CENELEC
Rue de Stassart, 35 - 1050 Bruxelles
Tél.: (+ 32 2) 519.68.71 - Fax: (+ 32 2) 519.69.19
Telelex 206 2210097 - CENCEL - Tx 172210097

INFORMATION SHEET

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HD 22.1 S2
Reprint incoporating
A1 to A10
May 1992

Rubber insulated cables of rated voltages up to and including 450/750 V
Part 1: General requirements

Conducteurs et câbles isolés au caoutchouc, de tension assignée au plus égale à 450/750 V
Première partie: Prescriptions générales

Isolierte Starkstromleitungen mit einer Isolierung aus Gummi mit Nennspannungen bis 450/750 V
Teil 1: Allgemeine Anforderungen

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NOS No standard
SP Standard in preparation
NR Standard under revision

HARMONIZATION DOCUMENT

DOCUMENT D'HARMONISATION

HARMONISIERUNGSDOKUMENT

HD 22.1 S2

Reprint incorporating A1 to A10

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Descriptors: Conductor, cable, flexible cable, rigid cable, single core cable, multicore cable, conductor material, flat cable, compound, polychloroprene, rubber, elastomer, insulation compound, type test, sample test, routine test, nominal voltage, mark, common marking, identification, colour scheme, construction, insulation, separator, filler, sheath, braid, inner layer, outer layer, thickness, mean value, specified value, electrical resistance, test, tensile strength, elongation at break, ageing, air oven, oxygen bomb, hot set, complete cable, overall dimensions, bending, flexing, voltage test, absence of short circuits, spark (test), insulation resistance, wear resistance, test (under) fire (conditions), guide to use

English version

Rubber insulated cables of rated voltages up to and including 450/750 V Part 1: General requirements (IEC 245-1:1980, modified)

Conducteurs de câbles isolés au caoutchouc de tension assignée au plus égale à 450/750 V Première partie: Prescriptions générales (CEI 245-1:1980, modifiée)

Isolierte Starkstromleitungen mit einer Isolierung aus Gummi mit Nennspannungen bis 450/750 V Teil 1: Allgemeine Anforderungen (IEC 245-1:1980, modifiziert)

This Harmonization Document was approved by CENELEC on 23 September 1991. 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

Ref. No. HD 22.1 S2:1992 E

FOREWORD

HD22 was originally adopted by CENELEC on 9th July 1975.

Edition 2 of HD22 was implemented on 1st January 1984, and at that time contained 4 parts.

Since 1984, new parts have been published, original parts amended, and in addition HD 505 has superseded HD 385 as the cross-reference for test methods.

This reprint of the four parts of Edition 2 of HD22 incorporates all ratified amendments and the change to HD 505.

The new parts of HD22, which are Edition 1 versions, already incorporate the change to HD 505 and are being updated as appropriate.

HD22 now has the following parts:

HD22.1 S2	-	General requirements (with AM1 to AM10 inclusive)
HD22.2 S2	-	Test methods (with AM1 to AM4 inclusive)
HD22.3 S2	-	Heat resistant silicone rubber insulated cables (with AM1)
HD22.4 S2	-	Cords and flexible cables (with AM1 to AM5 inclusive)
HD22.5	-	(Spare)
HD22.6 S1	-	Arc welding cables
HD22.7 S1	-	Cables with increased heat resistance for internal wiring for a conductor temperature of 110°C
HD22.8 S1	-	Polychloroprene or equivalent synthetic elastomer sheathed cables for use as decorative chains (with AM1)

This Edition 2 of part 1 of HD22 now incorporates:

AM1	- dop	1989-09-01	AM6	- dop	1990-12-01
AM2	- dop	1990-06-01	AM7	- dop	1991-06-15
AM3	- dop	1989-09-01	AM8	- dop	1992-03-01
AM4	- dop	1989-09-01	AM9	- dop	1992-03-01
AM5	- dop	1989-09-01	AM10	- dop	1993-01-01

In accordance with the guidance given by CENELEC the dop for this Reprint is 1993-01-01.

References are made, in this Part 1 of HD22, to other Parts of this HD and to other Harmonisation Documents as follows:

HD 186	Marking by inscription for the identification of cores of electric cables having more than five cores.
HD 308	Identification and use of cores of flexible cables
HD 361	System for cable designation
HD 383	Conductors of insulated cables (Endorsing IEC 228 and 228A)
HD 405.1	Tests on electric cables under fire conditions. Part 1: Test on a single vertical cable (Endorsing IEC 332-1)
HD 505	Common test methods for insulating and sheathing materials of electric cables (Endorsing IEC 811)

In all cases a reference to another HD implies the latest edition of that document.

CONTENTS

RUBBER INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750V

Part 1 : General Requirements

1. General

1.1 Scope

HD22 applies to rigid and flexible cables with insulation and sheath if any, based on vulcanised rubber, of rated voltages U_o/U up to and including 450/750V used in power installations of nominal voltage not exceeding 450/750V A.C.

NOTE: For some types of flexible cables, the term "cord" is used.

This Part 1 specifies the General Requirements applicable to these cables.

The test methods specified are given in Part 2 of this HD, in HD 405 Part 1 and HD 505.

The particular types of cables are specified in Part 3 onwards of this HD, and are hereafter referred to as "the particular specifications".

The code designations of these types of cables are in accordance with HD 361.

1.2 Object

The objects of this Harmonisation Document are to standardise cables and cords that are safe and reliable when properly used, to state the characteristics and manufacturing requirements directly or indirectly bearing on safety, and to specify methods for checking conformity with those requirements.

1.3 Common Marking

The Common Marking (◂HAR▸) signifies that the manufacturer has been assessed and his production is subjected to continuing surveillance in accordance with the technical procedures by a recognised national Approval Organisation which is a signatory to the "Agreement on the use of the Common Marking for cables and cords complying with Harmonised Specifications".

Compliance with this Harmonisation Document may be certified by the application of the agreed technical procedures for granting the Common Marking (*), which are the recognised means of ensuring that a manufacturer is competent and takes all reasonable care to produce cables complying with this HD.

The Common Marking may be used, under these conditions, by manufacturers in countries which have implemented this HD and in which the national Approval Organisations are signatories to the Agreement.

NOTE: See Appendix 2 to Part 1 for guidance on National Marking

(*) These are given in Appendices 4 and 5 of the "Agreement on the use of a Commonly Agreed Marking for Cables and Cords complying with Harmonised Specifications".

2. Definitions

2.1 Definitions relating to insulating and sheathing materials

2.1.1 Rubber compound

Combination of materials suitably selected, proportioned, treated, and vulcanized, of which the characteristic constituent is a rubber and/or synthetic elastomer.

Vulcanisation is defined as a post application treatment taking place after the insulation and/or sheath has been applied in order to induce permanent cross-linking of the elastomer.

2.1.2 Polychloroprene compound or other equivalent synthetic elastomer

A vulcanised compound in which the elastomer is polychloroprene or other equivalent synthetic elastomer providing a compound with properties similar to polychloroprene.

2.1.3 Chlorinated rubber compound

A vulcanised compound in which the characteristic constituent is a synthetic chlorinated rubber, e.g. Polychloroprene (PCP), Chlorosulphonated Polyethylene (CSP), Chlorinated Polyethylene (CPE), etc.

2.1.4 Ethylene-propylene rubber compound (EPR) or other equivalent synthetic elastomer

A vulcanised compound in which the elastomer is ethylene-propylene or other equivalent synthetic elastomer providing a compound with properties similar to EPR.

2.1.5 Ethylene vinyl acetate rubber compound (EVA) or other equivalent synthetic elastomer

A vulcanised compound in which the elastomer is ethylene vinyl acetate or other equivalent synthetic elastomer providing a compound with properties similar to EVA.

2.1.6 Type of compound

The category in which a compound is placed according to its properties, is determined by specific tests. The type designation is not directly related to the composition of the compound.

2.2 Definitions relating to the tests

2.2.1 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. 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 or design which might change the performance characteristics.

2.2.2 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.

2.2.3 Routine tests (Symbol R)

Tests made on all completed lengths of cable or as appropriate during manufacturing.

2.3 Rated voltage

The rated voltage of a cable is the reference voltage for which the cable is designed, and which serves to define the electrical tests.

The rated voltage is expressed by the combination of two values U_o/U, expressed in volts:

U_o being the r.m.s. value between any insulated conductor and "earth" (metal covering of the cable or the surrounding medium);

U being the r.m.s. value between any two phase-conductors of a multicore cable or of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended.

This condition applies both to the value U_o and to the value U.

In a direct current system, the nominal voltage of the system shall be not higher than 1.5 times the rated voltage of the cable.

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 a 10% higher operating voltage than its rated voltage if the latter is at least equal to the nominal voltage of the system.

3. Marking

3.1 Indication of origin

Cables shall be provided with an identification of origin consisting of:

(1) Either the manufacturer's identification thread,
(2) Or the continuous marking of the manufacturer's name or trademark, or (if legally protected) identification number, by one of the three following alternative methods:

(a) Printed tape within the cable;
(b) Printing, indenting or embossing on the insulation of at least one core (the core coloured light blue, if any);
(c) Printing, indenting or embossing on the sheath, if any.

3.1.1 Continuity of marks

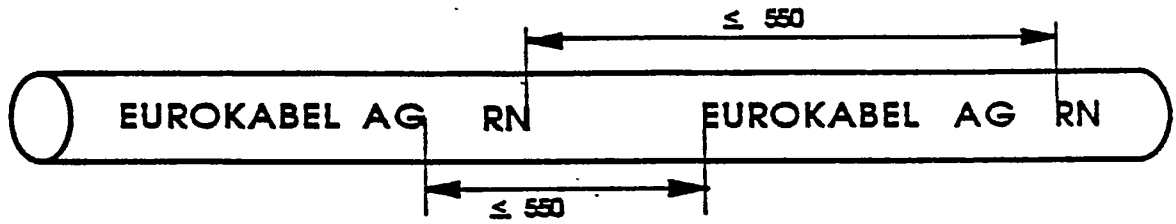
Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed:

550 mm if the marking is on the outer sheath of the cable;
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.

NOTE: A 'Specified Mark' is any mandatory mark covered by this Part of the HD or by the particular specifications of Part 3 onwards of this HD, or the optional common marking (◂HAR▸).

The diagram below shows an example of the marking as used on the outer sheath of the cable.



3.2 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in Sub-clause 1.8 of Part 2.

3.3 Legibility

All markings shall be legible.

The colours of the identification threads shall be easy to recognise or easily made recognisable, if necessary by cleaning with petrol or other suitable solvent.

3.4 Common Marking

If the Common Marking (◂HAR▸) is used, it shall be as specified in the "Agreement on the use of the Common Marking for cables and cords complying with Harmonised Specifications". It will consist of :

(1) Either the common thread as specified and allotted in Appendix 2 to the above mentioned "Agreement".

(2) Or a continuous (see 3.1.1) marking of the symbols specified and allotted in Appendix 1 to the above mentioned "Agreement", by one of the three alternative methods a), b), c) specified in Sub-Clause 3.1.

3.5 Use of the name CENELEC

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

3.6 Outer marking

In order to distinguish cables having the same cross-sectional area and number of cores but having a sheath made of other than tough rubber, an outer marking is required as specified case by case in the particular specifications.

4. Core identification

4.1 General requirements

Identification of the cores of a cable shall be achieved by the use of coloured insulation or by a coloured surface.
Each core of a multicore cable shall have only one colour, except the core identified by a combination of the colours green and yellow. In multicore cables, the colours green and yellow shall not be used separately as single colours.

The colours shall be clearly identifiable and durable. Durability shall be checked by the test given in Sub Clause 1.8 of Part 2.

4.2 Colour schemes

4.2.1 Flexible cables

The core colours for flexible cables and cords shall be in accordance with HD 308.

4.2.2 Single core non-sheathed cables

For cable type HO7G (Part 7, Clause 2) the following mono-colours are recognised: black, blue, brown, grey, orange, pink, red, turquoise, violet and white.

Bi-colours shall not be used except the combination of the mono-colours green and yellow, the distribution of the colours of which shall comply with Part 1 sub-clause 4.3.

NOTE: Other mono-colours are permitted by National standards, pending CENELEC TC64 harmonisation of installation rules.

4.3 Colour combination green/yellow

The distribution of the colours for the core coloured green/yellow shall comply with the following condition (which is in accordance with HD 308): 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, the other colour covering the remainder.

NOTE: Information on the use of the colours green/yellow and light blue.

It is understood that the colours green and yellow when they are combined as specified above are recognised exclusively as a means of identification of the core intended for use at earth connection or similar protection, and that the colour light blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, light blue can be used to identify any core except the earthing or protective conductor.

4.4 Core identification of flexible cables by the 'Marking by Inscription' method .

Where cables of more than five cores are identified by marking by inscription, this shall be in accordance with HD 186.

For special types of cable in this HD (see for instance HD 22.4 Clause 6) other means of identification are permitted.

5. General requirements for the construction of cables

5.1 Conductors

5.1.1 Material

The conductors shall consist of annealed copper. Unless otherwise specified in the particular specifications, the wires of conductors may be plain or tinned. Tinned wires shall be covered with an effective layer of tin.

5.1.2 Construction

The maximum diameters of the wires of flexible conductors and the minimum number of wires of rigid conductors shall be in accordance with HD 383, unless otherwise specified in the particular specifications.

The classes of the conductors relevant to the various types of cables are given in the particular specifications.

5.1.3 Separator between conductor and insulation

If permitted or required in the particular specification a separating tape may or shall be placed between the conductor and the insulation.

5.1.4 Check of construction

Compliance with the requirements of Part 1 Sub-clauses 5.1.1 and 5.1.2, including the requirements of HD 383 shall be checked by inspection and by measurement.

5.1.5 Electric resistance

Unless otherwise specified in the particular specifications, the resistance of each conductor at 20°C shall be in accordance with the requirements of HD 383 for the given class of the conductor.

Compliance shall be checked by the test given in Part 2 Sub-clause 2.1.

5.1.6 Solderability test for untinned conductors

To asses any possible interaction between insulation and bare copper conductor, untinned conductors shall comply with the solderability test specified in Part 2, sub-clause 1.12, unless otherwise specified in the particular specifications of the HD.

5.2 Insulation

5.2.1 Material

The insulation shall be a vulcanised rubber compound of the type specified for each type of cable in the particular specifications:

Type EI2 for cables insulated with silicone rubber compound
Type EI3 for cables insulated with compound based on EVA or equivalent material
Type EI4 for cables insulated with ordinary ethylene-propylene rubber compound.

The test requirements for these compounds are specified in Part 1 Table I.
The maximum continuous conductor operating temperatures for cables insulated with any of the above types of compound and covered by the particular specifications are as follows:

Insulation compound EI 4 - 60°C
Insulation compound EI 2 - 180°C, if there are no limits imposed by environmental conditions
Insulation compound EI 3 - 110°C

The maximum temperatures for short-circuit conditions are given in Appendix 1 to Part 1.

5.2.2 Application to the conductor

The insulation shall be closely applied to the conductor or separator. In the particular specifications it is stated, for each type of cable, whether the insulation shall be applied in a single layer or in a number of layers, and whether it shall or shall not be covered with a proofed tape. It shall be possible to remove the insulation, without damage to the insulation itself, to the conductor, or to the tin or metal coating if any. Compliance shall be checked by inspection and by manual test.

5.2.3 Thickness

The mean value of the thickness of insulation shall be not less than the specified value of each type and size of cable shown in the tables of the particular specifications.

However, the thickness at any place may be less than the specified value, provided that the difference does not exceed 0.1 mm + 10% of the specified value. Compliance shall be checked by the test given in Part 2 Sub-clause 1.9.

5.2.4 Mechanical properties before and after ageing

The insulation shall have appropriate mechanical characteristics within the temperature limits to which it may be exposed to normal use.

Compliance shall be checked by carrying out the tests specified in Part 1, Table I.

The applicable test methods and the results to be obtained are specified in Part 1, Table I.

TABLE 1

REQUIREMENTS FOR THE NON-ELECTRICAL TEST FOR VULCANISED RUBBER INSULATION

1	2	3	4	5	6	7	8
Ref. No.	Test	Unit	Type of compound			Test method described in	
			EI2	EI3	EI4	HD	Clause
	Maximum rated conductor temperature	°C	180 (but see sub-clause 5.2.1)	110	60		
1.	Tensile strength and elongation at break					505.1.1	9.1
1.1	Properties in the state as delivered						
1.1.1	Values to be obtained for the tensile strength:						
	- median, min.	N/mm^2	5.0	6.5	5.0		
1.1.2	Values to be obtained for the elongation at break:						
	- median, min.	%	150	200	200		
1.2	Properties after ageing in air oven					505.1.2	8.1
1.2.1	Ageing conditions [2], [4]						
	- temperature	°C	200±3	150±2	100±2		
	- duration of treatment	h	10x24	10x24	7x24		
1.2.2	Value to be obtained for the tensile strength:						
	- median, min.	N/mm^2	4.0	-	4.2		
	- variation [1] max.	%	-	±30	±25		
1.2.3	Values to be obtained for the elongation at break:						
	- median, min.	%	120	-	200		
	- variation [1] max.	%	-	±30	±25		
1.3	(Spare)						
1.4	Properties after ageing in the oxygen bomb for seven days					505.1.2	8.3
1.4.1	Ageing conditions [4]						
	- temperature	°C	-	-	70±2		
	- duration of treatment	h	-	-	7x24		
1.4.2	Value to be obtained for the tensile strength:						
	- median, min.	N/mm^2	-	-	-		
	- variation [1] max.	%	-	-	±25		
1.4.3	Values to be obtained for the elongation at break:						
	- median, min.	%	-	-	-		
	- variation [1] max.	%	-	-	±25		

TABLE 1
(continued)

REQUIREMENTS FOR THE NON-ELECTRICAL TEST FOR VULCANISED RUBBER INSULATION

1	2	3	4	5	6	7	8
Ref. No.	Test	Unit	Type of compound			Test method described in	
			EI2	EI3	EI4	HD	Clause
	Maximum rated conductor temperature	°C	180 (but see sub-clause 5.2.1)	110	60		
1.5	Properties after ageing in the air bomb					505.1.2	8.2
1.5.1	Ageing conditions						
	- temperature	°C	-	150 ± 2	-		
	- duration of treatment	h	-	7x24	-		
1.5.2	Values to be obtained for the tensile strength						
	- median, min.	N/mm^2	-	6.0	-		
1.5.3	Values to be obtained for the elongation at break						
	- variation, max.	%	-	-30[3]	-		
2.	Hot set test					505.2.1	9
2.1	Conditions of treatment						
	- temperature	°C	250 ± 3	200 ± 3	200 ± 3		
	- time under load	min	15	15	15		
	- mechanical stress	N/cm^2	20	20	20		
2.2	Test requirements						
	- max. elongation under load	%	100	100	100		
	- max. elongation after unloading	%	25	25	25		
3.	Pressure test at high temperature					505.3.1	8
3.1	Test conditions						
	- force exerted by blade						
	- K value : 1.0						
	- duration of heating under load	h	-	0.5	-		
	- temperature	°C	-	150 ± 2	-		
3.2	Result to be obtained						
	- median of the depth of penetration						
	max.	%	-	50	-		
4.	Ozone resistance test						
	Method A					505.2.1	8
	Test conditions						
	- test temperature	°C	-	-	25 ± 2		
	- test duration	h	-	-	24		
	- ozone concentration	ppm	-	-	250 to 300		
	Method B					22.2	7.3
	- test temperature	°C	-	-	40 ± 2		
	- test duration	h	-	-	72		
	- ozone concentration	pphm	-	-	200 ± 50		

TABLE 1
(continued)

(1) Variation: Difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

(2) Unless otherwise specified in the relevant cable specifications a rotating fan inside the oven is normally permissible when testing rubber compounds. However, in case of dispute, ageing shall be carried out in an oven which is designed to operate without a fan rotating inside it.

(3) No limit for the positive tolerance.

(4) Ageing of Type EI4 shall be carried out with the conductor in place; if it is expected that the conductors cannot be removed after ageing without damaging the insulation, then the ageing test shall be carried out with at least 70% of the conductor strands in place.

5.3 Filler

5.3.1 Material

Unless otherwise specified in the particular specifications, the fillers shall be composed of one of the following or of any combination of the following:

- a compound of rubber or equivalent synthetic elastomers, vulcanised or unvulcanised, or
- natural or synthetic textiles, or
- paper

There shall be no harmful interactions between the constituents of the filler and the insulation and/or the sheath.

5.3.2 Application

For each type of cable, the particular specifications specify whether that cable includes fillers or whether the sheath may penetrate between the cores, thus forming a filling. (See Part 1, Sub- clause 5.5.2.) The fillers, if any, shall fill the spaces between the cores giving the assembly a practically circular shape and shall not adhere to the cores. The assembly of cores and fillers may be held together by a film or tape.

A centre filler, if used, shall comply with Part 1, Sub-Clause 5.3.1.

5.4 Textile braid

5.4.1 Material

The yarns forming the textile braid shall be of the material required for each type of cable by the particular specifications. Where textile braid is specified in the particular specifications, the yarns may be based on natural material (cotton, treated cotton, silk) or on synthetic material (polyamide, etc.) or else may be filaments made of glass or equivalent material.

5.4.2 Application

The braid shall have a uniform texture, without knots or gaps. Braids made of glass filament shall be treated with a suitable substance in order to avoid fraying.

5.5 Sheath

5.5.1 Material

The sheath shall be a elastomeric based compound, vulcanised or cross linked of the type specified for each type of cable in the particular specifications.

Type EM1 for cables sheathed with a compound of rubber or equivalent synthetic elastomer.

Type EM2 for cables sheathed with polychloroprene compound or other equivalent synthetic elastomer.

Type EM3 for cables sheathed with ordinary ethylene-propylene rubber compound or other equivalent synthetic elastomer.

The test requirements for these compounds are specified in Part 1 Table II.

5.5.2 Application

The sheath shall consist of either a single layer or of two layers as specified for each type of cable in the particular specifications.

5.5.2.1 Sheath in a single layer

The sheath shall be applied in a single layer:

- to the core, in single core cables;

- to the assembly of the cores and any filler, in multicore cables.

The sheath shall be capable of being removed without damage to the cores.

A tape or film may be applied under the sheath.

In certain cases, indicated in the particular specifications, the sheath may penetrate into the spaces between the cores, thus forming a filling (see Part 1, Sub-clause 5.3.2).

5.5.2.2 Sheath in two layers

Inner layer

The inner layer of the sheath shall be applied as specified in Part 1, Sub-clause 5.5.2.1. A proofed tape or equivalent may be applied over the inner layer.

The thickness of 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.

Outer layer

The outer layer of the sheath shall be applied over the inner layer or over the tape. It may or may not be bonded to the inner layer or to the tape.

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.

5.5.3 Thickness

The mean value of the thickness of the sheath shall be not less than the specified value for each type and size of cable shown in the tables of the particular specifications.

However, the thickness at any place may be less than the specified value provided that the difference does not exceed 0.1 mm + 15% of the specified value, unless otherwise specified.

Compliance shall be checked by the test given in Part 2 Sub-clause 1.10.

5.5.4 Mechanical properties before and after ageing

The sheath shall have appropriate mechanical characteristics within the temperature limits to which it may be exposed in normal use.

Compliance shall be checked by carrying out the tests specified in Part 1 Table II.

The applicable test values and the results to be obtained are specified in Part 1 Table II.

5.5.5 Colour

In certain cases, as indicated in the particular specifications (Part 3 onwards), the sheath (or outer sheath of a two layer construction) shall be coloured black. In such cases the sheath (or outer sheath of a two layer construction) shall have a minimum content of carbon black as specified in Part 1, Table II. The colour shall be throughout the whole of the sheath (or outer sheath of a two layer construction).

TABLE II

REQUIREMENTS FOR THE NON-ELECTRICAL TEST FOR VULCANISED RUBBER SHEATH

1	2	3	4	5	6	7	8	9
Ref. No.	Test	Unit	Type of compound				Test method described in	
			EM1	EM2	EM3	EM5	HD	Clause
1.	Tensile strength and elongation at break							
1.1	Properties in the state as delivered						505.1.1	9.2
1.1.1	Values to be obtained for the tensile strength: - median, min.	N/mm^2	7.0	10.0	7.0	10.0		
1.1.2	Values to be obtained for the elongation at break: - median, min.	%	300	300	250	300		
1.2	Properties after ageing in air oven						505.1.2	8.1
1.2.1	Ageing conditions: [3] - temperature - duration of treatment	°C h	70±2 10x24	70±2 10x24	80±2 10x24	100±2 14x24		
1.2.2	Values to be obtained for the tensile strength: - median, min. - variation [2] max.	N/mm^2 %	- ±20	- -15[1]	- ±30	- -30[1]		
1.2.3	Values to be obtained for the elongation at break: - median, min. - variation [2] max.	% %	250 ±20	250 -25[1]	- ±30	- -40[1]		
1.3	Mechanical properties after immersion in mineral oil						505.2.1	10
1.3.1	Test conditions: - temperature of oil - duration of immersion in oil	°C h	- -	100±2 24	- -	100±2 24		
1.3.2	Values to be obtained for the tensile strength: - variation [2] max.	%	-	±40	-	-40[1]		
1.3.3	Values to be obtained for the elongation at break: - variation [2] max.	%	-	±40	-	-40[1]		

TABLE II
(continued)

REQUIREMENTS FOR THE NON-ELECTRICAL TEST FOR VULCANISED RUBBER SHEATH

1	2	3	4	5	6	7	8	9
Ref. No.	Test	Unit	Type of compound				Test method described in	
			EM1	EM2	EM3	EM5	HD	Clause
2.	Hot set test						505.2.1	9
2.1	Conditions of treatment							
	- temperature	°C	200 ± 3	200 ± 3	200 ± 3	200 ± 3		
	- time under load	min	15	15	15	15		
	- mechanical stress	N/cm²	20	20	20	20		
2.2	Test requirements							
	- max. elongation under load	%	100	100	100	100		
	- max. elongation after unloading	%	25	25	25	25		
3.	Bending test at low temperature						505.1.4	8.2
3.1	Test conditions							
	- temperature	°C	-	-35 ± 2	-35 ± 2	-		
	- period of application of low temperature	h	-	See HD 505.1.4 Sub-clause 8.2.3	See HD 505.1.4 Sub-clause 8.2.3	-		
3.2	Result to be obtained		-	Absence of cracks	Absence of cracks	-		
4.	Elongation test at low temperature						505.1.4	8.4
4.1	Test conditions							
	- temperature	°C	-	-35 ± 2	-35 ± 2	-		
	- period of application of low temperature	h	-	See HD 505.1.4 Sub-clauses 8.4.4 & 8.4.5	See HD 505.1.4 Sub-clauses 8.4.4 & 8.4.5	-		
4.2	Result to be obtained							
	- elongation without break	%	-	30	30	-		
5.	Ozone resistance test							
	Method A						505.2.1	8
	- test temperature	°C	-	-	25 ± 2	-		
	- test duration	h	-	-	24	-		
	- ozone concentration	ppm	-	-	250 to 300	-		
	Method B						22.2	.3
	- test temperature	°C	-	-	40 ± 2	-		
	- test duration	h	-	-	72	-		
	- ozone concentration	pphm	-	-	200 ± 50	-		
6.	Carbon black content (where applicable)						505.4.1	11
	- min. content	%	-	-	2	-		

TABLE II
(continued)

(1) No limit for the positive tolerance.
(2) Variation: Difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.
(3) Unless otherwise specified in the relevant cable specifications a rotating fan inside the oven is normally permissible when testing rubber compounds. However, in case of dispute, ageing shall be carried out in an oven which is designed to operate without a fan rotating inside it.

5.6 Tests on completed cables

5.6.1 Electrical properties

The cables shall have adequate dielectric strength and insulation resistance.

Compliance shall be checked by carrying out the tests specified in Part 1 Table III.

The test methods and the results to be obtained are specified in Part I Table III.

5.6.2 Overall dimensions

The mean overall dimensions of the cables shall be within the limits specified in the tables in the particular specifications, unless otherwise indicated in the corresponding clause in the particular specification.

The difference between any two values of the overall diameter of sheathed circular cables at the same cross-section (ovality) shall not exceed 15% of the upper limit specified for the mean overall diameter.

Compliance shall be checked by the test given in Part 2 Sub-clause 1.11.

5.6.3 Mechanical strength of flexible cables

The flexible cables shall be capable of withstanding bending and other mechanical stresses occurring in normal use.

When specified in the particular specifications compliance shall be checked by the test given in Part 2 Clause 3.

5.6.3.1 Flexing tests for flexible cables

Multicore flexible cables having conductors of cross-sectional area up to and including 4mm^2 shall be subjected to the test given in Part 2, Sub-clause 3.1.

During the test with 30 000 backward and forward movements, i.e. 60 000 single strokes, neither interruption of the current nor short circuit between the conductors shall occur.

After the test, the sheath, if any, of cables with three or more cores, shall be removed.

The cable or cores shall then withstand the voltage test carried out in accordance with Part 2, Sub-clause 2.2 or 2.3 as appropriate, but with a test voltage not exceeding 2000 V.

5.6.3.2 Wear resistance test

See Part 2 Sub-clause 3.3.

After 20 000 single strokes, the insulation of the fixed sample shall not be visible over a total length of more than 10 mm.

After this test, the fixed sample shall withstand the voltage test in accordance with Part 2 Sub-clause 2.2.

5.6.4 Test under fire conditions

HD 405 Part 1 shall apply.

This test applies to cables, as delivered, with a sheath made of compound EM2 (polychloroprene or equivalent material).

TABLE III

REQUIREMENTS FOR ELECTRICAL TESTS FOR VULCANISED RUBBER INSULATED CABLES

1	2	3	4	5	6	7	8
Ref. No.	Test	Unit	Rated Voltage of cables			Test method described in	
			300/300V	300/500V	450/750V	HD	Clause
1.	Measurement of the resistance of conductor					22.2	2.1
1.1	Values to be obtained, max.		**	**	**		
2.	Voltage test on completed cables					22.2	2.2
2.1	Test conditions:						
	- minimum length of the sample	m	20	20	20		
	- minimum period of immersion in water	h	1	1	1		
	- temperature of the water	°C	20±5	20±5	20±5		
2.2	Voltage applied (a.c.)	V	2 000	2 000	2 500		
2.3	Duration of each application of voltage, minimum	min	15	15	15		
2.4	Result to be obtained		No break-down	No break-down	No break-down		
3.	Voltage test on cores					22.2	2.3
3.1	Test conditions:						
	- length of sample	m	5	5	5		
	- minimum period of immersion in water	h	1	1	1		
	- temperature of the water	°C	20±5	20±5	20±5		
3.2	Applied voltage (a.c.) according to specified thickness of insulation:						
	- up to and incl. 0.6mm	V	1 500	1 500	-		
	- exceeding 0.6mm	V	2 000	2 000	2 500		
3.3	Duration of each application of voltage, minimum	min	5	5	5		
3.4	Result to be obtained		No break-down	No break-down	No break-down		

** See HD 383 and particular specifications

TABLE III
(continued)

REQUIREMENTS FOR ELECTRICAL TESTS FOR VULCANISED RUBBER INSULATED CABLES

1	2	3	4	5	6	7	8
Ref. No.	Test	Unit	Rated Voltage of cables			Test method described in	
			300/300V	300/500V	450/750V	HD	Clause
(4)	(Spare)						
(5)	(Spare)						
6.	Check on absence of faults on insulation					22.2	2.6
6.1	Spark test						
6.1.1	Test condition		***	***	***	22.2	2.6.1 and Appendix 1
6.1.2	Result to be obtained		No break-down	No break-down	No break-down		
6.2	Voltage test						
6.2.1	Test conditions: - voltage applied, a.c. - voltage applied, d.c. - duration of test	 V V min	*** 2 000 5 000 5	*** 2 000 5 000 5	*** 2 500 5 000 5	22.2	2.6.2
6.2.2	Result to be obtained		No break-down	No break-down	No break-down		
7.	Surface resistance of sheath						
7.1	Test conditions: - voltage applied, d.c. - duration of test	 V min	 100 to 500 1	 100 to 500 1	 100 to 500 1	22.2	2.7
7.2	Result to be obtained	ohm	Not less than 10^9	Not less than 10^9	Not less than 10^9		

*** see test method referred to in columns 7 and 8

6. Guide to use of the cables

See Appendix 1 to Part 1.

APPENDIX 1

GUIDE TO USE OF HARMONISED TYPES OF RUBBER INSULATED CABLES

(Provisional information: more precise harmonised instructions are under consideration).

1) General : not intended to be laid underground.

2) Temperatures and current ratings

2.1) Maximum continuous operating temperatures: as specified in Part 1, Sub-clause 5.2.1.
2.2) Current ratings :
2.2.1) - Cables for fixed installations: current ratings are the subject of pending recommendations from TC64.
2.2.2) - Cords and flexible cables:

Conductor area, mm²	0.5	0.75	1	1.5	2.5	4	6	10
Single Phase Current rating, A	3	6	10	16	25	32	40	63
Three Phase Current rating, A	3	6	10	16	20	25		

These values apply to the majority of cases. Further information should be sought in unusual cases e.g.:
(i) When high temperatures are involved, i.e. above 30°C
(ii) Where long lengths are used
(iii) Where ventilation is restricted
(iv) Where the cords are used for other purposes, e.g. internal wiring of apparatus

2.3) In the case of a short circuit (maximum allowable time 5 s), the maximum temperature of conductors shall not exceed:

200°C for cables and cords insulated with type EI4 compound:
350°C for cables and cords insulated with type EI2 compound:
Under consideration for cables and cords insulated with type EI3 compound.

APPENDIX 1
(continued)

1	2	3
PART NO.	RECOMMENDED USE	COMMENTS
PART 3 Clause 2 Heat resistant silicone insulated cable H05SJ-K	At high temperatures; for fixed installation in and on lamps and in appliances. Cables having a conductor cross-section of 1.5mm² or more are permitted for installation in visible or embedded conduits. For internal wiring at high ambient temperatures and in protected locations.	
PART 3 Clause 3 Unbraided heat resistant silicone rubber insulated cables H05S-U, H05S-K	For internal wiring at high ambient temperatures and in protected locations.	This cable may be damaged by contact with sharp edges and by abrasion. Care should be taken to avoid this in installation and in use.
PART 4 Clause 2 Braided cord H03RT-F	In domestic premises, kitchens, offices; for supplying hand appliances which are subjected to low mechanical stresses.	Not suitable for use outdoors, in industrial* or agricultural work-shops or for feeding electric tools.
PART 4 Clause 3 Ordinary tough rubber sheathed cord H05RR-F PART 4 Clause 4 Ordinary polychloroprene sheathed cord H05RN-F	For general use in domestic premises, kitchens and offices and for supplying appliances where the cables are subjected to low mechanical stresses (e.g. vacuum cleaners, cooking appliances, soldering irons, toasters).	Not suitable for permanent use outdoors, in agriculture, in industrial* or agricultural workshops or for supplying non-domestic tools.

* but permissible in tailor's workshops and similar premises

APPENDIX 1
(continued)

1	2	3
PART NO.	RECOMMENDED USE	COMMENTS
PART 4 Clause 5 Heavy polychloroprene or other equivalent synthetic elastomer sheathed flexible cable H07RN-F	In dry, humid or moist rooms, in open air, in workshops having an explosive atmosphere; for medium mechanical stresses, e.g. for industrial and agricultural workshop appliances, large boiling installations, heating plates, inspection lamps, electrical tools such as drills, circular saws, domestic electric tools, and also for transportable motors or machines on building sites or in agricultural workings, etc; also for fixed installations, e.g. on rough-cast in temporary buildings and huts for accommodation purposes; suitable for the wiring of constructional components in lifting appliances, machinery, etc.	Use up to 1000V, A.C. or D.C. is permitted for fixed, protected installation (in conduit or appliances) and also for motor connections of hoisting motors and the like.
PART 7 Clause 2 Cables with increased heat resistance for internal wiring	For internal wiring in dry locations only. For fixed installations or elsewhere e.g. visible or embedded conduits or tubes.	Maximum conductor temperature in normal use 110°C.
PART 8 Polychloroprene or other equivalent synthetic elastomer sheathed cable for decorative chains H05RN-F H05RNH2-F	For use in decorative chains for indoor or outdoor use. Single core cables in series lighting as decorative chains for Christmas Trees and similar temporary decorative object. Flat two core cables for temporary decorative illumination only.	National Wiring Rules should be taken into account for matters like protection by safety low voltage, protection by electrical separation and placing out of reach.

APPENDIX 2

National Marking

The national mark of the Approval Organisation of any country who are members of the EEC without the common marking also signifies that the manufacturer has been assessed and that his production of cables included in this HD is surveyed in accordance with the procedures mentioned in Part 1, Clause 1.3.