

Electrical strength of insulating materials — Test methods —

Part 1: Tests at power frequencies

The European Standard EN 60243-1:1998 has the status of a
British Standard

ICS 17.220.99; 29.035.01

National foreword

This British Standard is the English language version of EN 60243-1:1998. It is identical with IEC 60243-1:1998. It supersedes BS 2918-1:1994 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/15, Insulating materials, to Subcommittee GEL/15/5, Methods of test, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

From 1 January 1997, all IEC publications have the number 60 000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 18 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Contents

	Page
National foreword	Inside front cover
Foreword	2
Text of EN 60243-1	3

English version

Electrical strength of insulating materials — Test methods Part 1: Tests at power frequencies

(IEC 60243-1:1998)

Rigidité diélectrique des matériaux isolants —
Méthodes d'essai
Partie 1: Essais aux fréquences industrielles
(CEI 60243-1:1998)

Elektrische Durchschlagfestigkeit von
isolierenden Werkstoffen — Prüfverfahren
Teil 1: Prüfungen bei technischen Frequenzen
(IEC 60243-1:1998)

This European Standard was approved by CENELEC on 1998-01-01. 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, 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/86/FDIS, future edition 2 of IEC 60243-1, 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 60243-1 on 1998-01-01.

This European Standard supersedes HD 559.1 S1:1991.

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) 1998-10-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-10-01

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information only. In this standard, Annex ZA is normative and Annex A is informative. Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60243-1:1998 was approved by CENELEC as a European Standard without any modification.

Contents

	Page
Introduction	3
1 General	3
2 Definitions	3
3 Significance of the test	4
4 Electrodes and specimens	4
5 Conditioning before tests	7
6 Surrounding medium	7
7 Electrical apparatus	8
8 Procedure	8
9 Mode of increase of voltage	9
10 Criterion of breakdown	10
11 Number of tests	10
12 Report	10
Annex A (informative) Treatment of experimental data	17
Annex ZA (normative) Normative references to international publications with their corresponding European publications	18
Figure 1 — Electrode arrangements for tests on boards and sheets perpendicularly to the surface	11
Figure 2 — Typical example of electrode arrangement for tests on tapes perpendicularly to the surface	12
Figure 3 — Electrode arrangement for tests perpendicularly to the surface on tubes and cylinders with internal diameter greater than 100 mm	13
Figure 4 — Electrode arrangement for tests on casting and moulding materials (diameter of the spherical electrodes: $d = 20$ mm)	13
Figure 5 — Electrode arrangement for test on shaped insulating parts	14
Figure 6 — Electrode arrangement for tests parallel to the surface (and along the laminae, if present)	14
Figure 7 — Electrode arrangement for tests parallel to the surface (and along the laminae if present)	15
Figure 8 — Arrangement for tests parallel to the laminae for boards more than 15 mm thick with parallel cylindrical electrodes	16
Table 1 — Increments of voltage increase (kilovolts, peak/ $\sqrt{2}$)	9

Introduction

This International Standard is one of a series which deals with tests for electric strength of solid insulating materials. The series consists of three parts under the general title: *Electric strength of insulating materials — Test methods —*

— *Part 1: Tests at power frequencies (IEC 60243-1);*

— *Part 2: Additional requirements for tests using direct voltage (IEC 60243-2);*

— *Part 3: Additional requirements for impulse tests (IEC 60243-3).*

1. General

1.1 Scope

This part of IEC 60243 gives methods of test for the determination of the short-time electric strength of solid insulating materials at power frequencies, that is, those between 48 Hz and 62 Hz. It does not consider the testing of liquids and gases, although these are specified and used as impregnants 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.

1.2 Normative references

The following normative documents contain provisions which, through reference in the text, constitute provisions of this part of IEC 60243. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60243 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently available International Standards.

IEC 60212:1971, *Standard conditions for use prior to and during the testing of solid electrical insulating materials.*

IEC 60296:1982, *Specification for unused mineral insulating oils for transformers and switchgears.*

IEC 60455-2:1977, *Specification for solventless polymerizable resinous compounds used for electrical insulation — Part 2: Methods of test.*

IEC 60464-2:1974, *Specification for insulating varnishes containing solvent — Part 2: Test methods.*

IEC 60674-2, *Specification for plastic films for electrical purposes — Part 2: Methods of test.*

IEC 60684-2 –, *Specification for flexible insulating sleeving — Part 2: Methods of test*¹⁾.

ISO 293:1986, *Plastics — Compression moulding of test specimens of thermoplastic materials.*

ISO 294-1:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens.*

ISO 294-3:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 3: Small plates.*

ISO 295:1991, *Plastics — Compression moulding of test specimens of thermosetting materials.*

ISO 10724:1994, *Plastics — Thermosetting moulding materials — Injection moulding of multipurpose test specimens.*

2 Definitions

For the purpose of this standard, the following definitions apply:

2.1

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 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).

2.2

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

2.3 breakdown voltage

2.3.1

(in tests with continuously rising voltage) Voltage at which a specimen suffers breakdown under the prescribed test conditions

2.3.2

(in step-by-step tests) Highest voltage which a specimen withstands without breakdown for the duration of the time at that voltage level

¹⁾ To be published.

2.4 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 The distance between the test electrodes should be determined as specified in 4.4 of this standard, unless otherwise specified.

3 Significance of the test

3.1 Electric strength test results obtained in accordance with this standard can be used for detecting changes or deviations from normal characteristics resulting from processing variables, ageing conditions or other manufacturing or environmental situations but can seldom be used directly to determine the behaviour of insulating materials in an actual application.

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

3.2.1 Condition of test specimens:

- a) the thickness and homogeneity of the specimen and the presence of mechanical strain;
- b) previous conditioning of the specimens, in particular drying and impregnation procedures;
- c) the presence of gaseous inclusions, moisture or other contamination.

3.2.2 Test conditions:

- a) the frequency, waveform and rate of rise or time of application of the voltage;
- b) the ambient temperature, pressure and humidity;
- c) the configuration, the dimensions, and thermal conductivity of the test electrodes;
- d) the electrical and thermal characteristics of the surrounding medium.

3.3 The effects of all these factors should be considered when investigating materials for which no experience exists. This standard defines particular conditions which give rapid discrimination between materials and which can be used for quality control and similar purposes.

The results given by different methods are not directly comparable but each may provide information on relative electric strengths of materials. It should be noted that the electric strength of most materials decreases as the thickness of the specimen between the electrodes increases and as the time of voltage application increases.

3.4 The measured electric strength of most materials is significantly affected by the intensity and the duration of surface discharges prior to breakdown. For designs which are free from partial discharges up to the test voltage, it is very important to know the electric strength without discharges prior to breakdown but the methods in this standard are generally not suitable for providing this information.

3.5 Materials with high electric strength will not necessarily resist long-term degradation processes such as heat, erosion or chemical deterioration by partial discharges, or electrochemical deterioration in the presence of moisture, all of which may cause failure in service at much lower stress.

4 Electrodes and specimens

The metal electrodes shall be maintained smooth, clean and free from defects at all times.

NOTE 1 This maintenance becomes more important when thin specimens are being tested. Stainless steel electrodes are preferred to minimize electrode damage at breakdown.

The leads to the electrodes shall not tilt or otherwise move the electrodes or affect the pressure on the specimen, nor appreciably affect the electric field configuration in the neighbourhood of the specimen.

NOTE 2 When very thin films (for example $< 5 \mu\text{m}$ thick) are to be tested the standards for those materials should specify the electrodes and special procedures for handling and specimen preparation.

4.1 Tests perpendicularly to the surface of non-laminated materials and normal to laminae of laminated materials

4.1.1 Boards and sheet materials, including pressboards, papers, fabrics and films

4.1.1.1 Unequal electrodes

The electrodes shall consist of two metal cylinders with the edges rounded to give a radius of $3 \text{ mm} \pm 0,2 \text{ mm}$. One electrode shall be $25 \text{ mm} \pm 1 \text{ mm}$ in diameter and approximately 25 mm high. The other electrode shall be $75 \text{ mm} \pm 1 \text{ mm}$ in diameter and approximately 15 mm high. These electrodes shall be arranged coaxially within 2 mm as in Figure 1a.

4.1.1.2 Equal diameter electrodes

If a fixture is employed, which accurately aligns upper and lower electrodes within 1,0 mm, the diameter of the lower electrode may be reduced to $25 \text{ mm} \pm 1 \text{ mm}$, the diameters of the two electrodes differing by no more than 0,2 mm. The results obtained will not necessarily be the same as those obtained with the unequal electrodes of 4.1.1.1.