

Electric cables — Flexible cables rated up to 450/750 V, for use with appliances and equipment intended for industrial and similar environments

ICS 29.060.20

Committees responsible for this British Standard

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Association of Consulting Engineers

Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)

British Approvals Service for Cables

British Cables Association

British Plastics Federation

British Retail Consortium

Chartered Institution of Building Services Engineers

Department of Trade and Industry (Consumer Safety Unit, CA Division)

Electrical Installation Equipment Manufacturers Association

Electricity Association

Energy Industries Council

Engineering Industries Association

ERA Technology Ltd.

Institution of Incorporated Engineers

Lift and Escalator Industry Association

London Underground Ltd.

Transmission and Distribution Association (BEAMA Ltd.)

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Contents

	Page
Committees responsible	Inside front cover
Foreword	iv
1 Scope	1
2 Normative references	2
3 Terms and definitions	3
4 Voltage designation	4
5 General	4
6 Flexible cables with thermosetting insulation	6
7 Flexible cables with thermoplastic insulation	14
Annex A (informative) Guide to use of insulated flexible cables	51
Annex B (informative) Guidance on procedure for routine tests on rubber and PVC insulated flexible cables of rated voltages U_0/U up to 450/750 V	51
Annex C (normative) Electrical tests	54
Annex D (normative) Mechanical test — Two pulley flexing test	58
Annex E (normative) Procedure for checking the efficacy of the spark testing method and equipment	61
Annex F (normative) Solderability test for plain conductors	63
Annex G (normative) Compatibility test	64
Annex H <i>Spare</i>	64
Annex I (normative) Water immersion tests for H07RN8-F flexible cables	64
Annex J <i>Spare</i>	66
Annex K (normative) Measurement of thickness	66
Bibliography	69
Figure D.1 — Flexing apparatus	59
Figure E.1 — Preparation of core for spark test equipment check: removal of insulation	62
Figure E.2 — Preparation of core for spark test equipment check: covering with tape	62
Figure K.1 — Measurement of sheath thickness	68
Table 1 — List of tests applicable to the flexible cables specified in Clause 6	12
Table 2 — Schedule of tests	13
Table 3 — Compatibility requirements for the cables specified in Clause 6	14
Table 4 — List of tests applicable to the flexible cables specified in Clause 7	17
Table 5 — Schedule of tests	18
Table 6 — Compatibility requirements for flexible cables specified in Clause 7	19
Table 7 — <i>Spare</i>	19
Table 8 — <i>Spare</i>	19
Table 9 — <i>Spare</i>	19
Table 10 — Ordinary duty rubber insulated and sheathed flexible cable, 3-core and 4-core, 300/500 V	20
Table 11 — Ordinary duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and sheathed flexible cable, 3-core and 4-core, 300/500 V	21
Table 12 — Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core, 450/750 V	22

	Page
Table 13 — Ordinary duty heat resisting 110 °C EVA or equivalent synthetic elastomer insulated and sheathed flexible cable, parallel twin, circular twin, 3-core, 4-core and 5-core, 300/500 V	25
Table 14 — Heavy duty rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core, 450/750 V	26
Table 15 — Heavy duty rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, 6-core, 12-core, 18-core, 24-core and 36-core, 450/750 V	29
Table 16 — Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and CSP or equivalent synthetic elastomer sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core, 450/750 V	30
Table 17 — Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and CSP or equivalent synthetic elastomer sheathed flexible cable, 6-core, 12-core, 18-core, 24-core and 36-core, 450/750 V	33
Table 18 — Heavy duty cross-linked polymer insulated and sheathed flexible cable having low emission of smoke and corrosive gases, single-core, circular twin, 3-core, 4-core and 5-core, 450/750 V	34
Table 19 — Heavy duty cross-linked polymer insulated and sheathed flexible cable having low emission of smoke and corrosive gases, 6-core, 12-core, 18-core, 24-core and 36-core, 450/750 V	37
Table 20 — Heavy duty water resisting rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core, 450/750 V	38
Table 21 — Heavy duty water resisting rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, 6-core, 12-core, 18-core, 24-core and 36-core, 450/750 V	41
Table 22 — Ordinary duty heat resisting 180 °C silicone rubber insulated and sheathed flexible cable, circular twin, 3-core, 4-core and 5-core, 300/500 V	42
Table 23 — Ordinary duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and thermoplastic polyurethane sheathed flexible cable, circular twin, 3-core, 4-core and 5-core, 300/500 V	43
Table 24 — Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and thermoplastic polyurethane sheathed flexible cable, circular twin, 3-core, 4-core and 5-core, 450/750 V	44
Table 25 — <i>Spare</i>	45
Table 26 — <i>Spare</i>	45
Table 27 — <i>Spare</i>	45
Table 28 — <i>Spare</i>	45
Table 29 — <i>Spare</i>	45
Table 30 — <i>Spare</i>	45
Table 31 — <i>Spare</i>	45
Table 32 — <i>Spare</i>	45
Table 33 — <i>Spare</i>	45
Table 34 — <i>Spare</i>	45
Table 35 — <i>Spare</i>	45
Table 36 — <i>Spare</i>	45
Table 37 — <i>Spare</i>	45
Table 38 — <i>Spare</i>	45
Table 39 — <i>Spare</i>	45
Table 40 — Ordinary duty PVC insulated and sheathed flexible cable, circular twin, 3-core, 4-core and 5-core, 300/500 V	45
Table 41 — Ordinary duty 90 °C PVC insulated and sheathed flexible cable, circular twin, 3-core, 4-core and 5-core, 300/500 V	46

	Page
Table 42 — Ordinary duty PVC insulated and oil resisting PVC sheathed flexible cable, circular twin, 3-core, 4-core and 5-core, 300/500 V	47
Table 43 — Ordinary duty PVC insulated and oil resisting PVC sheathed flexible cable, 6-core, 7-core, 12-core, 18-core, 27-core, 36-core, 48-core and 60-core, 300/500 V	48
Table 44 — Ordinary duty low temperature PVC insulated and sheathed flexible cable, parallel twin, circular twin, 3-core, 4-core and 5-core, 300/500 V	50
Table B.1 — Spark test voltage	51
Table B.2 — Insulation test voltage	52
Table B.3 — Temperature correction factors	53
Table C.1 — Summary of electrical tests for cables with thermosetting insulation specified in Clause 6	54
Table C.2 — Summary of electrical tests for cables with thermoplastic insulation specified in Clause 7	55
Table D.1 — Mass of weights, diameter of pulley wheels and current loading for cables with thermoplastic insulation and sheath	60
Table D.2 — Mass of weights, diameter of pulley wheels and current loading for cables with thermosetting insulation and sheath	61
Table I.1 — Tensile strength and elongation at break after water immersion	66

Foreword

This British Standard has been prepared by Subcommittee GEL/20/1. It specifies requirements for flexible cables for industrial and similar environments. It incorporates cables specified in HD 21.12 and HD 21.13, and in HD 22.10, HD 22.11, HD 22.12, HD 22.13, HD 22.15 and HD 22.16.

BS 7919 complements BS 6500:2000 which specifies requirements for flexible cords for domestic and similar environments.

Together with BS 6500:2000, BS 6004:2000 and BS 6007:2000, it supersedes BS 6141:1991 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **[A1]** **[A1]**. Tags indicating changes to text carry the number of the amendment. For example, text altered by amendment no. 1 is indicated by **[A1]** **[A1]**.

Amendment No. 2:2004 implements the changes to the identification of cores by colours, in accordance with HD 308 S2. The principal identification colours are now:

Single phase – Green-and-yellow (Earth); blue (Neutral); brown (Live).

Three phase – Green-and-yellow (Earth); blue (Neutral); brown, black, grey (Live).

Users should ensure that any interconnection between cables with these new colours and those with the pre-existing ones is carried out safely. BS 7671, as amended in parallel with this standard, gives some guidance in this respect, but does not cover all installation conditions or cable uses.

The provisions introduced by amendment No. 2:2004 are effective from 1st April 2004. The version of this standard incorporating amendment No. 1:2002 remains current until 31st March 2006.

The following cable types have been transferred from other standards:

H07RN-F types (previously in BS 6500:1994, Table 8 and in BS 6007:1993, Table 4 and Table 4A);

H05RR-F types having conductor sizes larger than 2.5 mm² (previously in BS 6007:1993, Table 3);

H05VV-F types having conductor sizes larger than 2.5 mm² (previously in BS 6500:1994, Table 16).

A national type of low temperature 300/500 V PVC cable has also been included.

The following national type has been superseded by the H07BN4-F harmonized type:

450/750 V rubber insulated, HOFR sheathed flexible cable (previously in BS 6007:1993, Table 5).

Annex C, Annex D, Annex E, Annex F, Annex G, Annex I and Annex K are normative. Annex A and Annex B are informative. Annex H and Annex J are spare.

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.

A3 *Product certification/inspection/testing.* Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association. **A3**

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 69 and a back cover.

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1 Scope

This British Standard specifies requirements for the construction, dimensions and mechanical and electrical properties of insulated flexible cables for operation at voltages up to and including 450 V a.c. to earth and 750 V a.c. between conductors, intended for use with appliances and equipment in industrial or similar environments for ordinary or heavy duty.

The types of cables included in this standard are as follows:

Table 10	Ordinary duty rubber insulated and sheathed flexible cable, 3-core and 4-core. (H05RR-F)	300/500 V;
Table 11	Ordinary duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and sheathed flexible cable, 3-core and 4-core. (H05BB-F)	300/500 V;
Table 12	Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core. (H07BB-F)	450/750 V;
Table 13	Ordinary duty heat resisting 110 °C EVA or equivalent synthetic elastomer insulated and sheathed flexible cable, parallel twin, circular twin, 3-core, 4-core and 5-core. (H05GG-F, H05GGH2-F)	300/500 V;
Table 14	Heavy duty rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core. (H07RN-F)	450/750 V;
Table 15	Heavy duty rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, 6-core, 12-core, 18-core, 24-core and 36-core. (H07RN-F)	450/750 V;
Table 16	Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and CSP or equivalent synthetic elastomer sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core. (H07BN4-F)	450/750 V;
Table 17	Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and CSP or equivalent synthetic elastomer sheathed flexible cable, 6-core, 12-core, 18-core, 24-core and 36-core. (H07BN4-F)	450/750 V;
Table 18	Heavy duty cross-linked polymer insulated and sheathed flexible cable having low emission of smoke and corrosive gases, single-core, circular twin, 3-core, 4-core and 5-core. (H07ZZ-F)	450/750 V;
Table 19	Heavy duty cross-linked polymer insulated and sheathed flexible cable having low emission of smoke and corrosive gases, 6-core, 12-core, 18-core, 24-core and 36-core. (H07ZZ-F)	450/750 V;
Table 20	Heavy duty water resisting rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, single-core, circular twin, 3-core, 4-core and 5-core. (H07RN8-F)	450/750 V;
Table 21	Heavy duty water resisting rubber insulated, PCP or equivalent synthetic elastomer sheathed flexible cable, 6-core, 12-core, 18-core, 24-core and 36-core. (H07RN8-F)	450/750 V;
Table 22	Ordinary duty heat resisting 180 °C silicone rubber insulated and sheathed flexible cable, circular twin, 3-core, 4-core and 5-core. (H05SS-F, H05SST-F)	300/500 V;
Table 23	Ordinary duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and thermoplastic polyurethane sheathed flexible cable, circular twin, 3-core, 4-core and 5-core. (H05BQ-F)	300/500 V;
Table 24	Heavy duty heat resisting 90 °C EPR or equivalent synthetic elastomer insulated and thermoplastic polyurethane sheathed flexible cable, circular twin, 3-core, 4-core and 5-core. (H07BQ-F)	450/750 V;
Table 40	Ordinary duty PVC insulated and sheathed flexible cable, circular twin, 3-core, 4-core and 5-core. (H05VV-F)	300/500 V;
Table 41	Ordinary duty 90 °C insulated and sheathed flexible cable, circular twin, 3-core, 4-core and 5-core. (H05V2V2-F)	300/500 V;
Table 42	Ordinary duty PVC insulated and oil resisting PVC sheathed flexible cable, circular twin, 3-core, 4-core and 5-core. (H05VV5-F)	300/500 V;
Table 43	Ordinary duty PVC insulated and oil resisting PVC sheathed flexible cable, 6-core, 7-core, 12-core, 18-core, 27-core, 36-core, 48-core and 60-core. (H05VV5-F)	300/500 V;
Table 44	Ordinary duty low temperature PVC insulated and sheathed flexible cable, parallel twin, circular twin, 3-core, 4-core and 5-core. (National type)	300/500 V.

A guide to the use of the cables specified in this standard is given in Annex A. Guidance to manufacturers on procedures for routine testing is given in Annex B. Test methods are given in Annex C, Annex D, Annex E, Annex F, Annex G, Annex I and Annex K.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions 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 publications referred to applies.

 Text deleted 

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

BS 7655-1.1, *Specification for insulating and sheathing materials for cables — Part 1: Cross-linked elastomeric insulating compounds — Section 1.1: Harmonized types.*

BS 7655-2.1, *Specification for insulating and sheathing materials for cables — Part 2: Cross-linked elastomeric sheathing compounds — Section 2.1: Harmonized types.*

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

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

BS 7655-4.2, *Specification for insulating and sheathing materials for cables — Part 4: PVC sheathing compounds — Section 4.2: General application.*

BS 7655-5.1, *Specification for insulating and sheathing materials for cables — Part 5: Cross-linked insulating compounds having low emission of corrosive gases, and suitable for use in cables having low emission of smoke when affected by fire — Section 5.1: Harmonized cross-linked types.*

BS 7655-8.1, *Specification for insulating and sheathing materials for cables — Part 8: Cross-linked sheathing compounds having low emission of corrosive gases, and suitable for use in cables having low emission of smoke when affected by fire — Section 8.1: Harmonized types.*

BS 7655-12.1, *Specification for insulating and sheathing materials for cables — Part 12: Miscellaneous sheathing compounds — Section 12.1: Harmonized thermoplastic polyurethane sheathing compound.*

BS EN 50265-2-1:1999, *Common test methods for cables under fire conditions — Test for resistance to vertical flame propagation for a single insulated conductor or cable — Part 2-1: Procedures — 1 kW premixed flame.*

 BS EN 50266-2-4, *Common test methods for cables under fire conditions — Test for vertical flame spread of vertically-mounted bunched wires or cables — Part 2-4: Procedures — Category C.* 

BS EN 50267-2-2:1999, *Common test methods for cables under fire conditions — Tests on gases evolved during combustion of materials from cables — Part 2-2: Procedures — Determination of degree of acidity of gases for materials by measuring pH and conductivity.*

BS EN 50268-2, *Common test methods for cables under fire conditions — Measurement of smoke density of cable burning under defined conditions — Part 2: Procedure.*

 BS EN 50334 , *Marking by inscription for the identification of cores of electric cables.*

BS EN 60719:1993, *Calculation for the lower and upper limits for the average outer dimensions of cables with circular copper conductor and rated voltages up to and including 450/750 V.*

BS EN 60811-1-1:1995, *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, *Insulating and sheathing materials of electric cables — Common test methods — Part 1: General application — Section 1.2: Thermal ageing methods.*

 Footnote deleted 

BS EN 60811-4-1, *Insulating and sheathing materials of electric cables — Common test methods — Part 4: Methods specific to polyethylene and polypropylene compounds — Section 4.1: Resistance to environmental stress cracking — Wrapping test after thermal ageing in air — Measurement of the flow index — Carbon black and/or mineral content measurement in PE.*

PD 2379, *Register of colours of manufacturers' identification threads for electric cables and cords.*

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

rated voltage U_0

nominal power-frequency voltage between conductor(s) 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

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 measurement taking into account specified tolerances.

3.4

approximate value

value which is only indicative

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

3.5

type tests (symbol T)

tests required to be made before supplying a type of cable covered by this standard on a general commercial basis 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 materials, design or type of manufacturing process which might change the performance characteristics.

3.6

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

3.7

routine tests (symbol R)

tests made on all production lengths of cable to demonstrate their integrity

4 Voltage designation

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

In an a.c. system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended and this applies both to the value U_0 and to the value U .

In a d.c. system, the nominal voltage between conductors shall be not higher than 1.5 times the rated voltage U of the cable and the nominal voltage between any conductor and earth shall be not higher than 1.5 times the rated voltage U_0 of the cable.

The rated voltages recognized for the purposes of this standard shall be 300/500 V and 450/750 V.

NOTE The operating voltage of a system may permanently exceed the nominal voltage of such a system by 10 %. A cable can be used at 10 % higher voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

5 General

5.1 Construction

The construction of the cables shall be as given in the appropriate construction table (Table 10 to Table 24 or Table 40, Table 41, Table 42, Table 43 and Table 44).

Conformity shall be checked by examination.

5.2 Core identification

5.2.1 General

Each core shall be identified by its colour or number as indicated in the appropriate construction table.

5.2.2 Core colours

The colour shall be either throughout the whole of the insulation or on its surface. Alternatively, for cables having an optional proofed tape, that tape shall be coloured.

The colours of the cores according to the number of cores in the cable and also the sequence of the colours shall be as given in the appropriate construction table.

Where indicated in the construction table, cables shall be colour coded using the pilot and marker system. In each layer, two adjacent cores shall be distinctively coloured, with all other cores the same colour as each other. For cables including a protective earth conductor, one core coloured green-and-yellow shall replace one of the two distinctively coloured cores in the outer layer only.

On the core marked with the bi-colour combination green-and-yellow, the distribution of these colours shall be such that for every 15 mm length of core, one of these colours shall cover at least 30 % and not more than 70 % of the surface of the core, while the other colour covers the remainder of the surface.

Conformity shall be checked by measurement.

When a green/yellow bi-colour combination is used the core marked with it shall be laid up in the outer layer.

NOTE 1 In cases of dispute regarding the green/yellow combination and where appropriate to the method of colour marking of the insulation, a suitable test method for checking conformity is given in BS 6469-99.1:1992, Clause 8.

NOTE 2 It is understood that the colours green and yellow when they are combined as specified are recognized as identifying exclusively the core intended for use as an earth connection or similar protection. The colour blue is for the identification of the core intended to be connected to the neutral but, if there is no neutral, blue may be used to identify any core except for the earthing or protective conductor.

5.2.3 Core numbering

Where cables of more than 5-cores are identified by marking by inscription this shall be in accordance with BS EN 50334.

5.2.4 Clarity and durability of colours and numbers

The colours or numbers shall be clearly identifiable and durable.

Conformity shall be checked by trying to remove the colour or inscribed number of the cores by rubbing the core lightly 10 times with a piece of cotton wool or cloth soaked in water.

5.3 Cable markings

5.3.1 General

Designated harmonized codes for cables are given in the appropriate construction tables and, except where explicitly shown as national types, these cables shall be permitted to bear the CENELEC Common Marking in accordance with 5.3.3.

5.3.2 Indication of origin

All cables shall be provided with an indication of origin consisting of either an identification thread or threads or the continuous marking of the manufacturer's name or trademark.

If coloured threads are used, the colours shall conform to those registered in PD 2379, where applicable. The colours shall be easy to recognize or shall become recognizable by cleaning with petrol or other suitable solvent, if necessary.

The marking of the manufacturer's name or trademark, if used, shall be by one of the following alternative methods:

- a) printed tape within the cable;
- b) printing, indenting or embossing on the insulation of at least the blue core;
- c) printing, indenting or embossing on the sheath, if any.

Each specified mark shall be legible and shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed the following:

- 1) 550 mm if the marking is on the outer sheath of the cable;
- 2) 275 mm if the marking is:
 - i) on the insulation of an unsheathed cable;
 - ii) on the insulation of a sheathed cable;
 - iii) on a tape within a sheathed cable.

Conformity shall be checked by measurement.

NOTE A "specified mark" is a mandatory mark covered by this standard, or the optional CENELEC Common Marking as specified in 5.3.3.

5.3.3 CENELEC "Common Marking"

It shall be permitted for cables for which a harmonized code designation is given in the appropriate construction table to carry an indication that it has been manufactured under a licence issued by one of the approvals organizations subscribing to the CENELEC agreement on the use of a commonly agreed marking for cables. If it does carry such an indication this shall be one of the following.

- a) The mark of the approvals organization, followed by the Common Marking   applied by one of the three methods specified in 5.3.2.
- b) An identification thread extending throughout the length of the cable indicating the approvals organization. The base colour shall be yellow and this shall be serially dyed or printed in red and black. The lengths of the coloured sections shall conform to the dimensions laid down by CENELEC for that approvals organization (see PD 2379).

Neither of these indications shall be used for a cable shown in the construction tables as a national type or national size.

The name CENELEC, in full or abbreviated, shall not be marked on, or in, the cable.

5.3.4 Identification mark

 Harmonized cables shall be marked with the CENELEC harmonized code designation, as given in the applicable construction table. The marking shall be on the sheath, except for cables to Table 10, Table 22 and Table 40 to Table 44 where it shall be on the sheath or on the insulation of one core.

The marking shall be continuous as specified in 5.3.2.

Conformity shall be checked by measurement. 

5.3.5 Durability

Any marking by printing shall be durable.

Conformity shall be checked by rubbing the marking lightly 10 times with a piece of cotton wool or cloth soaked in water.

5.4 Cable testing

5.4.1 Schedule of tests

The tests to be performed on cables specified in this standard shall be as specified in Table 2 and Table 5, 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 (as defined in Clause 3).

NOTE Table 2 and Table 5 also indicate which tests relate to completed cables, and which relate to components.

5.4.2 Test conditions

5.4.2.1 Ambient temperature

Tests shall be performed at an ambient temperature of $(20 \pm 15) ^\circ\text{C}$ unless otherwise specified in the details for a particular test.

5.4.2.2 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.

6 Flexible cables with thermosetting insulation

6.1 Conductors

The conductors shall be tinned or plain annealed copper conforming to BS 6360.

The class of conductor shall be as given in the appropriate construction table.

The d.c. resistance of the conductors shall be as specified in 6.8.2.

Plain conductors shall conform to the solderability requirements specified in 6.9.9. A separator tape shall be applied around the conductor where specified in the appropriate construction table. Any separator tape used in type H07ZZ-F cables (specified in Table 18 and Table 19), shall conform to the corrosive and acid gas emission requirements specified in 6.10.4.

NOTE The construction tables indicate those cables in which an optional separator tape may be applied around the conductor.

6.2 Insulation

6.2.1 Type of insulation

The insulation shall be one of the following types as specified in the appropriate construction table:

- a) type EI 2, EI 3, EI 4, EI 6 or EI 7 conforming to BS 7655-1.1;
- b) type EI 8 conforming to BS 7655-5.1.

6.2.2 Application

The insulation shall be applied closely by extrusion to the conductor or separator.

It shall be possible to remove the insulation easily, without damage to the insulation itself, to the conductor or to the tin coating, if any.

Conformity shall be checked by examination and by a manual test.

6.2.3 Thickness

The radial thickness of the insulation, when determined by taking the average of a number of measurements in accordance with K.1, shall be not less than the value given in the appropriate construction table and the smallest of the measured values shall not fall below the value by more than $10\% + 0.1\text{ mm}$.

6.2.4 Additional tape

Where specified in the appropriate construction table, it shall be permissible for a tape to be applied over the insulation. Where tapes are used, it shall be possible to remove the tape from a completed cable without damage to the insulation.

Any tape used in type H07ZZ-F cables (specified in Table 18 and Table 19), shall conform to the corrosive and acid gas emission requirements specified in 6.10.4.

6.3 Core identification

Each core shall be identified by its colour or number in accordance with 5.2 and the specific requirements given in appropriate construction table.

6.4 Fillers and binders

The use of fillers and binders shall be in accordance with the appropriate construction table.

NOTE Where applicable, the construction tables indicate whether:

- a centre filler is permitted;
- the outer sheath is required to fill the outer interstices;
- separate fillers are permitted to fill the interstices;
- a binder tape is permitted over the assembly of cores, and fillers if any.

Where separate fillers are permitted, they shall be of elastomeric compound, natural textiles, synthetic textiles or similar material.

Any fillers or binder tapes used in type H07ZZ-F cables (specified in Table 18 and Table 19) shall conform to the corrosive and acid gas emission requirements specified in 6.10.4.

It shall be possible to remove the sheath, fillers and binder tape without damage to the cores.

6.5 Spare

6.6 Sheath

6.6.1 Type of sheath

The sheath shall be one of the following types as specified in the appropriate construction table:

- a) type EM 2, EM 3, EM 4, EM 6, EM 7 or EM 9 conforming to BS 7655-2.1;
- b) type EM 8 or EM 10 conforming to BS 7655-8.1;
- c) type TMPU conforming to BS 7655-12.1.

6.6.2 Application

6.6.2.1 General

The sheath shall be extruded and shall consist of either a single layer or two layers as specified for each type of cable in the appropriate construction table.

6.6.2.2 Sheath in a single homogeneous layer

The sheath shall be extruded in a single homogeneous layer, and shall be capable of being removed without damage to the cores. Where taped cores are employed, some transfer of proofing from the tapes shall be permissible.

6.6.2.3 Sheath in two separate homogeneous layers

6.6.2.3.1 Inner layer

The inner layer of the sheath shall be applied as specified in 6.6.2.2.

NOTE 1 A proofed tape or equivalent separator may be applied over the inner layer.

NOTE 2 The thickness of the tape or separator, if any, may be included, for a value not exceeding 0.5 mm, in the measurement of the thickness of inner layer provided that it adheres to the latter.

6.6.2.3.2 Outer layer

The outer layer of the sheath shall be applied over the inner layer or over the tape. It shall be applied as a homogeneous layer.

If the outer layer is bonded to the inner layer, it shall be visibly distinguishable from the inner layer. If it is not bonded, it shall be easily separable from the inner layer.

6.6.3 Thickness

6.6.3.1 Sheath in a single homogeneous layer

The radial thickness of the sheath, when determined by taking the average of a number of measurements in accordance with **K.2** or **K.3** as applicable, shall be not less than the value given in the appropriate construction table and the smallest of the measured values shall not fall below the value by more than 15 % + 0.1 mm.

6.6.3.2 Sheath in two homogeneous layers

The radial thickness of each layer of the sheath, when determined by taking the average of a number of measurements in accordance with **K.4**, shall be not less than the value given in the appropriate construction table and the smallest of the measured values shall not fall below the value by more than 15 % + 0.1 mm. If the outer layer is bonded to the inner layer, then the measurement shall be made with a measuring microscope.

The radial thickness of the two separate homogeneous layers of sheath combined, when determined by taking the average of a number of measurements in accordance with **K.4**, shall be not less than the values given in the appropriate construction table for the inner layer and outer layer added together, and the smallest of the measured values shall not fall below this total value by more than 15 % + 0.1 mm.

6.6.4 Colour

6.6.4.1 General

The colour of the sheath shall be as specified in the appropriate construction table.

6.6.4.2 Black sheaths

Where the appropriate construction table specifies that the cable shall have a black sheath, or where a black sheath is applied to a cable where colour is not specified, the colour shall be throughout the whole of the sheath, or the whole of the outer layer in a two layer construction.

6.6.4.3 Non-black sheaths

For all non-black sheaths, the colour shall be throughout the whole of the sheath (or the whole of the outer layer in a two layer construction) or on its surface. Where surface colouring is applied, the surface colour shall be of essentially the same material as the underlying material and shall be applied as part of the extrusion process. The surface colour shall not be separable from the underlying material and shall be durable.

6.7 Spare

6.8 Electrical tests

6.8.1 General

The electrical tests to be performed on flexible cables with thermosetting insulation shall be as specified in Table 1.

The tests shall be performed in accordance with the test schedule given in Table 2.

6.8.2 Conductor resistance

The d.c. resistance of each conductor shall be measured in accordance with BS 6360 on a sample of completed cable not less than 1 m in length. The resistance of each conductor of all cables shall not exceed the relevant value specified in BS 6360.

6.8.3 Voltage test on completed cable

When the cable is tested in accordance with **C.2**, no breakdown of the insulation shall occur.

6.8.4 Voltage test on cores

When the cores are tested in accordance with **C.3**, no breakdown of the insulation shall occur.

6.8.5 Absence of faults in the insulation

When the cable is tested in accordance with **C.6**, no breakdown of the insulation shall occur.

6.8.6 *Surface resistance of sheath*

This test shall be carried out on cables with sheaths made of compounds EM 2, EM 3, EM 4, EM 6, EM 7 and TMPU.

The surface resistance when tested in accordance with C.7 shall be not less than $1 \times 10^9 \Omega$.

6.8.7 *Long term resistance to d.c.*

For cables specified in Table 18 and Table 19, the insulation shall not break down nor shall the exterior of the insulation show damage when the cable is tested in accordance with C.5. Discoloration of the insulation shall be ignored.

6.8.8 *Insulation resistance*

For cables specified in Table 18 and Table 19, when the cable is tested in accordance with C.4, the insulation resistance of each core shall be not less than the minimum value specified in the appropriate construction table.

6.9 Non-electrical tests

6.9.1 *General*

The non-electrical tests and long term water immersion tests to be performed on flexible cables with thermosetting insulation shall be as specified in Table 1.

These tests shall be performed in accordance with the test schedule given in Table 2.

NOTE 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.

In the case of sheath in two layers, each of the two layers shall be tested separately using the test methods applicable to the compound of which the layer is made. Each layer shall conform to the requirements specified for the particular compound of which it is made. If the two layers are bonded and separation with low mechanical deformation and/or without damaging the surface is not possible, test samples of each compound shall be prepared by cutting or grinding, care being taken to avoid undue heating.

6.9.2 *Mean overall dimensions*

The mean overall diameter of circular cables and the mean overall dimensions of flat cables shall be within the limits specified in the appropriate construction table, with the exception of national types and sizes for which the lower limit given in the construction tables shall be taken as an indicative value and not a requirement for conformity to this standard.

Conformity shall be checked by the method described in BS EN 60811-1-1:1995, 8.3.

One sample of cable shall be taken from each of three places separated by at least 1 m. For circular cable the mean of the six values obtained shall be taken as the mean overall diameter. For flat cables, the mean of each set of three values, for the major and minor axis, respectively, shall be taken as the relevant overall dimension.

6.9.3 *Ovality of circular cables*

The difference between any two values of the overall diameter of circular sheathed cables at the same cross-section shall not exceed 15 % of the upper limit for the mean overall diameter given in the appropriate construction table.

Conformity shall be checked by the method described in BS EN 60811-1-1:1995, 8.3.

One sample of cable shall be taken from each of three places separated by at least 1 m.

Two measurements shall be taken at the same cross-section of the cable, covering the maximum and minimum values.

6.9.4 *Spare*

6.9.5 *Two pulley flexing test*

When tested in accordance with Annex D, the cables shall conform to the following requirements.

During the test with 30 000 cycles, i.e. 60 000 single movements, there shall be:

- no interruption of the current;
- no short-circuit between the conductors;
- no short-circuit between the cable and the pulley wheels (the flexing apparatus).

After the required number of cycles the sheath of the cable shall be removed. The cores shall then be subjected to the voltage test specified in C.3. No breakdown of the insulation shall occur.

6.9.6 *Spare*

6.9.7 *Spare*

6.9.8 *Spare*

6.9.9 *Solderability test*

To assess any possible interaction between the insulation and any plain conductor, the cable shall be subjected to the solderability test specified in Annex F.

After testing in accordance with F.2, those conductors which are not blackened shall be considered to have passed the test. When cables which failed the test described in F.2 are subjected to the test procedure described in F.3, F.4 and F.5, the part of the plain conductor which has been immersed in the solder bath shall be adequately tinned.

6.9.10 *Compatibility*

For cables specified in Table 16, Table 17, Table 18, Table 19, Table 23 and Table 24, after a sample of completed cable has been aged in accordance with G.2, the insulation and sheath shall conform to the requirements given in Table 3. In addition, at the end of the test period in the oven, the blotting paper shall be free of stains.

6.10 Tests under fire conditions

6.10.1 *Flame propagation of a single cable*

Cables specified in Table 14 to Table 22 inclusive shall be tested in accordance with BS EN 50265-2-1. The test shall be carried out on a sample of the completed cable. After the test the cable shall conform to the performance A_2 recommendations given A_2 in BS 50265-2-1:1999, Annex A.

6.10.2 *Flame propagation of bunched cables*

A_2 Cables specified in Table 18 and Table 19 shall be tested in accordance with BS EN 50266-2-4. After the test, the cable shall conform to the performance recommendations given in BS EN 50266-2-4:2001, Annex B. A_2

6.10.3 *Smoke emission*

For cables specified in Table 18 and Table 19, when a sample of the completed cable is tested in accordance with BS EN 50268-2, the values for light transmittance shall not fall below 60 % at any time during the test.

The samples of cable shall be tested as a flat horizontal unit. The number of samples of cable shall be determined in accordance with BS EN 50268-2 using the values of mean overall diameter given in Table 18 and Table 19.

6.10.4 *Corrosive and acid gas emission*

For cables specified in Table 18 and Table 19, when the non-metallic components of the cables are tested in accordance with BS EN 50267-2-2 the pH and conductivity of the solution shall conform to the requirements recommended in BS EN 50267-2-2:1999, Annex A.

6.11 Long term water immersion tests

6.11.1 *Long term voltage tests in water*

Cables specified in Table 20 and Table 21 shall be tested in accordance with **I.1**, and shall conform to the requirements specified in **I.1**.

6.11.2 *Mechanical properties of sheath after immersion in water*

Cables specified in Table 20 and Table 21 shall be tested in accordance with **I.2** and shall conform to the requirements specified in **I.2**.

Table 1 — List of tests applicable to the flexible cables specified in Clause 6

Clause number	Test	Cable specified in table																
		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
<i>Electrical tests</i>																		
6.8.2	Conductor resistance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
6.8.3	Voltage test on completed cable at 2 000 V	X	X	—	X	—	X	—	X	—	X	—	X	X	X	—	—	
6.8.3	Voltage test on completed cable at 2 500 V	—	—	X	—	X	X	X	—	X	X	X	X	—	—	X	X	
6.8.4	Voltage test on cores at 2 500 V	—	—	X	—	X	X	X	—	X	X	X	X	—	—	—	—	
6.8.4	Voltage test on cores at 2 000 V	X	X	—	X	—	—	—	—	—	—	—	—	X	—	—	—	
6.8.4	Voltage test on cores at 1 500 V	—	—	—	X	—	—	—	—	—	—	—	—	X	X	—	—	
6.8.5	Absence of faults in the insulation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
6.8.6	Surface resistance of sheath	X	X	X	X	X	X	X	X	X	X	X	X	—	X	X	X	
6.8.7	Long term resistance to d.c.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6.8.8	Insulation resistance at 70 °C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
<i>Constructional and dimensional tests</i>																		
5.1	Check on construction	X	X	X	X	X	X	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	X	X	X	X	X	X	
6.6.3	Measurement of sheath thickness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
6.9.2	Measurement of overall dimensions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
6.9.3	Measurement of ovality	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Mechanical strength of completed cables</i>																		
6.9.5	Two pulley flexing test ^a	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>Other tests</i>																		
6.9.9	Solderability test	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
6.9.10	Compatibility test	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6.10.1	Flame propagation of a single cable	—	—	—	—	X	X	X	X	X	X	X	X	X	—	—	—	
6.10.2	Flame propagation of bunched cables	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6.10.3	Smoke emission	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6.10.4	Corrosive and acid gas emission	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6.11	Long term water immersion tests	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Not applicable to cables having conductors of cross-sectional area greater than 4 mm² or cables having more than 18-cores laid up in more than two concentric layers.

^a Not applicable to cables having conductors of cross-sectional area greater than 4 mm² or cables having more than 18-cores laid up in more than two concentric layers.

Table 2 — 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 7655-1.1 or BS 7655-5.1	T
application	6.2.2	Visual examination and a manual test	S
thickness	6.2.3	K.1	S
Core identification:			
colour	6.3	Visual examination	S
number	6.3	BS EN 50334	S
clarity and durability of colours and numbers	5.2.4	5.2.4	S
Fillers and binders	6.4	Visual examination	S
Sheath:			
physical properties	6.6.1	BS 7655-2.1, BS 7655-8.1 or BS 7655-12.1	T
application	6.6.2	Visual examination	S
thickness	6.6.3	K.2, K.3 or K.4	S
<i>Tests on completed cables</i>			
Cable markings	5.3	Visual examination and measurement	R
Durability of marking	5.3.5	5.3.5	S
Conductor resistance	6.8.2	BS 6360	S
Voltage test on completed cable	6.8.3	C.2	S
Voltage test on cores	6.8.4	C.3	T
Absence of faults in the insulation	6.8.5	C.6	R
Surface resistance of sheath	6.8.6	C.7	T
Long term resistance to d.c	6.8.7	C.5	T
Insulation resistance	6.8.8	C.4	S
Mean overall dimensions	6.9.2	BS EN 60811-1-1:1995, 8.3	S
Ovality	6.9.3	BS EN 60811-1-1:1995, 8.3	S
Two pulley flexing test	6.9.5	Annex D	T
Solderability test	6.9.9	Annex F	T
Compatibility test	6.9.10	Annex G	T
Flame propagation of a single cable	6.10.1	BS EN 50265-2-1	T ^a
Flame propagation of bunched cables	6.10.2	A₂ BS EN 50266-2-4 A₂	T
Smoke emission	6.10.3	BS EN 50268-2	T
Corrosive and acid gas emission	6.10.4	BS EN 50267-2-2	T
Long term water immersion tests	6.11	Annex I	T
NOTE Tests classified as sample (S) or routine (R) may be required as part of a type approval scheme.			
^a For cables specified in Table 18 and Table 19 this test is category S.			

Table 3 — Compatibility requirements for the cables specified in Clause 6

Component	Parameter	Requirement for material type						
		EI 6	EI 7	EI 8	EM 7	EM 8	EM 10	TMPU
Insulation	Minimum tensile strength (N/mm ²)	5.0	5.0	—	—	—	—	—
	Minimum percentage elongation at break	—	—	125	—	—	—	—
	Maximum percentage variation ^a of tensile strength	±30	±30	−30 ^b	—	—	—	—
	Maximum percentage variation ^a of elongation at break	±30	±30	±30	—	—	—	—
Sheath	Minimum tensile strength (N/mm ²)	—	—	—	—	—	—	—
	Minimum percentage elongation at break	—	—	—	—	100	100	300
	Maximum percentage variation ^a of tensile strength	—	—	—	±30	−30 ^b	−30 ^b	±30
	Maximum percentage variation ^a of elongation at break	—	—	—	±40	±30	±30	±30

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

^b No limit for the positive tolerance.

7 Flexible cables with thermoplastic insulation

7.1 Conductors

The conductors shall be tinned or plain annealed copper conforming to BS 6360.

The class of the conductor shall be as given in the appropriate construction table.

The d.c. resistance of the conductors shall be as specified in 7.8.2.

7.2 Insulation

7.2.1 Type of insulation

The insulation shall be type TI 2, TI 3 or TI 4 conforming to BS 7655-3.1, as specified in the appropriate construction table.

7.2.2 Application

The insulation shall be applied closely by extrusion to the conductor. It shall be possible to remove the insulation easily, without damage to the insulation itself or to the conductor or to the tin coating, if any.

Conformity shall be checked by examination and by a manual test.

7.2.3 Thickness

The radial thickness of the insulation, when determined by taking the average of a number of measurements in accordance with K.1, shall be not less than the value given in the appropriate construction table and the smallest of the measured values shall not fall below the value by more than 10 % + 0.1 mm.

7.3 Core identification

Each core shall be identified by its colour or number in accordance with 5.2 and the specific requirements given in the appropriate construction table.

7.4 Fillers and binders

The use of fillers and binders shall be in accordance with the appropriate construction table.

NOTE Where applicable the construction tables indicate whether:

- a centre filler is permitted;
- the outer sheath is required fill the outer interstices;
- separate fillers are permitted to fill the interstices;
- a binder tape is permitted over the assembly of cores and fillers, if any.

Where separate fillers are permitted, they shall be of thermoplastic compound, natural textiles, synthetic textiles or similar material.

It shall be possible to remove the outer sheath, fillers and binder tape without damage to the cores.

7.5 Spare

7.6 Sheath

7.6.1 Type of sheath

The sheath shall be one of the following types as specified in the appropriate construction table:

- a) type TM 2, TM 3 or TM 5 conforming to BS 7655-4.1;
- b) type 10 conforming to BS 7655-4.2.

7.6.2 Application

The sheath shall be extruded in an homogeneous layer, and shall be capable of being removed without damage to the cores.

7.6.3 Thickness

The radial thickness of the sheath, when determined by taking the average of a number of measurements in accordance with **K.2** or **K.3**, as appropriate, shall be not less than the value given in the appropriate construction table and the smallest of the measured values shall not fall below the value by more than 15 % + 0.1 mm.

7.6.4 Colour

Where the sheath is coloured, the colour shall be throughout the whole of the sheath or on its surface. Where surface colouring is applied, the surface colour shall be of essentially the same material as the underlying material and shall be applied as part of the extrusion process. The surface colour shall not be separable from the underlying material and shall be durable.

7.7 Spare

7.8 Electrical tests

7.8.1 General

The electrical tests to be performed on flexible cables with thermoplastic insulation shall be as specified in Table 4.

These tests shall be performed in accordance with the test schedule given in Table 5.

7.8.2 Conductor resistance

The d.c. resistance of each conductor shall be measured in accordance with BS 6360 on a sample of completed cable not less than 1 m in length. The resistance of each conductor of all cables shall not exceed the relevant value given in BS 6360.

7.8.3 Voltage test on completed cable

When the cable is tested in accordance with **C.2**, no breakdown of the insulation shall occur.

7.8.4 Voltage test on cores

When the cores are tested in accordance with **C.3**, no breakdown of the insulation shall occur.

7.8.5 Absence of faults in the insulation

When the cable is tested in accordance with **C.6**, no breakdown of the insulation shall occur.

7.8.6 Insulation resistance

When the cable is tested in accordance with **C.4**, the insulation resistance of each core shall be not less than the value specified in the appropriate construction table.

7.8.7 Long term resistance of insulation to d.c.

The insulation shall not break down nor shall the exterior of the insulation show damage when the cable is tested in accordance with **C.5**. Discoloration of the insulation shall be ignored.

7.9 Non-electrical tests

7.9.1 General

The non-electrical tests to be performed on flexible cables with thermoplastic insulation shall be as specified in Table 4.

These tests shall be performed in accordance with the test schedule given in Table 5.

NOTE In some tests, the preparation and presentation of the test sample can have a critical effect on the results 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 Mean overall dimensions

The mean overall diameter of circular cables and the mean overall dimensions of flat cables shall be within the limits specified in the appropriate construction table, with the exception of national types and sizes for which the lower limit given in the construction tables shall be taken as an indicative value and not a requirement for conformity to this standard.

Conformity shall be checked by the method described in BS EN 60811-1-1:1995, **8.3**.

One sample of cable shall be taken from each of three places separated by at least 1 m. For circular cables, the mean of the six values obtained shall be taken as the mean overall diameter. For flat cables, the mean of each set of three values, for the major and minor axis respectively, shall be taken as the relevant overall dimension.

7.9.3 Ovality of circular cables

The difference between any two values of the overall diameter of circular sheath cables at the same cross-section shall not exceed 15 % of the upper limit for the mean overall diameter given in the appropriate construction table.

Conformity shall be checked by the method described in BS EN 60811-1-1:1995, **8.3**.

One sample shall be taken from each of three places separated by at least 1 m.

Two measurements shall be taken at the same cross-section of the cable, covering the maximum and minimum values.

7.9.4 Two pulley flexing test

When tested in accordance with Annex D the cables shall conform to the following requirements.

During the test with 30 000 cycles, i.e. 60 000 single movements, there shall be:

- no interruption of the current;
- no short circuit between the conductors;
- no short circuit between the cable and the pulley wheels (the flexing apparatus).

After the required number of cycles the sheath of the cable, if any, shall be removed. The cores shall then be subjected to the voltage test specified in **C.3**. The insulation shall not break down.