HARMONIZATION DOCUMENT

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HD 605 S1

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Descriptors: Electric cable, test, dimension measuring, mechanical test, physical test, chemical test, electrical test, test of fire behaviour, thermal endurance test, classification, test conditions

ENGLISH VERSION

Electric cables - Additional test methods

Câbles électriques - Méthodes d'essais supplémentaires

Elektrische Kabel - Ergänzende Prüfverfahren

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

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

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FOREWORD

This Harmonisation Document was prepared jointly by WG9 and WG10 of CENELEC Technical Committee TC20, Electric cables.

The document rationalises all those test methods which are additional to those in HD 405 and HD 505, and which were originally planned to be included in Part 2 of each of HD 603 (Distribution cables of rated voltage 0.6/1kV) and HD 604 (0.6/1kV Power Cables with special fire performance for use in power stations). Consequently there is no Part 2 for either HD 603 or HD 604. By decision of the Technical Board (D68/047) National Committees are only required to implement in their national language the nationally applicable parts of HD 603 and HD 604. Therefore not all test methods in HD 605 apply to both the other HDs, nor are they all called up by any particular nationally applicable part.

The draft was submitted to the CENELEC members for formal vote in March 1993 and was approved by CENELEC as HD 605 S1 on 8th December 1993.

References to other HDs, ENs and international standards are given in Annex III.

The following dates were fixed:

- latest date of announcement of the HD at national level (doa) 1994-06-01
- latest date of publication of a harmonised national standard (dop) 1994-12-01
- latest date of withdrawal of conflicting national standards (dow) 1994-12-01

CONTENTS

ELECTRIC CABLES

ADDITIONAL TEST METHODS

1 GENERAL

1.1 Scope

This HD collates and specifies the test methods to be used for testing polymeric insulated and sheathed electric cables, of rated voltage up to and including 0,6/1kV, intended for public distribution systems, and for use in power generating plants and sub-stations.

Test methods in this HD are additional to those already harmonised, eg HD 405 and HD 505, and are used for testing cable types specified in HD 603 and HD 604. In each case, these HDs give complementary information needed for the practical application to each specific type. Therefore the present HD as such is not sufficient for carrying out and evaluating the tests on electric cables.

Full test conditions (eg temperatures, durations) and/or test requirements are not specified in this HD. Such data needed to carry out the tests is given in the particular sections.

(NOTE: The words 'particular section' refer throughout to the section of HD 603 or HD 604, or other HD to which HD 605 applies, in which a particular cable type is specified.)

1.2 Applicable tests

Tests applicable to each type of cable are given in the particular section, which state also the sequence, the frequency of test, and the possibility of repeating failed tests.

1.3 Classification of tests

The classification of tests is given in Parts 1 of HD 603 and HD 604.

1.4 Sampling

The size and number of samples are given either in this HD or in the particular HDs.

If a marking is indented in the insulation or sheath surface, the samples used for the tests shall be taken so as to include such markings.

For multicore cables, except for the test specified in 2.1.1, not more than three cores (of different colours, if available) shall be tested unless otherwise specified.

1.5 Test conditions

1.5.1 Ambient temperature

Tests shall be made at an ambient temperature within the range 5°C to 35°C unless otherwise specified in the details for the particular test.

1.5.2 Tolerance on temperature values

Unless otherwise specified in the particular specification, the tolerance on temperature values quoted in the test methods are the following:

Specified Temperature, t(°C)	Tolerance (K)
$-40 \leq t \leq 0$	± 2
$0 < t \leq 50$	according to relevant clause
$50 < t \leq 150$	± 2
$t > 150$	± 3

1.5.3 **Frequency and waveform of power-frequency test voltages**

Unless otherwise specified the test voltage shall be in the range 49 to 61Hz of approximately sine-wave form, the peak ratio value/r.m.s. value being equal to $\sqrt{2}$ with a tolerance of ± 7%. The values given are rms.

1.5.4 **Pre-conditioning**

Unless otherwise stated the tests shall be carried out not less than 16h after the extrusion or cross-linking, if any, of the insulating or sheathing compounds.

2 NON-ELECTRICAL TESTS

2.1 Dimensional measurements

2.1.1 Measurement of insulation thickness

2.1.1.1 Procedure

The thickness of insulation shall be measured in accordance with sub-clause 8.1 of HD 505.1.1. Unless otherwise specified one sample of cable shall be taken from each of three places.

Compliance shall be checked on each core of cables having up to five cores, and on the number of cores stated in the individual specification for cables with more than five cores.

If withdrawal of the conductor is difficult, it shall be stretched in a tensile machine or the piece of core shall be immersed in an appropriate liquid until the insulation becomes loose.

2.1.1.2 Evaluation of results

Unless otherwise specified the mean of the 18 values (expressed in millimetres) obtained from the three pieces of insulation from each core shall be calculated to two decimal places and rounded off as given below, and this shall be taken as the mean value of the thickness of insulation.

If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number thus, for example, 1.74 shall be rounded off to 1.7 and 1.75 to 1.8.

The lowest of all values obtained shall be taken as the minimum thickness of insulation at any place.

2.1.2 Measurement of non-metallic sheath thickness

2.1.2.1 Procedure

The thickness of sheath shall be measured in accordance with sub-clause 8.2 of HD 505.1.1. Unless otherwise specified one sample of cable shall be taken from each of three places.

2.1.2.2 Evaluation of results

The mean of all the values (expressed in millimetres) obtained from the three pieces of sheath shall be calculated to two decimal places and rounded off as given below, and this shall be taken as the mean value of the thickness of the sheath.

If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number, thus, for example, 1.74 shall be rounded off to 1.7 and 1.75 to 1.8.

The lowest of all values obtained shall be taken as the minimum thickness of sheath at any place.

2.1.3 Measurement of cable dimensions

2.1.3.1 Measurement of overall dimensions

Unless otherwise specified the three samples taken in accordance with this HD, sub-clause 2.1.1 or 2.1.2 shall be used.

The measurement of the overall diameter of any circular cable and of the overall dimensions of flat cables with a major dimension not exceeding 15mm shall be carried out in accordance with sub-clause 8.3 of HD 505.1.1.

For the measurement of flat cables with a major dimension exceeding 15mm, a micrometer, a profile projector or similar equipment shall be used.

The mean of the values obtained shall be taken as the mean overall dimensions.

2.1.3.2 Measurement of ovality

For checking the ovality of circular sheathed cables, two measurements shall be made at the same cross-section of the cable, covering the maximum and minimum values.

2.1.4 Measurement of wires, strips and tapes

2.1.4.1 Conductor wires

Measurement of the diameter of conductor wires (class 5 conductors).

(a) **Sampling**

Take at random either 10% of the total number of wires, rounded upwards, or 10 wires, whichever is the lowest, from one core of each length of cable selected for the test.

(b) **Method**

Determine the diameter of each wire with a micrometer by taking a measurement in three positions, approx. 300mm far away from each other. The readings shall be made to two decimal places. Take the average of the three measurements to be the wire diameter.

2.1.4.2 Wires and tapes for concentric conductor or screen

(a) **Sampling**

A sample of about 500mm length is taken from the test piece and straightened by means of a non-damaging tool. After that it is cleaned.

(b) **Procedure**

For wires and tapes the diameter or the thickness is measured with an screw type micrometer or a dial gauge with a measuring element with flat measurement planes with a diameter 4mm to 8mm. Measurements shall be made at three points which are uniformly spread along the sample.

(c) **Expression of results**

The diameter of the thickness is the mean value obtained from the three measurements. The test is considered to be fulfilled if the mean value does not fall below the minimum value prescribed in the particular specification.

2.1.4.3 Wires, strips and tapes for armour

(a) **Round wires**

Take at random 10% of the total number of wires from a sample of completed cable. Determine the diameter of each wire of this sampling by using a micrometer with flat noses and taking two measurements at right angles to each other. Take the average value as the wire diameter.

(b) **Flat wires or strips**

Take at random 10% of the total number of flat wires or strips from a sample of completed cable. Determine the thickness and width of each flat wire by using a micrometer or vernier calliper with flat noses. Take the average values as the wire thickness and width respectively.

(c) **Metallic tapes thickness**

Take and straighten a sample of each armour tape, remove the non metallic coating if any, and determine the tape thickness at six different places by using a micrometer or vernier calliper with flat noses. Take the smallest value to be compared with the specified thickness with a tolerance given in the particular specification.

2.1.5 **Measurement of thickness of metallic sheath**

The thickness of lead sheaths shall be determined by one of the following methods, at the discretion of the manufacturer. (Methods of measuring thickness of other types of metallic sheath are under consideration.)

(a) Strip method. The measurement shall be made on a test piece of sheath about 50mm in length removed from the finished cable length. The test piece shall be taken a sufficient distance from the cable end to allow a proper measurement to be made.

The piece shall be slit longitudinally and carefully flattened. After cleaning the test piece, a number of measurements shall be taken along the circumference of the sheath and not less than 10mm away from the edge of the flattened piece to ensure that the minimum thickness is measured. The measurement shall be made with a micrometer with plane faces of 4mm to 8mm diameter and an accuracy of ±0.01mm.

(b) Ring method. The measurements shall be made on a ring of the sheath carefully cut from the sample. The thickness shall be determined at a sufficient number of points around the circumference of the ring to ensure that the minimum thickness is measured.

The measurements shall be made with a micrometer having either one flat nose and one ball nose, or one flat nose and a flat rectangular nose 0.8mm wide and 2.4mm long. The ball nose or the flat rectangular nose shall be applied to the inside of the ring. The accuracy of the micrometer shall be ±0.01mm.

2.1.6 **Check of application of screen or armour tapes, or wires**

2.1.6.1 Method 1

Take a cable sample 300mm long, at not less than 150mm from the end of a factory length. Measure the gap between adjacent edges of the tape(s), and also the tape width. Measurement is made at 4 positions along the sample, with an accuracy better than 0.5mm.

2.1.6.2 Method 2

Remove two rings of the oversheath each 50mm in length, cut at a distance of 5D and 15D, respectively, (where D is the overall diameter) from one end of the cable length, so as to expose the metallic tapes or wires.

Make a visual examination of the exposed components and measure the largest gap between adjacent wires or tapes. The measurement shall be made with an accuracy better than 0.5mm and the result shall be given to one decimal place.

2.1.7 **Percentage coverage of a braided metallic layer**

The percentage coverage "B" of the braiding shall be calculated by the following formula:

$$B=\frac{100d}{q}\left(m_1n_1+m_2n_2-m_1n_1m_2n_2\frac{d}{q}\right)$$

where:

$$q=\frac{\pi DS}{\sqrt{\pi^2D^2+S^2}}$$

D = mean diameter of braiding (= diameter under metallic layer + 2d, mm)
d = nominal diameter of the wires of the braid, mm
S = lay of the wires of the braiding, mm
m_1 = number of spindles in one direction
m_2 = number of spindles in the other direction
$n_1;n_2$ = number of wires per spindle according to the direction

2.1.8 **Measurement of the gap between non-metallic tapes of taped bedding**

Measure the gap between the adjacent edges of each bedding tape at right angles to the tape, and also the tape width, on a sample of cable 300mm long, taken not less than 150mm from the end of a factory length.

Take the measurements by any suitable means in which the error of determination does not exceed 0.5mm. Measure the gaps at four positions approximately 50mm apart along the length of the sample.

2.1.9 **Measurement of rubber layer thickness**

2.1.9.1 Single rubber layer

The diameters over the copper concentric neutral/earth conductor and the laid up cores shall be determined by a diameter tape at the same position. The nominal thickness of the rubber layer is to be taken as half the difference between these two diameters, less the diameter of one copper wire comprising the neutral/earth layer.

2.1.9.2 Double rubber layer

The diameters over the anti-corrosion layer and over the core of single-phase cables, or over the laid-up cores of three-phase cables shall be determined by diameter tape at the same position. The average thickness of the anti-corrosion layer is to be taken as half the difference between these two diameters. For three-phase cables with circular conductors and without fillers the value indicated by the diameter tape measurement over the cores shall be increased by 10 per cent to give the true diameter over the laid-up cores.

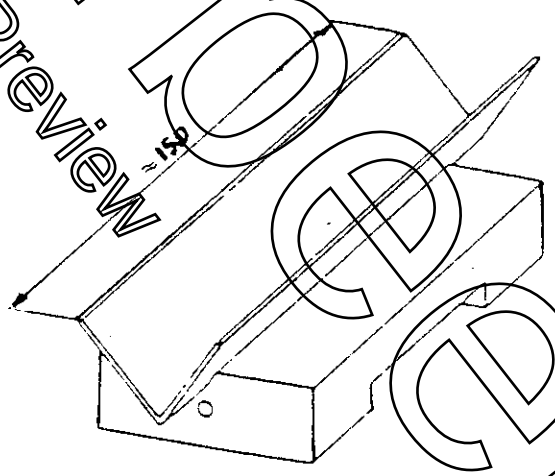
2.2 Mechanical tests on non-metallic components

2.2.1 Measurement of Shore D hardness of PE sheath

(a) Test equipment

* Equipment for testing the hardness according to Shore D with supplementary device where the testing equipment can be clamped and which allows a pressure with a force of 50 N.

* Indentation rod
* Support for cable samples. (Figure 2.2.1)
* Steel frame with the dimensions of about 75 mm x 75 mm x 6.5 mm.
* Heatable press for manufacturing test plates.
* Thermometer.



Dimensions in mm

Figure 2.2.1 : Support for cable samples

(b) **Test method A (test on the cable)**

Testing of the hardness of the sheath on cable samples with an outer diameter > 20mm and a sheath wall thickness > 2mm.

(i) Sampling - one sample of about 200mm in length is taken from the cable to be tested. The sample is to be chosen in such a way that it does not show any bends. The sheath surface shall be smooth and without grooves.

(ii) Preparation of test - After taking the sample from the cable it is stored for at least 16h at a temperature of (23 ± 2)°C.

The sample is laid into the support in such a way that it evenly lies in the support and when lighting from the back no gleam may be seen between the indentation rod and the sheath surface.

(iii) Test procedure - The test is carried out at a temperature of (23 ± 2)°C with the testing equipment and the indentation rod according to clause 2.2.1 (a). The hardness shall be read 3 s after the contact between the supporting surface of the equipment for testing the hardness and the sample.

The test is carried out on a sheath line on 4 points and on the diametrical sheath line on 3 points having a distance of about 20mm. The measured values shall be rounded to integers.

(iv) Expression of Results - The test is considered to be fulfilled if the median obtained from each of the 7 measurements does not fall below the minimum value given in the particular specification.

Note: The Shore D grade of hardness registered on the cable sheath cannot be regarded as a material coefficient. In case of doubt test method B shall be applied.

(c) **Test method B (test on test plates)**

Testing on the hardness of the sheath material for cables with an outer diameter ≤ 20mm and a sheath wall thickness ≤ 2mm.

(i) Sampling - The sheath material is chopped and laid into the press according to clause (a). Raw granulates of the sheath material may also be used.

In the press according to clause (a) the material is formed to a plate in the steel angle at a temperature up to (180 +3/-0)°C. First of all the material is heated to the temperature given within 5 min and without pressure. After that it is formed within 5 min with a pressure of 20MPa.

The thickness of the plate shall be at least 6mm and the surfaces shall be flat and smooth, as far as possible.

After taking the samples from the press two plates are manufactured which are chilled in water for at least 5 min. After that they are further cooled at room temperature. These samples shall be stored for at least 16h at (23 ± 2)°C.

(ii) Test procedure - The test is carried out on both samples. 4 measurements are carried out on one sample and 3 measurements on the other one.

(iii) Expression of results - The measured values shall be rounded to integers. The test is considered to be fulfilled if the median obtained from each of the 7 measurements does not fall below the minimum value given in the particular specifications.

2.2.2 Determination of tear resistance of the protective sheath

2.2.2.1 Method 1

(a) Principle

The test involves measuring the force required to start a tear in a test piece incorporating a 90° reflex angle.

The force required to start the tear, expressed per millimetre of thickness, constitutes the tear resistance of the sheath.

(b) Test piece

(b1) Sampling

Test pieces are prepared from samples of sheath material taken from 3 points over a length of at least 1m. In the case of cross-linked materials, sampling is carried out at least 3 days after manufacture.

Each tubular sample is split along two longitudinal lines to form a curved section 120mm or more in length and at least 34mm wide.

This plate is then ground or trimmed to obtain a strip with flat and parallel surfaces at least 1mm thick.

If grinding is used, avoid overheating.

(b2) Preparation of test piece

Three test pieces are cut from the strip thus obtained, using a punch shaped as shown in figure 2.2.2.1.

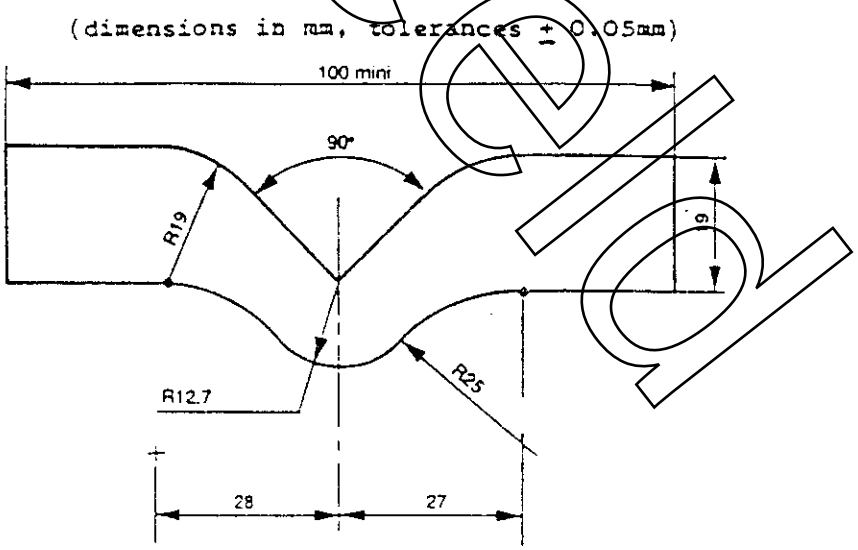


Fig 2.2.2.1 - Test piece for tear resistance method 1

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