

Australian Standard™

**Insulators—Ceramic or glass—Hollow
pressurized and unpressurized—
Voltages greater than 1000 V a.c.**



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Australian Chamber of Commerce and Industry
Australian Electrical and Electronic Manufacturers Association
Australian Porcelain Insulators Association
Electricity Engineers Association (New Zealand)
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**Insulators—Ceramic or glass—Hollow
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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EL-010, Overhead Lines. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian, rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide users and manufacturers of hollow ceramic and glass insulators with definitions and terms, test methods and acceptance criteria to facilitate their specification.

This Standard is identical with, and has been reproduced from IEC 62155, Ed. 1.0 (2003), *Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
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The term 'informative' is used to define the application of the annex to which it applies. An informative annex is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard
**Insulators—Ceramic or glass—Hollow pressurized and unpressurized—
Voltages greater than 1000 V a.c.**

1 Scope and object**1.1 General**

This standard is applicable to

- ceramic and glass hollow insulators intended for general use in electrical equipment;
- ceramic hollow insulators intended for use with a permanent gas pressure in switchgear and controlgear.

These insulators are intended for indoor and outdoor use in 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 of greater than 1 500 V.

The hollow insulators are intended for use in electrical equipment, for example:

- circuit-breakers,
- switch-disconnectors,
- disconnectors,
- earthing switches,
- instrument transformers,
- surge arresters,
- bushings,
- cable sealing ends,
- capacitors.

It is not the object of this standard to prescribe dielectric type tests because the withstand voltages are not characteristics of the hollow insulator itself but of the apparatus of which it ultimately forms a part.

1.2 Hollow insulators or hollow insulator bodies intended for general use

Hollow insulators or insulator bodies of ceramic material or glass, intended for use

- without pressure;
- with permanent pressure ≤ 50 kPa gauge;
- with permanent gas pressure > 50 kPa gauge in combination with an internal volume < 1 l ($1\,000\text{ cm}^3$);
- with permanent hydraulic pressure.

The object of this standard is to define

- the terms used;
- the mechanical and dimensional characteristics of hollow insulators and hollow insulator bodies;

- the electrical soundness of the wall;
- the conditions under which the specified values of these characteristics are verified;
- the methods of test;
- the acceptance criteria.

1.3 Ceramic hollow insulators intended for use with permanent gas pressure

Hollow insulators or hollow insulator bodies with their fixing devices, intended for use with permanent gas pressure: permanent gas pressure >50 kPa gauge in combination with an internal volume ≥ 1 l ($1\,000\text{ cm}^3$).

NOTE 1 The gas can be dry air, inert gases, for example, SF_6 or nitrogen or a mixture of such gases.

The object of this standard is to define

- the terms used;
- the mechanical and dimensional characteristics of hollow insulators and hollow insulator bodies;
- the electrical soundness of the wall;
- the conditions under which the specified values of these characteristics are verified;
- the methods of test;
- the acceptance criteria;
- design rules;
- test procedures and test values.

NOTE 2 Hollow insulators or hollow insulator bodies are usually integrated into electrical equipment which is electrically type tested as required by the equipment standard.

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.

References to international standards that are struck through in this clause are replaced by references to Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is identified as such.

IEC 60672-3:1997, *Ceramic and glass insulating materials – Part 3: Specifications for individual materials*

~~IEC 60694:1996, Common specifications for high-voltage switchgear and controlgear standards~~

AS/NZS 2650, Common specifications for high-voltage switchgear and controlgear

IEC 60865-1:1993, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

IEC 61166:1993, *High-voltage alternating current circuit-breakers – Guide for seismic qualification of high-voltage alternating current circuit-breakers*

IEC 61463:1996, *Bushings – Seismic qualification*

IEC 62271-100:2001, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers*

~~ISO 1460:1992, *Metallic coatings — Hot dip galvanized coatings on ferrous metals — Gravimetric determination of the mass per unit area*~~

~~ISO 1461:1999, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods*~~

AS 1214, Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)

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

ISO 2064:1996, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*

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

ISO 4287:1997, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

3 Terms and definitions

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

NOTE Some of the definitions cited below are taken from IEC 60050(471), modified or unmodified.

3.1

hollow insulator body

hollow insulating body, which is open from end to end, with or without sheds, not including the fixing devices or end fittings

3.2

hollow insulator

hollow insulating part, which is open from end to end, with or without sheds, including the fixing devices or end fittings

[IEV 471-01-17, modified]

NOTE This is a general term which also covers the definitions 3.4, 3.5 and 3.6.

3.3

fixing device

end fitting

device forming part of a hollow insulator, intended to connect it to a supporting structure or to an item of equipment, or to another insulator

NOTE Where the fixing device is metallic, the term "metal fitting" is also used.

[IEV 471-01-02, modified]

3.4

hollow post insulator

hollow post insulator, which consists of one hollow post insulator unit or an assembly of more units and is intended to give support to a live part, which is to be insulated from earth or from another live part

3.5

hollow post insulator unit

hollow post insulator unit, which consists of a permanent assembly of a hollow insulating body with fixing devices and is intended to give support

3.6**chamber insulator**

hollow insulator, which is used as a housing

EXAMPLE Arc extinction chamber of a circuit-breaker.

3.7**bushing**

device that enables one or several conductors to pass through a partition such as a wall or tank and insulates the conductors from it

[IEV 471-02-01, modified]

NOTE The means of attachment (flange or other fixing device) to the partition forms part of the bushing.

3.8**puncture**

disruptive discharge passing through the solid insulating material of the insulator which produces a permanent loss of dielectric strength

[IEV 471-01-11]

3.9**creepage distance**

shortest distance along the external surface of an insulator between two conductive parts

[IEV 471-01-08, modified]

NOTE 1 The surface of cement, or of 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 surface of an insulator, such parts are considered to be effective insulating surfaces, and the distance over them is included in the creepage distance.

NOTE 3 The surface resistivity of such high-resistance coatings is usually about $10^6 \Omega$ but may be as low as $10^5 \Omega$.

NOTE 4 If high-resistance coatings are applied to the whole surface of an insulator (the so-called stabilized insulator), the questions of surface resistivity and creepage distance should be subject to agreement between the purchaser and the manufacturer.

3.10**specified characteristic**

- either the numeric value of a voltage, of a mechanical load, or any other characteristic specified in an IEC standard,
- or the numeric value of any such characteristic agreed between the purchaser and the manufacturer

3.11**withstand bending moment**

withstand bending moment verified in a type test, which is based on load conditions specified for the hollow insulator

NOTE For a pressurized hollow insulator, it is based on the load conditions specified in 5.2.

3.12**mechanical failing load**

maximum load reached when a hollow insulator or hollow insulator body is tested under the prescribed conditions of test

3.13**design pressure**

upper limit at least of differential pressure reached between the interior and exterior of the hollow insulator during operation at the design temperature

3.14**design temperature**

highest temperature reached inside the hollow insulator which can occur under service conditions

NOTE This is generally the upper limit of ambient air temperature increased by the temperature rise due to the flow of the rated normal current, and to dielectric losses, if any.

3.15**manufacturer**

organization that produces the hollow insulators or hollow insulator bodies

3.16**equipment manufacturer**

individual or organization which produces the electrical equipment utilizing the hollow insulators or hollow insulator bodies

3.17**parallelism of the end faces**

maximum difference in the height of a hollow insulator measured across the surfaces of the end fittings or the surfaces of the hollow insulator body

3.18**eccentricity**

displacement, perpendicular to the axis of the hollow insulator, between the centres of the pitch circles of the fixing holes in the top and bottom metal fittings

3.19**axial run-out**

relative axial displacement of the end faces of the insulator measured during one revolution (see Figure A.6)

3.20**angular deviation of the fixing holes**

rotational displacement, expressed as an angle, between corresponding fixing holes in the end fittings at the top and bottom of a hollow insulator

3.21**camber of an insulator**

maximum distance between the theoretical axis of an insulator and the curved line being the locus of the centres of all the transverse cross-sections of the unloaded insulator

[IEV 471-01-19]

3.22**lot**

group of hollow insulators or hollow insulator bodies offered for acceptance from the same manufacturer, of the same design and manufactured under similar conditions of production

NOTE 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.

4 Insulating materials

The insulating materials of hollow insulator bodies intended for general use (see 1.2) covered by this standard 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.

The insulating materials of hollow insulator bodies intended for use with permanent gas pressure (see 1.3) covered by this standard are:

- ceramic material complying in its characteristics with IEC 60672-3, group C-100 and C-200.

NOTE 1 Further information on the definition and classification of ceramic and glass insulating materials can be found in other IEC publications (see [4]¹).

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

5 General recommendations for design

5.1 General recommendations for design of hollow insulators and hollow insulator bodies intended for general use

Specific design rules are not prescribed since the requirements are a function of the equipment application (see 1.2).

5.2 Design rules for hollow insulators and hollow insulator bodies for use with permanent gas pressure

5.2.1 Purpose

The rules for the design of gas-pressurized hollow insulators for high-voltage equipment prescribed in this clause take into account that these hollow insulators are subjected to particular operating conditions which distinguish them from compressed air receivers and other similar storage vessels (see 1.3).

5.2.2 Rules for design

When designing hollow insulators, the following points shall be taken into consideration.

- Deviations and tolerances of profile: circularity, run-out, camber, parallelism, coaxiality, evenness, differences in wall thickness, and angular and radial position of fixing holes shall all take account of the parts to be fitted inside.
- It shall be considered that electrical strength, mechanical strength and technological problems may influence the real construction, but, due to the complexity of this subject, no definitive guide can be given.
- A critical selection of materials for cementing and fittings is also necessary. The ceramic material shall comply in its characteristics with IEC 60672-3, group C-100 and C-200.
- An insulating pressurized enclosure may be considered as appropriate for its intended use only after the electrical equipment of which it is a part has satisfactorily passed the type tests provided for by the particular standards with which this equipment must comply.

5.2.3 Determination of the design pressure

The design pressure shall be the difference between the maximum absolute pressure, when the equipment (of which the hollow insulator is a part) is carrying its rated normal current at maximum ambient temperature and the outside pressure.

The maximum absolute pressure of the gas inside the hollow insulator shall be determined by the equipment manufacturer.

(i) _____

¹ Figures in square brackets refer to the bibliography.

NOTE In some special cases (for example, circuit-breakers), the pressure rise occurring after a breaking operation should be taken into account.

5.2.4 Determination of the design temperature

The equipment manufacturer shall determine this value taking account of 3.14.

Solar radiation shall be taken into account.

5.2.5 Determination of the type-test withstand bending moment

The following factors may all contribute to the bending stress that may occur in electrical equipment: mass, internal pressure, terminal loads, short-circuit loads, ice loads, operating loads, wind loads, seismic loads (see Table 1).

The following sources shall be used for determining the values necessary for calculating the relevant loads:

- terminal loads: 6.101.6.1 of IEC 62271-100
- wind loads: 6.101.6.1 of IEC 62271-100 and 2.1.2 of IEC 60694
- ice loads: 6.101.6.1 of IEC 62271-100 and 2.1.2 of IEC 60694
- short-circuit loads: determined from the rated short-circuit level of the equipment (section 2 of IEC 60865-1)
- seismic loads: 8.1 of IEC 61166 and 10.1 of IEC 61463
- operating loads: values depending on design of equipment

The alternative combinations detailed in Table 1 are typical examples of load combinations that must be considered in design. Column 1 of Table 1 covers the routinely expected loads and has been assigned a safety factor of 2,1 for the type-test bending stress.

The three other conditions covering rarely occurring extreme loads have been assigned safety factors of 1,2 for the type-test bending stress, and for seismic stresses a safety factor of 1,0.

The most onerous of the applicable alternatives shall be used to determine the test withstand bending stress.

From the test withstand bending stress, the test withstand bending moment can be calculated.

Table 1 – Typical examples of load combinations and weighting factors

Loads	Stress from routinely expected loads	Stress from rarely occurring extreme loads		
		Alternative 1 Short-circuit load	Alternative 2 Ice load	Alternative 3 Seismic load
Design pressure ^a	100%	100%	100%	100%
Mass	100%	100%	100%	100%
Rated terminal load	100%	50%	0%	70%
Wind pressure	30%	100%	0%	10%
Short-circuit load	0%	100%	0%	0%
Ice load	0%	0%	100%	0%
Seismic load	0%	0%	0%	100%
Safety factor	2,1	1,2	1,2	1,0

NOTE For details see IEC 62271-100, IEC 60694, IEC 60865-1, IEC 61166 and IEC 61463.

^a See Annex D.

Figure 1 shows the relation between the testing values and the utilization values for the bending moment of a hollow insulator.

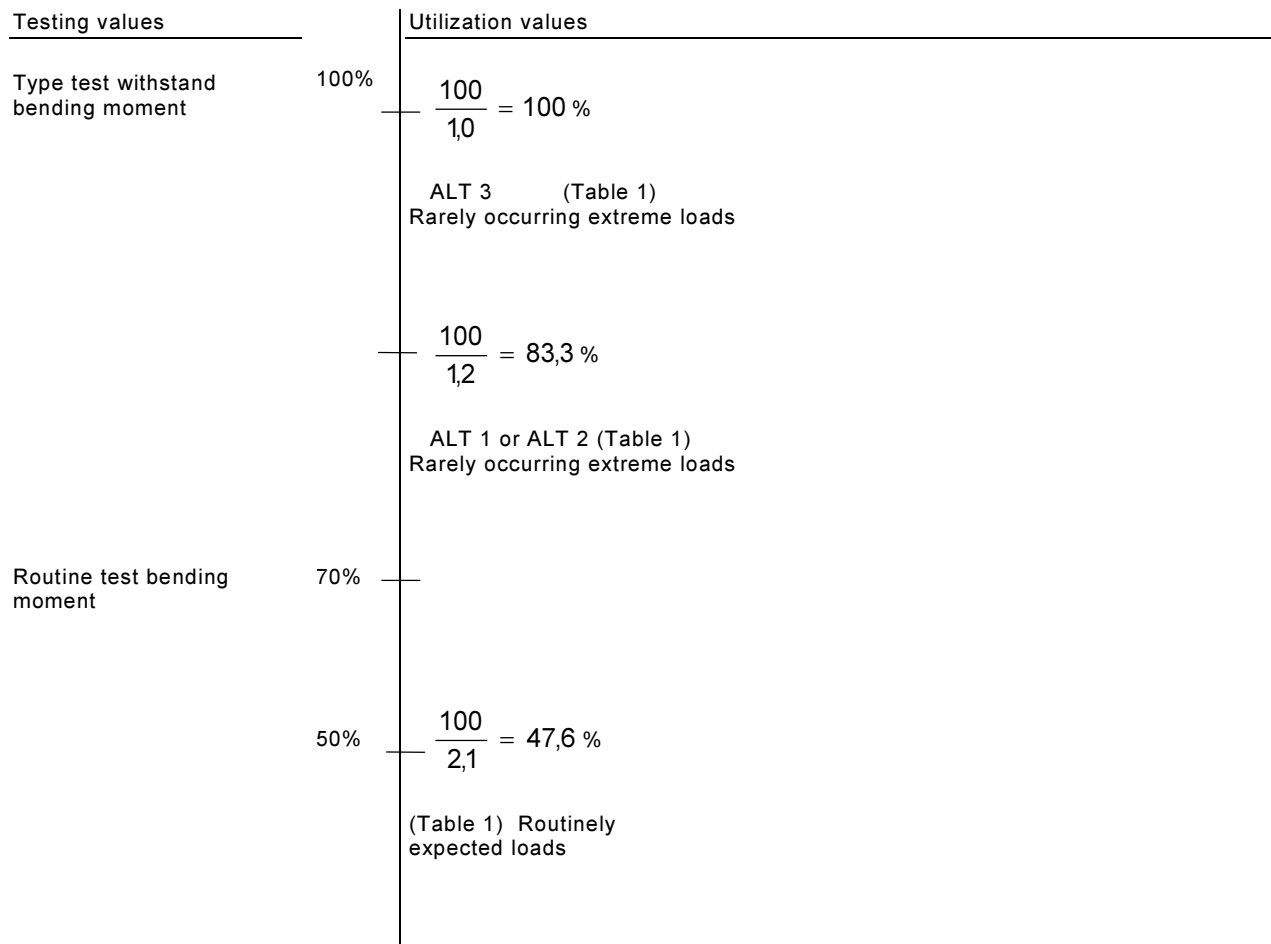


Figure 1 – Bending moments

IEC 1079/03

6 Classification of the tests, sampling rules and procedures

6.1 Classification of the tests

The tests are divided into three groups as follows.

- Type tests
- Sample tests
- Routine tests

6.1.1 Type tests

The type tests are intended to verify the main characteristics of a hollow insulator and/or a hollow insulator body, which depend mainly on its design. They are usually carried out on one hollow insulator and/or hollow insulator body, and only once for a new design or manufacturing process, and then subsequently repeated only when the design, material or manufacturing process is changed; when the change only affects certain characteristics, only the test(s) relevant to those characteristics need to be repeated. Moreover, it is not necessary

to perform all the type tests on a new design of hollow insulator and/or hollow insulator body if a test report is available for a hollow insulator and/or hollow insulator body of mechanically equivalent design. A mechanically equivalent design is the hollow insulator or hollow insulator body having identical manufacturing and design parameters, and having the following characteristics:

- the internal and external core diameters are the same;
- the design of the connection between the insulating component and the end fitting is the same;
- the shape and size of the parts of the end fittings which connect to the insulating components are the same;
- the nominal height does not differ by more than $\pm 20\%$.

NOTE 1 Since all factors (materials, manufacturing process, and dimensions) which influence the mechanical strength of hollow insulators or hollow insulator bodies should be the same for mechanical equivalence, the value of the bending moment strength, the tensile strength, and the torsional strength will then be the same as those for hollow insulators or hollow insulator bodies of mechanically equivalent designs, by which they are represented.

NOTE 2 When establishing mechanical equivalence of design, the effect of a significant difference in nominal external diameter due to change of shed overhang and of shed spacing may need to be considered.

The type tests shall be carried out on hollow insulators and/or hollow insulator bodies which meet the requirements of all the routine tests. When the insulators for type tests are taken from a lot offered for acceptance, they shall also serve as sample tests for that lot.

6.1.2 Sample tests

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

6.1.3 Routine tests

The routine tests are intended to eliminate defective units and are carried out during the manufacturing process. Routine tests shall be carried out on each hollow insulator and/or hollow insulator body.

6.2 Relevant tests for type, sample and routine tests

All hollow insulators or hollow insulator bodies intended for general use shall be tested according to tests given in Table 2.

All hollow insulators or hollow insulator bodies intended for use with permanent gas pressure shall be tested according to tests given in Table 3.

The series of tests to be conducted shall verify the characteristics of the hollow insulator or hollow insulator body, which are specified on the drawing. In addition, the purchaser and the manufacturer may agree to make tests other than those specified.

Additional routine tests such as verification of relevant dimensions (7.1) and mechanical tests (10.5) may be performed after agreement between manufacturer and purchaser.

Table 2 – Hollow insulators or hollow insulator bodies intended for general use – Relevant tests for type, sample and routine tests

Tests	Tests specified in Subclause	Type tests in Clause 8	Sample tests in Clause 9	Routine tests in Clause 10
Verification of dimensions and roughness of ground surfaces	7.1	–	x	–
Mechanical failing load test	7.2	x ^a	x ^a	–
Temperature-cycle test	7.3	x ^f	x	–
Porosity test	7.4	–	x ^b	–
Galvanizing test	7.5	–	x ^c	–
Visual examination	10.3	–	–	x
Electrical routine test	10.4	–	–	x
Mechanical routine test	10.5	–	–	x ^e
Routine thermal shock test	10.7	–	–	x ^d
x Required by this standard.				
^a This test is to verify the mechanical performance of the hollow insulator or hollow insulator body when defined by the relevant drawing. Such tests shall be carried out after the temperature-cycle test. ^b Applicable only to ceramic insulators. ^c Applicable only to hollow insulators assembled with hot dip galvanized metal fittings. ^d Applicable only to toughened glass insulators. ^e Applicable only when specified on the drawing. ^f Applicable only when mechanical failing load test is specified.				