
Post insulators of ceramic material or glass for nominal voltages greater than 1000 V

Part 1. Methods of test

Isolateurs supports en céramique ou verre pour tensions nominales supérieures à 1000 V
Partie 1. Méthodes d'essai

Stützisolatoren aus Kermik oder Glas für Nennspannungen über 1000 V
Teil 1. Prüfverfahren

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Foreword

This revision of BS 3297 : Part 1 has been prepared under the direction of the Power Electrical Engineering Standards Committee. It is based on IEC Publication 168 : 1979 'Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V' incorporating Amendment 1 published by the International Electrotechnical Commission (IEC). This Part of this standard supersedes BS 3297 : Part 1 : 1974 which is therefore now withdrawn.

The purpose of this revision is to implement the IEC Publication as far as possible technically and in keeping with UK practice. Changes and improvements include the removal of references to agreement between purchaser and supplier because they are of a contractual nature and not

appropriate to this British Standard.

The IEC clause numbering has been retained from clause 3 onward with the following main changes.

(a) **25.2** has been deleted because it deals with rigid insulators composed of annealed glass which are not used in the UK; **25.1** has been renumbered **25**.

(b) The original clause **28** 'Galvanizing test' of IEC Publication 168, which included a test by immersion in copper sulphate, has been retained, with alterations, as an alternative test and renumbered **28.2** in this standard.

For ease of production it has been found convenient to reproduce the figures from IEC Publication 168, with alterations, for the figures in this standard.

British Standard

Post insulators of ceramic material or glass for nominal voltages greater than 1000 V

Part 1. Methods of test

Section one. General

1. Scope

This Part of this British Standard describes methods of test for post insulators and post insulator units of ceramic material or toughened glass for indoor and outdoor service in electrical installations or equipment operating on alternating current with a nominal voltage greater than 1000 V and a frequency not greater than 100 Hz.

It gives the electrical and mechanical characteristics of post insulators and the conditions under which the specified values of these characteristics are verified.

This Part does not apply to indoor post insulators of organic material.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Definitions

For the purposes of this British Standard the following definitions apply.

NOTE. The definitions regarding test voltages are given for convenience; for additional details, see BS 923 : Part 1.

3.1 post insulator. One post insulator unit or an assembly of such units, intended to give rigid support to a live part which is to be insulated from earth or from another live part.

3.2 post insulator unit. A constituent part of a post insulator, consisting of a permanent assembly of one or more insulating parts complete with other parts (metallic or not) designed to facilitate attachment to it.

NOTE. In this standard, the term 'post insulator' is taken to mean post insulator or post insulator unit as required by the text.

3.3 pedestal post insulator. A post insulator having two metal parts, a 'cap' partly embracing an insulating component and a 'pedestal' cemented into a recess in the insulating component. The cap normally has tapped holes and the pedestal a flange with plain holes for attachment by bolts or screws.

3.4 cylindrical post insulator. A post insulator of approximately cylindrical shape, consisting of one or more insulating components with a metal fitting attached to each end. The metal fitting may consist of a cap, insert or flange with plain or tapped holes for attachment by bolts or screws.

NOTE. The term 'approximately cylindrical shape' covers a unit of circular cross-section which may vary in diameter.

3.5 outdoor post insulator. A post insulator that is intended to be subjected in service to the weather (rain, snow, etc.).

3.6 indoor post insulator. A post insulator that is intended to be installed indoors where it is not subject to excessive condensation.

3.7 classification. Post insulators are divided into two types according to their construction.

(a) *Type A post insulators*, in which the length of the shortest puncture path through solid insulating material is at least equal to half the length of the shortest flashover path through air outside the insulator.

(b) *Type B post insulators*, in which the length of the shortest puncture path through solid insulating material is less than half the length of the shortest flashover path through air outside the insulator.

3.8 batch. The number of post insulators from the same manufacturer and of the same design offered for acceptance; a batch may consist of the whole, or part, of the quantity ordered.

3.9 flashover. A disruptive discharge (see BS 923 : Part 1), external to the post insulator connecting those parts which normally have the operating voltage between them.

NOTE. The term 'flashover' used in this standard includes flashover across the insulator surface as well as disruptive discharges by spark-over through air adjacent to the insulator. Disruptive discharges should only occur occasionally elsewhere (for instance to other structures or to earth), in which event they should not be regarded as flashovers for the purposes of this standard.

3.10 puncture. A disruptive discharge (see BS 923 : Part 1), passing through the insulating parts of a post insulator. A fragment breaking away from the rim of a shed or damage to the insulator due to the heat of a surface discharge is not considered a puncture.

3.11 dry lightning impulse withstand voltage. The lightning impulse voltage that the post insulator withstands dry, under specified conditions of test.

3.12 50 % dry lightning impulse flashover voltage. The value of the lightning impulse voltage that, under specified conditions of test, has a 50 % probability of producing flashover on the post insulator, dry.

3.13 dry or wet switching impulse withstand voltage. The switching impulse voltage that the post insulator withstands, dry or wet respectively, under specified conditions of test.

3.14 50 % dry or wet switching impulse flashover voltage.

The value of the switching impulse voltage that, under specified conditions of test, has a 50 % probability of producing flashover on the post insulator, dry or wet respectively.

3.15 dry or wet power-frequency withstand voltage. The power-frequency voltage that the post insulator withstands, dry or wet respectively, under specified conditions of test.

3.16 dry or wet power-frequency flashover voltage. The arithmetic mean value of the measured voltages that cause flashover on the post insulator, dry or wet respectively, under specified conditions of test.

3.17 puncture voltage. The voltage that causes puncture of a post insulator under specified conditions of test.

3.18 mechanical failing load. The maximum load that can be reached when a post insulator is tested under the conditions specified. It corresponds to the maximum load of a load deflection curve.

3.19 creepage distance. The shortest distance or the sum of the shortest distances along the contours of the external surfaces of the ceramic or glass insulating parts of the post insulator between those parts that normally have the operating voltage between them. A distance measured over the surface of cement or other conducting jointing material is not considered as forming part of the creepage distance. If high-resistance coatings are applied to parts of the post insulator, such coatings are considered as effective creepage surfaces and the distance over them is included in the creepage distance.

NOTE. The surface resistivity of such high-resistance coatings is usually about $10^6 \Omega$ but may be as low as $10^4 \Omega$.

4. Values of voltages

In accordance with BS 923 : Part 2, lightning and switching impulse withstand voltages shall be expressed by their prospective peak values and power-frequency voltages shall be expressed as peak values divided by $\sqrt{2}$.

5. Values which characterize a post insulator

A post insulator is characterized by the following values, where applicable:

- (a) the specified dry lightning impulse withstand voltage;
- (b) the specified dry switching impulse withstand voltage (for indoor insulators only);
- (c) the specified wet switching impulse withstand voltage (for outdoor insulators only);
- (d) the specified dry power-frequency withstand voltage (for indoor insulators only);
- (e) the specified wet power-frequency withstand voltage (for outdoor insulators only);
- (f) the specified puncture voltage (for insulators type B only, see 3.7);
- (g) the specified mechanical failing loads;
- (h) the specified significant dimensions including the creepage distance.

Switching impulse withstand voltage shall be specified only for post insulators for use on a.c. systems with highest voltage of equipment equal to or above 300 kV.

NOTE 1. Service voltage is not to be considered as a characteristic of a post insulator.

NOTE 2. The withstand voltages of post insulators under service conditions may differ from the voltages under standard testing conditions. This effect has been recognized with lightning impulse testing, especially for very high voltages of equipment, but the effect of ambient conditions and the arrangement of post insulators and associated metal work is much greater with switching impulses.

The verification of the specified switching impulse withstand voltage may therefore be required with a mounting arrangement which closely represents the service conditions.

NOTE 3. Experience has shown with many existing systems from 300 kV to 420 kV highest voltage of equipment that the switching impulse withstand voltage has not been a critical factor in the design of post insulators. Therefore, for post insulators used to extend such existing systems, wet switching impulse tests are not normally carried out.

6. Marking

Each post insulator shall be marked with the name or trade mark of the manufacturer, the year of manufacture and the post insulator reference mark. These markings shall be legible and indelible.

Section two. General requirements for tests

NOTE. Information given in clauses 7 to 13 is given in more detail in BS 923 : Parts 1 and 2, and is mentioned here only for convenience.

7. General requirements for electrical tests

Lightning and switching impulse voltages and power-frequency voltage test methods shall be in accordance with BS 923 : Part 2.

When the natural atmospheric conditions at the time of test differ from the standard values (see clause 12), correction factors shall be applied in accordance with clause 13.

The insulators shall be clean and dry before starting the high-voltage tests.

Precautions shall be taken to avoid condensation on the surface of the post insulator, especially when the relative humidity is high. For example, the post insulator shall be maintained at the ambient temperature of the test location for sufficient time for thermal equilibrium to be reached before the test starts. Tests shall not normally be made if the relative humidity exceeds 85 %.

8. Lightning impulse voltage tests

The standard 1.2/50 lightning impulse shall be used (see BS 923 : Part 2) with the following tolerances:

- (a) peak value : $\pm 3 \%$;
- (b) front time : $\pm 30 \%$;
- (c) time to half-value : $\pm 20 \%$.

The value of the lightning impulse voltage shall be its peak value as measured by a sphere gap or another method given in BS 923 : Part 2.

9. Switching impulse voltage tests

The standard $250 \pm 50/2500 \pm 1500$ switching impulse shall be used (see BS 923 : Part 2) with the following tolerances:

- (a) peak value: $\pm 3 \%$;
- (b) time to peak: $\pm 20 \%$;
- (c) time to half-value: $\pm 60 \%$.

The value of the switching impulse voltage shall be its prospective peak value as measured by a method given in BS 923 : Part 2.

10. Power-frequency voltage tests

The test voltage shall normally be an alternating voltage having a frequency in the range 15 Hz to 100 Hz.

The test circuit shall be in accordance with 7.2.1 of BS 923 : Part 2 : 1980.

11. Wet tests

The characteristics of the artificial rain shall be in accordance with 8.1 of BS 923 : Part 1 : 1980, which are summarized as follows:

Average precipitation rate for all measurements:		
vertical component	mm/min	1.0 to 1.5
horizontal component	mm/min	1.0 to 1.5
Limits for any individual measurement and for each component		
	mm/min	0.5 to 2.0
Temperature of collected water	°C	Ambient temperature ± 15
Resistivity of collected water corrected to 20 °C	$\Omega \text{ m}$	100 $\pm$ 15
(for correction of water resistivity to 20 °C, see figure 1)		

NOTE 1. The test is normally made with the insulator in the vertical position.

The measurement of the precipitation rate shall be made near the top, centre and bottom of the insulator under test.

The test object shall be pre-wetted initially for 15 min under the above specified conditions for the rain (which may however include the time needed for adjustment) and these conditions shall remain unchanged throughout the test.

NOTE 2. The pre-wetting time may be reduced if special means are used to ensure effective wetting or when repeat tests are made after short intervals.

12. Standard atmospheric conditions for tests

Standard atmospheric conditions for tests shall be as follows, in accordance with BS 923 : Part 1.

(a) Temperature $t_0 = 20^\circ\text{C}$.

(b) Pressure $b_0 = 1.013 \times 10^5 \text{ N/m}^2$ (1013 mbar)*.

(c) Humidity $h_0 = 11 \text{ g water per m}^3$.

NOTE. A pressure of 1013 mbar corresponds to a height of 760 mm in a mercury barometer at 0 °C. If the barometric height is h , in mm of mercury, the atmospheric pressure b , in mbar, is approximately:

$$b = \frac{1013 h}{760}$$

Correction for temperature is considered to be negligible with respect to the height of the column of mercury.

13. Correction factors for atmospheric conditions

Withstand and flashover voltages depend on the atmospheric conditions at the time of the test; if these differ from the selected standard conditions, correction factors k_d (air density) and k_h (humidity) shall be applied as shown in the table at the bottom of the page to obtain the voltage to be applied in a withstand test or the voltage to be recorded in a flashover test.

Clause	Test		Correction
17	Dry lightning impulse voltage	Withstand	Multiply specified withstand voltage by k_d and divide by k_h
		Flashover	Divide measured flashover voltage by k_d and multiply by k_h
18	Dry switching impulse voltage	Withstand	Multiply specified withstand voltage by k_d and divide by k_h
		Flashover	Divide measured flashover voltage by k_d and multiply by k_h
18	Wet switching impulse voltage	Withstand	Multiply specified withstand voltage by k_d
		Flashover	Divide measured flashover voltage by k_d
19	Dry power-frequency voltage	Withstand	Multiply specified withstand voltage by k_d and divide by k_h
		Flashover	Divide measured flashover voltage by k_d and multiply by k_h
20	Wet power-frequency voltage	Withstand	Multiply specified withstand voltage by k_d
		Flashover	Divide measured flashover voltage by k_d

*1 mbar = 10^2 N/m^2 = 0.1 kPa.

13.1 Air density correction factor k_d . With the atmospheric pressure b , in mbar, and the temperature t , in °C, the following air density correction factors shall be applied.

(a) Dry lightning impulse test, positive and negative polarity: $k_d = \delta$.

(b) Dry or wet switching impulse test:

(1) positive polarity: $k_d = \delta^m$;

(2) negative polarity: $k_d = 1$.

(c) Dry or wet power-frequency test: $k_d = \delta^m$

where

$$\delta = 0.289 \frac{b}{273 + t}$$

m is the exponent given in figure 2 as a function of the insulating distance d .

13.2 Humidity correction factor k_h . The following correction factors shall be applied.

(a) Dry lightning impulse test:

(1) positive polarity: k_h given by curve b in figure 3, ($k_h = k^m$ where $m = 1$);

(2) negative polarity: k_h given by curve c in figure 3.

NOTE. For dry lightning impulse test correction, negative polarity, curve c of figure 3 was calculated in accordance with BS 923 : Part 1, using the exponent $m = 0.8$ (rod-rod configuration).

(b) Dry switching impulse test:

(1) positive polarity: $k_h = k^m$, where m is the exponent given in figure 2 as a function of the insulating distance d and k is given by curve b in figure 3;

(2) negative polarity: $k_h = 1$.

(c) Dry power-frequency test: k_h given in figure 4.

14. Classification of tests

The tests shall be divided into the following three groups.

(a) *Group I (type tests)*. These tests are intended to verify the principal characteristics of a post insulator i.e. those which depend chiefly on its shape and size. They are made once only on post insulators complying with the conditions specified in clause 24. They shall be repeated only when the design or the material of the post insulator is changed.

(b) *Group II (sample tests)*. These tests are for the purpose of verifying the other characteristics of a post insulator i.e. those which depend on the quality of manufacture and of the materials used. They are made on post insulators taken at random from batches offered for acceptance.

(c) *Group III (routine tests)*. These tests are for the purpose of eliminating post insulators with manufacturing defects. They are made on every post insulator offered for acceptance.

Section three. Tests in group I (type tests)

15. General

The following tests shall be made, as applicable:

(a) dry lightning impulse withstand voltage test (see clause 17);

(b) dry switching impulse withstand voltage test (see clause 18), this test is applicable only to post insulators for indoor use;

(c) wet switching impulse withstand voltage test (see clause 18), this test is applicable only to post insulators for outdoor use;

(d) dry power-frequency withstand voltage test (see clause 19), this test is applicable only to post insulators for indoor use;

(e) wet power-frequency withstand voltage test (see clause 20), this test is applicable only to post insulators for outdoor use;

(f) test for mechanical strength (see clause 21).

NOTE. For certain post insulators, deflection under bending load may be especially important. When required, a test for deflection under load may be made in accordance with clause 22.

16. General requirements for electrical tests in group I

16.1 Standard mounting arrangements for all electrical tests

(a) *Mounting arrangement of a post insulator for use in systems with a highest voltage of equipment below 300 kV.* The post insulator shall be mounted vertically upright on a horizontal earthed metal support consisting of a U-channel section with the flanges pointing downwards. The earthed metal support shall have a width about equal to the diameter of the mounting face of the post insulator under test and a length at least equal to twice the height of the post insulator, and shall be placed at least 1 m above ground for post insulators not higher than 1.80 m. For higher post insulators, the distance shall be at least 2.50 m.

A cylindrical conductor, maintained in the horizontal plane, and perpendicular to the earthed support, shall be attached to the top of the post insulator. The length of the conductor shall be at least equal to 1.5 times the height of the post insulator and it shall extend at least 1 m on each side of the post insulator axis. The diameter of the conductor shall be approximately 1.5 % of the height of the post insulator, with a minimum of 25 mm.

The test voltage shall be applied between the conductor and the earthed support, the high-voltage connection being made at one end of the conductor.

During the test, no object other than those described in this clause shall be nearer to the top of the post insulator than 1 m or 1.5 times the height of the post insulator, whichever is the greater.

The post insulator shall be complete with those parts which are considered necessarily associated with the post insulator and are specified as such by the manufacturer.

(b) *Mounting arrangement of a post insulator for use in systems with a highest voltage of equipment equal to or above 300 kV.* The post insulator shall be mounted vertically upright on a vertical earthed metal support. The upper part of the metal support shall have a square mounting surface with the width of each side between one and two times the diameter of the metal fitting at the base of the post insulator under test.