

Insulators for overhead lines with nominal voltage above 1 kV —

Part 1: Ceramic or glass insulator units for a.c. systems — Definitions, test methods and acceptance criteria

The European Standard EN 60383-1:1996 with the inclusion of amendment A11:1999 has the status of a British Standard

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National foreword

This British Standard is the English language version of EN 60383-1:1996 including amendment A11:1999. It is identical with IEC 60383-1:1993. The UK participation in its preparation was entrusted by Technical Committee PEL/36, Insulators for power systems, to Subcommittee PEL/36/2, Line insulators, 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 60000 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 these international or European publications 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

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Insulators for overhead lines with a nominal voltage
above 1 kV
Part 1: Ceramic or glass insulator units for a.c. systems
Definitions, test methods and acceptance criteria
(includes amendment A11:1999)
(IEC 383-1:1993)

Isolateurs pour lignes aériennes de tension
nominale supérieure à 1 kV
Partie 1: Eléments d'isolateurs en matière
céramique ou en verre pour systèmes à courant
alternatif
Définitions, méthodes d'essai et critères
d'acceptation
(inclut l'amendement A11:1999)
(CEI 383-1:1993)

Isolatoren für Freileitungen mit einer
Nennspannung über 1 kV
Teil 1: Keramik- oder Glas-Isolatoren für
Wechselstromsysteme
Begriffe, Prüfverfahren und Annahmekriterien
(enthält Änderung A11:1999)
(IEC 383-1:1993)

This European Standard was approved by CENELEC on 1996-10-01. 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, 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

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Foreword

The text of the International Standard IEC 383-1:1993, prepared by SC 36B, Insulators for overhead lines, of IEC TC 36, Insulators, was submitted to the formal vote and was approved by CENELEC as EN 60383-1 on 1996-10-01 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) 1997-06-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-06-01

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, Annex B, Annex C and Annex ZB are informative.

Annex ZA and Annex ZB have been added by CENELEC.

In the official version, for Annex C, List of normative documents given for information, the following notes have to be added for the standards indicated:

IEC 168	NOTE IEC 168:1994 is harmonized as EN 60168:1994 (not modified).
IEC 383-2	NOTE Harmonized as EN 60383-2:1995 (not modified).
IEC 507	NOTE Harmonized as EN 60507:1993 (not modified).
IEC 672-1	NOTE Harmonized as HD 426.1 S1:1983, which is superseded by EN 60672-1:1995 (IEC 672-1:1995, not modified).
IEC 672-3	NOTE Harmonized as HD 426.3 S1:1987 (not modified).
ISO 9000	NOTE ISO 9000-1:1994 is harmonized as EN ISO 9000-1:1994 (not modified).
ISO 9001	NOTE ISO 9001:1994 is harmonized as EN ISO 9001:1994 (not modified).
ISO 9002	NOTE ISO 9002:1994 is harmonized as EN ISO 9002:1994 (not modified).
ISO 9003	NOTE ISO 9003:1994 is harmonized as EN ISO 9003:1994 (not modified).
ISO 9004	NOTE ISO 9004-1:1994 is harmonized as EN ISO 9004-1:1994 (not modified).

Foreword to amendment A11

At the request of the Austrian electrotechnical committee, a draft for an amendment to EN 60383-1:1996 was submitted to the CENELEC members for acceptance in July 1999.

The text of the draft was accepted by CENELEC as amendment A11 to EN 60383-1:1996 on 1999-09-27.

The following dates were fixed:

- latest date by which the existence of the amendment has to be announced at national level (doa) 1999-12-27
- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-03-27

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Section 1. General

Introduction

This part of IEC 383 is divided into nine sections.

The first five sections cover general clauses, including general requirements and relevant test procedures.

Sections 6 to 9 deal with four different types of insulators:

Section 6: Pin insulators

Section 7: Line post insulators

Section 8: String insulator units

Section 9: Insulators for overhead electric traction lines.

Sections 6, 7 and 8 begin with a cross-reference table giving the tests applicable to the insulators and the quantity of insulators to be tested.

Section 9, dealing with traction insulators, does not have a cross-reference table as traction insulators can be referenced to one of the three other types of insulator dealt with by this part of IEC 383.

The user of this part need only refer to the section dealing with the type of insulator to be tested and to the general requirements and relevant test procedures contained in sections 1 to 5.

1 Scope and object

This part of IEC 383 applies to insulators of ceramic material or glass for use on a.c. overhead power lines and overhead traction lines with a nominal voltage greater than 1 000 V and a frequency not greater than 100 Hz.

It also applies to insulators for use on d.c. overhead electric traction lines.

This part applies to string insulator units, rigid overhead line insulators and to insulators of similar design when used in substations.

It does not apply to insulators forming parts of electrical apparatus or to parts used in their construction or to post insulators which are covered by IEC 168: Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V.

It may be regarded as a provisional standard for insulators for use on d.c. overhead power lines.

IEC 438: Tests and dimensions for high-voltage d.c. insulators, gives general guidance for those insulators.

NOTE An international standard dealing with tests on insulators for d.c. overhead lines is in preparation and is intended to replace the relevant clauses of IEC 438.

Tests on insulator strings and insulator sets (for example, wet switching impulse voltage) are dealt with in part 2 of IEC 383.

NOTE 1 This part does not include artificial pollution tests, radio-interference tests or residual strength tests. These subjects and relevant test methods are dealt with in the following IEC reports:

IEC 437: Radio interference test on high-voltage insulators

IEC 507: Artificial pollution tests on high-voltage insulators to be used on a.c. systems

IEC 797: Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric.

NOTE 2 The term "ceramic material" is used in this part to refer to porcelain materials and, contrary to North American practice, does not include glasses.

The object of this part is:

- to define the terms used;
- to define insulator characteristics and to prescribe the conditions under which the specified values of these characteristics shall be verified;
- to prescribe test methods;
- to prescribe acceptance criteria.

This part does not include requirements dealing with the choice of insulators for specific operating conditions.

NOTE A guide for the choice of insulators under polluted conditions has been published, see IEC 815.

Numerical values for insulator characteristics are specified in IEC 305, IEC 433 and IEC 720.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 383. 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 383 are encouraged to investigate the possibility of applying the most recent edition of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(471):1984, *International Electrotechnical Vocabulary (IEV) — Chapter 471: Insulators*.

IEC 60-1:1989, *High-voltage test techniques — Part 1: General definitions and test requirements*.

IEC 120:1984, *Dimensions of ball and socket couplings of string insulator units*.

IEC 305:1978, *Characteristics of string insulator units of the cap and pin type*.

IEC 372:1984, *Locking devices for ball and socket couplings of string insulation units: Dimensions and tests*.

IEC 433:1980, *Characteristics of string insulator units of the long rod type*.

IEC 471:1977, *Dimensions of clevis and tongue couplings of string insulator units*.

IEC 720:1981, *Characteristics of line post insulators*.

IEC XXX:19XX, *Puncture testing of insulators of glass or ceramic material for overhead lines with a nominal voltage greater than 1 000 V (under consideration)*.

ISO 1459:1973, *Metallic coatings — Protection against corrosion by hot dip galvanizing — Guiding principles*.

ISO 1460:1973, *Metallic coatings — Hot dip galvanized coatings on ferrous metals — Determination of the mass per unit area — Gravimetric method*.

ISO 1461:1973, *Metallic coatings — Hot dip galvanized coatings on fabricated ferrous products — Requirements*.

ISO 1463:1982, *Metal and oxide coatings — Measurement of coating thickness — Microscopical method*.

ISO 2064:1980, *Metallic and other non-organic coatings — Definitions and conventions concerning the measurement of thickness*.

ISO 2178:1982, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*.

3 Definitions

For the purposes of this part of IEC 383, the following definitions apply.

The term “insulator” is used in this part to refer to the object being tested.

The definitions given below are those which either do not appear in IEC 50(471) or differ from those given in IEC 50(471).

3.1

insulator string

one or more connected string insulator units intended to give flexible support to overhead line conductors and stressed mainly in tension

3.2

pin insulator

a rigid insulator consisting of an insulating component intended to be mounted rigidly on a supporting structure by means of a pin passing up inside the insulator. The insulating component may consist of one or more pieces of insulating material permanently connected together. The fixing of the insulating component to the pin can either be separable or permanent (pin insulator with integral pin)

unless otherwise stated, the term “pin insulator” does not include the pin if separable

NOTE The pin can have two basic shapes. With one shape, the insulating component is fixed to the end of the pin and does not allow contact of the insulating component with the supporting structure. With the other shape, the insulating component is fixed by means of the pin in contact with the supporting structure either directly or with a plate in between, the plate being either a separate washer or part of the pin (sometimes referred to as a pin post insulator).

3.3**line post insulator**

a rigid insulator consisting of one or more pieces of insulating material permanently assembled with a metal base and sometimes a cap intended to be mounted rigidly on a supporting structure with the metal base attached by means of a stud or one or several bolts

3.4**traction insulator**

an insulator or insulator set intended to give flexible or rigid support for overhead electric traction lines. All types of overhead line insulators may be used for this purpose

3.5**lot**

a group of insulators offered for acceptance from the same manufacturer, of the same design and manufactured under presumed similar conditions of production. One or more lots may be offered together for acceptance; the lot(s) offered may consist of the whole, or part, of the quantity ordered

3.6**flashover**

a disruptive discharge external to the insulator, connecting those parts which normally have the operating voltage between them

NOTE The term "flashover" used in this part includes a flashover across the insulator surface as well as disruptive discharges by sparkover through air adjacent to the insulator.

3.7**dry lightning impulse withstand voltage**

the lightning impulse voltage which the insulator withstands dry, under the prescribed conditions of test

3.8**50 % dry lightning impulse flashover voltage**

the value of the lightning impulse voltage which, under the prescribed conditions of test, has a 50 % probability of producing flashover on the insulator, dry. Represented by U_{50}

3.9**wet power-frequency withstand voltage**

the power-frequency voltage which the insulator withstands wet, under the prescribed conditions of test

3.10**electromechanical failing load**

the maximum load reached when a string insulator unit is tested under the prescribed conditions of test

3.11**mechanical failing load**

the maximum load reached when a string insulator unit or a rigid insulator is tested under the prescribed conditions of test

3.12**puncture voltage**

the voltage which causes puncture of a string insulator unit or a rigid insulator under the prescribed conditions of test

3.13**creepage distance**

the shortest distance or the sum of the shortest distances along the ceramic or glass insulating parts of the insulator between those parts which normally have the operating voltage between them

NOTE The surface of cement or other non-insulating jointing material is not considered as forming part of the creepage distance. If high resistance coating is applied to parts of the insulating part of an insulator such parts are considered to be effective insulating surfaces and the distance over them is included in the creepage distance.

3.14**displacements**

axial or radial displacement

the maximum positional variation of a definite point of the considered insulator during one complete revolution around the insulator axis

angular displacement

the angular deviation around the insulator axis between corresponding planes of the two coupling pieces

3.15**short standard string**

a short standard string is used to verify characteristics of a unit which are significant only for an insulator string. It consists of:

for cap and pin units:

an insulator string of a least 5 insulator units and not more than 1,5 m in length

for long rod insulator units:

an insulator string between 1 m and 2 m in length for long rod insulator units intended to be assembled in a string. For long rod insulator units less than 1 m long intended to be used singly as a string, the unit itself is considered as a short standard string

3.16**specified characteristics**

a specified characteristic is:

- either the numeric value of a voltage or of a mechanical load or any other characteristic specified in an IEC international standard;
 - or the numeric value of any such characteristic agreed between the purchaser and the manufacturer.
- specified withstand and flashover voltages are referred to standard atmospheric conditions (see clause 10)

Section 2. Insulators**4 Classification, types of insulators and insulating materials****4.1 Insulator classes**

Overhead line string insulators are divided into two classes according to their design:

Class A: an insulator or insulator unit in which the length of the shortest puncture path through solid insulating material is at least equal to half the arcing distance. An example of a class A insulator is a long rod insulator with external fittings.

Class B: an insulator or insulator unit in which the length of the shortest puncture path through solid insulating material is less than half the arcing distance. An example of a class B insulator is a cap and pin insulator.

4.2 Insulator types

For the purposes of this part of IEC 383, overhead line insulators are divided into the four following types:

- pin insulators
- line post insulators
- string insulator units, divided into two sub-types:
 - cap and pin insulators
 - long rod insulators
- insulators for overhead electric traction lines

NOTE Insulators for overhead traction lines are normally insulators of one of the first three types above, with or without special adaptations of the metal fittings, designed for use on overhead electric traction lines.

4.3 Insulating materials

The insulating materials of overhead line insulators covered by this part are:

- ceramic material, porcelain;

- annealed glass, being glass in which the mechanical stresses have been relaxed by thermal treatment;
- toughened glass, being glass in which controlled mechanical stresses have been induced by thermal treatment.

NOTE 1 Further information on the definition and classification of ceramic and glass insulating materials can be found in IEC 672-1 and IEC 672-3.

NOTE 2 The term “ceramic material” is used in this part to refer to porcelain materials and, contrary to North American practice, does not include glass.

5 Identification of insulators

Each insulator shall be marked, either on the insulating component or on a metal part, with the name or trade mark of the manufacturer and the year of manufacture. In addition, each string insulator unit shall be marked with the specified electromechanical or mechanical failing load whichever is applicable. These markings shall be legible and indelible.

The designations included in IEC 305, IEC 433 and IEC 720 may be used.

Section 3. Classification of tests, sampling rules and procedures

6 Classification of tests

The tests are divided into three groups as follows:

6.1 Type tests

Type tests are intended to verify the main characteristics of an insulator which depend mainly on its design. They are usually carried out on a small number of insulators and only once for a new design or manufacturing process of insulator and then subsequently repeated only when the design or manufacturing process is changed. When the change affects only certain characteristics, only the test(s) relevant to these characteristics need to be repeated. Moreover, it is not necessary to perform the electrical, mechanical and thermal-mechanical type tests on a new design of insulator if a valid test certificate is available on an insulator of equivalent design and same manufacturing process. The meaning of equivalent design is given in the relevant clauses when applicable. The results of type tests are certified either by test certificates accepted by the purchaser or by test certificates confirmed by a qualified organization.

For mechanical tests, the certificate shall be valid for ten years from the date of issue.

There is no time limit for the validity of certificates for electrical type tests.

Within the above limits, the type test certificates remain valid while there is no significant disparity between the results of the type tests and subsequent corresponding sample tests. A method for comparing type and sample test results is given in Annex A.

Type tests shall be carried out only on insulators from a lot which meets the requirements of all the relevant sample and routine tests not included in the type tests.

6.2 Sample tests

Sample tests are carried out to verify the characteristics of an insulator which can vary with the manufacturing process and the quality of the component materials of the insulator. Sample tests are used as acceptance tests on a sample of insulators taken at random from a lot which has met the requirements of the relevant routine tests.

NOTE The acceptance coefficients and sample sizes used in this part of IEC 383 for the statistical evaluation of results by variables have been chosen to reproduce as closely as possible the operating characteristic (OC) curves of the method by attributes used in former editions of IEC 383 for usual lot sizes. For other lot sizes, the OC curves will be different. Further information on the statistical evaluation of test results and calculation of OC curves can be found in ISO 2859-1974, /1-1989, /2-1985: Sampling procedures and tables for inspection by attributes and ISO 3951-1981: Sampling procedures and charts for inspection by variables for percent defective. IEC 591 gives methods for statistical evaluation of test results on insulator units.

6.3 Routine tests

Routine tests are intended to eliminate defective units and are carried out during the manufacturing process. Routine tests are carried out on every insulator.

NOTE 1 When, in certain cases, the type, sample and routine tests are carried out as a whole on a new design of insulator, they are referred to as “prototype tests”.

NOTE 2 Only routine tests applicable to complete insulators are considered in this part. The choice of routine tests carried out on unassembled insulators is left to the manufacturer as they are most often carried out during the manufacturing process.

7 Quality assurance

A quality assurance programme taking into account the requirements of this part can be used, after agreement between the purchaser and the manufacturer, to verify the quality of the insulators during the manufacturing process.

NOTE Detailed information on the use of quality assurance is given in the following ISO standards:

ISO 9000-1987: Quality management and quality assurance standards guidelines for selection and use.

ISO 9001-1987: Quality systems — Model for quality assurance in design/development, production, installation and servicing.

ISO 9002-1987: Quality systems — Model for quality assurance in production and installation.

ISO 9003-1987: Quality systems — Model for quality assurance in final inspection and test.

ISO 9004-1987: Quality management and quality system elements — Guidelines.

ISO 9002-1987 is a recommendable guideline for a quality system for insulators.

Certain well established national standards for quality assurance programmes are also available.

8 Procedures for type and sample tests

8.1 Insulator selection for type tests

The quantity of insulators to be tested for each test, as indicated in the cross-reference table in the relevant section (6, 7, 8 or 9), shall be taken from a lot of insulators which meets the requirements of all the relevant sample and routine tests.

NOTE This selection is normally carried out by the manufacturer.

8.2 Sampling rules and procedures for sample tests

For the sample tests, two samples are used, E1 and E2. The sizes of these samples are indicated in the table below. When more than 10 000 insulators are concerned they shall be divided into an optimum number of equal lots comprising between 2 000 and 10 000 insulators. The results of the tests shall be evaluated separately for each lot.

Lot size (N)	Sample size	
	E1	E2
$N \leq 300$	Subject to agreement	
$300 < N \leq 2\,000$	4	3
$2\,000 < N \leq 5\,000$	8	4
$5\,000 < N \leq 10\,000$	12	6

The insulators shall be selected at random from the lot. The purchaser has the right to make the selection. The samples shall be subjected to the applicable sample tests shown in the cross-reference table given in the relevant section (6, 7, 8, or 9). In the case of failure of the sample to satisfy a test, the relevant re-test procedure (see subclause 8.3) shall be applied.

Insulators which have been submitted to sample tests which may affect their mechanical and/or electrical characteristics shall not be used in service.

8.3 Re-test procedure for sample tests

When specified in the acceptance criteria, the following re-test procedure applies for sample tests.

If only one insulator or metal part fails to comply with the sample tests, a new sample equal to twice the quantity originally submitted to that test shall be subjected to re-testing. The re-testing shall comprise the test in which failure occurred, preceded by those tests which may be considered as having influenced the results of the original test.

If two or more insulators or metal parts fail to comply with any of the sample tests, or if any failure occurs during the re-testing, the complete lot is considered as not complying with this part and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with this defect. (In the case of a lot that has been divided into smaller lots and if one of the smaller lots does not comply, the investigation may be extended to the other lots.) The sorted lot(s) or part thereof may then be re-submitted for testing. The number then selected shall be three times the first quantity chosen for the tests. The re-testing shall comprise the test in which failure occurred preceded by those tests which may be considered as having influenced the results of the original test. If any insulator fails during this re-testing, the complete lot is considered as not complying with this part.

Section 4. Test procedures for electrical tests

This section gives the test procedures and requirements for electrical testing of the different types of insulators which fall within the scope of this part of IEC 383. The lists of tests, mounting arrangements and acceptance constants are given in sections 6 to 9 for each type of insulator.

9 General requirements for high voltage tests

- a) The lightning impulse voltage and power-frequency voltage test procedures shall be in accordance with IEC 60-1.
 - b) Lightning impulse voltages shall be expressed by their prospective peak values and power-frequency voltages shall be expressed as peak values divided by $\sqrt{2}$.
 - c) When the natural atmospheric conditions at the time of the test differ from the standard values (subclause 10.1), it is necessary to apply correction factors in accordance with subclause 10.2.
 - d) The insulators shall be clean and dry before starting high-voltage tests.
 - e) Special precautions shall be taken to avoid condensation on the surface of the insulators, especially when the relative humidity is high. For example, the insulator shall be maintained at the ambient temperature of the test location for sufficient time for thermal equilibrium to be reached before the test starts.
- Except by agreement between the purchaser and the manufacturer, dry tests shall not be made if the relative humidity exceeds 85 %.
- f) The time intervals between consecutive applications of the voltage shall be sufficient to minimize effects from the previous application of voltage in flashover or withstand tests.

10 Standard atmospheric conditions and correction factors for electrical tests

10.1 Standard reference atmosphere

The standard reference atmospheric conditions shall be in accordance with IEC 60-1.

10.2 Correction factors for atmospheric conditions

The correction factors shall be determined in accordance with IEC 60-1. If the atmospheric conditions at the time of test differ from the standard reference atmosphere, then the correction factors for air density (k_1) and humidity (k_2) shall be calculated and the product $K = k_1 \times k_2$ determined. The test voltages shall then be corrected as follows:

Withstand voltages (lightning impulse and power frequency)

Applied test voltage = $K \times$ specified withstand voltage

Flashover voltages (lightning impulse and power frequency)

Recorded flashover voltage = $\frac{\text{Measured flashover voltage}}{K}$

NOTE For wet power frequency voltage tests no correction for humidity shall be applied i.e. $k_2 = 1$ and $K = k_1$.

11 Artificial rain parameters for wet tests

The standard wet test procedure described in IEC 60-1 shall be used. The artificial rain shall be in accordance with the requirements of IEC 60-1.

NOTE When tests are made on insulators in the horizontal or inclined positions, an agreement shall be reached between the purchaser and the manufacturer regarding direction of rainfall.