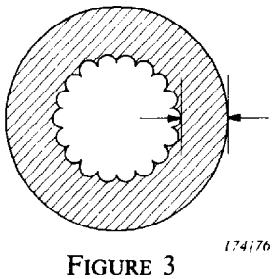


FIGURE 3

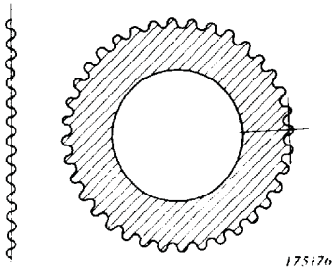


FIGURE 4

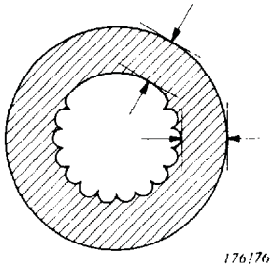


FIGURE 5

APPENDIX A

CORRESPONDING CLAUSES AND SUB-CLAUSES IN I E C PUBLICATIONS 538 AND 540 AND I E C PUBLICATION 811

A1. Corresponding clauses and sub-clauses in I E C Publications 538 and 811

Heading of clause in Publication 538 *	538	811		
	Clause or sub-clause	Part	Section	Clause or sub-clause
General	1	All	All	1 to 7
Mechanical properties of insulation	2	1	1	9.1
Mechanical properties of sheath	3	1	1	9.2
Melt flow index (MFI)	4	4	1	10
Density	5	1	3	8
Ageing test for insulation and sheath	6.1	1	2	8
Shrinkage test for insulation	6.2	1	3	10
Bending test at low temperature				
Insulation	6.3.1	1	4	8.1
Sheath	6.3.2	1	4	8.2
Carbon black and/or mineral filler content	7	4	1	11
Measurement of thicknesses and diameters	Appendix A	1	1	8
Melt flow index	Appendix B	4	1	10

Heading of clause in Publication 538A **	538A	811		
	Clause or sub-clause	Part	Section	Clause or sub-clause
Wrapping test after thermal ageing in air	1	4	1	9
Resistance to environmental stress cracking	2	4	1	8

* Publication 538: Electric Cables, Wires and Cords: Methods of Test for Polyethylene Insulation and Sheath.

** Publication 538A: First Supplement to Publication 538 (1976) — Additional Methods of Test for Polyethylene Insulation and Sheath of Electric Cables, Wires and Cords Used in Telecommunication Equipment and in Devices Employing Similar Techniques.

A2. Corresponding clauses in I E C Publications 540, 811 and 885 *

Heading of clause in Publication 540 *	540	811			885
	Clause	Part	Section	Clause	Part
Partial discharge tests	3	–	–	–	2
Measurement of thicknesses and diameters **	4	1	1	8	–
Tests for determining the mechanical properties of insulating and sheathing compounds	5	1	1	9	–
Thermal ageing methods	6	1	2	8	–
Loss of mass test for PVC insulations and sheaths	7	3	2	8	–
Pressure test at high temperature for PVC insulations and sheaths	8	3	1	8	–
Tests at low temperature for PVC insulations and sheaths	9	1	4	8	–
Tests for resistance of PVC insulations and sheaths to cracking	10	3	1	9	–
Method for determining the density of elastomeric and thermoplastic compounds	11	1	3	8	–
Measurement of the melt flow index of thermoplastic polyethylene	12	4	1	10	–
Ozone resistance test	13	2	1	8	–
Hot set test	14	2	1	9	–
Mineral oil immersion test for elastomeric sheaths	15	2	1	10	–
Electrical tests for cables, cords and wires for voltages up to and including 450/750 V	16	–	–	–	1
Thermal stability of PVC insulations and sheaths	17	3	2	9	–
Carbon black and/or mineral filler content in PE	18	4	1	11	–
Water absorption tests	19	1	3	9	–
Shrinkage test	20	1	3	10	–

* Publication 540: Test Methods for Insulations and Sheaths of Electric Cables and Cords (Elastomeric and Thermoplastic Compounds).
Publication 885: Electrical Test Methods for Electric Cables.

** Technically not identical.

National annex NA (informative)

Cross-references

Publication referred to	Corresponding British Standard
	BS 6469 Insulating and sheathing materials of electric cables
IEC 811-1-1 : 1985	Section 1.1 : 1992 Measurement of thickness and overall dimensions — Tests for determining the mechanical properties
IEC 811-1-2 : 1985	Section 1.2 : 1992 Thermal ageing methods

National annex NB (informative)

Table NB.1. Corresponding clauses or sub-clauses in BS 6469 : 1990 and BS 6469 : 1992

Clause in BS 6469 : 1990	BS 6469 : 1990	BS 6469 : 1992		
	Clause or sub-clause	Part	Section	Clause or sub-clause
General	1.1 to 1.3	1 to 4 and 99 5	All 5.1	1 to 7 1 to 3
Measurement of thickness and diameters	2.1	1	1.1	8
Determination of tensile strength and elongation at break	2.2	1	1.1	9
Thermal ageing methods	2.3	1	1.2	8
Methods for determining density	2.4	1	1.3	8
Shrinkage test	2.5	1	1.3	10
Gravimetric water absorption test	2.6	1	1.3	9.2
Green/yellow proportions	2.7	99	99.1	8
Mineral oil immersion test	3.1	2	2.1	10
Ozone resistance test	3.2	2	2.1	8
Hot set test	3.3	2	2.1	9
Tear resistance	3.4	99	99.1	9
Loss of mass tests	4.1	3	3.2	8
Pressure tests at high temperature	4.2	3	3.1	8
Tests at low temperature	4.3	1	1.4	8
Tests for resistance to cracking	4.4	3	3.1	9
Hot deformation test	4.5	99	99.1	10
Thermal stability test for insulations and sheaths	4.6	3	3.2	9
Determination of melt flow index (MFI)	5.1	4	4.1	10
Test for resistance to environmental stress cracking: Original granules	5.2.2	4	4.1	8
Test for resistance to environmental stress cracking: Complete cable	5.2.3	99	99.1	11
Carbon black content	5.3.2	4	4.1	11
Carbon black dispersion[1)]	5.3.3	-	-	-
Wrapping test after thermal ageing[2)]	5.4	4 4	4.1 4.2	9 10

[1)] Methods given in BS 2782 : Methods 823A or 823B.

[2)] It is intended that a formal proposal to IEC will result in the test in clause 9 of Section 4.1 being withdrawn.

National annex NC (informative)

Table NC.1. Tests included in BS 6469 : 1992 not previously covered

Test	Part	Section	Clause
Water absorption test: electrical	1	1.3	9.1
Tests specific to filling compounds:			
Drop-point	5	5.1	4
Separation of oil	5	5.1	5
Low temperature brittleness	5	5.1	6
Total acid number	5	5.1	7
Absence of corrosive components	5	5.1	8
Permittivity at 23 °C	5	5.1	9
D.C. resistivity at 23 °C and 100 °C	5	5.1	10
Determination of linear swell after ageing in oil	99	99.1	12
Alternative ozone resistance test method (low concentration)	99	99.1	13
Method of test for insulation resistance constant (K value)	99	99.2	8
Method of test for power factor and permittivity	99	99.2	9
Water absorption determined by the capacitance method	99	99.2	10

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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.

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