

Test procedure for the determination of the temperature index of enamelled winding wires

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National Foreword

This British Standard is the UK implementation of EN 60172:1994+A2:2010. It is identical to IEC 60172:1987, incorporating amendments 1:1998 and 2:2010. It supersedes BS EN 60172:1996, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/55, Winding wires.

A list of organizations represented on this committee can be obtained on request to its secretary.

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

Compliance with a British Standard cannot confer immunity from legal obligations.

Summary of pages

The following table identifies the current issue of each page. Issue 1 indicates that a page has been introduced for the first time by amendment. Subsequent issue numbers indicate an updated page. Vertical sidelining on replacement pages indicates the most recent changes (amendment, addition, deletion).

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Amendments/corrigenda issued since publication

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 March 1996

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Amd. No.	Date	Text affected
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	31 May 2010	Implementation of IEC amendment 2:2010 with CENELEC endorsement A2:2010; Indicated by a double line in the margin; BSI and CEN publication dates aligned

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English version

Test procedure for the determination of the temperature index of enamelled winding wires

Méthode d'essai pour la détermination
de l'indice de température des fils de
bobinage émaillés

Prüfverfahren zur Bestimmung
des Temperaturindex von
Lackdrähten

This European Standard was approved by CENELEC on 1994-09-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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CENELEC

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

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

Foreword

The text of the International Standard IEC 172:1987, prepared by IEC TC 55, Winding wires, was approved by CENELEC as HD 41 S3 on 1989-08-01.

This Harmonization Document was submitted to the formal vote for conversion into a European Standard and was approved by CENELEC as EN 60172 on 1994-09-01.

The following date was fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1995-10-15

Annexes designated 'normative' are part of the body of the standard. In this standard, annex ZA is normative. Annex ZA has been added by CENELEC.

Foreword to amendment A1

The text of document 55/615/FDIS, future amendment 1 to IEC 60172:1987, prepared by IEC TC 55, Winding wires, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60172:1994 on 1998-01-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-10-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1998-10-01

Annexes designated 'normative' are part of the body of the standard.

In this standard, annexes A, B and ZA are normative.

Annex ZA has been added by CENELEC.

Foreword to amendment A2

The text of document 55/1140/CDV, future amendment 2 to IEC 60172:1987, prepared by IEC TC 55, Winding wires, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 60172:1994 on 2010-02-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held

responsible for identifying any or all such patent rights.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2010-11-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2013-02-01

Endorsement notice

The text of amendment 2:2010 to the International Standard IEC 60172:1987 was approved by CENELEC as an amendment to the European Standard without any modification.

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TEST PROCEDURE FOR THE DETERMINATION OF THE TEMPERATURE INDEX OF ENAMELLED WINDING WIRES

1. Scope

This test procedure specifies, in accordance with the provisions of IEC 60216-1, a method for evaluating the temperature index of enamelled and of tape wrapped round and rectangular wire. It does not include fibre-insulated wire or wire covered with tapes containing inorganic fibres.

2. Object

This test procedure is to determine the temperature index of enamelled and of tape-wrapped bare or enamelled, round and rectangular wire in air at atmospheric pressure by change in electric strength. The definition of the temperature index is in accordance with IEC 60216-1. The specimen is unvarnished or varnished with an impregnating agent. Testing varnished specimens will also evaluate the compatibility of the wire insulation with an impregnating agent. Thus the temperature indices of different combinations can be compared.

Note—The data obtained according to this test procedure provide the designer and development engineer with information for the selection of winding wire for further evaluation in insulation systems and equipment tests.

3. Definition of terms

Temperature index

The temperature index is a measure of relative thermal life and is the number, which corresponds to the temperature in degrees Celsius (°C) derived from the thermal endurance graph at 20 000 h, as calculated by equation 6 of annex A.

Specimen failure time

The hours at the exposure temperature that have resulted in a specimen failing the proof test (see Sub-clause 8.1).

Time to failure

The hours to failure calculated from the specimen failure times for a set of specimens at one exposure temperature in accordance with Sub-clause 8.2.

4. Summary of procedure

A set of specimens in accordance with Clause 5 is subjected to a testing cycle. This cycle consists of a heat-storing period at a temperature given in Clause 6, followed by a proof voltage test at room temperature in accordance with Clause 7.

This cycle is repeated until a sufficient number of specimens has failed, and the time to failure is calculated in accordance with Clause 8. The test is carried out at three or more temperatures. A regression line is calculated in accordance with Sub-clause 8.4 and the time to failure values plotted on thermal endurance graph paper as a function of the exposure temperature.

The temperature, in degrees Celsius, corresponding to the point of intersection of the regression line with the ordinate of 20 000 h endurance represents the Temperature Index of the winding wire under test.

5. Test specimens

5.1 Preparation

5.1.1 Enamelled round wire with a nominal conductor diameter of 0,224 mm up to and including 2,65 mm

The grade of insulation used for determining the thermal index shall be grade 2 or grade 2B for self-bonding winding wires.

Wire sizes 0,315 mm and 0,28 mm are permitted for use when the specification size range is limited to 0,50 mm and finer.

NOTE For round enamelled winding wires, in order to avoid undue fragility of the test specimen, experience has shown that nominal conductor diameters of 0,800 mm up to and including 2,65 mm are generally found convenient to handle and test.

TABLE I

Force and number of twists for specimens

Nominal diameter mm		Force applied to wire pairs N	Number of twists per 125 mm
Over	Up to and including		
0,224	0,25	0,85	33
0,25	0,35	1,7	23
0,35	0,50	3,4	16
0,50	0,75	7,0	12
0,75	1,05	13,5	8
1,05	1,50	27,0	6
1,50	2,15	54,0	4
2,15	2,65	108,0	3

5.1.2 *Tape wrapped round wire and enamelled or tape wrapped rectangular wire*

Note – Any convenient dimension of round or rectangular wire may be used. However, for case of forming, it is recommended that the dimensions be such that small bending forces can be used to shape the pieces required to prepare the specimen. Wire with high stiffness will yield specimens with poor wire-to-wire contact areas.

- a) Two straight pieces of wire each of 250 mm length shall be cut from the supply spool.
- b) 10 mm and 15 mm of the insulation shall be removed from one end of each piece of wire to provide for electrical connection.
- c) Each piece shall be formed in a jig, as shown in figure 9. This produces a straight centre section of about 150 mm with bent ends, which provide the necessary flare at both ends of the final specimen.
- d) The two formed pieces shall be placed together back-to-back and tightly wrapped with glass yarn over the straight centre section of the specimen, as shown in figure 10.
- e) Prior to testing the specimen shall be proof-tested at 1 000 V a.c.

5.2 *Varnish impregnation*

Experience has shown that insulated wire according to IEC 60317 and impregnating agents according to IEC 60455-3-5 or IEC 60464-3-2 can affect one another during the thermal ageing process. Interaction between wire insulation and such agent may increase or decrease the relative thermal life of this combination compared with the life of the wire tested without impregnation. Therefore, with impregnated specimens, this test procedure may give an indication of thermal endurance of a combination of wire insulation and impregnating agent.

If such impregnation is required, the following procedure shall be applied:

With the specimen in the vertical position, it shall be immersed in the impregnating agent for (60 ± 10) s (see note). It shall be removed slowly and uniformly at a rate of about 1 mm/s. It shall be drained horizontally for 10 min to 15 min and cured horizontally according to the manufacturer's recommendation or to an agreed schedule. If more than one treatment is to be given, immerse, drain and cure the specimen vertically reversing the specimen for each subsequent treatment.

Note – Some impregnation agents, such as high viscosity or thixotropic products may require alternative processing methods.

5.3 *Number of test specimens*

Experience has shown that 20 specimens without impregnation and 10 specimens with impregnation give results with an acceptable tolerance. A minimum of 10 specimens shall be used.

5.4 *Specimen holder*

5.4.1 *For specimens according to 5.1.1*

It has been found that individual handling of the twisted specimens may introduce premature failures. It is, therefore, recommended that the specimens be placed in a suitable holder, as shown in Figure 6. The holder should be designed in a manner that will protect the twisted specimens from external mechanical damage and warpage. The holder will be so constructed as to allow the ends of the twist to protrude from the holder to make electrical connection for the proof testing as shown in Figure 7. The holder shall be designed for at least 10 specimens to decrease handling time.

5.4.2 *For specimens according to 5.1.2*

The specimen shall be hung in the oven. No special holder is required.

6. Temperature exposure

Recommended temperatures to which the test specimens are subjected are given in this clause.

In Table II, the recommended temperature and time of exposure in each cycle are given. A test cycle consists of exposure to a high temperature and testing at room temperature (20 °C to 30 °C). The test specimens shall be placed directly into and removed from the ageing ovens without controlling the heating or cooling rate.

The ovens should be heated to the proper temperature before the specimens are subjected to the exposure temperature.

The specimens should be aged in a forced air circulation oven which is capable of maintaining the temperature of the specimens under test within 2 °C of the selected exposure temperature.

The exposure times are selected to subject the test specimens to approximately 10 cycles at each temperature before the time to failure is reached.

Thermal endurance values obtained from test specimens subjected to an average of less than eight or more than twenty cycles at the exposed temperature may not be reliable and should not be used to predict the temperature rating of the enamelled wire. A shorter or longer cycle time than those given in the table may, therefore, be chosen for certain exposure temperatures, to ensure that the average number of cycles to failure falls within this range.

After the specimens have been subjected to a particular cycle, the time may be appropriately increased or decreased to control the number of cycles required to reach the time to failure.

Test specimens should be exposed to a minimum of three and preferably four exposure temperatures. The lowest temperature, recommended at 20 °C above the desired thermal class, should be one which results in a time frame to failure of more than 5000 h. The highest exposure temperature must have a value of at least 100 h to be considered a valid data point. Exposure temperatures should not be more than 20 °C apart. The accuracy of the temperature index predicted from the results will increase as the exposure temperature approaches the temperature to which the insulation is exposed in service.

