
Guide for the determination of thermal endurance properties of electrical insulating materials - Part 3: Instructions for calculating thermal endurance characteristics - Section 2: Calculations for incomplete data: proof test results up to and including the median time to end-point (equal test groups) (IEC 60216-3-2:1993)

Guide for the determination of thermal endurance properties of electrical insulating materials -- Part 3: Instructions for calculating thermal endurance characteristics -- Section 2: Calculations for incomplete data: proof test results up to and including the median time to end-point (equal test groups)

Leitlinie zur Bestimmung thermischer Langzeiteigenschaften von Elektroisolierstoffen -- Teil 3: Vorschriften zur Berechnung thermischer Langzeitkennwerte -- Hauptabschnitt 2: Berechnung für unvollständige Schwellwertprüfergebnisse bis zu und einschließlich des Median für die Ausfallzeit (gleiche Prüfgruppen)

Guide pour la détermination des propriétés d'endurance thermique de matériaux isolants électriques -- Partie 3: Instructions pour le calcul des caractéristiques d'endurance thermique -- Section 2: Calculs applicables aux résultats incomplets: résultats des essais d'épreuve de durée inférieure ou égale au temps médian pour atteindre le point limite (groupes d'essai égaux)

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EUROPEAN STANDARD
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EN 60216-3-2

April 1995

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Descriptors: Insulating material, heating resistance test, thermal endurance test, statistical analysis, computing, flow diagram, test results

English version

**Guide for the determination of thermal endurance properties
of electrical insulating materials
Part 3: Instructions for calculating thermal endurance characteristics
Section 2: Calculations for incomplete data: proof test results up to
and including the median time to end-point (equal test groups)
(IEC 216-3-2:1993)**

Guide pour la détermination des propriétés
d'endurance thermique de matériaux
isolants électriques

Partie 3: Instructions pour le calcul des
caractéristiques d'endurance thermique
Section 2: Calculs applicables aux résultats
incomplets: résultats des essais d'épreuve
de durée inférieure ou égale au temps
médián pour atteindre le point limite
(groupes d'essai égaux)
(CEI 216-3-2:1993)

Leitlinie zur Bestimmung der thermischen
Langzeiteigenschaften von
Elektroisolerstoffen

Teil 3: Vorschriften zur Berechnung der
thermischen Langzeitkennwerte
Hauptabschnitt 3: Berechnung für
unvollständige Schwellwertprüfergebnisse
bis zu und einschließlich des Median für die
Ausfallzeit (gleiche Prüfgruppen)
(IEC 216-3-2:1993)

This European Standard was approved by CENELEC on 1995-03-06. 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, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, 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 the International Standard IEC 216-3-2:1993, prepared by SC 15B, Endurance tests, of IEC TC 15, Insulating materials, was submitted to the formal vote and was approved by CENELEC as EN 60216-3-2 on 1995-03-06 without any modification.

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) 1996-03-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1996-03-01

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

Annexes designated "informative" are given for information only.

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

Annex ZA has been added by CENELEC.

Endorsement notice

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The text of the International Standard IEC 216-3-2:1993 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 216-1	1990	Guide for the determination of thermal endurance properties of electrical insulating materials Part 1: General guidelines for ageing procedures and evaluation of test results	HD 611.1 S1	1992
IEC 216-2	1990	Part 2: Choice of test criteria	HD 611.2 S1	1992
IEC 216-3-1	1990	Part 3: Instructions for calculating thermal endurance characteristics Section 1: Calculations using mean values of normally distributed complete data	HD 611.3.1 S1	1992
IEC 216-5	1990	Part 5: Guidelines for the application of thermal endurance characteristics	HD 611.5 S1	1992
IEC 493-1	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
INTERNATIONAL
STANDARD**

**CEI
IEC
216-3-2**

Première édition
First edition
1993-09

**Guide pour la détermination des propriétés
d'endurance thermique de matériaux isolants
électriques**

Troisième partie:

Instructions pour le calcul des caractéristiques
d'endurance thermique

Section 2 - Calculs applicables aux résultats

incomplets: résultats des essais d'épreuve

de durée inférieure ou égale au temps

médian pour atteindre le point limite

(groupes d'essai égaux)

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**Guide for the determination of thermal
endurance properties of electrical insulating
materials**

Part 3:

Instructions for calculating thermal endurance
characteristics

Section 2 - Calculations for incomplete data:

proof test results up to and including the

median time to end-point (equal test groups)

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International Electrotechnical Commission
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CONTENTS

	Page
FOREWORD.....	5
INTRODUCTION.....	9
Clause	
1 Scope and object.....	11
2 Calculation principles.....	11
3 Instructions for deriving thermal endurance characteristics.....	17
4 References.....	31
APPENDIX A – List of symbols.....	35
APPENDIX B – Worked example.....	39
APPENDIX C – Fractiles of the χ^2 , t and F distributions.....	47
APPENDIX D – BASIC program for incomplete data.....	48
APPENDIX E – Coefficients for estimation of group means, variances and variance of means for incomplete data.....	57
APPENDIX F – Single and multiple times to end-point within first cycle.....	59

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**GUIDE FOR THE DETERMINATION OF THERMAL
ENDURANCE PROPERTIES OF ELECTRICAL INSULATING
MATERIALS**

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

**Section 2 - Calculations for incomplete data: proof test results
up to and including the median time to end-point
(equal test groups)**

FOREWORD

- 1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
- 3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by Sub-Committee 15B: Endurance tests, of IEC Technical Committee No. 15: Insulating materials.

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

DIS	Report on Voting
15B(CO)82	15B(CO)88

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

The following IEC publications are quoted in this standard:

Publication Nos. 216: Guide for the determination of thermal endurance properties of electrical insulating materials

216-1 (1990): Part 1: General guidelines for ageing procedures and evaluation of test results.

216-2 (1990): Part 2: Choice of test criteria.

216-3-1 (1990): Part 3: Instructions for calculating thermal endurance characteristics.
Section 1 - Calculations using mean values of normally distributed complete data.

216-5 (1990): Guidelines the for the application of thermal endurance characteristics.

493: Guide for the statistical analysis of ageing test data.

493-1 (1974): Part 1: Methods based on mean values of normally distributed test results.

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GUIDE FOR THE DETERMINATION OF THERMAL ENDURANCE PROPERTIES OF ELECTRICAL INSULATING MATERIALS

Part 3: Instructions for calculating thermal endurance characteristics

Section 2 - Calculations for incomplete data: proof test results up to and including the median time to end-point (equal test groups)

INTRODUCTION

IEC Publication 216: Guide for the determination of thermal endurance properties of electrical insulating materials, is composed of several parts:

- Part 1: General guidelines for ageing procedures and evaluation of test results (IEC Publication 216-1).
- Part 2: Choice of test criteria (IEC Publication 216-2).
- Part 3: Instructions for calculating thermal endurance characteristics (IEC Publication 216-3).
- Part 4: Ageing ovens (IEC Publication 216-4).
- Part 5: Guidelines for the application of thermal endurance characteristics (IEC Publication 216-5).

This part consists of several sections based upon mean values of normally distributed test results. Further sections may be added to take account of other statistical procedures, for example extreme value statistics for those cases where mean value treatments are inadequate. However, there is at present insufficient experience to enable these methods to be used in thermal endurance standards.

This is Section 2. It consists exclusively of calculation instructions. The relevant statistical theory will be found in the appropriate part of IEC Publication 493, or in the references given.

A new Part 3 is in preparation combining and further developing the present Sections 1 and 2 together with the draft of a separate Section: Calculation procedures for normally distributed results from destructive test procedures.

1 Scope and object

This part of IEC Publication 216 gives instructions for calculation of thermal endurance characteristics from data obtained in accordance with IEC Publications 216-1 and 216-2.

Section 1 gives the main sequence calculation scheme for complete normally distributed data, in accordance with the statistical principles set out in IEC Publication 493-1, to which reference should be made for the mathematical background details.

Section 3 gives the calculation sequence for incomplete test results from groups of equal magnitude, where results are available up to and including the median time to end-point.

A worked example, a computer program written in "BASIC" and appropriate statistical tables are given in the appendices.

2 Calculation principles

2.1 Statistical principles

The calculation procedures and instructions given in Clause 3 are based upon the principles and assumptions set out in IEC Publication 493-1. The assumptions made may be expressed in simple form as follows (see IEC publication 493-1, sub-clause 3.7.1):

- 1) The relation between the mean of the logarithms of the times taken to reach a given end-point ("time to end-point") and the reciprocal thermodynamic (absolute) ageing temperature is linear.
- 2) The values of the deviations of the logarithms of the times to end-point from this linear relation are normally distributed with a variance which is independent of the ageing temperature.

Where the available data are incomplete, in that times to end-point above the median value of each group are not determined, unbiased estimates of the mean and variance of the logarithm of time to end-point within each group, and of the variance of the mean may be determined by a simple algebraic method (see reference in Clause 4).

These estimates are used in a fashion similar to that used for the estimates of mean and variance in Section 1 of this part of Publication 216.

The best estimates of the coefficients of the linear relationship are obtained by the method of least squares, and the confidence limits associated with an estimate using this linear relationship are obtained using the methods of generalized regression analysis.

2.2 Data for analysis

The experimental data are obtained as values of temperature (ϑ °C) and time to end-point (t hours). Each value is transformed to an x or y value:

$x_i = 1 / (\vartheta_i + 273)$ value (i) of reciprocal thermodynamic (absolute) temperature.

$y_{ij} = \log(t_{ij})^*$ log of value (j) of time in i'th ageing group (i)

n = number of specimens in each group

k = number of groups (= number of exposure temperatures)

The individual value of t_{ij} is taken as the mid-point of the last proof test cycle before the end point is reached.

Values are included in the calculation up to the m 'th time to end-point, t_{im}

$$m = (n + 1)/2 \quad \text{if } n \text{ is odd}$$

or

$$m = n/2 + 1 \quad \text{if } n \text{ is even}$$

2.3 Restrictions

- a) The initial numbers of specimens in all groups shall be equal and not less than 11.
- b) Testing in each group shall be continued until the median time to end-point is reached.
- c) The cycle time for each group shall be chosen so that the median time to end-point is reached not earlier than the eighth cycle and preferably not later than the twelfth.
- d) A time to end-point within the first cycle cannot be treated by any known mathematical procedure, and shall be treated as invalid.

Either:

- i) start again with a new group of specimens;
- ii) adopt the procedure of Appendix F as the mathematical inaccuracy introduced by this procedure will be small.

If the end-point is reached for more than one specimen during the first cycle, it is necessary to discard the group and test a further group, paying particular attention to any critical points of experimental technique.

* In principle, calculations may be made using natural (base e) or Briggsian (base 10) logarithms, as long as the choice is consistent throughout. For this reason, the symbol $\log(y)$ is used throughout, except in Sub-clause 3.1.5.

In order to enable some intermediate results to be comparable with those of the second edition of Publications 216-3 (1980) and 216-4 (1980), the computer program (Appendix D) uses logarithms to base 10.