Electrical insulating materials - Thermal endurance properties -- Part 1: Ageing procedures and evaluation of test results

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NATIONAL FOREWORD

See Eesti standard EVS-EN 60216-1:2013 sisaldab Euroopa standardi EN 60216-1:2013 ingliskeelset teksti.	This Estonian standard EVS-EN 60216-1:2013 consists of the English text of the European standard EN 60216-1:2013.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 12.07.2013.	Date of Availability of the European standard is 12.07.2013.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 17.220.99, 29.035.01

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60216-1

July 2013

ICS 17.220.99; 29.035.01

Supersedes EN 60216-1:2001 (partially)

English version

Electrical insulating materials - Thermal endurance properties - Part 1: Ageing procedures and evaluation of test results

(IEC 60216-1:2013)

Matériaux isolants électriques - Propriétés d'endurance thermique - Partie 1: Méthodes de vieillissement et évaluation des résultats d'essai (CEI 60216-1:2013)

Elektroisolierstoffe - Eigenschaften hinsichtlich des thermischen Langzeitverhaltens - Teil 1: Warmlagerungsverfahren und Auswertung von Prüfergebnissen (IEC 60216-1:2013)

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 60216-1:2013 E

Foreword

The text of document 112/235/FDIS, future edition 6 of IEC 60216-1, prepared by IEC/TC 112 "Evaluation and qualification of electrical insulating materials and systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60216-1:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-01-19
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-04-19

This document supersedes EN 60216-1:2001 (PART).

EN 60216-1:2013 includes the following significant changes with respect to EN 60216-1:2001:

This edition constitutes an editorial revision where the simplified method has been removed and now forms Part 8 of the EN 60216 Series: Instructions for calculating thermal endurance characteristics using simplified procedures.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60216-1:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

ISO 291	NOTE	Harmonised as EN ISO 291.
ISO 2578:1993	NOTE	Harmonised as EN ISO 2578:1998 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60212	-	Standard conditions for use prior to and during the testing of solid electrical insulating materials	EN 60212	-
IEC 60216-2	-	Electrical insulating materials - Thermal endurance properties - Part 2: Determination of thermal endurance properties of electrical insulating materials - Choice of test criteria	EN 60216-2	-
IEC 60216-3 + corr. December	2006 2009	Electrical insulating materials - Thermal endurance properties - Part 3: Instructions for calculating thermal endurance characteristics	EN 60216-3	2006
IEC 60216-4	Series	Electrical insulating materials - Thermal endurance properties	EN 60216-4	Series
IEC 60216-4-1	-	Electrical insulating materials - Thermal endurance properties - Part 4-1: Ageing ovens - Single-chamber ovens	EN 60216-4-1	-
IEC 60216-8	2013	Electrical insulating materials - Thermal endurance properties - Part 8: Instructions for calculating thermal endurance characteristics using simplified procedures	EN 60216-8	2013
IEC 60493-1	2011	Guide for the statistical analysis of ageing test data - Part 1: Methods based on mean values of normally distributed test results	-	-

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INTRODUCTION

The listing of the thermal capabilities of electrical insulating materials, based on service experience, was found to be impractical, owing to the rapid development of polymer and insulation technologies and the long time necessary to acquire appropriate service experience. Accelerated ageing and test procedures were therefore required to obtain the necessary information. The IEC 60216 series has been developed to formalize these procedures and the interpretation of their results.

Physico-chemical models postulated for the ageing processes led to the almost universal assumption of the Arrhenius equations to describe the rate of ageing. Out of this arose the concept of the temperature index (TI) as a single-point characteristic based upon accelerated ageing data. This is the numerical value of the temperature in °C at which the time taken for deterioration of a selected property to reach an accepted end-point is that specified (usually 20 000 h).

NOTE The term Arrhenius is widely used (and understood) to indicate a linear relationship between the logarithm of a time and the reciprocal of the thermodynamic (absolute or Kelvin) temperature. The correct usage is restricted to such a relationship between a reaction rate constant and the thermodynamic temperature. The common usage is employed throughout this standard.

The large statistical scatter of test data which was found, together with the frequent occurrence of substantial deviations from the ideal behavior, demonstrated the need for tests to assess the validity of the basic physico-chemical model. The application of conventional statistical tests, as set out in IEC 60493-1, fulfilled this requirement, resulting in the "confidence limit", (TC) of TI, but the simple, single-point TI was found inadequate to describe the capabilities of materials. This led to the concept of the "Thermal Endurance Profile" (TEP), incorporating the temperature index, its variation with specified ageing time, and a confidence limit.

A complicating factor is that the properties of a material subjected to thermal ageing may not all deteriorate at the same rate, and different end-points may be relevant for different applications. Consequently, a material may be assigned more than one temperature index, derived, for example, from the measurement of different properties and the use of different end-point times.

It was subsequently found that the statistical confidence index included in the TEP was not widely understood or used. However, the statistical tests were considered essential, particularly after minor modifications to make them relate better to practical circumstances: the concept of the halving interval (HIC) was introduced to indicate the rate of change of ageing time with temperature. TEP was then abandoned, with the TI and HIC being reported in a way which indicated whether or not the statistical tests had been fully satisfied. At the same time, the calculation procedures were made more comprehensive, enabling full statistical testing of data obtained using a diagnostic property of any type, including the particular case of partially incomplete data. Simultaneously with the development of the IEC 60216 series, other standards were being developed in ISO, intended to satisfy a similar requirement for plastics and rubber materials. These are ISO 2578 and ISO 11346 respectively, which use less rigorous statistical procedures and more restricted experimental techniques. A simplified calculation procedure is described in IEC 60216-8.

ELECTRICAL INSULATING MATERIALS – THERMAL ENDURANCE PROPERTIES –

Part 1: Ageing procedures and evaluation of test results

1 Scope

This part of IEC 60216 specifies the general ageing conditions and procedures to be used for deriving thermal endurance characteristics and gives guidance in using the detailed instructions and guidelines in the other parts of the standard.

Although originally developed for use with electrical insulating materials and simple combinations of such materials, the procedures are considered to be of more general applicability and are widely used in the assessment of materials not intended for use as electrical insulation.

In the application of this standard, it is assumed that a practically linear relationship exists between the logarithm of the time required to cause the predetermined property change and the reciprocal of the corresponding absolute temperature (Arrhenius relationship).

For the valid application of the standard, no transition, in particular no first-order transition should occur in the temperature range under study.

Throughout the rest of this standard the term "insulating materials" is always taken to mean "insulating materials and simple combinations of such materials".

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-3:2006, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60216-4 (all Parts 4), *Electrical insulating materials – Thermal endurance properties – Part 4: Ageing ovens*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

IEC 60216-8, *Electrical insulating materials – Thermal endurance properties – Part 8: Instructions for calculating thermal endurance characteristics using simplified procedures*[1]

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1 To be published.

IEC 60493-1:2011, *Guide for the statistical analysis of ageing test data – Part 1: Methods based on mean values of normally distributed test results*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1.1
temperature index
TI
numerical value of the temperature in degrees Celsius derived from the thermal endurance relationship at a time of 20 000 h (or other specified time)

3.1.2
halving interval
HIC
numerical value of the temperature interval in Kelvin which expresses the halving of the time to end-point taken at the temperature equal to TI

[SOURCE: IEC 60050-212:2010, definition 212-12-13, modified – "equal to TI" replaces "corresponding to the temperature index or the relative temperature index"]

3.1.3
thermal endurance graph
graph in which the logarithm of the time to reach a specified end-point in a thermal endurance test is plotted against the reciprocal thermodynamic (absolute) test temperature

[SOURCE: IEC 60050-212:2010, definition 212-12-10, modified – "insertion of word "(absolute)"]

3.1.4
thermal endurance graph paper
graph paper having a logarithmic time scale as the ordinate, graduated in powers of ten (from 10 h to 100 000 h is often a convenient range)

Note 1 to entry: Values of the abscissa are proportional to the reciprocal of the thermodynamic (absolute) temperature. The abscissa is usually graduated in a non-linear (Celsius) temperature scale oriented with temperature increasing from left to right.

3.1.5
ordered data
set of data arranged in sequence so that, in the appropriate direction through the sequence, each member is greater than, or equal to, its predecessor

Note 1 to entry: Ascending order in this standard implies that the data is ordered in this way, the first order-statistic being the smallest.

3.1.6
order-statistics
each individual value in a set of ordered data is referred to as an order-statistics identified by its numerical position in the sequence

3.1.7
incomplete data
ordered data, where the values above and/or below defined points are not known