HARMONIZATION DOCUMENT **HD 22.1 S4**

DOCUMENT D'HARMONISATION

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English version

Cables of rated voltages up to and including 450/750 V and having cross-linked insulation Part 1: General requirements

Conducteurs et câbles isolés
avec des matériaux réticulés
de tension assignée
au plus égale à 450/750 V
Partie 1: Prescriptions générales

Starkstromleitungen mit vernetzter
Isolierhülle mit Nennspannungen
bis 450/750 V
Teil 1: Allgemeine Anforderungen

This Harmonization Document was approved by CENELEC on 2002-09-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

Up-to-date lists and bibliographical references concerning such 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, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, 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

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Foreword

This edition 4 of HD 22.1 has been prepared by the Technical Committee CLC/TC 20, Electric cables.

HD 22 was originally adopted by CENELEC on 9th July 1975.

Edition 2 of HD 22 was implemented on 1st January 1984. A third edition of Part 1 was published in September 1997.

This 4th edition provides a full updating, including incorporation of amendments ratified during the maintenance of Part 3 onwards of HD 22, and introduces other improvements.

HD 22.1 S4 is related to IEC 60245-1:1994, but is not directly equivalent.

HD 22 now has the following parts:

HD 22.1 S4	General requirements
HD 22.2 S3	Test methods
HD 22.3 S3	Heat resistant silicone rubber insulated cables
HD 22.4 S3	Cords and flexible cables
HD 22.5	(Spare)
HD 22.6 S2	Arc welding cables
HD 22.7 S2	Cables with increased heat resistance for internal wiring for a conductor temperature of 110 °C
HD 22.8 S2	Polychloroprene or equivalent synthetic elastomer sheathed cable for decorative chains
HD 22.9 S2	Single core non-sheathed cables for fixed wiring having low emission of smoke and corrosive gases
HD 22.10 S1	EPR insulated and polyurethane sheathed flexible cable
HD 22.11 S1	EVA cords and flexible cables
HD 22.12 S1	Heat resistant EPR cords and flexible cables
HD 22.13 S1	Single and multicore flexible cables, insulated and sheathed with cross-linked polymer and having low emission of smoke and corrosive gases
HD 22.14 S2	Cords for applications requiring high flexibility
HD 22.15 S1	Multicore cables insulated and sheathed with heat resistant silicone rubber
HD 22.16 S1	Water resistant polychloroprene or equivalent synthetic elastomer sheathed cables

In order that this revision of Part 1 of HD 22 does not introduce unnecessary changes to long-established clause numbers, the normative references (which would otherwise be inserted as clause 2) are given in annex A.

The draft Harmonization Document was submitted to the Unique Acceptance Procedure and approved by CENELEC as HD 22.1 S4 on 2002-09-01.

The following dates were fixed:

- latest date by which the existence of the HD has to be announced at national level	(doa)	2003-03-01
- latest date by which the HD has to be implemented at national level by publication of a harmonized national standard or by endorsement	(dop)	2003-09-01
- latest date by which the national standards conflicting with the HD have to be withdrawn	(dow)	2003-09-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex A is normative and annex B is informative.

Contents

1 General

1.1 Scope

HD 22 applies to rigid and flexible cables, sheathed and unsheathed, and insulated with cross-linked material, of rated voltages U_o/U up to and including 450/750V, used in power installations.

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 Harmonization Document (HD), or in the common test methods for cables given in EN 50265, EN 50266, EN 50267, EN 50268 and EN 60811.

The particular types of cables are specified in Part 3 onwards of this HD, which 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 HD 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 a Commonly Agreed Marking for Cables and Cords complying with Harmonised Specifications."

Compliance with this HD may be certified by the application of the agreed technical procedures for granting the common marking [1)], 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 annex B for guidance on national marking.

2 Definitions

2.1 Definitions relating to insulating and sheathing materials and their processing

2.1.1 cross-linking

the process of multiple intermolecular covalent bonding between polymer chains obtained through a chemical process, with or without the contribution of heat, or through a physical process such as irradiation

1) 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'.

2.1.2 vulcanisation
a post-application treatment taking place after the insulation and/or sheath has been applied in order to induce cross-linking of the rubber or synthetic elastomer

NOTE Vulcanisation is an historical term now largely limited to use with the longer-established materials which did, and in some cases still do, use sulphur as the primary chemical agent of cross-linking.

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

2.1.4 rubber compound
combination of materials suitably selected, proportioned, treated, and vulcanised, of which the characteristic constituent is a rubber and/or synthetic elastomer

2.1.5 polychloroprene compound or equivalent synthetic elastomer
a vulcanised compound in which the elastomer is polychloroprene (PCP) or equivalent synthetic elastomer providing a compound with properties similar to polychloroprene

2.1.6 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

2.1.7 ethylene-propylene rubber compound (EPR) or equivalent synthetic elastomer
a cross-linked compound in which the elastomer is ethylene-propylene or equivalent synthetic elastomer providing a compound with properties similar to EPR

2.1.8 ethylene vinyl acetate rubber compound (EVA) or equivalent synthetic elastomer
a cross-linked compound in which the elastomer is ethylene vinyl acetate or equivalent synthetic elastomer providing a compound with properties similar to EVA

2.1.9 polyolefin based cross-linked compound or equivalent synthetic compound having a low level of emission of corrosive gases when burned
a cross-linked compound in which the polymer is a polyolefin or equivalent synthetic non-halogenated polymer providing a compound which, when burned, has low emission of corrosive gases and is suitable for use in cables which, when burned, have low emission of smoke

2.1.10 cross-linked polyvinyl chloride (XLPVC)
combinations of materials of which polyvinyl chloride is the characteristic constituent, including adequate cross-linking agents, suitably selected, proportioned and treated which when cross-linked, meet the requirements given in the particular specification

2.1.11 cross-linked silicone rubber (SiR)
a compound based on a poly-siloxane polymer which, when cross-linked, meets the requirements given for the particular cable

2.1.12 thermoplastic polyurethane compound (TMPU)
a thermoplastic compound based on polyurethane which meets the requirements given in the particular specification

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, design or type of manufacturing process 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 production cable lengths to demonstrate their integrity

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 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 not be more than 1,5 times the rated voltage (U_o) 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 either

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

   a) printed tape within the cable;

b) printing, indenting or embossing on the insulation of at least one core (the core coloured blue, if any);

c) printing, indenting or embossing on the sheath, if any.

3.2 Continuity of marks

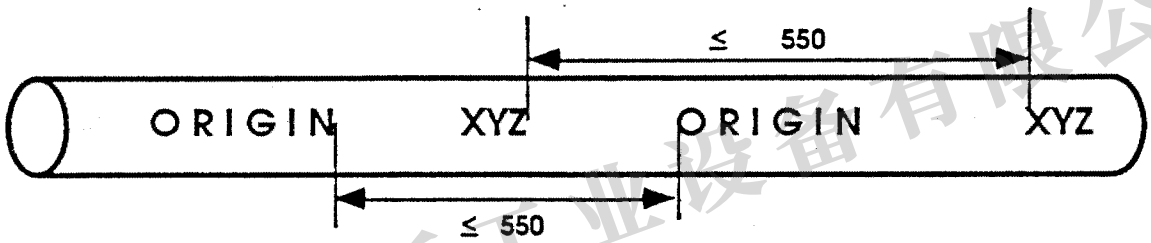
Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed:

- 550 mm if the marking is on the outer sheath or the covering 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 requirements 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.



3.3 Durability

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

3.4 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.

3.5 Common marking

If the common marking (◁HAR▷) is used, it shall be as specified in the "Agreement on the use of a Commonly Agreed Marking for Cables and Cords complying with Harmonised Specifications". It shall consist of either

1. the common thread as specified and allotted in appendix 2 to the above mentioned "Agreement", or,

2. a continuous (see 3.2) marking of the symbols specified and allotted in appendix 1 to the above mentioned "Agreement", by one of the three methods a), b), c) specified in 3.1.

3.6 Use of the name CENELEC

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

3.7 Code designation

Each cable or cord shall have its full code designation marked continuously (see 3.2) on the sheath or, where permitted by the particular specifications in Part 3 onwards of this HD, on the insulation of one core. The code designation for each cable is given in the particular specifications in Part 3 onwards of this HD.

NOTE The particular specifications of Part 3 onwards of this HD presently specify either no such marking, or only part of the code designation. The requirement in this 3.7 supersedes that in the particular specifications, which will be amended in due course.

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 1.8 of Part 2.

4.2 Colour schemes

4.2.1 Flexible cables

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

4.2.2 Single core non-sheathed cables

The core colours, which should be a reasonable match to those given in HD 402, shall be chosen from the following:

a) for cable types rated 300/500 V (H05 types) the following mono-colours are recognised: black, blue, brown, grey, orange, pink, red, turquoise, violet, white, green and yellow. Bi-colours or any combination of the above mono-colours are permitted. The distribution of the colours for the core bi-coloured green-and-yellow shall comply with 4.3 of Part 1;

NOTE The use of green or yellow in some countries may be forbidden or restricted by National safety or other regulations. In some countries, green is specifically permitted for decorative chains.

b) for cable types rated 450/750 V (H07 types) 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 4.3 of Part 1.

NOTE Other mono-colours are permitted by National standards, pending CENELEC TC 64 harmonization of installation rules.

4.3 Colour combination green-and-yellow

The distribution of the colours for the core coloured green-and-yellow shall comply with the following condition: 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-and-yellow and 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 blue is intended for the identification of the core intended to be connected to neutral. If, however, there is no neutral, 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 the cores of cables are identified by marking by inscription, this shall be in accordance with EN 50334.

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 metal coated, for example with tin or silver. Coated wires shall be covered with an effective layer of the coating.

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 5.1.1 and 5.1.2 of Part 1, including the requirements of HD 383, shall be checked by inspection and by measurement.

5.1.5 Electrical resistance

Unless otherwise specified in the particular specifications, the resistance of each conductor at 20 ^{o}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 2.1 of Part 2.

5.1.6 Solderability test for plain conductors

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

5.2 Insulation

5.2.1 Material

The insulation shall be a cross-linked or vulcanised material, of the type specified for each type of cable in the particular specifications:

Type EI 2	for cables insulated with silicone rubber compound;
Type EI 3	for cables insulated with EVA or equivalent material;
Type EI 4	for cables insulated with ordinary ethylene-propylene rubber compound;
Types EI 5 and EI 8	for cables insulated with polyolefin-based cross-linked compound having a low level of emission of corrosive gases when burned and which is suitable for use in cables which, when burned, have low emission of smoke. Type EI 8 is for flexible cables;
Types EI 6 and EI 7	for cables insulated with ethylene propylene rubber or equivalent synthetic elastomer. Type EI 6 is for cables requiring handling down to -40 °C;
Type XI 1	for cables insulated with cross-linked PVC.

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

NOTE 1 The requirements for XI 1 are presently in annex A of HD 22.14 S2.

The maximum continuous conductor operating temperatures for each insulation compound, and the maximum temperatures for short-circuit conditions, are given in Table 1.

NOTE 2 The value of 180 °C for Type EI 2 applies only if there are no limits imposed by environmental conditions.

NOTE 3 The maximum operating and short-circuit temperatures for a particular cable may be lower than that given for the specific insulation compound. See HD 516 for further guidance.

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 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 + 10 % of the specified value.

Compliance shall be checked by the test given in 1.9 of Part 2.

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 in normal use.

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

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

Table 1 - Requirements for the non-electrical tests for cross-linked insulation

1	2	3	4	5	6	7	8	9	10	11	12
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**						
			Section	**Clause**	**EI 2**	**EI 3**	**EI 4**	**EI 5**	**EI 6**	**EI 7**	**EI 8**
	Maximum continuous conductor temperature	°C			180 (but see 5.2.1)	110	60	90	90	90	70
	Maximum temperature for short circuit conditions	°C			350	250	200	250	250	250	250
1	**Mechanical properties**										
1.1	Properties before ageing		1-1	9.1							
1.1.1	Values to be obtained for the tensile strength:										
	- median, min.	N/mm^2			5,0	6,5	5,0	10,0	5,0	5,0	5,0
1.1.2	Values to be obtained for the elongation at break:										
	- median, min.	%			150	200	200	125	200	200	125
1.2	Properties after ageing in air oven		1-2	8.1							
1.2.1	Ageing conditions: [2) 4)]										
	- temperature	°C			200 ± 3	150 ± 2	100 ± 2	135 ± 2	135 ± 2	135 ± 2	110 ± 2
	- duration of treatment	h			10 x 24	10 x 24	7 x 24	7 x 24	7 x 24	7 x 24	7 x 24
1.2.2	Value to be obtained for the tensile strength:										
	- median, min.	N/mm^2			4,0	-	4,2	-	5,0	5,0	-
	- variation [1)] max.	%			-	± 30	± 25	± 30	± 30	± 30	- 30 [3)]
1.2.3	Values to be obtained for the elongation at break:										
	- median, min.	%			120	-	200	-	-	-	125
	- variation [1)] max.	%			-	± 30	± 25	± 30	± 30	± 30	± 30
NOTES: see end of table.											

Table 1 - Requirements for the non-electrical tests for cross-linked insulation (continued)

1	2	3	4	5	6	7	8	9	10	11	12
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**						
			Section	**Clause**	**EI 2**	**EI 3**	**EI 4**	**EI 5**	**EI 6**	**EI 7**	**EI 8**
1.3	(Spare)										
1.4	(Spare)										
1.5	Properties after ageing in the air bomb		1-2	8.2							
1.5.1	Ageing conditions [4)]										
	- temperature	°C			-	150 ± 2	127 ± 2	-	127 ± 2	127 ± 2	-
	- duration of treatment	h			-	7 x 24	40	-	40	40	-
1.5.2	Values to be obtained for the tensile strength										
	- median, min.	N/mm^2			-	6,0	-	-	-	-	-
	- variation [1)] max.	%			-	-	± 30	-	± 30	± 30	-
1.5.3	Values to be obtained for the elongation at break										
	- variation [1)] max.	%			-	- 30 [3)]	± 30	-	± 30	± 30	-
2	**Hot set test**		2-1	9							
2.1	Conditions of treatment										
	- temperature	°C			250 ± 3	200 ± 3	200 ± 3	200 ± 3	250 ± 3	250 ± 3	200 ± 3
	- time under load	min			15	15	15	15	15	15	15
	- mechanical stress	N/mm^2			20	20	20	20	20	20	20
2.2	Test requirements										
	- max. elongation under load	%			100	100	100	100	100	100	100
	- max. elongation after unloading	%			25	25	25	25	25	25	25

NOTES: see end of table.

Table 1 - Requirements for the non-electrical tests for cross-linked insulation (continued)

1	2	3	4	5	6	7	8	9	10	11	12
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**						
			Section	**Clause**	**EI 2**	**EI 3**	**EI 4**	**EI 5**	**EI 6**	**EI 7**	**EI 8**
3	**Pressure test at high temperature**		3-1	8.1							
3.1	Test conditions										
	- force exerted by blade (k value):				-	1,0	-	1,0	-	-	-
	- duration of heating under load [5]	h			-	0,5	-	4 or 6	-	-	-
	- temperature	°C			-	150 ± 2	-	100 ± 2	-	-	-
3.2	Result to be obtained										
	- median of the depth of penetration, max.	%			-	50	-	50	-	-	-
4	**Ozone resistance test**										
4.1	Method A		2-1	8							
	Test conditions										
	- test temperature	°C			-	-	25 ± 2	25 ± 2	25 ± 2	25 ± 2	25 ± 2
	- test duration	h			-	-	24	24	24	24	24
	- ozone concentration	%			-	-	(250 - 300) x 10^{-6}	(250 - 300) x 10^{-6}	(250 - 300) x 10^{-6}	(250 - 300) x 10^{-6}	(250 - 300) x 10^{-6}
4.2	Method B		HD 22.2	7.3							
	- test temperature	°C			-	-	40 ± 2	40 ± 2	40 ± 2	40 ± 2	40 ± 2
	- test duration	h			-	-	72	72	72	72	72
	- ozone concentration	%			-	-	(200 ± 50) x 10^{-8}	(200 ± 50) x 10^{-8}	(200 ± 50) x 10^{-8}	(200 ± 50) x 10^{-8}	(200 ± 50) x 10^{-8}
4.3	Result to be obtained				-	-	[7]	[7]	[7]	[7]	[7]

NOTES: see end of table.

Table 1 - Requirements for the non-electrical tests for cross-linked insulation (continued)

1	2	3	4	5	6	7	8	9	10	11	12
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**						
			Section	**Clause**	**EI 2**	**EI 3**	**EI 4**	**EI 5**	**EI 6**	**EI 7**	**EI 8**
5	**Low temperature tests**										
5.1	Bending test		1-4	8.1							
5.1.1	Test conditions										
	- temperature	°C			-	-15 ± 2	-35 ± 2	-15 ± 2	-50 ± 3	-35 ± 2	-15 ± 2
	- period of application of low temperature	h	1-4	8.1.4 and 8.1.5	-	8)	8)	8)	8)	8)	8)
5.1.2	Result to be obtained				-	7)	7)	7)	7)	7)	7)
5.2	Elongation test		1-4	8.3							
5.2.1	Test conditions										
	- temperature	°C			-	-15 ± 2	-35 ± 2	-15 ± 2	-50 ± 3	-35 ± 2	-15 ± 2
	- period of application of low temperature	h	1-4	8.3.4 and 8.3.5	-	8)	8)	8)	8)	8)	8)
5.2.2	Result to be obtained										
	- elongation without break (min.)	%			-	30	30	30	30	30	30
5.3	Impact test		1-4	8.5							
5.3.1	Test conditions										
	- temperature	°C			-	-	-	-15 ± 2	-	-	-
	- period of application of low temperature	h	1-4	8.5.5	-	-	-	8)	-	-	-
	- mass of hammer		1-4	8.5.4	-	-	-	8)	-	-	-
5.3.2	Result to be obtained		1-4	8.5.6	-	-	-	8)	-	-	-
NOTES: see end of table.											

Table 1 - Requirements for the non-electrical tests for cross-linked insulation (concluded)

1	2	3	4	5	6	7	8	9	10	11	12
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**						
			Section	**Clause**	**EI 2**	**EI 3**	**EI 4**	**EI 5**	**EI 6**	**EI 7**	**EI 8**
6	**Acidic (corrosive) gases evolved**										
6.1	- pH (minimum)		EN 50267-2-2		-	-	-	4,3	-	-	4,3
6.2	- conductivity (maximum)	µS/mm	EN 50267-2-2		-	-	-	10	-	-	10
7	**Compatibility test** [6]		1-2	8.1.4							
7.1	Ageing conditions:										
	- temperature	°C			200 ± 3	135 ± 2	80 ± 2	-	100 ± 2	100 ± 2	80 ± 2
	- duration of treatment	h			10 x 24	7 x 24	7 x 24	-	7 x 24	7 x 24	7 x 24
7.2	Values to be obtained for the tensile strength:										
	- median, min.	N/mm^2			4,0	-	4,2	-	5,0	5,0	-
	- variation [1], max.	%			-	± 30	± 25	-	± 30	± 30	- 30 [3]
7.3	Values to be obtained for the elongation at break:										
	- median, min.	%			120	-	200	-	-	-	125
	- variation [1], max.	%			-	± 30	± 25	-	± 30	± 30	± 30

* Unless otherwise shown in column 4.

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 cross-linked 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 EI 4, EI 6, EI 7 and EI 8 shall be carried out in accordance with 8.1.3.2 a) of EN 60811-1-2. Ageing of Type EI 2, EI 3, EI 5 shall be carried out in accordance with 8.1.3.1 of EN 60811-1-2.

5) For EI 5 duration of heating depends on cable dimensions. Four hours for cables of mean overall diameter up to and including 15 mm, six hours for cables of mean overall diameter greater than 15 mm.

6) Only applicable when called up by the particular cable standard.

7) No cracks.

8) See test method referred to in columns 4 and 5.10

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

A strain bearing member (sbm) may also form part of the internal construction of a cable and, if present, shall conform to 5.3.3.

There shall be no harmful interactions between the fillers and the insulation and/or the sheath. Compliance shall be checked as part of the compatibility test requirements for the relevant insulation and sheath materials of the particular cable.

5.3.2 Application

For each type of cable, the particular specifications specify whether that cable includes fillers (and/or sbms) or whether the sheath may penetrate between the cores, thus forming a filling (see 5.5.2 of Part 1).

A centre filler, if used, shall comply with 5.3.1 of Part 1.

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.

5.3.3 Strain bearing members (sbm)

Where a strain bearing member, or members, is required it shall be incorporated into the cable in accordance with the particular specification. It may be metallic or non-metallic according to the particular specification.

There shall be no harmful interactions between the sbm and the insulation and/or the sheath. This shall be checked as given for fillers in 5.3.1.

5.4 Textile braid

5.4.1 Material

Where textile braid is required, as specified for each type of cable in the particular specifications, the material for 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 an elastomeric based compound of the type specified for each type of cable in the particular specifications.

Type EM 2 for cables sheathed with polychloroprene compound or equivalent synthetic elastomer.

Type EM 3 for cables sheathed with ordinary ethylene-propylene rubber compound or other equivalent synthetic elastomer.

Type EM 4 for cables sheathed with cross-linked EVA or equivalent synthetic elastomer.

Type EM 5 for the covering of arc-welding cables.

NOTE 1 Single core arc welding cables to HD 22.6 are rated 100/100 V and have a protective layer referred to as a 'covering'. EM 5 is therefore included in this listing for completeness only.

Type EM 6 for cables insulated with compound EI 6 and sheathed with a compound of ethylene-propylene rubber or equivalent synthetic elastomer for use down to – 40 °C.

Type EM 7 for cables insulated with compound EI 7 and sheathed with a compound of chlorosulfonated polyethylene or equivalent synthetic elastomer.

Type EM 8 for flexible cables sheathed with polyolefin-based cross-linked compound, having a low level of emission of corrosive gases when burned.

Type EM 9 for cables sheathed with silicone rubber or equivalent synthetic elastomer.

Type EM 10 for the inner-layer of dual-layer sheaths when EM 8 is the outer layer.

Type XM 1 for cables sheathed with cross-linked PVC.

Type TMPU for cables sheathed with thermoplastic polyurethane.

The test requirements for these compounds are specified in Part 1, Table 2.

NOTE 2 Requirements for XM 1 and TMPU are presently in annex A of HD 22.14 S2 and annex A of HD 22.10/A1 respectively.

5.5.2 Application

The sheath shall be extruded and 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 as an homogeneous layer

a) on the core, for single core cables;
b) on the assembly of cores and fillers or inner covering, if any, for multicore cables.

The sheath shall not adhere to the cores, and shall be capable of being removed without damage to the cores.

A separator, consisting of a film or tape or 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 5.3.2 of Part 1).

5.5.2.2 Sheath in two separate homogeneous layers

a) Inner layer

The inner layer of the sheath shall be applied as specified in 5.5.2.1 of Part 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.

b) Outer layer

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

c) Non-electrical tests on sheath in two layers

Each of the two layers shall be tested separately with test methods and requirements as for each type of compound as given in Part 1, Table 2. If the two layers are bonded and a 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, and tested as stated above, care being taken to avoid undue heating.

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 1.10 of Part 2.

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 2.

The applicable test values and the results to be obtained are specified in Part 1 Table 2.

5.5.5 Colour

5.5.5.1 Black sheaths

Where the particular specification requires the cable to 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).

5.5.5.2 Other coloured sheaths

For all sheaths other than black, 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.

Table 2 - Requirements for the non-electrical tests for cross-linked sheath

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**								
			Section	**Clause**	**EM 2**	**EM 3**	**EM 4**	**EM 5**	**EM 6**	**EM 7**	**EM 8**	**EM 9**	**EM 10**
1	**Mechanical properties**												
1.1	Properties before ageing		1-1	9.2									
1.1.1	Values to be obtained for the tensile strength:												
	- median, min.	N/mm^2			10,0	7,0	6,5	10,0	7,0	10,0	7,0	5,0	5,0
1.1.2	Values to be obtained for the elongation at break:												
	- median, min.	%			300	250	200	300	200	250	125	150	125
1.2	Properties after ageing in air oven		1-2	8.1									
1.2.1	Ageing conditions [3]												
	- temperature	°C			70 ± 2	80 ± 2	150 ± 2	100 ± 2	120 ± 2	120 ± 2	100 ± 2	200 ± 3	100 ± 2
	- duration of treatment	h			10 x 24	10 x 24	10 x 24	14 x 24	3 x 24	7 x 24	7 x 24	10 x 24	7 x 24
1.2.2	Values to be obtained for the tensile strength:												
	- median, min.	N/mm^2			-	-	-	-	7,0	-	-	4,0	5,0
	- variation [2] max.	%			-15 [1]	± 30	± 30	- 30 [1]	-	± 30	- 30 [1]	-	- 30 [1]
1.2.3	Values to be obtained for the elongation at break:												
	- median, min.	%			250	-	-	-	200	-	100	120	100
	- variation [2] max.	%			- 25 [1]	± 30	± 30	- 40 [1]	-	± 40	± 30	-	± 30
1.2.4	Continued ageing conditions												
	- temperature	°C			-	-	-	-	120 ± 2	-	-	-	-
	- total duration of treatment	h			-	-	-	-	10 x 24	-	-	-	-
1.2.5	Values to be obtained for the tensile strength												
	- variation [4] max.	%			-	-	-	-	± 20	-	-	-	-
1.2.6	Values to be obtained for the elongation at break												
	- variation [4] max.	%			-	-	-	-	± 30	-	-	-	-

NOTES: see end of table.

Table 2 - Requirements for the non-electrical tests for cross-linked sheath (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**								
			Section	**Clause**	**EM 2**	**EM 3**	**EM 4**	**EM 5**	**EM 6**	**EM 7**	**EM 8**	**EM 9**	**EM 10**
1.3	Properties after ageing in the air bomb		1-2	8.2									
1.3.1	Ageing conditions:												
	- temperature	°C			-	-	150 ± 2	-	-	-	-	-	-
	- duration of treatment	h			-	-	7 x 24	-	-	-	-	-	-
1.3.2	Values to be obtained for the tensile strength:												
	- median, min.	N/mm^2			-	-	6,0	-	-	-	-	-	-
	- variation [2], max.	%			-	-	-	-	-	-	-	-	-
1.3.3	Values to be obtained for the elongation at break:												
	- median, min.	%			-	-	-	-	-	-	-	-	-
	- variation [2], max.	%			-	-	- 30 [1]	-	-	-	-	-	-
1.4	Mechanical properties after immersion in mineral oil		2-1	10									
1.4.1	Test conditions:												
	- temperature of oil	°C			100 ± 2	-	-	100 ± 2	-	100 ± 2	100 ± 2	-	-
	- duration of immersion in oil	h			24	-	-	24	-	24	24	-	-
1.4.2	Values to be obtained for the tensile strength:												
	- variation [2], max.	%			± 40	-	-	- 40 [1]	-	± 40	± 40	-	-
1.4.3	Values to be obtained for the elongation at break:												
	- variation [2] max.	%			± 40	-	-	- 40 [1]	-	± 40	± 40	-	-

NOTES: see end of table.

Table 2 - Requirements for the non-electrical tests for cross-linked sheath (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**								
			Section	**Clause**	**EM 2**	**EM 3**	**EM 4**	**EM 5**	**EM 6**	**EM 7**	**EM 8**	**EM 9**	**EM 10**
2	**Hot set test**		2-1	9									
2.1	Conditions of treatment:												
	- temperature	°C			200 ± 3	200 ± 3	250 ± 3	200 ± 3	250 ± 3	200 ± 3	200 ± 3	250 ± 3	200 ± 3
	- time under load	min			15	15	15	15	15	15	15	15	15
	- mechanical stress	N/cm^2			20	20	20	20	20	20	20	20	20
2.2	Test requirements:												
	- max. elongation under load	%			100	100	100	100	100	100	100	100	100
	- max. elongation after unloading	%			25	25	25	25	25	25	25	25	25
3	**Pressure test at high temperature**		3-1	8.2									
3.1	Test conditions:												
	- force exerted by blade: (k = 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** [6]												
4.1	Method A		2-1	8									
	- test temperature	°C			-	25 ± 2	-	-	25 ± 2	25 ± 2	25 ± 2	-	-
	- test duration	h			-	24	-	-	24	24	24	-	-
	- ozone concentration	%			-	(250 - 300) x 10^{-6}	-	-	(250 - 300) x 10^{-6}	(250 - 300) x 10^{-6}	(250 - 300) x 10^{-6}	-	-
4.2	Method B		HD 22.2	7.3									
	- test temperature	°C			-	40 ± 2	-	-	40 ± 2	40 ± 2	40 ± 2	-	-
	- test duration	h			-	72	-	-	72	72	72	-	-
	- ozone concentration	%			-	(200 ± 50) x 10^{-8} [7]	-	-	(200 ± 50) x 10^{-8} [7]	(200 ± 50) x 10^{-8} [7]	(200 ± 50) x 10^{-8} [7]	-	-
4.3	Result to be obtained				-		-	-				-	-

NOTES: see end of table.

Table 2 - Requirements for the non-electrical tests for cross-linked sheath (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**								
			Section	**Clause**	**EM 2**	**EM 3**	**EM 4**	**EM 5**	**EM 6**	**EM 7**	**EM 8**	**EM 9**	**EM 10**
5	**Low temperature tests**												
5.1	Bending test		1-4	8.2									
5.1.1	Test conditions												
	- temperature	°C			-35 ± 2 [8]	-35 ± 2 [8]	-15 ± 2 [8]	-35 ± 2 [8]	-50 ± 3 [8]	-30 ± 2 [8]	-15 ± 2 [8]	-	-15 ± 2 [8]
	- period of application of low temperature	h	1-4	8.2.3								-	
5.1.2	Result to be obtained				[7]	[7]	[7]	[7]	[7]	[7]	[7]	-	[7]
5.2	Elongation test		1-4	8.4									
5.2.1	Test conditions												
	- temperature	°C			-35 ± 2 [8]	-35 ± 2 [8]	-15 ± 2 [8]	-35 ± 2 [8]	-50 ± 3 [8]	-30 ± 2 [8]	-15 ± 2 [8]	-	-15 ± 2 [8]
	- period of application of low temperature	h	1-4	8.4.4 and 8.4.5								-	
5.2.2	Result to be obtained												
	- elongation without break (min.)	%			30	30	30	30	30	30	30	-	30
5.3	Impact test		1-4	8.5									
5.3.1	Test conditions												
	- temperature	°C			-	-	-	-	-	-	-15 ± 2 [8]	-	-
	- period of application	h	1-4	8.5.5	-	-	-	-	-	-	[8]	-	-
	- mass of hammer		1-4	8.5.4	-	-	-	-	-	-	[8]	-	-
5.3.2	Result to be obtained		1-4	8.5.6	-	-	-	-	-	-	[8]	-	-
NOTES: see end of table.													

Table 2 - Requirements for the non-electrical tests for cross-linked sheath (concluded)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ref No.	**Test**	**Unit**	**Test method described in EN 60811 ***		**Type of compound**								
			Section	**Clause**	**EM 2**	**EM 3**	**EM 4**	**EM 5**	**EM 6**	**EM 7**	**EM 8**	**EM 9**	**EM 10**
6	**Acidic (corrosive) gases evolved**												
6.1	- pH (min.)		EN 50267-2-2		-	-	-	-	-	-	4,3	-	4,3
6.2	- conductivity (max.)	µS/mm	EN 50267-2-2		-	-	-	-	-	-	10	-	10
7	**Compatibility test** [5]		1-2	8.1.4									
7.1	Ageing conditions:												
	- temperature	°C			80 ± 2	80 ± 2	135 ± 2	-	100 ± 2	100 ± 2	80 ± 2	200 ± 3	80 ± 2
	- duration of treatment	h			7 x 24	7 x 24	7 x 24	-	7 x 24	7 x 24	7 x 24	10 x 24	7 x 24
7.2	Values to be obtained for the tensile strength:												
	- median, min.	N/mm^2			-	-	-	-	7,0	-	-	4,0	-
	- variation [2], max.	%			-15 [1]	± 30	± 30	-	-	± 30	-30 [1]	-	- 30 [1]
7.3	Values to be obtained for the elongation at break:												
	- median, min.	%			250	-	-	-	200	-	100	120	100
	- variation [2], max.	%			-25 [1]	± 30	± 30	-	-	± 40	± 30	-	± 30
8	**Carbon black content (where applicable)** [6]		4-1	11									
	- minimum content	%			-	2	-	-	2	-		-	-

* Unless otherwise shown in column 4.

[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 cross-linked 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.

[4] Variation in this case is the difference between the median value after ageing for 10 days and the median value after ageing for 3 days, expressed as a percentage of the latter.

[5] The compatibility test applies only where specified in the particular cable standard.

[6] When the designated compound is used for the inner layer of a sheath in two layers, these tests are not required.

[7] No cracks.

[8] See test method referred to in columns 4 and 5.

5.6 Tests on completed cable

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 3.

The test methods and the results to be obtained are specified in Part 1, Table 3.

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 1.11 of Part 2.

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 tests given in Part 2 clause 3.

5.6.3.1 Flexing tests for flexible cables

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

During the test with 30 000 cycles, i.e. 60 000 single movements, neither interruption of the current, short circuit between the conductors nor short circuit between the cable and the pulleys (the flexing apparatus) shall occur.

After the required number of cycles the sheath of the cable, if any, shall be removed. The cores shall then withstand the voltage test carried out in accordance with 2.3 of Part 2, but with a test voltage not exceeding 2 000 V.

5.6.3.2 Wear resistance test

See 3.3 of Part 2.

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 2.2 of Part 2.

5.6.3.3 Three pulley test

Cables to HD 22.14 shall be subjected to the test given in 3.4 of Part 2.

During the test with 2 000 cycles, i.e. 4 000 single movements, neither interruption of the current, short circuit between the conductors nor short circuit between the cable and the pulleys (the flexing apparatus) shall occur.

After the required number of cycles the sheath of the cable, if any, shall be removed. The cores shall then withstand the voltage test carried out in accordance with 2.3 of Part 2, but with a test voltage not exceeding 2 000 V.

5.6.3.4 Kink test

Cables to HD 22.14 shall be subjected to the test given in 3.5 of Part 2.

During the test with 1 500 cycles, i.e. 3 000 single movements, neither interruption of the current, nor short circuit between the conductors shall occur.

Also there shall be no damage (cracking or tearing) to the sheath or any outer covering (textile braid). Textile braids shall have no gap bigger than 2 mm.

At the conclusion of the test the sheath and any outer covering shall be removed, and the cores shall be subjected to the voltage test on cores specified in Table 3.

5.6.4 Test under fire conditions

When required by the particular part of HD 22, the performance of the cable under fire conditions shall be demonstrated by one or more of the common test methods for cables given in EN 50265, EN 50266, EN 50267 and EN 50268.

Table 3 - Requirements for electrical tests for cross-linked insulated cables

1	2	3	4	5	6	7	8	9
Ref No	**Test**	**Unit**	**Test method described in**		**Rated voltage of cables**			
			HD	**Clause**	**100/100 V**	**300/300 V**	**300/500 V**	**450/750 V**
1	**Measurement of the resistance of conductor**		22.2	2.1				
1.1	Values to be obtained, max.				1)	1)	1)	1)
2	**Voltage test on completed cable**		22.2	2.2				
2.1	Test conditions:							
	- minimum length of the sample	m			20	20	20	20
	- minimum period of immersion in water	h			1	1	1	1
	- temperature of the water	°C			20 ± 5	20 ± 5	20 ± 5	20 ± 5
2.2	Voltage applied (a.c.)	V			1 000	2 000	2 000	2 500
2.3	Duration of each application of voltage, minimum	min			15	15	15	15
2.4	Result to be obtained				No breakdown	No breakdown	No breakdown	No breakdown
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 inc. 0,6 mm	V			-	1 500	1 500	-
	- exceeding 0,6 mm	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 breakdown	No breakdown	No breakdown
4	**Measurement of insulation resistance**							
4.1	Cables ≤ 90 °C		22.2	2.4.1				
4.1.1	Test conditions:							
	- length of sample from the previous voltage test (ref. 2 or 3)	m			-	-	5	5
	- minimum period of immersion in hot water	h			-	-	2	2
	- temperature of the water	°C			-	-	2)	2)
4.1.2	Result to be obtained	MΩ			-	-	2)	2)

Table 3 - Requirements for electrical tests for thermosetting insulated cables (concluded)

1	2	3	4	5	6	7	8	9
Ref No	**Test**	**Unit**	**Test method described in**		**Rated voltage of cables**			
			HD	**Clause**	**100/100 V**	**300/300 V**	**300/500 V**	**450/750 V**
4.2	Cables > 90 °C		22.2	2.4.2				
4.2.1	Test conditions:							
	- length of sample from the previous voltage test (ref. 2 or 3)	m					1,40 (from original 5)	1,40 (from original 5)
	- minimum period of heating	h					2	2
	- temperature of heating	°C					2)	2)
4.2.2	Result to be obtained	MΩ					2)	2)
5	**Long term resistance of insulation to d.c.**		22.2	2.5				
5.1	Test conditions:							
	- length of sample	m			-	-	-	5
	- duration of test	h			-	-	-	240
	- water temperature	°C			-	-	-	60 ± 5
	- d.c. voltage applied	V			-	-	-	220
5.2	Result to be obtained							No breakdown or damage to the surface
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 annex B	-	3)	3)	3)
6.1.2	Result to be obtained				-	No breakdown	No breakdown	No breakdown
6.2	Voltage test							
6.2.1	Test conditions:		22.2	2.6.2	-	3)	3)	3)
	- voltage applied, a.c.	V				2 000	2 000	2 500
	- voltage applied, d.c.	V				5 000	5 000	5 000
	- duration of test	min				5	5	5
6.2.2	Result to be obtained				m	No breakdown	No breakdown	No breakdown
7	**Surface resistance of sheath**		22.2	2.7				
7.1	Test conditions:							
	- voltage applied, d.c.	V			-	100 to 500	100 to 500	100 to 500
	- duration of test	min			-	1	1	1
7.2	Result to be obtained	ohm			-	$\geq 10^9$	$\geq 10^9$	$\geq 10^9$

1) See HD 383 and particular specifications.
2) See tables in the particular specifications.
3) See test method referred to in columns 4 and 5.

6 Guide to use of the cables

See HD 516

NOTE HD 516 includes current ratings for cords and flexible cables and for arc welding cables.

Annex A
(normative)

Normative references

HD 22.1 incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to HD 22.1 only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 50265	series	Common test methods for cables under fire conditions – Test for resistance to vertical flame propagation for a single insulated conductor or cable
EN 50266	series	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables
EN 50267	series	Common test methods for cables under fire conditions – Tests on gases evolved during combustion of materials from cables
EN 50268	series	Common test methods for cables under fire conditions – Measurement of smoke density of cables burning under defined conditions
EN 50334		Marking by inscription for the identification of cores of electric cables
EN 60811	series	Insulating and sheathing materials of electric and optical fibre cables - Common test methods
HD 308		Identification of cores in cables and flexible cables
HD 361		System for cable designation
HD 383		Conductors of insulated cables (endorsing IEC 60228 and 60228A, mod.)
HD 402		Standard colours for insulation for low-frequency cables and wires (Endorsing IEC 60304)
HD 516		Guide to use of low voltage harmonized cables

Annex B
(informative)

National marking

The national mark of an Approval Organisation which is signatory to the HAR Agreement, also signifies that a manufacturer's production of the cables covered by this HD has been assessed in accordance with the procedures mentioned in 1.3 of Part 1.