
Electrical insulating materials - Thermal endurance properties - Part 3: Instructions for calculating thermal endurance characteristics (IEC 60216-3:2002)

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EUROPEAN STANDARD

EN 60216-3

NORME EUROPÉENNE

EUROPÄISCHE NORM

April 2002

ICS 17.220.99;19.020;29.035.01

Supersedes HD 611.3.1 S1:1992 & EN 60216-3-2:1995

English version

**Electrical insulating materials -
Thermal endurance properties
Part 3: Instructions for calculating
thermal endurance characteristics
(IEC 60216-3:2002)**

Matériaux isolants électriques -
Propriétés d'endurance thermique
Partie 3: Instructions pour le calcul
des caractéristiques d'endurance thermique
(CEI 60216-3:2002)

Elektroisolierstoffe -
Eigenschaften hinsichtlich
des thermischen Langzeitverhaltens
Teil 3: Anweisungen zur Berechnung
thermischer Langzeitkennwerte
(IEC 60216-3:2002)

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This European Standard was approved by CENELEC on 2002-03-01. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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 Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

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

Foreword

The text of document 15E/162/FDIS, future edition 1 of IEC 60216-3, prepared by SC 15E, Methods of test, of IEC TC 15, Insulating materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60216-3 on 2002-03-01.

This European Standard supersedes HD 611.3.1 S1:1992 and EN 60216-3-2:1995.

The following dates were 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) 2002-12-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2005-03-01

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

Annexes designated "informative" are given for information only.

In this standard, annexes A, B and ZA are normative and annexes C, D and E are informative.

Annex ZA has been added by CENELEC.

A computer-readable medium (diskette or CD-ROM) containing the computer programme given in Annex E is an integral part of the national implementation of this European Standard.

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Endorsement notice

The text of the International Standard IEC 60216-3:2002 was approved by CENELEC as a European Standard without any modification.

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard 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 this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60216-1	2001	Electrical insulating materials - Properties of thermal endurance Part 1: Ageing procedures and evaluation of test results	EN 60216-1	2001
IEC 60216-2	1990	Part 2: Choice of test criteria	HD 611.2 S1	1992
IEC 60493-1	1974	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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**NORME
INTERNATIONALE
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**CEI
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60216-3

Première édition
First edition
2002-02

**Matériaux isolants électriques –
Propriétés d'endurance thermique –**

**Partie 3:
Instructions pour le calcul des caractéristiques
d'endurance thermique**

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**Electrical insulating materials –
Thermal endurance properties–**

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**Part 3:
Instructions for calculating thermal
endurance characteristics**

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL INSULATING MATERIALS –
THERMAL ENDURANCE PROPERTIES –****Part 3: Instructions for calculating
thermal endurance characteristics**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60216-3 has been prepared by subcommittee 15E, Methods of test, of IEC technical committee 15: Insulating materials.

This first edition cancels and replaces the third edition of IEC 60216-3-1 published in 1990 and the first edition of IEC 60216-3-2 published in 1993. It constitutes a technical revision of the cancelled and replaced editions.

The text of this standard is based on the following documents:

FDIS	Report on voting
15E/162/FDIS	15E/170/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next revision.

Annexes A and B form an integral part of this standard.

Annexes C, D and E are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A diskette containing the computer programme given in Annex E is affixed to the back cover of this publication.

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INTRODUCTION

IEC 60216-3 series of publications was previously conceived as having four sections. Two of these have been published, i.e. IEC 60216-3-1 and IEC 60216-3-2. The remaining two sections were under consideration. Of these, section 4 is not now required, since the relative temperature index is no longer included in the thermal endurance characteristics. This part of IEC 60216 is now combining the three sections into one standard, with substantial elimination of replicated matter.

At the same time, the scope has been extended to cover a greater range of data characteristics, particularly with regard to incomplete data, as often obtained from proof test criteria. The greater flexibility of use should lead to more efficient employment of the time available for ageing purposes.

Some minor errors in mathematical usage have also been eliminated.

The procedures specified in this part of IEC 60216 have been extensively tested and have been used to calculate results from a large body of experimental data obtained in accordance with other parts of the standard.

IEC 60216, which deals with the determination of thermal endurance properties of electrical insulating materials, is composed of several parts:

- Part 1: Ageing procedures and evaluation of test results
- Part 2: Choice of test criteria
- Part 3: Instruction for calculating thermal endurance characteristics
- Part 4-1: Ageing ovens – Section 1 Single-chamber ovens
- Part 4-2: Ageing ovens – Precision ovens for use up to 300 °C
- Part 4-3: Ageing ovens – Multi-chamber ovens
- Part 5: Guidelines for the application of thermal endurance characteristics

NOTE This series may be extended. For revisions and new parts, see the current catalogue of IEC publications for an up-to-date list.

ELECTRICAL INSULATING MATERIALS – THERMAL ENDURANCE PROPERTIES –

Part 3: Instructions for calculating thermal endurance characteristics

1 Scope

This part of IEC 60216 specifies the calculation procedures to be used for deriving thermal endurance characteristics from experimental data obtained in accordance with the instructions of IEC 60216-1 and IEC 60216-2.

The experimental data may be obtained using non-destructive, destructive or proof tests. Data obtained from non-destructive or proof tests may be incomplete, in that measurement of times taken to reach the endpoint may have been terminated at some point after the median time but before all specimens have reached end-point.

The procedures are illustrated by worked examples, and suitable computer programs are recommended to facilitate the calculations.

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2 Normative references **(standards.iteh.ai)**

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60216. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60216 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60216-1:2001, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2:1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 2: Choice of test criteria*

IEC 60493-1:1974, *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 abbreviated terms

3.1 Terms and definitions

For the purposes of this part of IEC 60216, the following definitions apply:

3.1.1

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 In this standard ascending order in this standard implies that the data is ordered in this way, the first being the smallest.

3.1.2

order-statistics

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

3.1.3

incomplete data

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

3.1.4

censored data

incomplete data, where the number of unknown values is known. If the censoring is begun above/below a specified numerical value, the censoring is Type 1. If above/below a specified order-statistic it is Type 2

NOTE This standard is concerned only with Type 2.

3.1.5

degrees of freedom

number of data values minus the number of parameter values

3.1.6

variance of a data set

sum of the squares of the deviations of the data from a reference level defined by one or more parameters, for example a mean value (one parameter) or a line (two parameters, slope and intercept), divided by the number of degrees of freedom

3.1.7

central second moment of a data set

sum of the squares of the differences between the data values and the value of the group mean, divided by the number of data in the group

3.1.8

covariance of data sets

for two sets of data with equal numbers of elements where each element in one set corresponds to one in the other, the sum of the products of the deviations of the corresponding members from their set means, divided by the number of degrees of freedom

3.1.9**regression analysis**

process of deducing the best-fit line expressing the relation of corresponding members of two data groups by minimizing the sum of squares of deviations of members of one of the groups from the line

NOTE The parameters are referred to as the regression coefficients.

3.1.10**correlation coefficient**

number expressing the completeness of the relation between members of two data sets, equal to the covariance divided by the square root of the product of the variances of the sets

NOTE The value of its square is between 0 (no correlation) and 1 (complete correlation).

3.1.11**end-point line**

line parallel to the time axis intercepting the property axis at the end-point value

3.2 Symbols and abbreviated terms

		Clause
a	Regression coefficient (y -intercept)	4.3, 6.2
a_p	Regression coefficient for destructive test calculations	6.1
b	Regression coefficient (slope)	4.3, 6.2
b_p	Regression coefficient for destructive test calculations	6.1
b_r	Intermediate constant (calculation of \bar{X}_c)	6.3
c	Intermediate constant (calculation of χ^2)	6.3
f	Number of degrees of freedom	Tables C.2, C.3
F	Fisher distributed stochastic variable	4.2, 6.1, 6.3
F_0	Tabulated value of F (linearity of thermal endurance graph)	4.4, 6.3
F_1	Tabulated value of F (linearity of property graph – significance 0,05)	6.1
F_2	Tabulated value of F (linearity of property graph – significance 0,005)	6.1
g	Order number of ageing time for destructive tests	6.1
h	Order number of property value for destructive tests	6.1
HIC	Halving interval at temperature equal to T_I	4.3, 7
HIC_g	Halving interval corresponding to T_{I_g}	7.3
i	Order number of exposure temperature	4.1, 6.2
j	Order number of time to end-point	4.1, 6.2
k	Number of ageing temperatures	4.1, 6.2
m_i	Number of specimens aged at temperature ϑ_i	4.1, 6.1
N	Total number of times to end-point	6.2
n_g	Number of property values in group aged for time τ_g	6.1
n_i	Number of values of y at temperature ϑ_i	4.1, 6.1