

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Electric strength of insulating materials – Test methods –  
Part 1: Tests at power frequencies**

**Rigidité diélectrique des matériaux isolants – Méthodes d'essai –  
Partie 1: Essais aux fréquences industrielles**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2013 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### Useful links:

IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,...).

It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

---

### A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Liens utiles:

Recherche de publications CEI - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,...).

Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).



IEC 60243-1

Edition 3.0 2013-03

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Electric strength of insulating materials – Test methods –  
Part 1: Tests at power frequencies**

**Rigidité diélectrique des matériaux isolants – Méthodes d'essai –  
Partie 1: Essais aux fréquences industrielles**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

ICS 17.220.99; 29.035.01

ISBN 978-2-83220-696-6

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references .....	6
3 Terms and definitions .....	7
4 Significance of the test .....	7
5 Electrodes and specimens.....	8
5.1 General.....	8
5.2 Tests perpendicular to the surface of non-laminated materials and normal to laminate of laminated materials .....	8
5.2.1 Boards and sheet materials, including pressboards, papers, fabrics and films.....	8
5.2.2 Tapes, films and narrow strips .....	9
5.2.3 Flexible tubing and sleeving .....	9
5.2.4 Rigid tubes (having an internal diameter up to and including 100 mm).....	9
5.2.5 Tubes and hollow cylinders (having an internal diameter greater than 100 mm).....	10
5.2.6 Cast and moulded materials .....	10
5.2.7 Shaped solid pieces .....	11
5.2.8 Varnishes .....	11
5.2.9 Filling compounds.....	11
5.3 Tests parallel to the surface of non-laminated materials and parallel to the laminate of laminated materials .....	11
5.3.1 General .....	11
5.3.2 Parallel plate electrodes .....	11
5.3.3 Taper pin electrodes.....	12
5.3.4 Parallel cylindrical electrodes .....	12
5.4 Test specimens .....	12
5.5 Distance between electrodes.....	12
6 Conditioning before tests .....	13
7 Surrounding medium .....	13
7.1 General.....	13
7.2 Tests in air at elevated temperature .....	13
7.3 Tests in liquids .....	13
7.4 Tests in solid materials.....	14
8 Electrical apparatus.....	14
8.1 Voltage source .....	14
8.2 Voltage measurement.....	14
9 Procedure.....	15
10 Mode of increase of voltage.....	15
10.1 Short-time (rapid-rise) test.....	15
10.2 20 s step-by-step test.....	16
10.3 Slow rate-of-rise test (120 s... 240 s).....	16
10.4 60 s step-by-step test.....	17
10.5 Very slow rate-of-rise test (300 s... 600 s) .....	17
10.6 Proof tests.....	17
11 Criterion of breakdown .....	17
12 Number of tests .....	18

13 Report .....	18
Annex A (informative) Treatment of experimental data .....	25
Bibliography .....	26
Figure 1 – Electrode arrangements for tests on boards and sheets perpendicular to the surface .....	19
Figure 2 – Typical example of electrode arrangement for tests on tapes perpendicular to the surface (see 5.2.2) .....	20
Figure 3 – Electrode arrangement for tests perpendicular to the surface on tubes and cylinders with internal diameter greater than 100 mm .....	20
Figure 4 – Electrode arrangement for tests on casting and moulding materials (diameter of the spherical electrodes: $d = (20 \pm 0,1)$ mm) .....	21
Figure 5 – Electrode arrangement for test on shaped insulating parts (see 5.2.7) .....	21
Figure 6 – Electrode arrangement for tests parallel to the surface (and along the laminae, if present) .....	22
Figure 7 – Electrode arrangement for tests parallel to the surface (and along the laminae if present) .....	23
Figure 8 – Arrangement for tests parallel to the laminae for boards more than 15 mm thick with parallel cylindrical electrodes (see 5.3.4) .....	24
Table 1 – Increments of voltage increase (kilovolts, peak / $\sqrt{2}$ ) .....	16

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**ELECTRIC STRENGTH OF INSULATING MATERIALS –  
TEST METHODS –**
**Part 1: Tests at power frequencies**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60243-1 has been prepared by technical committee 112: Evaluation and qualification of electrical insulating materials and systems.

This third edition cancels and replaces the second edition, published in 1998, and constitutes a technical revision.

The significant technical change with respect to the previous edition is that the current version now includes an option for testing elastomeric materials.

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

FDIS	Report on voting
112/237/FDIS	112/248/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 2.

A list of all the parts in the IEC 60243 series, published under the general title *Electric strength of insulating materials – Test methods*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

This document is a preview generated by EVS

# ELECTRIC STRENGTH OF INSULATING MATERIALS – TEST METHODS –

## Part 1: Tests at power frequencies

### 1 Scope

This part of IEC 60243 provides test methods for the determination of short-time electric strength of solid insulating materials at power frequencies between 48 Hz and 62 Hz.

This standard does not cover the testing of liquids and gases, although these are specified and used as impregnates or surrounding media for the solid insulating materials being tested.

NOTE Methods for the determination of breakdown voltages along the surfaces of solid insulating materials are included.

### 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 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60455-2, *Specification for solventless polymerizable resinous compounds used for electrical insulation – Part 2: Methods of test*

IEC 60464-2, *Varnishes used for electrical insulation – Part 2: Methods of test*

IEC 60684-2, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60836, *Specifications for unused silicone insulating liquids for electrotechnical purposes*

IEC 61099, *Insulating liquids – Specifications for unused synthetic organic esters for electrical purposes*

ISO 293, *Plastics – Compression moulding of test specimens of thermoplastic materials*

ISO 294-1, *Plastics – Injection moulding of test specimens of thermoplastic materials – Part 1: General principles, and moulding of multipurpose and bar test specimens*

ISO 294-3, *Plastics – Injection moulding of test specimens of thermoplastic materials – Part 3: Small plates*

ISO 295, *Plastics – Compression moulding of test specimens of thermosetting materials*

ISO 10724 (all parts), *Plastics – Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs)*

### 3 Terms and definitions

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

#### 3.1

##### **electric breakdown**

severe loss of the insulating properties of test specimens while exposed to electric stress, which causes the current in the test circuit to operate an appropriate circuit-breaker

Note 1 to entry: Breakdown is often caused by partial discharges in the gas or liquid medium surrounding the test specimen and the electrodes which puncture the specimen beyond the periphery of the smaller electrode (or of both electrodes, if of equal diameter).

#### 3.2

##### **flashover**

loss of the insulating properties of the gas or liquid medium surrounding a test specimen and electrodes while exposed to electric stress, which causes the current in the test circuit to operate an appropriate circuit-breaker

Note 1 to entry: The presence of carbonized channels or punctures through the specimen distinguishes tests where breakdown occurred, from others where flashover occurred.

#### 3.3

##### **breakdown voltage**

##### **3.3.1**

< tests with continuously rising voltage > voltage at which a specimen suffers breakdown under the prescribed test conditions

##### **3.3.2**

< step-by-step tests > highest voltage which a specimen withstands without breakdown for the duration of the time at that voltage level

#### 3.4

##### **electric strength**

quotient of the breakdown voltage and the distance between the electrodes between which the voltage is applied under the prescribed test conditions

Note 1 to entry: The distance between the test electrodes is determined as specified in 5.5, unless otherwise specified.

### 4 Significance of the test

Electric strength test results obtained in accordance with this standard are useful for detecting changes or deviations from normal characteristics resulting from processing variables, ageing conditions or other manufacturing or environmental situations. However, they are not intended for use in evaluating the behaviour of insulating materials in an actual application.

Measured values of the electric strength of a material may be affected by many factors, including:

a) Condition of test specimens

- 1) the thickness and homogeneity of the specimen and the presence of mechanical strain;
- 2) previous conditioning of the specimens, in particular drying and impregnation procedures;