BS EN 62231:2006

Composite station post insulators for substations with a.c. voltages greater than 1 000 V up to 245 kV — Definitions, test methods and acceptance criteria

The European Standard EN 62231:2006 has the status of a British Standard

ICS 29.080.10

British Standards

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 62231:2006. It is identical with IEC 62231:2006.

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 clause **8.4** in BS EN 62231:2007, which references BS EN 62217:2006 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 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 arrestor specifications in addition to the test in BS EN 62217:2006. 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.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2007

ISBN 978 0 580 50841 7

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 62231

December 2006

ICS 29.080.10

English version

Composite station post insulators for substations with a.c. voltages greater than 1 000 V up to 245 kV - Definitions, test methods and acceptance criteria
(IEC 62231:2006)

Isolateurs supports composites rigides à socle destinés aux postes à courant alternatif de tensions supérieures à 1 000 V jusqu'à 245 kV - Définitions, méthodes d'essai et critères d'acceptation
(CEI 62231:2006)

Verbundstützisolatoren für Unterwerke für Wechselspannung größer 1 kV bis 245 kV - Definitionen, Prüfmethoden und Annahmekriterien
(IEC 62231:2006)

This European Standard was approved by CENELEC on 2006-09-12. 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, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization

Comité Européen de Normalisation Electrotechnique

Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 62231:2006 E

Foreword

The text of document 36C/159/FDIS, future edition 1 of IEC 62231, 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 62231 on 2006-09-12.

This standard is to be used in conjunction with EN 62217:2006, *Polymeric insulators for indoor and outdoor use with a nominal voltage > 1 000 V - General definitions, test methods and acceptance criteria*.

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)	2007-07-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2009-10-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62231:2006 was approved by CENELEC as a European Standard without any modification.

CONTENTS

INTRODUCTION

Composite station post insulators consist of a cylindrical solid insulating core made of resin impregnated fibres, bearing the mechanical load, protected by an elastomer housing, the loads being transmitted to the core by metal fittings. Despite these common features, the materials used and the construction details employed by different manufacturers may be different.

Some tests have been grouped together as "design tests" to be performed only once for insulators of the same design. The design tests are performed in order to eliminate insulator designs, materials and manufacturing technologies not suitable for high-voltage applications. The influence of time on the electrical and mechanical properties of the complete composite station post insulator and its components (core material, housing material, interfaces, etc.) has been considered in specifying the design tests in order to ensure a satisfactory lifetime under normal service conditions.

The approach for mechanical testing under bending loads used in this Standard is based on IEC 61952. This approach uses the concept of a damage limit that is the maximum stress that can be developed in the insulator before damage begins to occur. Work is underway to validate the acoustic emission technique to determine the inception of damage.

In some cases, station post insulators can be subjected to a combination of loads. In order to give some guidance, Annex B explains how to calculate the equivalent bending moment in the insulators resulting from the combination of bending, tensile and compression loads.

Pollution tests, as specified in IEC 60507 and IEC 61245, are not included in this document, their applicability to composite station post insulators having not been proven. Such pollution tests performed on composite insulators do not correlate with experience obtained from service. Specific pollution tests for composite insulators are under consideration.

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 the manufacturer. IEC 61467 gives details of a.c. power arc testing of insulator sets.

Impulse (mechanical) loads in substation are typically caused by short-circuits. Post insulators are affected by forces due to the interaction of the currents circulating in conductors/busbars supported by insulators.

The impulse load or peak load may be evaluated using guidance found in the IEC 60865 series.

Work is in progress in CIGRE ESCC (Effects of Short-Circuit Currents) task force to review impulse loads caused by short-circuit currents in substations. The aim of this work is to introduce a new concept: the ESL factor (Equivalent Static Load factor) which is frequency dependent. The actual peak load may be replaced, in a first approximation, by the peak load times the ESL factor. This new value may be used as the MDCL in this document for the determination of the cantilever strength.

Radio interference and corona tests are not specified in this standard since the radio interference and corona performances are not characteristics of the insulator alone.

Composite hollow core station post insulators are currently not dealt with in this standard. IEC 61462 gives details of tests on hollow core composite insulators, many of which can be applied to such station post insulators.

COMPOSITE STATION POST INSULATORS FOR SUBSTATIONS WITH AC VOLTAGES GREATER THAN 1 000 V UP TO 245 kV – DEFINITIONS, TEST METHODS AND ACCEPTANCE CRITERIA

1 Scope and object

This International Standard applies to composite station post insulators consisting of a load bearing cylindrical insulating solid core made of resin impregnated fibres, a housing (outside the insulating solid core) made of elastomer material (e.g. silicone or ethylene-propylene) and end fittings attached to the insulating core. Composite station post insulators covered by this standard are subjected to cantilever, torsion, tension and compression loads. They are intended for substations with a.c. voltages greater than 1 000 V up to 245 kV.

The object of this standard is

– to define the terms used,

– to prescribe test methods,

– to prescribe acceptance or failure 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 60050-471, *International Electrotechnical Vocabulary (IEV) – Chapter 471: Insulators*

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

IEC 60168:1994, *Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V*

IEC 62217, *Polymeric insulators for indoor and outdoor use with a nominal voltage greater than 1000 V – General definitions, test methods and acceptance criteria*

ISO 1101, *Technical drawings – Geometrical tolerancing – Tolerancing of form, orientation, location and run-out – Generalities, definitions, symbols, indications on drawings*

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 station post insulator
post insulator consisting of a solid load bearing cylindrical insulating core, a housing and end fittings attached to the insulating core

3.2
core (of an insulator)
central insulating part of an insulator which provides the mechanical characteristics

NOTE The housing and sheds are not part of the core.

[IEV 471-01-03]

3.3
housing
external insulating part of composite insulator providing necessary creepage distance and protecting core from environment

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

[IEV 471-01-09]

3.4
housing profile
shape and dimensions of the housing of the composite station post insulator which include the following:

– shed overhang(s)
– shed thickness at the base and at the tip
– shed spacing
– shed repetition
– shed inclination(s)

3.5
shed (of an insulator)
insulating part, projecting from the insulator trunk, intended to increase the creepage distance. The shed can be with or without ribs

[IEV 471-01-15]

3.6
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]

3.7
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]

3.8
arcing distance
shortest distance in 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.

3.9
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.

[IEC 62217]

3.10
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, modified]

3.11
connection zone
zone where the mechanical load is transmitted between the insulating body and the end fitting

[IEC 62217]

3.12
coupling
part of the fixing device which transmits load to the hardware external to the insulator

[IEC 62217]

3.13
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]

3.14
erosion
irreversible and non-conducting degradation of the surface of the insulator that occurs by loss of material which can be uniform, localized 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]

3.15
delamination (of the core)
loss of bonding between fibres and matrix

3.16
crack
any internal fracture or surface fissure of depth greater than 0,1 mm

[IEC 62217]

3.17
specified cantilever load
SCL
cantilever load which can be withstood by the insulator when tested under the prescribed conditions

3.18
maximum design cantilever load
MDCL
cantilever load level above which damage to the insulator begins to occur and that should not be exceeded in service

3.19
specified torsion load
SToL
torsion load level which can be withstood by the insulator when tested under the prescribed conditions

3.20
maximum design torsion load
MDToL
torsion load level above which damage to the insulator begins to occur and that should not be exceeded in service

3.21
specified tension load
STL
tension load which can be withstood by the insulator when tested under the prescribed conditions

3.22
maximum design tension load
MDTL
tension load level above which damage to the insulator begins to occur and that should not be exceeded in service

3.23
specified compression load
SCoL
compression load which can be withstood by the insulator when tested under the prescribed conditions

3.24
buckling load
compression load that induces buckling of the insulator core

3.25
maximum design compression load
MDCoL
load level above which damage to the insulator begins to occur and that should not be exceeded in service

3.26
failing load (of a composite station post insulator)
maximum load that is reached when tested under the prescribed conditions

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

3.27
overall length
distance from flange face to flange face of the end fitting

3.28
puncture (of an insulator)
permanent loss of dielectric strength due to a disruptive discharge passing through the solid insulating material of an insulator

[IEV 471-01-14]

3.29
residual deflection
the difference between the initial deflection, if any, of the tip of the insulator measured prior to cantilever load application and the final deflection measured after load release

NOTE The residual deflection may depend on the duration of application of the load and on the time duration between the load release and the measurement of the deflection.

3.30
residual angular displacement
the difference between the initial angular displacement, if any, of one of the insulator end fitting with respect to the other insulator end fitting measured prior to the application of the torsion load and the final angular displacement measured after torsion load release

NOTE The residual angular displacement may depend on the duration of application of the torsion load and on the time duration between the torsion load release and the measurement of the displacement.

4 Identification

The manufacturer's drawing shall show the relevant dimensions and values necessary for identifying and testing the insulator in accordance with this standard. The drawing shall also show applicable manufacturing tolerances. In addition, the relevant IEC designation, when available, shall figure on the drawing.

Each insulator shall be marked with the name or trademark of the manufacturer and the year of manufacture. In addition, each insulator shall be marked with at least the Maximum Design Cantilever Load (MDCL) (example: MDCL: 4 kN) or, when available, with the relevant IEC designation. These markings shall be legible and indelible.

NOTE At present there is no IEC standard giving designations of composite station post insulators.

5 Environmental conditions

See description in IEC 62217.

6 Information on transport, storage and installation

See description in IEC 62217.

7 Classification of tests

The tests are divided into four groups as follows:

7.1 Design tests

These tests are intended to verify the suitability of the design, materials and manufacturing technology (see Annex A for notes on the concept of damage limit).

A composite station post insulator design is defined by

- materials of the core, housing and manufacturing method;
- material of the end fittings, their design and method of attachment;
- 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 done according to Table 1.

Table 1 – Tests to be carried out after design changes

IF the insulator design changes the...		**THEN** the following design tests shall be repeated:							
		8.2	8.3	8.4	8.4	8.4	8.4	8.5	8.5
		Interfaces and connections of end fittings	Assembled core load tests	Hardness test	Accelerated weathering	Tracking and erosion test	Flammability test	Dye penetration test	Water diffusion test
1	Housing materials	X		X	X	X	X		
2	Housing profile [1)]					X			
3	Core material	X	X					X	X
4	Core diameter	X	X					X	X
5	Manufacturing process	X	X	X	X	X		X	X
6	End fitting material	X	X						
7a	End fitting connection zone design	X	X						
7b	End fitting coupling design		X						
7c	Core-housing-end fitting interface design	X							
8	End fitting method of attachment to core	X	X						

[1)] The following variation of the housing profile within following tolerances do not constitute a change:

Overhang:	±10 %	Spacing:	±10 %
Diameter:	+15 %, –0 %	Mean inclination:	±3 °
Thickness at base and tip:	±15 %	Shed repetition:	identical

When a composite station post 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 design, and the same method of attachment;

c) same or greater minimum layer thickness of the housing over the core (including a sheath where used) within a tolerance of ±15 %;

d) same or smaller stress under mechanical loads;

e) same or greater cross-diameter of the core;

f) same housing profile parameters, see the table footnote in Table 1.

7.2 Type tests

These tests are intended to verify the main characteristics of a composite station post insulator, which depend mainly on its shape and size. Type tests shall be applied to composite insulators belonging to an already qualified design. The type tests shall be repeated only when the type of the composite insulator is changed.

Electrically, an insulator type is defined by the

– arcing distance,
– creepage distance,
– housing profile.

The electrical type tests shall be performed only once on insulators satisfying the above design criteria for one type and shall be performed with arcing and field grading devices, if they are an integral part of the insulator type.

The electrical type tests shall be repeated only when one or more of the above characteristics is changed.

Mechanically, an insulator type is defined by the:

– length (only for the compression and buckling withstand load test),
– core diameter and material,
– design and method of attachment of the end fittings.

The mechanical type tests shall be performed only once on insulators satisfying the above criteria for each type.

The mechanical type tests shall be repeated only when one or more of the above characteristics is changed.

7.3 Sample tests

These tests are intended to verify the characteristics of composite station post insulators, which depend on the quality of manufacture and materials used. They shall be made on insulators taken at random from lots offered for acceptance.

7.4 Routine tests

These tests are intended to eliminate composite station post insulators with manufacturing defects. They shall be made on every composite station post insulator to be supplied.

8 Design tests

8.1 General

The design tests shall be performed only once and the results shall be recorded in a test report. Each test can be performed independently on new test specimens where appropriate. The composite station post insulator of a particular design shall be deemed qualified only when the insulators or test specimens pass all the design tests.

8.2 Tests on interfaces and connections of end fittings

See IEC 62217.

8.2.1 Test specimens

See IEC 62217.

8.2.2 Reference voltage and temperature for verification tests

See IEC 62217.

8.2.3 Reference dry power frequency test

See IEC 62217.

8.2.4 Thermal-mechanical pre-stressing

The three specimens shall be submitted to a mechanical load in two opposite directions and to temperature cycles as described in Figure 1. The 24 h temperature cycle shall be repeated twice. Each temperature cycle has two temperature levels with a duration of at least 8 h, one at +50 °C ± 5 K, the other at –35 °C ± 5 K. The cold period shall be at a temperature at least 85 K below the value actually applied in the hot period. The pre-stressing can be conducted in air or any other suitable medium.

The load applied to the specimens shall correspond to the MDCL.

The load shall be applied perpendicularly to the insulator's axis as near as possible to the normal load application point, either directly at the normal conductor position or at a hardware attachment point. When the load is not applied at the normal application point, it shall be corrected to produce the same bending moment at the base of the insulator as the one exerted by the MDCL.

The direction of the cantilever load applied to the specimens shall be reversed once, generally at the cooling passage through ambient temperature as described in Figure 1. The cycles may be interrupted for the load direction reversal and for maintenance of the test equipment for a total duration of 2 h. The starting point after any interruption shall be the beginning of the interrupted cycle.

NOTE The temperatures and loads in this pre-stressing are not intended to represent service conditions; they are designed to produce specific reproducible stresses in the interfaces on the insulator.

8.2.5 Water immersion pre-stressing

See IEC 62217.

8.2.6 Verification tests

See IEC 62217.

8.3 Assembled core load tests

Extreme service temperatures may affect the mechanical behaviour of composite insulators.

A general rule to define “extreme high or low” insulator temperatures is not available at this time; for this reason the supplier should always specify service temperature limitations.

NOTE Whenever the insulators are subjected to very high or low temperatures for long periods of time, it is advisable that customer and supplier agree on a mechanical test at higher or lower temperatures than that mentioned in this standard.

8.3.1 Test for the verification of the maximum design cantilever load (MDCL)

8.3.1.1 Test procedure

Three insulators made on the production line using the standard end fittings shall be selected. The overall length of the insulators shall be at least 8 times the diameter of the core, unless the manufacturer does not have facilities to make such a length. In this case, the length of insulator shall be as near as possible to the prescribed length range.

The base end-fitting has to be fixed rigidly. The insulators shall be gradually loaded to 1,1 times the MDCL rating at a temperature of 20 °C ± 10 K and held for 96 h. The load shall be applied to the insulators at the conductor position, perpendicular to the direction of the conductor, and perpendicular to the core of the insulators.

At 24 h, 48 h, 72 h and 96 h, the deflection of the insulators at the point of application of the load shall be recorded, as additional information.

After removal of the load, the steps below shall be followed:

– visually inspect the base end fitting for cracks or permanent deformation,
– check that threads of the end fitting are re-usable,
– if required, measure the residual deflection.

Cut each insulator 90° to the axis of the core and about 50 mm from the base of the end fitting, then cut the base end fitting part of the insulator longitudinally into two halves in the plane of the previously applied cantilever load. The cut surfaces shall be smoothed by means of fine abrasive cloth (grain size 180).

– visually inspect the cut halves for cracks and delaminations,
– perform a dye penetration test according to ISO 3452 to the cut surfaces to reveal cracks.

8.3.1.2 Acceptance criteria

Observation of any cracks, permanent deformation or delaminations shall constitute failure of the test.

8.3.2 Test for the verification of the maximum design torsion load (MDToL)

8.3.2.1 Test procedure

Three insulators made on the production line using the standard end fittings shall be selected. The overall length of the insulators shall be at least 8 times the diameter of the core, unless the manufacturer does not have facilities to make such a length. In this case, the length of insulators shall be as near as possible to the prescribed length range.

The torsion load shall be applied to the insulators perpendicularly with the axis of the core of the insulator. No bending moment should be applied. The insulators shall be gradually loaded to 1,1 times the MDToL rating at a temperature of 20 °C ± 10 K and held for 30 min. The angular displacement shall be measured at 30 min as additional information. An acceptable value of the angular displacement shall be agreed between manufacturer and user.

NOTE In a torsion test, the angular displacement is proportional to the length of the core between the end fittings.

An example of a test arrangement can be found in Annex C.

After removal of the load, the steps below shall be followed:

– if required, measure the residual angular displacement,
– visually inspect the end fittings for cracks or permanent deformation,
– check that threads of the end fitting are re-usable,
– cut each insulator 90° to the axis of the core at about 50 mm from the end fittings, and in the middle part of this cut section,
– polish the cut surfaces by means of fine abrasive cloth (grain size 180),
– visually inspect the cut surfaces for cracks and delaminations,
– perform a dye penetration test according to ISO 3452 to the cut surfaces to reveal cracks or delaminations.

8.3.2.2 Acceptance criteria

Observation of any cracks, permanent deformation or delaminations shall constitute failure of the test.

8.3.3 Verification of the specified tension load (STL)

8.3.3.1 Test procedure

Three insulators made on the production line using the standard end fittings shall be selected. The overall length of the insulators shall be at least 8 times the diameter of the core, unless the manufacturer does not have facilities to make such a length. In this case, the length of insulator shall be as near as possible to the prescribed length range.

The tensile load shall be applied to the insulators in line with the axis of the core of the insulator at a temperature of 20 °C ± 10 K. The load shall be increased rapidly but smoothly from zero to approximately 75 % of the specified tensile load and shall then be gradually increased in a time between 30 s and 90 s until the specified tensile load is reached. If 100 % of the STL is reached in less than 90 s, the load (100 % of STL) shall be maintained for the remainder of the 90 s.

8.3.3.2 Acceptance criteria

The test shall be regarded as passed if there is no evidence of

– pullout or slip of the core from the end fitting, or
– breakage of the end fitting.

8.4 Tests on shed and housing material

See IEC 62217.

8.5 Tests on the core material

See IEC 62217.

These tests can be carried out on specimens either with or without housing material.

9 Type tests

Insulators made on the production line using the standard end fittings shall be selected.

9.1 Verification of dimensions

Unless otherwise agreed, a tolerance of

± (0,04 x *d* + 1,5) mm when $d \leq 300$ mm, or

± (0,025 x *d* + 6,0) mm when $d > 300$ mm with a maximum tolerance of 50 mm

shall be allowed on all dimensions for which specific tolerances are not requested (*d* being the dimensions in millimetres).

The measurement of creepage distance shall be related to the design dimensions and tolerances as determined from the insulator drawing, even though this dimension may be greater than the value originally specified by the purchaser. When the creepage distance is specified as a minimum value, the negative tolerance is zero.

Tolerances of parallelism, eccentricity, angular deviation are given in Annex D.

9.2 Electrical tests

Tests in accordance with 9.2.1 and 9.2.2 shall be performed with the insulator in the position in which it will be used in service (vertical or horizontal). If field-grading devices are used in service they shall be used in the tests.

Interpolation of electrical test results may be used for insulators of intermediate length as long as the factor between the arcing distances of the insulators whose results form the end points of the interpolation range is less than or equal to 1,5. Extrapolation is not allowed.

9.2.1 Dry lightning impulse voltage test

The post insulator shall be tested under the conditions prescribed in 4.1, 4.2 and 4.4.1 of IEC 60168. The impulse generator shall be adjusted to produce a 1,2/50 impulse (see IEC 60060-1).

Impulses of both positive and negative polarity shall be used. However, when it is evident which polarity will give the lower flashover voltage, it shall be sufficient to test with that polarity.

Two test procedures are in common use for the lightning impulse test:

– the withstand voltage procedure with 15 impulses;
– the 50 % flashover voltage procedure.

NOTE The 50 % flashover voltage procedure gives more information.

The test procedure selected shall be agreed between the purchaser and the manufacturer.

9.2.1.1 Withstand voltage test using the withstand voltage procedure

The withstand voltage test shall be performed at the specified voltage corrected for the atmospheric conditions at the time of test (see 4.2.2 of IEC 60168). Fifteen impulses shall be applied to the post insulator.

The acceptance criteria are as follows:

– the station post insulator passes the test if the number of flashovers does not exceed two for each series of 15 impulses.

The station post insulator shall not be damaged by these tests but slight marks on the surface of the housing shall be permitted.

9.2.1.2 Voltage test using the 50 % flashover voltage procedure

The lightning impulse withstand voltage shall be calculated from the 50 % lightning impulse flashover voltage, determined by the up-and-down method described in IEC 60060-1.

The 50 % lightning impulse voltage shall be corrected in accordance with 4.2.2 of IEC 60168.

The acceptance criteria are as follows:

the station post insulator passes the test if the 50 % lightning impulse flashover voltage is not less than $(1/(1 - 1{,}3\ \sigma)) = 1{,}040$ times the specified lightning impulse withstand voltage, where σ is the standard deviation (assumed equal to 3 %).

The station post insulator shall not be damaged by these tests, but slight marks on the surface of the housing shall be permitted.

9.2.2 Wet power frequency withstand voltage test

9.2.2.1 Test procedure

The test circuit shall be in accordance with IEC 60060-1.

The station post insulator shall be tested under the conditions prescribed in 4.1, 4.2, 4.3 and 4.4.1 of IEC 60168.

The test voltage to be applied to the station post insulator shall be the specified wet power frequency withstand voltage corrected for the atmospheric conditions at the time of test (see 4.2.2 of IEC 60168). The test voltage shall be maintained at this value for 1 min. As additional information, the voltage can be raised until the flashover occurs.

9.2.2.2 Acceptance criteria

The station post insulator passes the test if no flashover or puncture occurs during the test.

NOTE If flashover occurs on the insulator tested, then a second test on the same unit may be performed, after verifying the rain conditions.

9.2.2.3 Wet power frequency flashover voltage

To provide information, when agreed between the purchaser and the manufacturer, the wet flashover voltage of the station post insulator may be determined by increasing the voltage gradually, from about 75 % of the wet power-frequency withstand voltage with a rate of rise of about 2 % of this voltage per second. The wet flashover voltage is the arithmetic mean of five consecutive readings, and the value, after correction to standard atmospheric conditions (see 4.2.2 of IEC 60168), shall be recorded.

9.3 Mechanical tests

9.3.1 Cantilever failing load test

Interpolation of test results may be used for insulators of intermediate length as long as the factor between the moment arm of the insulators whose results from the end points of the interpolation range is less than or equal to 1,5. Extrapolation is not allowed.

This test shall be performed at 20 °C ± 10 K and is used to determine the failing load of a complete station post insulator.

9.3.1.1 Test specimens

Three insulators made on the production line using the standard base fitting shall be selected.

9.3.1.2 Test procedure

It may be necessary to use special bolts to hold securely the base plate to the test jig. The cantilever load shall be increased rapidly but smoothly from zero to approximately 75 % of the specified cantilever load (SCL) of the post insulators and then shall be gradually increased in a time between 30 s and 300 s until breakage of either the core or the metal fitting occurs. Precautions shall be taken to keep the direction of application of the load as perpendicular as possible to the axis of the unloaded insulator.

9.3.1.3 Acceptance criteria

The three failing load values shall be greater than the SCL.

NOTE The mechanical failing load of a composite station post insulator is defined as the maximum load that is reached during the test. The failure mode is recorded in the test report.

9.3.2 Specified tension load test

This test shall be performed at 20 °C ± 10 K and is used to determine the specified tension load of a complete station post insulator. Short insulators may be used for this test.

9.3.2.1 Test specimens

Three insulators made on the production line using the standard end-fittings shall be selected.

9.3.2.2 Test procedure

The tension load shall be applied in the direction of the longitudinal axis of the insulator. The load shall be increased relatively quickly, but smoothly, from 0 kN to approximately 75 % of the STL. The load shall then be gradually increased to the STL in a period of no less than 30 s but no greater than 90 s. If 100 % of the STL is reached in less than 90 s, the load (100 % of STL) shall be maintained for the remainder of the 90 s.

9.3.2.3 Acceptance criteria

No evidence of partial, or complete, pullout of the core from the end fitting(s).

No evidence of end fitting breakage.

9.3.3 Compression and buckling withstand load test

This test is only required if compression is a major component of the overall service mechanical loads and shall be performed by agreement between the manufacturer and the user.

This test shall be performed at 20 °C ± 10 K and is used to determine the withstand load of a complete station post insulator.

9.3.3.1 Test specimen

One insulator made on the production line using the standard end fittings shall be selected.

9.3.3.2 Test procedure

In service, the coupling of the station post insulator belongs to one of the cases 1 to 4 in Annex E. In the laboratory, the post insulator shall be subjected to a compression load along their axis, according to any one of the cases 1 to 4 in Annex E.

The test load is given by SCoL multiplied by the correction factor CF given in Annex E.

The load applied to the insulator shall be increased rapidly but smoothly (within 90 s) from zero to approximately 75 % of the test load of the post insulators and then shall be gradually increased in a time between 30 s and 300 s up to the test load.

Precautions shall be taken to keep the direction of the load as close as possible to the axis of the unloaded insulator. It may be necessary to use special bolts or fixing arrangements to hold securely both end fittings to the test set-up.

9.3.3.3 Acceptance criteria

The insulator shall withstand the test load without visual damage.

10 Sample tests

10.1 General rules

For the sample tests, two groups of samples shall be used, E1 and E2. The sizes of these samples are indicated in Table 2. If more than 2 000 insulators are concerned, they shall be divided into an optimum number of lots of less than 2 000 insulators. The results of the tests shall be evaluated separately for each lot.

The insulators shall be selected from the lot at random. The purchaser has the right to make the selection. The samples shall be subjected to the applicable sample tests.

The sample tests are as follows:

– verification of the dimensions (E1 + E2);
– galvanizing test (E1 + E2);
– verification of the specified mechanical loads (E1).

In the event of a failure of the sample to satisfy a test, the re-testing procedure shall be applied as prescribed in 10.5.

Table 2 – Number of samples for sample tests

Lot size	Sample size	
N	E1	E2
N ≤ 100	By agreement	By agreement
100 < *N* ≤ 300	2	1
300 < *N* ≤ 2 000	4	3

Insulators of sample E2 only can be used in service only if the galvanising test is performed with the magnetic method.

10.2 Verification of dimensions (E1 + E2)

On all selected insulators, the dimensions of the composite station post insulator shall comply with the values shown on the drawing, within specified tolerances for geometry, form and position. Unless otherwise specified, the tolerances given in Annex D and in 9.1 of this document shall be used. The drawing can show points between which the creepage distance is specified.

The measurement of creepage distance shall be related to the design dimensions as determined from the insulator drawing, even though this dimension may be greater than the value originally specified by the purchaser. When the creepage distance is specified as a minimum value, the negative tolerance is zero.

10.3 Galvanizing test (E1 + E2)

This test shall be performed on all galvanised parts in accordance with IEC 60168.

10.4 Verification of the specified mechanical loads (E1)

10.4.1 Verification of the specified cantilever load (SCL) (E1 divided by 2)

10.4.1.1 Test procedure

It may be necessary to use special bolts to hold securely the base plate to the test jig. The cantilever load shall be applied to the insulator at the conductor position, perpendicular to the direction of the conductor, and perpendicular to the core of the insulator.

The load shall be increased rapidly but smoothly from zero to approximately 75 % of the specified cantilever load (SCL) of the post insulator and then shall be gradually increased in a time between 30 s and 90 s until the SCL is reached. If the SCL is reached in less than 90 s, the load shall be maintained for the remainder of the 90 s.

10.4.1.2 Acceptance criteria

The insulator shall be regarded as passed if the SCL can be maintained for the required time.

In order to obtain more information from the test, the load may then be increased until failure of the core or breakage of the metal fitting occurs. The failing load values and the failure modes shall be recorded.

10.4.2 Verification of the specified tensile load (STL) (E1 divided by 2)

10.4.2.1 Test procedure

The tension load shall be applied in the direction of the longitudinal axis of the insulator. The load shall be increased relatively quickly, but smoothly, from 0 kN to approximately 75 % of the STL. The load shall then be gradually increased to the STL in a period of no less than 30 s but no greater than 90 s. If 100 % of the STL is reached in less than 90 s, the load (100 % of STL) shall be maintained for the remainder of the 90 s.

10.4.2.2 Acceptance criteria

No evidence of partial, or complete, pullout of the core from the end fitting(s).

No evidence of end fitting breakage.

10.5 Re-testing procedure

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 the tests shall be subjected to re-testing.

The re-testing shall comprise the test in which failure occurred.

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 shall be considered as not complying with this standard 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. The sorted lot may then be resubmitted for testing. The number then selected shall be three times the first quantity chosen for tests. If any insulator fails during this re-testing, the complete lot shall be considered as not complying with this standard.

11 Routine tests

11.1 Identification of the station post insulator

Each insulator shall be marked with the name or trademark of the manufacturer and the year of manufacture. In addition, each insulator shall be marked according to Clause 4. These markings shall be legible and indelible.

11.2 Visual examination

The examination shall be made on each insulator. The mounting of the metal fittings on the insulating parts shall be in accordance with the drawings. The colour of the insulator shall be approximately as specified in the drawings.

The following imperfections shall be acceptable on the insulator surface:

– superficial defects of area less than 25 mm^2 (the total defective area not exceeding 0,2 % of the total insulator surface) and depth or height less than 1 mm.

11.3 Tensile load test

Every insulator shall be subjected, at ambient temperature, to a tensile load of at least 50 % of the specified tensile load (STL) for at least 10 s. If no STL is given for the insulator, an STL of at least 10 kN shall be assumed.

No pullout or slip of the core from the end fitting shall occur.

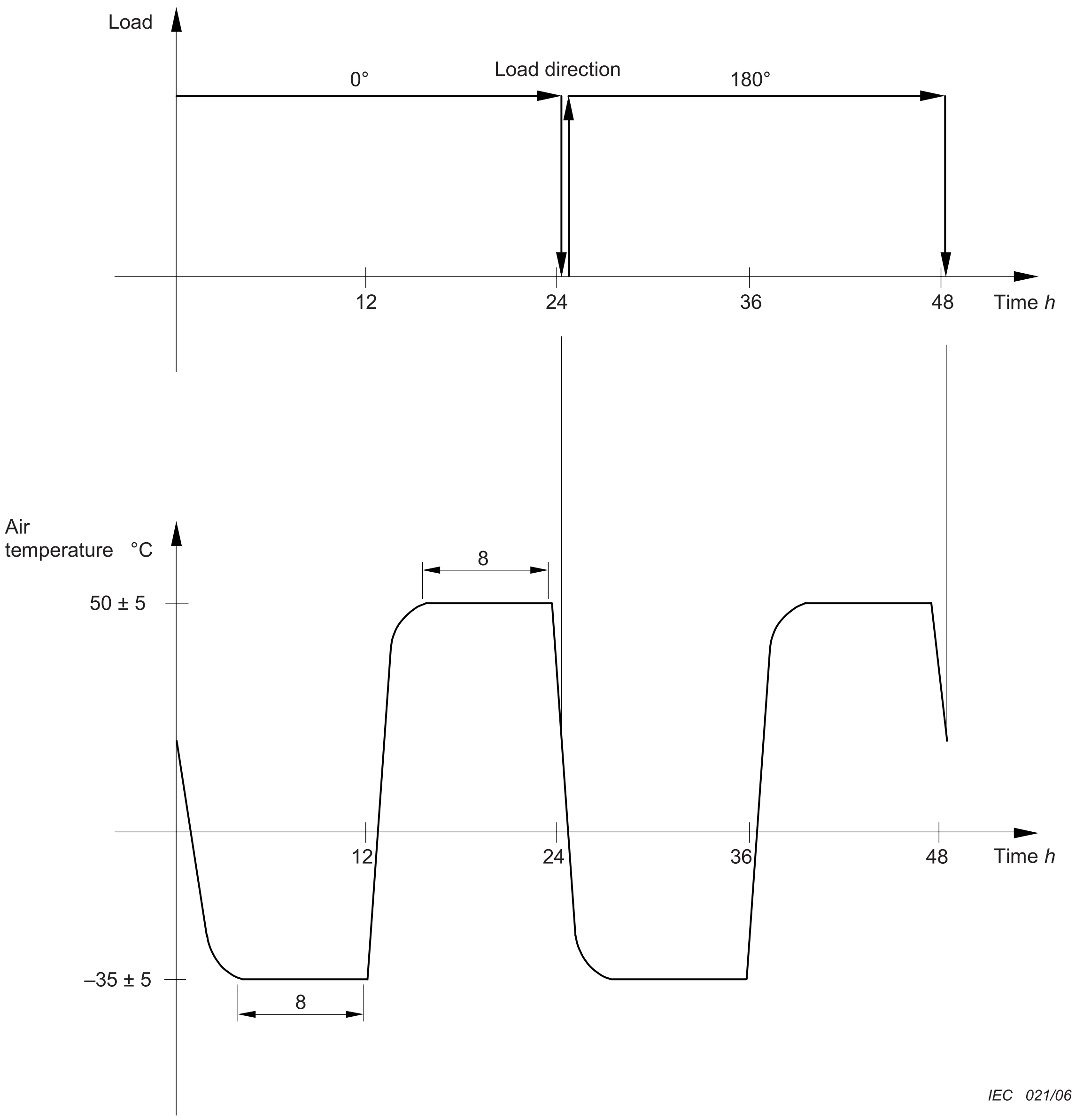


Figure 1 – Thermal-mechanical pre-stressing test – Typical cycles

Annex A
(informative)

Notes on the mechanical loads and tests

This annex presents some comments on the various mechanical tests of this standard.

A.1 Design tests

For a family of station post insulators, the maximum design bending stress or moment (generally expressed in megapascals, MPa, or newton metres, N.m, respectively) limits the cantilever loads. The core and the end fittings define a station post insulator family as each family may contain insulators of different length.

The maximum design bending stress (resulting from MDCL) is the maximum useable bending stress of the insulator. For each family of station post insulators, a 96 h cantilever load test verifies that the core can sustain the maximum design bending stress without damage. This test, as a design test, needs to be performed only once on a representative length insulator for each insulator family.

In applications where torsion loads are the major load component, a 30-min torsion load test verifies that the core can sustain the maximum design torsion load without damage.

In addition, a tensile load test is required to verify the design of the end fittings together with the method of attachment.

A.2 Type tests

The core diameter, insulator coupling length and method of attachment of the end fittings mechanically define a station post insulator type. A maximum design cantilever load (MDCL), in kN (kilonewtons), is assigned to each station post insulator type usually by interpolation from the design MDCL verification test. For each station post insulator type, the assigned MDCL is the allowable ultimate limit for service loads. A test to verify the MDCL for each station post insulator type is not included in this standard as such a type test would be uneconomic and time consuming.

The cantilever failing load is determined with a short time load type test. This standard requires that the cantilever failing load shall exceed the specified cantilever load (SCL), which is the short-time withstand strength of the insulator. The cantilever failing load verifies that the rod or base end fitting does not fail at the specified cantilever load, though damage to the core may occur.

A compression or buckling test may be performed to verify that the insulator can sustain the specified compression load without visual damage.

A.3 Sample test

A short-time cantilever load test has been included as a sample test to verify the specified cantilever load (SCL). A tension load test (STL) verifies that the end fittings are correctly fastened to the core and that they can sustain the specified load. These tests are performed on production insulators complete with production end fittings. They are simple and relatively quick to perform.

A.4 Routine tensile test

A routine tensile test is specified instead of a routine bending test. This test provides some verification of the end fitting attachment process during production and is similar to the routine test performed on composite suspension insulators. This test is used since, unlike porcelain, composite station post insulators are not made with brittle materials, and consequently a routine bending test at any level below the MDCL would not give any useful information.

By contrast with suspension insulators, this test may be more difficult to perform with some designs of end fittings and mounting bases. This difficulty arises since some designs of end fittings impose an unbalanced tensile load on the insulator. Care should be taken to ensure that the resulting load is applied in line with the axis of the insulator.

Annex B
(informative)

Determination of the equivalent bending moment caused by combined cantilever and compression (tension) loads

B.1 Introduction

This annex provides guidance for applications where the compression load is not dominant and will not lead to buckling of the station post insulator. The torsion load is also deemed to have no significant influence on the combined loading of the insulator.

This annex does not cover cases where the compression and/or torsion loads are significant compared to the bending load.

In cases where the bending load on the station post insulator is dominant, the corresponding stress may be significantly modified by the additional stress caused by the simultaneous application of a compression (or tension) load. The bending moment corresponding to the combination of these loads must not exceed the moment which corresponds to the MDCL.

The following clauses give information on calculating the approximate equivalent bending moment when station post insulators are submitted to combined loads.

The following notation is used:

Co, T, C	applied compression, tension and cantilever loads (N);
M_C	resulting moment in the post under compression;
M_T	resulting moment in the post under tension;
d	distance from the point of application of the load to the top edge of the metal base fitting in metres (m);
E	longitudinal Young's modulus (Pa or N m^{-2});
I	moment of inertia of the rod (m) to the fourth power (for a solid round rod of diameter *D*: $I = \pi D^4/64$).

NOTE The values for Young's modulus and for the moment of inertia (or the real diameter) should be supplied by the manufacturer.

B.2 Maximum allowable bending moment, m_{max}

The maximum design cantilever load of a composite station post insulator induces the maximum allowable bending moment m_{max} = MDCL x *d*. The maximum stress associated with this bending moment must not produce any damage to the insulator core.

The maximum combined stress is the maximum stress resulting from the simultaneously applied cantilever and compression (or tension) loads. In service, the various combinations of loads must not produce a bending moment that is greater than the bending moment induced by the MDCL.

B.3 Combined loading of station post insulators

The following formulae allow the determination of the moment in the insulator when submitted to single or combined loads. It should be noted that the accuracy of these formulae depends on the deflection. The more the moment approaches the MDCL, the less accurate they become.

It should also be noted that the applied loads can induce damaging stress levels in the end fittings or accessories even when the moment in the insulator is at an acceptable level.

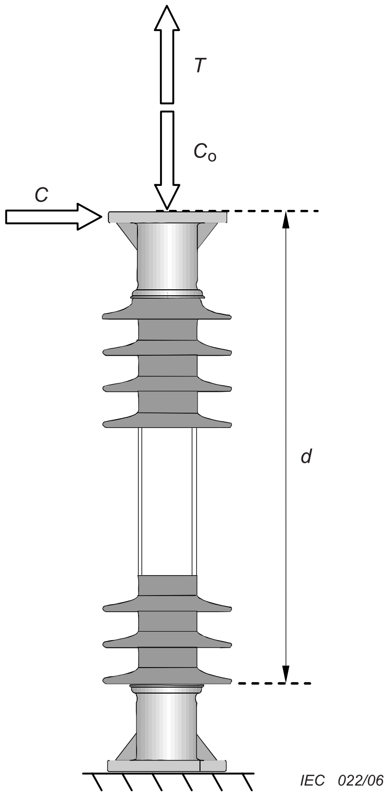


Figure B.1 – Combined loads applied to station post insulators

A – Compression case

The cantilever *(C)* component of the load applies a cantilever moment to the insulator; the compression load *(Co)* is taken as being applied to the head of the insulator toward its base. The moment resulting from the application of these two forces is given by

$$M_{Co} = \left[C^2\ EI/Co\right]^{1/2} \tan \left[d\ (Co/EI)^{1/2}\right]$$

In service, M_{Co} should not exceed $m_{\max}$.

B – Tension case

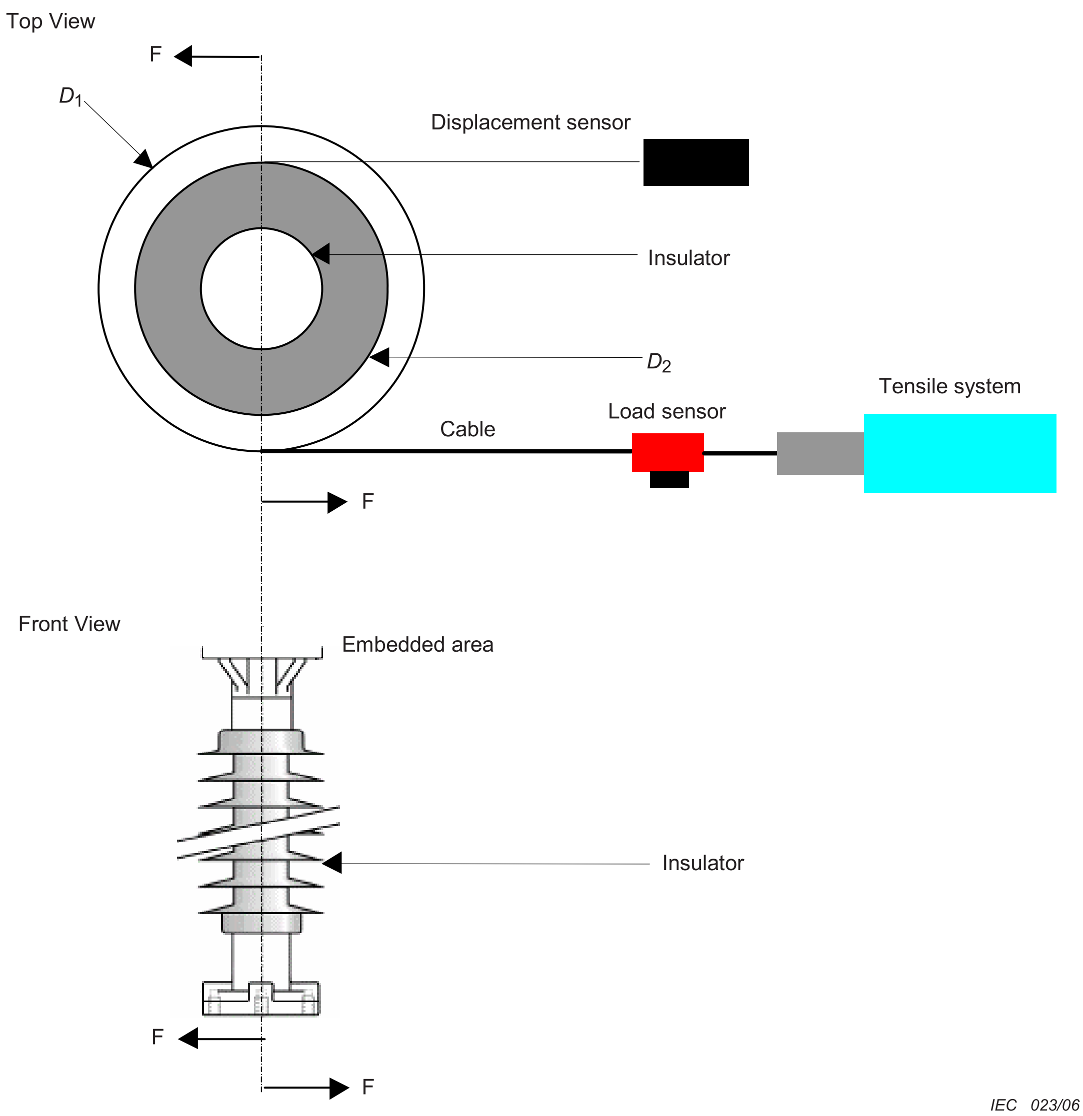
The cantilever *(C)* component of the load applies a cantilever moment to the insulator; the tension load *(T)* is taken as being applied to the head of the insulator away from its base. The moment resulting from the application of these two forces is given by

$$M_T = \left[C^2\ EI/T\right]^{1/2} \tanh \left[d\ (T/EI)^{1/2}\right]$$

In service, M_T should not exceed $m_{\max}$.

Annex C
(informative)

Example of torsion load test arrangement



One example of the mounting arrangement for the torsion load test could be as follows:

Torsion moment *Mt*: $Mt = F \times D_1/2$.

Linear displacement *d*

Angular displacement α

$\alpha = 2d/D_2$

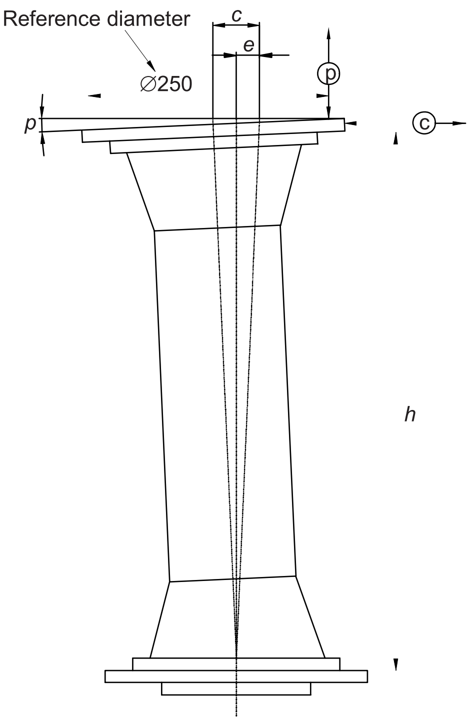
where α is in radians

Annex D
(normative)

Tolerances of form and position

The following Figures D.1 to D.3 give tolerances of form and position for composite station post insulators. Figure D.1 shows a typical jig for measurement of parallelism, coaxiality, concentricity and eccentricity along with the relative tolerances. Figures D.2 and D.3 show two examples of methods of measuring the angular deviation of the fixing holes; Figure D.4 summarizes the applicable tolerances according to standard drawing practice (ISO 1101).

Guidelines on the methods of measurement can be found in IEC 60168.



Legend

Parallelism of the end faces:

for $h \leq 1$ m, $p \leq 0,5$ mm
for $h > 1$ m, $p \leq 0,5\,h$ mm with h in m

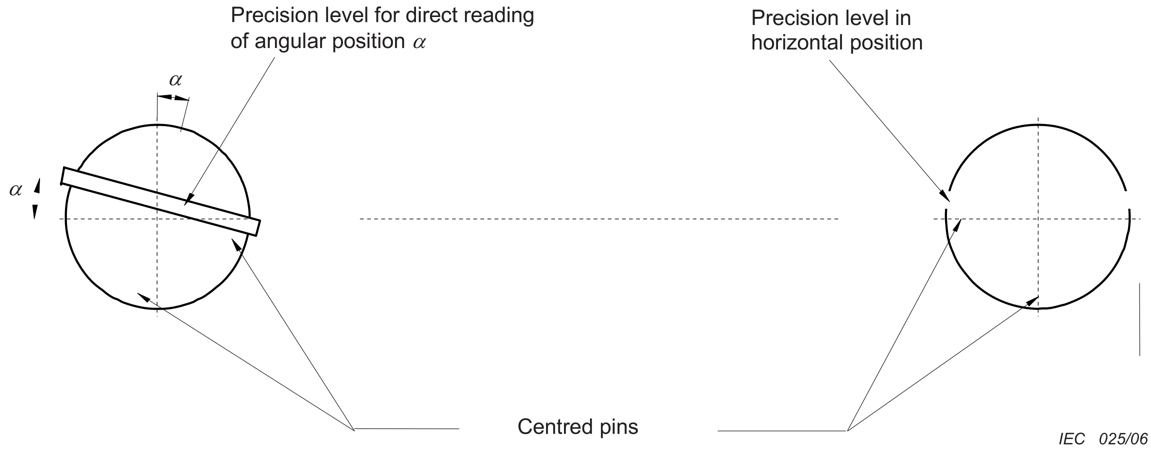
The tolerances of the parallelism are related to a diameter of 250 mm.

Coaxiality and concentricity: $C = 2 \times e$

Eccentricity: $e \leq 2\,(1 + h)$ mm with h in m

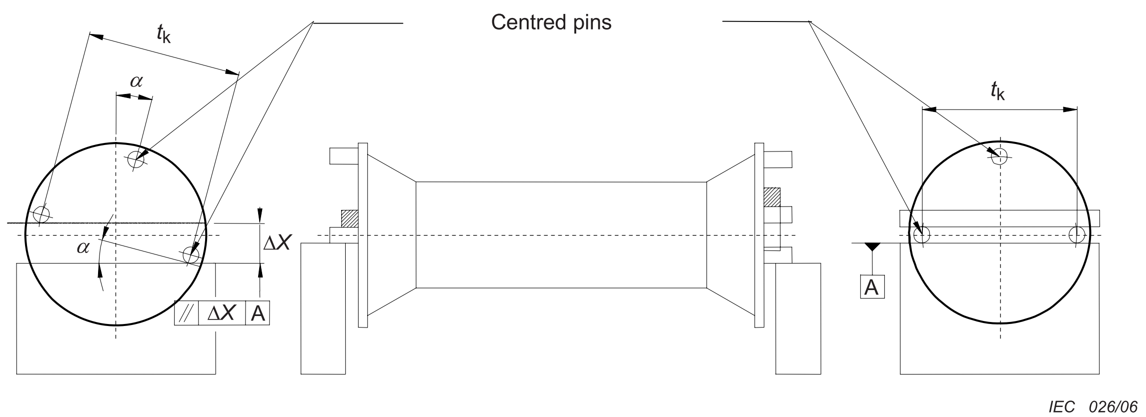
IEC 024/06

Figure D.1 – Parallelism, coaxiality and concentricity



Tolerance of the deviation: $\alpha \leq \pm 1°$

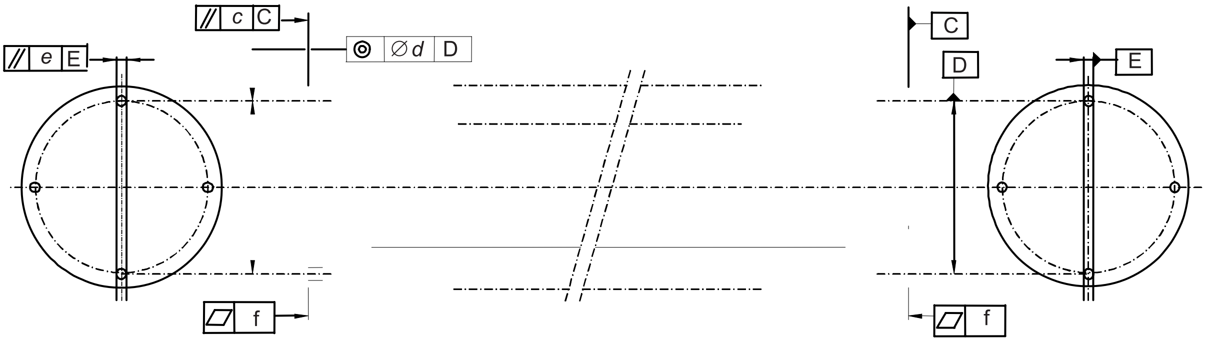
Figure D.2 – Angular deviation of fixing holes: Example 1



$\alpha = \tan^{-1}\left(\frac{\Delta x}{t_k}\right)$ where t_k is the distance between the centres of two opposite pins

Tolerance of the deviation: $\alpha \leq \pm 1°$

Figure D.3 – Angular deviation of fixing holes: Example 2



IEC 027/06

// c C	Parallelism: the upper plane face is parallel to the lower reference plane C within the indicated tolerances.
◎ Ød D	Coaxiality and concentricity: the axes of the top fitting fixing holes have to be within a cylinder with a diameter as indicated by the numerical value.
▱ f	Evenness: the numerical value indicates the maximum admissible unevenness of the face.
// e E	Alignment of the fixing holes: the line between two opposite axes of holes of the top fitting have to be in line with the corresponding line of the bottom fitting with two parallels of specified distance "*e*".

Figure D.4 – Tolerances according to standard drawing practice

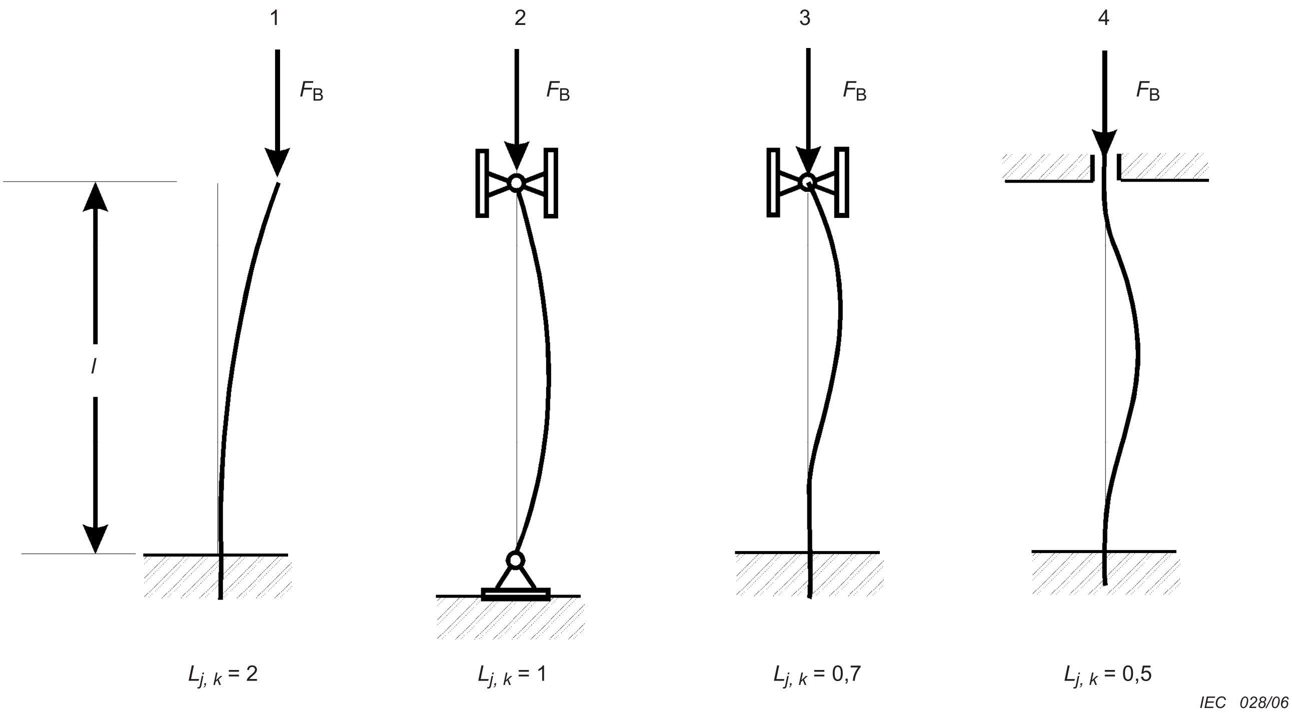
Annex E
(informative)

Notes on the compression and buckling test

The result of the compression and buckling test is influenced by:

– rod diameter,
– length between end fittings,
– coupling arrangement of the end fitting (top and bottom).

Depending on the coupling at the top and bottom of the station post insulator the buckling test has 4 load conditions (elastic Euler-buckling).



The correction factor CF is given by:

CF = $(L_j/L_k)^2$ where j corresponds to the service coupling arrangement, and k corresponds to the laboratory arrangement.

As an example, if service coupling arrangement corresponds to case 1, and the laboratory set-up corresponds to case 4, then the correction factor CF= $(2/0,5)^2$ = 16.

Bibliography

IEC 60865 (all parts), *Short-circuit currents – Calculation of effects*

NOTE Harmonized in EN 60865 series (not modified).

IEC 61245, *Artificial pollution tests on high-voltage insulators to be used on d.c. systems*

IEC 61462, *Composite insulators – Hollow insulators for use in outdoor and indoor electrical equipment – Definitions, test methods, acceptance criteria and design recommendations*

IEC 61467, *Insulators for overhead lines with a nominal voltage above 1 000 V – AC power arc tests on insulator sets*

IEC 60507, *Artificial pollution tests on high-voltage insulators to be used on a.c. systems*

NOTE Harmonized as EN 60507:1993 (not modified).

IEC 61952, *Insulators for overhead lines – Composite line post insulators for alternative current with a nominal voltage > 1 000 V*

NOTE Harmonized as EN 61952:2003 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-471	-[1]	International Electrotechnical Vocabulary (IEV) Chapter 471: Insulators	-	-
IEC 60060-1	-[1]	High-voltage test techniques Part 1: General definitions and test requirements	HD 588.1 S1	1991[2]
IEC 60168	1994	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V	EN 60168	1994[2]
IEC 62217	-[1]	Polymeric insulators for indoor and outdoor use with a nominal voltage > 1 000 V - General definitions, test methods and acceptance criteria	EN 62217 + corr. December	2006[2] 2006
ISO 1101	-[1]	Geometrical Product Specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out	EN ISO 1101	2005[2]
ISO 3452	-[1]	Non-destructive testing - Penetrant inspection - General principles	-	-

[1] Undated reference.

[2] Valid edition at date of issue.

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL