

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Insulators for overhead lines – Composite suspension and tension insulators with AC voltage greater than 1 000 V and DC voltage greater than 1 500 V – Definitions, test methods and acceptance criteria**

**Isolateurs pour lignes aériennes – Isolateurs composites de suspension et d'ancrage de tension supérieure à 1 000 V en courant alternatif et à 1 500 V en courant continu – Définitions, méthodes d'essai et critères d'acceptation**



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**INSULATORS FOR OVERHEAD LINES  
COMPOSITE SUSPENSION AND TENSION INSULATORS  
WITH AC VOLTAGE GREATER THAN  
1 000 V AND DC VOLTAGE GREATER THAN 1 500 V –  
DEFINITIONS, TEST METHODS AND ACCEPTANCE CRITERIA**

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IEC 61109 has been prepared by subcommittee 36B: Insulators for overhead lines, of IEC technical committee 36: Insulators. It is an International Standard.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) extension of this document to apply both to AC and DC systems;
- b) modifications of Clause 3, Terms, definitions and abbreviations;
- c) removal of Clause 7, Hybrid insulators, from this document;

- d) modifications of tests procedures recently included in IEC 62217 (hydrophobicity transfer test, stress corrosion, water diffusion test on the core with housing);
- e) modifications on environmental conditions;
- f) modifications on classification of tests and include the relevance of the interfaces;
- g) clarification and modification of the parameters determining the need to repeat design and type tests;
- h) revision of Table 1;
- i) revision of electrical type tests;
- j) revision of re-testing procedure of sample test;
- k) addition of a new Annex D on electric field control for AC;
- l) addition of a new Annex E on typical sketch for composite insulators assembly;
- m) addition of a new Annex F on mechanical evaluation of the adhesion between core and housing;
- n) addition of a new Annex G on applicability of design- and type tests for DC applications.

The text of this International Standard is based on the following documents:

Draft	Report on voting
36/609/FDIS	36/611/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

This International Standard is to be used in conjunction with IEC 62217:2012.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

## INTRODUCTION

Composite suspension and tension insulators (in the following the term "composite insulator" is used) consist of fibreglass insulating core, bearing the mechanical load protected by a polymeric housing, the load being transmitted to the core by metallic end fittings. Despite these common features, the materials used and the design details and manufacturing process used by different manufacturers may differ.

Some tests have been grouped together as "Design tests", to be performed only once on insulators which satisfy the same design conditions. For all design tests of these composite insulators, the appropriate common clauses defined in IEC 62217 are applied. As far as practical, the influence of time on the electrical and mechanical properties of its components (core, housing, interfaces etc.) and of the complete composite insulators has been considered in specifying the design tests to ensure a satisfactory lifetime under normally known stress conditions of transmission lines. Explanation of the principles of the damage limit, load coordination and testing are presented in Annex A.

It has not been considered useful to specify a power arc test as a mandatory test. The test parameters are manifold and can have very different values depending on the configurations of the network and the supports and on the design of arc-protection devices. The heating effect of power arcs need to be considered in the design of metal fittings. Critical damage to the metal fittings resulting from the magnitude and duration of the short-circuit current can be avoided by properly designed arc-protection devices. This document, however, does not exclude the possibility of a power arc test by agreement between the manufacturer and customer. IEC 61467 gives details on AC power arc testing of complete insulator sets, that match their configuration with actual protective and string fittings, to recreate the real electromagnetic field affecting the arc movement.

This document covers both AC and DC composite insulators. Before the appropriate standard for DC applications is issued, the majority of tests listed in this document can also be applicable for DC (Annex G). Due to the difference in AC and DC tracking performance, a specific tracking and erosion test procedure for DC applications as a design test is planned to be developed. The 1 000 h AC tracking and erosion test of IEC 62217 can be used only to establish a minimum requirement for the tracking and erosion resistance. This 1 000 h salt fog tracking and erosion test is considered as a screening test intended to reject materials in combination with the design which are inadequate. Tracking and erosion tests are not intended to evaluate long term performance of insulators. Such tests, e.g. the 5 000 h multiple stress test and wheel test in IEC TR 62730 [1]<sup>1</sup>, or other tests intended for research or sometimes used as a supplementary design test, are not considered in this document.

Composite suspension and tension insulators are, in general, not intended for torsion or other non-tensile loads. However, due to consideration to non-standard applications (interphase spacers etc.) loads during handling and installation have to be considered in the design. Guidance on non-standard loads is given in Annex C.

Wherever possible, IEC Guide 111 [2] has been followed for the drafting of this document.

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<sup>1</sup> Numbers in square brackets refer to the bibliography.

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WITH AC VOLTAGE GREATER THAN  
1 000 V AND DC VOLTAGE GREATER THAN 1 500 V –  
DEFINITIONS, TEST METHODS AND ACCEPTANCE CRITERIA**

## 1 Scope

This International Standard applies to composite insulators for overhead lines consisting of a load-bearing cylindrical insulating solid core consisting of fibres – usually glass – in a resin-based matrix, a housing (surrounding the insulating core) made of polymeric material and metal end fittings permanently attached to the insulating core.

Composite insulators covered by this document are intended for use as suspension/tension line insulators, but these insulators could occasionally be subjected to compression or bending, for example when used as interphase-spacers. Guidance on such loads is outlined in Annex C.

The object of this document is to

- define the terms used,
- specify test methods,
- specify acceptance criteria.

This document does not include requirements dealing with the choice of insulators for specific operating conditions or environments beyond normal environmental conditions defined in Table 1.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60383-1, *Insulators for overhead lines with a nominal voltage above 1000 V – Part 1: Ceramic or glass insulator units for AC systems – Definitions, test methods and acceptance criteria*

IEC 60383-2, *Insulators for overhead lines with a nominal voltage above 1 000 V – Part 2: Insulator strings and insulator sets for AC systems – Definitions, test methods and acceptance criteria*

IEC 60437, *Radio interference test on high-voltage insulators*

IEC 61284, *Overhead lines – Requirements and tests for fittings*

IEC 61466-1, *Composite string insulator units for overhead lines with a nominal voltage greater than 1 000 V – Part 1: Standard strength classes and end fittings*

IEC 61467, *Insulators for overhead lines – Insulator strings and sets for lines with a nominal voltage greater than 1 000 V – AC power arc tests*

IEC 62217:—<sup>2</sup>, *Polymeric HV insulators for indoor and outdoor use – General definitions, test methods and acceptance criteria*

IEC 62231, *Composite station post insulators for substations with AC voltages greater than 1 000 V up to 245 kV – Definitions, test methods and acceptance criteria*

ISO 3452 (all parts), *Non-destructive testing – Penetrant testing*

### 3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

Note 1 to entry: Certain terms from IEC 62217:2012 are reproduced here for ease of reference. Additional definitions applicable to insulators can be found in IEC 60050-471 [3].

#### 3.1 Terms and definitions

##### 3.1.1

##### **polymeric insulator**

insulator whose insulating body consists of at least one organic based material

Note 1 to entry: Polymeric insulators are also known as non-ceramic insulators.

Note 2 to entry: Coupling devices may be attached to the ends of the insulating body.

[SOURCE: IEC 60050-471:2007, 471-01-13]

##### 3.1.2

##### **composite insulator**

insulator made of at least two insulating parts, namely a core and a housing equipped with end fittings

Note 1 to entry: Composite insulators can consist either of individual sheds mounted on the core, with or without an intermediate sheath, or alternatively, of a housing directly moulded or cast in one or several pieces on to the core.

[SOURCE: IEC 60050-471:2007, 471-01-02]

##### 3.1.3

##### **core (of an insulator)**

central insulating part of an insulator which provides the mechanical characteristics

Note 1 to entry: The housing and sheds are not part of the core.

[SOURCE: IEC 60050-471:2007, 471-01-03]

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<sup>2</sup> Under preparation. Stage at the time of publication: IEC/RFDIS 62217:2025.

### 3.1.4

#### **insulator trunk**

central insulating part of an insulator from which the sheds project

Note 1 to entry: Also known as shank on smaller insulators.

[SOURCE: IEC 60050-471:2007, 471-01-11]

### 3.1.5

#### **housing**

external insulating part of composite insulator providing the necessary creepage distance and protects the core from the environment

Note 1 to entry: An intermediate sheath made of insulating material may be part of the housing.

[SOURCE: IEC 60050-471:2007, 471-01-09]

### 3.1.6

#### **shed (of an insulator)**

insulating part, projecting from the insulator trunk, intended to increase the creepage distance

Note 1 to entry: The shed can be with or without under-ribs.

[SOURCE: IEC 60050-471:2007, 471-01-15]

### 3.1.7

#### **interface**

contact surface between the different materials

Note 1 to entry: Various interfaces exist in composite insulators, e.g.:

- between housing and end fittings;
- between various parts of the housing; e.g. between separately manufactured sheds, or between sheath and sheds;
- between core and housing;
- between sealant and core;
- between sealant and end fittings.

(Annex E: Typical sketches for composite insulator assemblies)

[SOURCE: IEC 62217:—, 3.11, modified – "contact" added in definition, Note 1 to entry modified]

### 3.1.8

#### **end fitting**

integral component or formed part of an insulator intended to connect it to a supporting structure, or to a conductor, or to an item of equipment, or to another insulator

Note 1 to entry: Where the end fitting is metallic, in general the term "metal fitting" is used.

Note 2 to entry: Standard end fittings are defined in IEC 61466-1.

[SOURCE: IEC 60050-471:2007, 471-01-06]

### 3.1.9

#### **connection zone**

zone where the mechanical load is transmitted between the core and the end fitting

[SOURCE: IEC 62217:2012, 3.13, modified – "insulating body and the fixing device" replaced by "core and the end fitting"]

**3.1.10  
coupling**

part of the end fitting which transmits the load to the accessories external to the insulator

[SOURCE: IEC 62217:2012, 3.14, modified – "fixing device" replaced by "end fitting", "hardware" replaced by "accessories"]

**3.1.11  
creepage distance**

shortest distance or the sum of the shortest distances along the surface on an insulator between two conductive parts which normally have the operating voltage between them

[SOURCE: IEC 60050-471:2007, 471-01-04]

**3.1.12  
arcing distance**

shortest distance in the air external to the insulator between the metallic parts which normally have the operating voltage between them

Note 1 to entry: The term "dry arcing distance" is also used.

[SOURCE: IEC 60050-471:2007, 471-01-01]

**3.1.13  
specified mechanical load**

**SML**  
withstand load, specified by the manufacturer, which is used for mechanical tests in this document

**3.1.14  
routine test load**

**RTL**  
load applied to all assembled composite insulators during a routine mechanical test

**3.1.15  
mechanical failing load**

maximum load that is reached when the insulator is tested under the standard conditions

[SOURCE: IEC 60050-471:2007, 471-01-12, modified – "prescribed" replaced by "standard", Note 1 to entry removed]

**3.1.16  
insulator set**

assembly of one or more insulator strings suitably connected together, complete with end fittings and protective devices as required in service

Note 1 to entry: The terms "arcing and field grading devices" is also used for protective devices.

[SOURCE: IEC 60050-471:2007, 471-03-02]

**3.1.17  
string insulator unit**

cap and pin insulator or long rod insulator of which the end fittings are suitable for flexible attachment to other similar string insulator units or to connecting accessories

Note 1 to entry: Cap and pin insulators are not composite insulators and are not part of this document.

[SOURCE: IEC 60050-471:2007, 471-03-08]

### 3.1.18 sealing

method for providing the ability of a component to resist the ingress of contaminants

Note 1 to entry: Contaminants include pollution and moisture.

[SOURCE: IEC 60050-581:2008, 581-23-16]

### 3.1.19 sealant

additional material used for sealing

Note 1 to entry: Typically RTV-silicones are used for composite insulators.

Note 2 to entry: See sealant in Annex E: Typical principles sketch for composite insulators assembly.

### 3.1.20 grading/corona ring

protective devices made from metal attached to the composite insulator end fitting or intermediate string fitting intended to keep the electric field anywhere along the surface of composite insulator below the specified maximum value

## 3.2 Abbreviated terms

The following abbreviated terms are used in this document:

E1, E2	Sample sets for sample tests
$M_{AV}$	Average 1 min failing load of the core assembled with fittings
RTL	Routine test load
RTV	Room-temperature-vulcanizing silicone
SML	Specified mechanical load

## 4 Identification

In addition to the requirements of IEC 62217, each insulator shall be marked with the SML.

It is recommended that each insulator is marked or labelled by the manufacturer to show that it has passed the routine mechanical test.

## 5 Environmental conditions

The normal environmental conditions to which insulators are submitted in service are defined in IEC 62217 and shown in Table 1. Terms are defined as follows:

- Indoor environment: installation within a building or other construction where the insulators are protected against wind, rain, snow, periodical fast-built pollution deposits, abnormal condensation, ice and hoar frost.
- Outdoor environment: installation in open air outside any building or shelter, where the insulators are submitted to wind, rain, snow, periodical fast-built pollution deposits, high condensation, ice and hoar frost.

If service conditions of polymeric insulators deviate significantly from the parameters in Table 1, the insulator is to be designed or evaluated according to agreement between the customer and manufacturer. Alternatively, if positive service experience ("i.e. no failures") is available for a specific environment and specific insulator design (including material and profile), the insulator can be used for this specific environment, deviating from normal environmental conditions.

**Table 1 – Normal environmental conditions**

	Indoor insulation	Outdoor insulation
Maximum ambient air temperature <sup>a</sup>	Does not exceed 40 °C and its average value measured over a period of 24 h does not exceed 35 °C	
Minimum ambient air temperature <sup>b</sup>	–25 °C	–40 °C
Vibration	Negligible vibration due to causes external to the insulators or to earth tremors <sup>c</sup> .	
Solar radiation <sup>d</sup>	Not applicable	Up to a level of 1 120 W/m <sup>2</sup>
Site pollution severity <sup>e</sup>	No significant pollution by dust, smoke, corrosive and/or flammable gases, vapours, or salt.	Pollution by dust, smoke, corrosive gases, vapours or salt occurs. Pollution does not exceed SPS class "heavy" as defined in IEC TS 60815-1 [5].
Humidity <sup>f</sup>	No rain, snow, abnormal humidity, condensation, ice and hoar frost	Rain, snow, abnormal humidity, condensation, ice and hoar frost occur.

<sup>a</sup> If exceeded, follow the recommendations of IEC TR 62039 [5] for the core and adhesive materials (like glue) in "glass transition temperature" section.

<sup>b</sup> In general, temperatures below –40 °C are non-critical for service. However, for handling and installation the crystallization temperature of the polymeric housing is to be considered. For line installations with temperatures below –20 °C, special steel grades with low ductile transition temperature can be specified.

<sup>c</sup> Vibration due to external causes can be dealt with in accordance to IEC 60721-1 [6].

<sup>d</sup> For outdoor application, the influence of deviation from the assumed level of 1 120 W/m<sup>2</sup> depends on the insulator material. If service conditions of polymeric insulators deviate significantly from the parameters in Table 1, the insulator is to be designed/evaluated taking into account relevant service experience. In the absence of significant service experience, special tests simulating the solar radiation condition of the installation area have to be carried out.

<sup>e</sup> In general, pollution is not an issue for indoor insulators. In particular cases, such as DC, indoor conditions, the insulators can accumulate some contamination due to DC electrical field. However, the pollution flashover phenomena cannot develop when the humidity is controlled. For outdoor conditions the requirements of IEC 62217 are specified for stresses arising in relatively harsh but not extreme environments (see e.g. hydrophobicity verification and tracking and erosion tests for which criteria are provided in IEC 62039).

<sup>f</sup> Insulator for indoor applications can also be used in presence of limited deviations from the above conditions if positive service experience "i.e. no failures" is available and condensation occurs only occasionally. To limit condensation-related phenomena, the average value of the normal humidity condition, measured over a period of 24 h does not exceed 95 % and when measured over a period of one month, does not exceed 90 %. Exceeding these values is considered as abnormal humidity condition.

## 6 Transport, storage and installation

In addition to the requirements of IEC 62217, information on handling of composite insulators can be found in CIGRE TB 184 [7] and TB 919 [9]. During installation, or when used in non-standard configurations, composite insulators may be submitted to high torsion, compression or bending loads for which they are not designed. Annex C gives guidance for such loads.

Where required the assembly instruction of the grading/corona rings should be supplied to the client, containing the correct positioning and installation of the grading/corona rings on the insulators.

## 7 Tolerances

Unless otherwise agreed, a tolerance of

$$\pm (0,04 \times d + 1,5) \text{ mm when } d \leq 300 \text{ mm,}$$

$$\pm (0,025 \times d + 6) \text{ mm when } d > 300 \text{ mm with a maximum tolerance of } \pm 50 \text{ mm}$$