

Composite hollow insulators — Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V — Definitions, test methods, acceptance criteria and design recommendations

The European Standard EN 61462:2007 has the status of a British Standard

ICS 29.080.10

National foreword

This British Standard is the UK implementation of EN 61462:2007. It is identical to IEC 61462:2007.

The UK participation in its preparation was entrusted to Technical Committee PEL/36, Insulators for power systems.

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

The attention of users is drawn to the flammability test in subclause 7.3.4 of BS EN 61462:2006, which references BS EN 62217:2005, and is used as an indicator of power arc ignition and extinction performance. The UK Committee is of the opinion that work carried out before and after BS EN 62217:2005 was published shows that the flammability test is not suitable for assessing the power arc performance of insulators. The correlation between performance in different flammability tests, laboratory power arc tests and behaviour in service is currently under investigation by the International Council on Large Electric Systems study committee on Materials and Emerging Technologies (CIGRE SC D1). When applying this standard, users are recommended to consult the power arc tests in ANSI C29.18 or IEC 99-4 surge arrester specifications in addition to the test in 7.3.4. The ANSI test also usefully includes an end fitting seal test after power arc damage.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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**Composite hollow insulators -
Pressurized and unpressurized insulators for use in electrical equipment
with rated voltage greater than 1 000 V -
Definitions, test methods, acceptance criteria
and design recommendations
(IEC 61462:2007)**

Isolateurs composites creux -
Isolateurs avec ou sans pression interne
pour utilisation dans des appareillages
électriques de tensions nominales
supérieures à 1 000 V -
Définitions, méthodes d'essais,
critères d'acceptation
et recommandations de conception
(CEI 61462:2007)

Verbundhohlisolatoren -
Druckbeanspruchte und drucklose
Isolatoren für den Einsatz in elektrischen
Betriebsmitteln mit
Bemessungsspannungen über 1 000 V -
Begriffe, Prüfverfahren, Annahmekriterien
und Konstruktionsempfehlungen
(IEC 61462:2007)

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Foreword

The text of document 36C/167/FDIS, future edition 1 of IEC 61462, prepared by SC 36C, Insulators for substations, of IEC TC 36, Insulators, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61462 on 2007-10-01.

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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61462:2007 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Composite hollow insulators consist of an insulating tube bearing the mechanical load protected by an elastomeric housing, the loads being transmitted to the tube by metal fittings. Despite these common features, the materials used and the construction details employed by different manufacturers may vary.

Some tests have been grouped together as "Design tests" to be performed only once for insulators of the same design and material. The design tests are performed in order to eliminate designs and materials not suitable for high-voltage applications.

The relevant design tests defined in IEC 62217 are applied for composite hollow insulators; additional specific mechanical tests are given in this standard. The influence of time on the electrical and mechanical properties of the complete composite hollow insulator and its components (tube material, housing material, interfaces, etc.) has been considered in specifying the design tests in order to ensure a satisfactory lifetime under normal service conditions. These conditions may also depend on the equipment inside or outside the composite hollow insulators; however, this matter has not been covered in this standard. Test methods not specified in this standard may be considered for specific combinations of materials and specific applications, and are a matter of agreement between manufacturers and users. In this standard, the term "user" in general means the equipment manufacturer using composite hollow insulators.

The practical use of composite hollow insulators covers 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.

This standard distinguishes between design tests and type tests because several general characteristics of a specific design and specific combinations of materials do not vary for different insulator types. In these cases results from design tests can be adopted for different insulator types.

Pollution tests according to IEC 60507 are not included in this standard as they are generally not applicable. Such pollution tests performed on insulators made of non-ceramic materials do not correlate with experience obtained from service. Specific pollution tests for non-ceramic insulators are under consideration.

The mechanical characteristics of composite hollow insulators are quite different compared to those of hollow insulators made of ceramics. In order to determine the onset of mechanical deterioration of composite hollow insulators under the influence of mechanical stress, strain gauge measurements are used.

This standard refers to different characteristic pressures which are used for design and testing of composite hollow insulators. The term "maximum service pressure" (MSP) is equivalent to the term "design pressure" which is used in other standards for ceramic hollow insulators; however, this latter term is not used in this standard in order to avoid confusion with "design" as used in "design tests".

General recommendations for the design and construction of composite hollow insulators are presented in Annex B.

**COMPOSITE HOLLOW INSULATORS –
PRESSURIZED AND UNPRESSURIZED INSULATORS
FOR USE IN ELECTRICAL EQUIPMENT WITH RATED VOLTAGE GREATER
THAN 1 000 V –
DEFINITIONS, TEST METHODS, ACCEPTANCE CRITERIA AND
DESIGN RECOMMENDATIONS**

1 Scope and object

This International Standard applies to composite hollow insulators consisting of a load-bearing insulating tube made of resin impregnated fibres, a housing (outside the insulating tube) made of elastomeric material (for example silicone or ethylene-propylene) and metal fixing devices at the ends of the insulating tube. Composite hollow insulators as defined in this standard are intended for general use (unpressurized) or for use with a permanent gas pressure (pressurized). They are intended for use in both outdoor and indoor electrical equipment operating on alternating current with a rated voltage greater than 1 000 V and a frequency not greater than 100 Hz or for use in direct current equipment with a rated voltage greater than 1 500 V.

The object of this standard is:

- to define the terms used;
- to prescribe test methods;
- to prescribe acceptance criteria.

This standard does not prescribe impulse voltage or power frequency voltage type tests, nor does it prescribe pollution tests because the withstand voltages are not characteristics of the hollow insulator itself, but of the apparatus of which it ultimately forms a part.

All the tests in this standard, apart from the thermal-mechanical test, are performed at normal ambient temperature. This standard does not prescribe tests that may be characteristic of the apparatus of which the hollow insulator ultimately forms a part. Further technical input is required in this area.

NOTE 1 "Pressurized" means a permanent gas or liquid pressure greater than 0,05 MPa (0,5 bar) gauge. The gas can be dry air or inert gases, for example sulphur hexafluoride, nitrogen, or a mixture of such gases.

NOTE 2 "Unpressurized" means a gas or liquid pressure smaller than or equal to 0,05 MPa (0,5 bar) gauge.

NOTE 3 Composite hollow insulators are intended for use in electrical equipment, such as, but not limited to

- circuit-breakers,
- switch-disconnectors,
- disconnectors,
- earthing switches,
- instrument- and power transformers,
- bushings.

Additional testing defined by the relevant IEC equipment committee may be required.

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

IEC 60068-2-17: *Basic environmental testing procedures – Part 2: Tests – Test Q: Sealing*

IEC 60168: *Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V*

IEC 62155: *Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V*

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

ISO 1101: *Geometrical Product Specifications (GPS) – Geometrical tolerancing – Tolerancing of form, orientation, location and run out*

ISO 3452: *Non-destructive testing – Penetrant inspection – General principles*

3 Terms and definitions

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

3.1

composite hollow insulator

insulator consisting of at least two insulating parts, namely a tube and a housing

NOTE The housing may consist either of individual sheds mounted on the tube, with or without an intermediate sheath, or directly applied in one or several pieces onto the tube. A composite hollow insulator unit is permanently equipped with fixing devices or end fittings and is open from end to end.

3.2

tube

core

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

NOTE 1 The tube is generally cylindrical or conical, but may have other shapes (for example barrel). The tube is made of resin impregnated fibres.

NOTE 2 Resin impregnated fibres are structured in such a manner as to achieve sufficient mechanical strength. Layers of different fibres may be used to fulfil special requirements.

3.3

fixing device

end fitting

part of a composite hollow insulator attached to the tube to transmit the mechanical load

3.4**coupling**

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

[IEC 62217, definition 3.13]

3.5**connection zone**

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

[IEC 62217, definition 3.12]

3.6**housing**

external insulating part of composite hollow insulator providing necessary creepage distance and protecting tube from environment

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

[IEC 62217, definition 3.6, modified]

3.7**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]

3.8**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]

3.9**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

NOTE 1 The surface of cement or of any other non-insulating jointing material is not considered as forming part of the creepage distance.

NOTE 2 If a 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.

[IEV 471-01-04]

3.10**arcing distance**

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

[IEV 471-01-01]

NOTE The term “dry arcing distance” is also used.

3.11

tracking

process which forms irreversible degradation by formation of conductive paths (tracks) starting and developing on the surface of an insulating material

NOTE These paths are conductive even under dry conditions.

[IEC 62217, definition 3.14]

3.12

erosion

irreversible and non-conducting degradation of the surface of the insulator that occurs by loss of material which can be uniform, localised or tree-shaped

NOTE Light surface traces, commonly tree-shaped, can occur on composite insulators as on ceramic insulators, after partial flashover. These traces are not considered to be objectionable as long as they are non-conductive. When they are conductive they are classified as tracking.

[IEC 62217, definition 3.15]

3.13

crack

any fracture or surface fissure of depth greater than 0,1 mm

[IEC 62217, definition 3.10]

3.14

interface

surface between the different materials

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

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

[IEC 62217, definition 3.10]

3.15

damage limit of the tube under mechanical stress

limit below which mechanical loads (pressure, bending load) can be applied, at normal ambient temperature, without micro damage to the composite tube

NOTE Applying such loads means that the tube is in a reversible elastic phase. If the damage limit of the tube is exceeded, the tube is in an irreversible plastic phase, which means permanent damage to the tube which may not be visible at a macroscopic level (for a quantitative definition see Annex C).

3.16

specified mechanical load (SML)

load specified by the manufacturer that is used in the mechanical tests

NOTE 1 The load is normally applied by bending at normal ambient temperature.

NOTE 2 The SML forms the basis of the selection of composite hollow insulators with regard to external loads.

3.17

maximum mechanical load (MML)

highest mechanical load which is expected to be applied to the hollow insulator in service and in the equipment in which it is used

NOTE This load is specified by the equipment manufacturer.

3.18**deflection under bending load**

displacement of a point on an insulator, measured perpendicularly to its axis, under the effect of a load applied perpendicularly to this axis
[IEV 471-01-05]

NOTE Deflection/load relationships are determined by the manufacturer.

3.19**failing load**

maximum load that can be reached when the insulator is tested under the prescribed conditions (valid for bending or pressure tests).

NOTE Damage to the core is likely to occur at loads lower than the insulator failing load.

3.20**residual deflection**

difference between the initial deflection of a hollow insulator prior to bending load application, and the final deflection after release of the load

NOTE The measurement of residual deflection serves for comparison with strain gauge measurements.

3.21**specified internal pressure (SIP)**

internal pressure specified by the manufacturer which is verified during a type test at normal ambient temperature

NOTE The SIP forms the basis of the selection of composite hollow insulators with respect to internal pressure.

3.22**maximum service pressure (MSP)**

difference between the maximum absolute internal pressure, when the equipment (of which the hollow insulator is a part) is carrying its rated normal current at maximum operational temperature and the normal outside pressure

NOTE 1 The MSP of the hollow insulator is specified by the equipment manufacturer.

NOTE 2 The MSP is equivalent to "design pressure" as used for ceramic hollow insulators (see IEC 62155).

3.23**specified temperature**

highest and/or lowest temperature permissible for the composite hollow insulator

NOTE The specified temperature is specified by the manufacturer.

3.24**manufacturer**

individual or organization producing the composite hollow insulators

3.25**equipment manufacturer**

individual or organization producing the electrical equipment utilizing the composite hollow insulators

4 Relationships of mechanical loads

4.1 Loads from outside the insulator

Table 1 – Mechanical loads applied to the insulator

Load	Relation	Tube is in:
Maximum mechanical load (MML) which is the design load for the equipment manufacturer	$= 1,0 \times \text{MML}$	reversible elastic phase
Damage limit	$> 1,5 \times \text{MML}$	reversible elastic phase
Type test SML bending load	$= 2,5 \times \text{MML}$	irreversible plastic phase
Failure bending load	$> 2,5 \times \text{MML}$	irreversible plastic phase

An overview of loads is shown in Figure B.1.

4.2 Pressures

Table 2 – Pressures applied to the insulator

Pressure	Relation	Tube is in:
Maximum service pressure (MSP) which is the design pressure for the equipment manufacturer	$= 1,0 \times \text{MSP}$	reversible elastic phase
Routine test pressure	$= 2,0 \times \text{MSP}$	reversible elastic phase
Damage limit	$> 2,0 \times \text{MSP}$	reversible elastic phase
Type test pressure	$= 4,0 \times \text{MSP}$	irreversible plastic phase
Specified internal pressure (SIP)	$\geq 4,0 \times \text{MSP}$	irreversible plastic phase

An overview of pressures is shown in Figure B.2.

5 Marking

Each hollow insulator shall be marked with the name or trade mark of the manufacturer and the year of manufacture. In addition, each hollow insulator shall be marked with the type reference and serial numbers in order to allow identification. This marking shall be legible and indelible.

6 Classification of tests

The tests are divided into four groups as follows:

6.1 Design tests

These tests are intended to verify the suitability of the design, materials and manufacturing technology.

A composite hollow insulator design is defined by:

- materials and design of the tube, housing and manufacturing method,
- material of the end fittings, their design and method of attachment,
- layer thickness of the housing over the tube (including a sheath where used).

When changes in the design occur, re-qualification shall be done according to Table 3.

Table 3 – Tests to be carried out after design changes

IF the insulator design changes the...		THEN the following design tests shall be repeated :						
		7.2	7.3.1	7.3.2	7.3.3	7.3.4	7.4.1	7.4.2
		Interfaces and connections of end fittings (as per IEC 62217).	Hardness test (see IEC 62217)	Accelerated weathering (see IEC 62217)	Tracking and erosion test (see IEC 62217)	Flammability test (see IEC 62217)	Dye penetration test (see IEC 62217)	Water diffusion test (see IEC 62217)
1	Housing materials	X	X	X	X	X		
2	Housing profile ^a				X			
3	Tube material	X					X	X
4	Tube design ^b						X	X
5	Manufacturing process of housing ^c	X	X	X	X			
6	Manufacturing process of tube ^d	X					X	X
7	End fitting material	X						
8	End fitting method of attachment to tube ^e	X						
9	Tube-housing-end fitting interface design	X			X			
^a The following variation of the housing profile within following tolerances do not constitute a change: - Overhang of sheds: $\pm 10\%$ - Spacing: $\pm 10\%$ - Mean inclination of sheds: $\pm 3^\circ$ - Thickness at root and tip of sheds : $\pm 15\%$ - Shed repetition : identical								
^b Liner, winding angle.								
^c Curing and moulding method (e.g. extrusion, injection, single shed assembly...).								
^d Pultrusion, wet filament winding, vacuum impregnation, surface preparation.								
^e Applications: bending, pressure, combined pressure-bending.								

6.2 Type tests

These tests are intended to verify the mechanical characteristics of a composite hollow insulator which depends mainly on its tube and end fittings. Type tests shall be applied to the class of composite hollow insulators which have passed the design tests. The type test shall be repeated only when the type or the material or the manufacturing process of the composite hollow insulator is changed.