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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Insulators for overhead lines – Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V – Definitions, test methods and acceptance criteria

Isolateurs pour lignes aériennes – Isolateurs composites de suspension et d’ancrage destinés aux systèmes à courant alternatif de tension nominale supérieure à 1 000 V – Définitions, méthodes d'essai et critères d'acceptation

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CONTENTS

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INSULATORS FOR OVERHEAD LINES – COMPOSITE SUSPENSION AND TENSION INSULATORS FOR A.C. SYSTEMS WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V – DEFINITIONS, TEST METHODS AND ACCEPTANCE CRITERIA

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

This second edition cancels and replaces the first edition, published in 1992 and amendment 1, published in 1995. This edition constitutes a technical revision.

The main technical changes with respect to the previous edition are listed below:

– removal of tests procedures now given in IEC 62217;
– inclusion of clauses on tolerances, environmental conditions, transport, storage and installation;
– inclusion of hybrid insulators in the scope (see Clause 8);
– clarification and modification of the parameters determining the need to repeat design and type tests;

– general improvement of the description of tests;
– modification of the specification of load application in bending tests to simplify testing;
– mechanical tests adapted to improved knowledge of failure mechanisms;
– additional requirements for visual examination;
– Annex A simplified and adapted to include the damage limit concept;
– addition of a new Annex C on non-standard loads.

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

FDIS	Report on voting
36B/274/FDIS	36B/276/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

INTRODUCTION

Composite insulators consist of an insulating core, bearing the mechanical load protected by a polymeric housing, the load being transmitted to the core by end fittings. Despite these common features, the materials used and the construction details employed by different manufacturers may be quite different.

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 composite suspension and tension 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 the components (core material, housing, interfaces etc.) and of the complete composite insulators has been considered in specifying the design tests to ensure a satisfactory life-time under normally known stress conditions of transmission lines. An explanation of the principles of the damage limit, load coordination and testing is 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 should 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 standard, however, does not exclude the possibility of a power arc test by agreement between the user and manufacturer. IEC 61467 [1][1] gives details of a.c. power arc testing of insulator sets.

Composite insulators are used in both a.c. and d.c. applications. In spite of this fact, a specific tracking and erosion test procedure for d.c. applications as a design test has not yet been defined and accepted. The 1 000 h a.c. tracking and erosion test of IEC 62217 is used to establish a minimum requirement for the tracking resistance of the housing material.

The mechanism of brittle fracture has been investigated by CIGRE B2.03[2] and conclusions are published in [2, 3]. Brittle fracture is a result of stress corrosion induced by internal or external acid attack on the resin bonded glass fibre core. CIGRE D1.14 has developed a test procedure for core materials based on time-load tests on assembled cores exposed to acid, along with chemical analysis methods to verify the resistance against acid attack [4]. In parallel IEC TC36WG 12 is studying preventive and predictive measures.

Composite suspension/tension insulators are not normally intended for torsion or other non-tensile loads. Guidance on non-standard loads is given in Annex C.

Wherever possible, IEC Guide 111 [5] has been followed for the drafting of this standard.

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1 Figures in square brackets refer to the bibliography.

2 International Council on Large High Voltage Electric Systems: Working Group B2.03.

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1 Scope and object

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

Composite insulators covered by this standard are intended for use as suspension/tension line insulators, but it should be noted that these insulators can occasionally be subjected to compression or bending, for example when used as phase-spacers.

This standard can be applied in part to hybrid composite insulators where the core is made of a homogeneous material (porcelain, resin), see Clause 8.

The object of this standard is to

– define the terms used,

– prescribe test methods,

– prescribe acceptance criteria.

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

2 Normative references

The following referenced documents are indispensable for the application 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 60383-1, *Insulators for overhead lines with a nominal voltage above 1 000 V – Part 1: Ceramic or glass insulator units for a.c. 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 a.c. systems – Definitions, test methods and acceptance criteria.*

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 62217:2005, *Polymeric insulators for indoor and outdoor use with a nominal voltage > 1 000 V – General definitions, test methods and acceptance criteria*

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

3 Terms, definitions and abbreviations

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

NOTE Certain terms from IEC 62217 are reproduced here for ease of reference. Additional definitions applicable to insulators can be found in IEC 60050-471 [6].

3.1 Terms and definitions

3.1.1
polymeric insulator
insulator whose insulating body consists of at least one organic based material

NOTE Polymeric insulators are also known as non-ceramic insulators.

NOTE 2 Coupling devices may be attached to the ends of the insulating body.

[IEV 471-01-13]

3.1.2
composite insulator
insulator made of at least two insulating parts, namely a core and a housing equipped with metal fittings

NOTE Composite insulators, for example, 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.

[IEV 471-01-02]

3.1.3
core of a composite insulator

internal insulating part of a composite insulator which is designed to ensure the mechanical characteristics

NOTE The core usually consists of either fibres (e.g. glass) which are positioned in a resin-based matrix or a homogeneous insulating material (e.g. porcelain or resin).

[IEV 471-01-03, modified]

3.1.4
insulator trunk
central insulating part of an insulator from which the sheds project

NOTE Also known as shank on smaller insulators.

[IEV 471-01-11]

3.1.5
housing
external insulating part of a composite insulator providing the necessary creepage distance and protecting core from the environment

NOTE An intermediate sheath made of insulating material may be part of the housing.

[IEV 471-01-09]

3.1.6
shed of an insulator
insulating part, projecting from the insulator trunk, intended to increase the creepage distance.

NOTE The shed can be with or without ribs

[IEV 471-01-15]

3.1.7
interfaces
surface between the different materials

NOTE Various interfaces occur in most composite insulators, e.g.

– between housing and fixing devices,

– between various parts of the housing, e.g. between sheds, or between sheath and sheds,

– between core and housing

[Definition 3.10 of IEC 62217]

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 Where the end fitting is metallic, the term "metal fitting" is normally used.

[IEV 471-01-06]

3.1.9
connection zone
zone where the mechanical load is transmitted between the insulating body and the end fitting

[Definition 3.12 of IEC 62217]

3.1.10
coupling
part of the end fitting which transmits the load to the accessories external to the insulator

[Definition 3.13 of IEC 62217, modified]

3.1.11
specified mechanical load
SML
load, specified by the manufacturer, which is used for mechanical tests in this standard

3.1.12
routine test load
RTL
load applied to all assembled composite insulators during a routine mechanical test

3.1.13
failing load
maximum load that is reached when the insulator is tested under the prescribed conditions

3.2 Abbreviations

The following abbreviations are used in this standard:

E1, E2	Sample sets for sample tests
M_{AV}	Average 1 min failing load of the core assembled with fittings
RTL	Routine test load
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 be 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.

6 Transport, storage and installation

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

7 Hybrid insulators

As stated in Clause 1, this standard can be applied in part to hybrid composite insulators where the core is made of a homogeneous material (porcelain, resin). In general, the load-time mechanical tests and tests for core material are not applicable to porcelain cores. For such insulators, the purchaser and the manufacturer shall agree on the selection of tests to be used from this standard and from IEC 60383-1.

8 Tolerances

Unless otherwise agreed, a tolerance of

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

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

shall be allowed on all dimensions for which specific tolerances are not requested or given on the insulator drawing (d being the dimension in millimetres).

The measurement of creepage distances shall be related to the design dimensions and tolerances as determined from the insulator drawing, even if this dimension is greater than the value originally specified. When a minimum creepage is specified, the negative tolerance is also limited by this value.

In the case of insulators with creepage distance exceeding 3 m, it is allowed to measure a short section around 1 m long of the insulator and to extrapolate.

9 Classification of tests

9.1 Design tests

These tests are intended to verify the suitability of the design, materials and method of manufacture (technology). A composite suspension insulator design is defined by the following elements:

– materials of the core, housing and their manufacturing method;
– material of the end fittings, their design and method of attachment (excluding the coupling);
– layer thickness of the housing over the core (including a sheath where used);
– diameter of the core.

When changes in the design occur, re-qualification shall be carried out in accordance with Table 1.

When a composite suspension insulator is submitted to the design tests, it becomes a parent insulator for a given design and the results shall be considered valid for that design only. This tested parent insulator defines a particular design of insulators which have all the following characteristics:

a) same materials for the core and housing and same manufacturing method;
b) same material of the fittings, the same connection zone design, and the same housing-to-fitting interface geometry;
c) same or greater minimum layer thickness of the housing over the core (including a sheath where used);

d) same or smaller stress under mechanical loads;
e) same or greater diameter of the core;
f) equivalent housing profile parameters, see Note (a) in Table 1.

9.2 Type tests

The type tests are intended to verify the main characteristics of a composite insulator, which depend mainly on its shape and size. They also confirm the mechanical characteristics of the assembled core (see Clause A.4). They are made on insulators whose class has satisfied the design tests, more details are given in Clause 11.

9.3 Sample tests

The sample tests are for the purpose of verifying other characteristics of composite insulators, including those which depend on the quality of manufacture and on the materials used. They are made on insulators taken at random from lots offered for acceptance.

9.4 Routine tests

The aim of these tests is to eliminate composite insulators with manufacturing defects. They are made on every composite insulator offered for acceptance.

Table 1 – Tests to be carried out after design changes

IF the change in insulator design concerns:		**THEN** the following tests shall be repeated:									
		Design tests								**Type tests**	
		62217	61109	62217 Tests on housing material				62217 Tests on the core material		61109	
		Interfaces and connections of end fittings	Assembled core load–time tests	Hardness test	Accelerated weathering test	Tracking and erosion test	Flammability test	Dye penetration test	Water diffusion test	Electrical type tests	Mechanical type tests
1	Housing materials	X	X[c)]	X	X	X	X				
2	Housing profile[a)]	X				X				X	
3	Core material	X	X					X	X		X
4	Core diameter[b)]	X	X					X	X		X
5	Core and end-fitting manufacturing process	X	X					X	X		X
6	Core and end-fitting assembly process	X	X								X
7	Housing manufacturing process	X	X[c)]	X	X	X	X				X[c)]
8	Housing assembly process	X	X[c)]			X					X[c)]
9	End fitting material	X	X								X
10	End fitting connection zone design	X	X								X
11	Core/housing/end fitting interface design	X	X[c)]			X					X[c)]
12	Coupling type										X

a) Variations of the profile within following tolerances do not constitute a change:
- overhang : ± 10 %
- diameter : +15 %, -0 %
- thickness at base and tip : ± 15 %
- spacing : ± 15 %
- shed inclinations : ± 3°
- shed repetition : identical

b) Variations of the core diameter within ± 15 % do not constitute a change.

c) Not necessary if it can be demonstrated that the change has no influence on the assembled core strength.

10 Design tests

10.1 General

These tests consist of the tests prescribed in IEC 62217 as listed in Table 2 below and a specific assembled core load-time test. The design tests are performed only once and the results are recorded in a test report. Each part can be performed independently on new test specimens, where appropriate. The composite insulator of a particular design shall be qualified only when all insulators or test specimens pass the design tests.

Table 2 – Design tests

Tests on interfaces and connections of end fittings
Pre-stressing – Sudden load release pre-stressing Thermal-mechanical pre-stressing (see 10.2.1 and 10.3 below)
Water immersion pre-stressing
Verification tests
Visual examination
Steep-front impulse voltage test
Dry power-frequency voltage test
Tests on shed and housing material
Hardness test
Accelerated weathering test
Tracking and erosion test – see 10.2.2 below for specimens
Flammability test
Tests on the core material – see 10.2.3 below for specimens
Dye penetration test
Water diffusion test
Assembled core load-time test
Determination of the average failing load of the core of the assembled insulator
Control of the slope of the strength-time curve of the insulator

10.2 Test specimens for IEC 62217

10.2.1 Tests on interfaces and connections of end fittings

Three insulators assembled on the production line shall be tested. The insulation length (metal to metal spacing) shall be not less than 800 mm. Both end fittings shall be the same as on standard production insulators. The end fittings shall be assembled so that the insulating part from the fitting to the closest shed shall be identical to that of the production line insulator. If spacers, joining rings or other features are used in the insulator design (notably for longer insulators), the sample shall include any such devices in a typical position.

NOTE If the manufacturer only has facilities to produce insulators shorter than 800 mm, the design tests may be performed on insulators of those lengths available to him, but the results are only valid for up to the lengths tested.

10.2.2 Tracking and erosion test

If spacers, joining rings or other features are used in the insulator design (notably for longer insulators), the samples for this test shall include any such devices in a typical position.

IEC 62217 specifies that the creepage distance of the sample shall be between 500 mm and 800 mm. If the inclusion of spacers or joints, as mentioned above, requires a longer creepage distance, the design tests may be performed on insulators of lengths as close to 800 mm as possible. If the manufacturer only has facilities to produce insulators with creepage shorter than 500 mm, the design tests may be performed on insulators of those lengths he has available, but the results are only valid for up to the tested lengths.