

**Insulators for overhead lines —
Insulator strings and sets for
lines with a nominal voltage
greater than 1 000 V – AC
power arc tests**

National foreword

This British Standard is the UK implementation of EN 61467:2008. It is identical to IEC 61467:2008. It supersedes BS IEC 61467:1997 which is withdrawn.

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.

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English version

**Insulators for overhead lines -
Insulator strings and sets
for lines with a nominal voltage greater than 1 000 V -
AC power arc tests
(IEC 61467:2008)**

Isolateurs pour lignes aériennes -
Chaînes d'isolateurs et
chaînes d'isolateurs équipées
pour lignes de tension nominale
supérieure à 1 000 V -
Essais d'arc de puissance
en courant alternatif
(CEI 61467:2008)

Isolatoren für Freileitungen -
Isolatorstränge und -ketten
für Leitungen mit einer Nennspannung
größer 1 000 V -
Wechselstrom-Hochleistungs-
Lichtbogenprüfungen
(IEC 61467:2008)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 36B/277/FDIS, future edition 1 of IEC 61467, prepared by SC 36B, Insulators for overhead lines, of IEC TC 36, Insulators, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61467 on 2008-11-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2011-11-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61467:2008 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- | | |
|-------------|--|
| IEC 60383-1 | NOTE Harmonized as EN 60383-1:1996 (not modified). |
| IEC 60383-2 | NOTE Harmonized as EN 60383-2:1995 (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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC/TR 60797	- ¹⁾	Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric	-	-
IEC 60826	- ¹⁾	Design criteria of overhead transmission lines	-	-

¹⁾ Undated reference.

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INSULATORS FOR OVERHEAD LINES – INSULATOR STRINGS AND SETS FOR LINES WITH A NOMINAL VOLTAGE GREATER THAN 1 000 V – AC POWER ARC TESTS

1 Scope and object

This International Standard applies to insulator strings and sets comprising string insulator units of ceramic material, glass or composite material for use on a.c. overhead lines and traction lines with a nominal voltage above 1 000 V and a frequency between 15 Hz and 100 Hz.

This standard also applies to insulator strings or sets of similar design used in substations.

This standard establishes a standard test procedure for power arc tests on insulator sets. It also establishes a standard test procedure for power arc tests on short strings.

This standard does not apply to insulator sets mounted on non-metallic poles or towers.

This standard cannot be directly applied to line post insulators or sets, or to insulating structures such as braced line-posts, since their mounting arrangement cannot be reproduced by the standard arrangements as described herein. However, this standard can be used as a basis for agreement for tests on such insulators and arrangements.

The object of this standard is

- to define the terms used,
- to prescribe a standard test procedure,
- to prescribe criteria to evaluate the results of the tests.

Power arc tests are not an obligatory element of line insulator specifications. The standard test procedures and the evaluation criteria described in this standard are intended to provide testing guidance when power arc tests are felt to be necessary. It is not the object of this standard to introduce a general obligation to execute these tests.

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 60797, *Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric*

IEC 60826, *Design criteria of overhead transmission lines*

3 Terms and definitions

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

NOTE Definitions of other terms used in this standard can be found in IEC 60050-471, IEC 60383-1 and IEC 60383-2.

3.1**test**

one application of the specified test current for the specified duration to the insulator string or set

3.2**test sequence**

three successive tests on the same insulator string or set

3.3**test series**

a group of test sequences used to characterize the power arc performance of an insulator string or set

3.4**per cent initial asymmetry of current**

deviation of the current from a symmetrical wave during the first cycle of a power arc

NOTE Per cent initial asymmetry is expressed as a function of the absolute peak value of the current of the first cycle (I_m) divided by the r.m.s. value of the current (I) as follows:

$$\left(\frac{|I_m|}{I \times \sqrt{2}} - 1 \right) \times 100$$

3.5**supply circuit**

electrical connection through which the current of a power arc flows to the line side of the test object from the power source

3.6**return circuit**

electrical connection through which the current of power arc flows from the earth side of the test object to the power source

3.7**balanced circuit**

supply or return circuit in which the current flow is in two diametrically opposed directions

3.8**unbalanced circuit**

supply or return circuit in which the current flow is principally in one direction

3.9**short string (cap and pin units)**

string of three to six insulator units having a minimum arcing distance of 400 mm

3.10**short string (long rod and composite units)**

string of one or more insulator units having an arcing distance between 400 mm and 1 000 mm

4 Symbols and abbreviations

The following symbols and abbreviations are principally used in the tables and figures hereafter.

Unless otherwise stated currents and voltages are expressed as r.m.s values.

I	Arc current
I_n	Specified arc current
t	Arc time
t_n	Specified arc time
I_m	Peak current value
$I_{R1,2}$	Currents in the return circuit
$I_{S1,2}$	Currents in the supply circuit
I_{sys}	Rated short-circuit current of the network system
L_A	Length of the insulator string
L_B	Length of the insulator set
L_R	Length of simulation of the return circuit
L_S	Length of simulation of the supply circuit
D	Distance from the centre point of the tested insulator set to the surrounding framework
M_L	Mechanical load on the tested insulator set
α	Angle from the horizontal plane of a tension insulator set
SFL	Specified minimum (electro-)mechanical failing load
SML	Specified mechanical load

5 Characteristics of the test current

The tests shall be made with single-phase alternating current. Initial asymmetry (d.c. component) shall not exceed 30 %.

NOTE This requirement is explained by the fact that the flashovers on a contaminated insulator set in service generally occur in the vicinity of a voltage peak, consequently with a minimal direct current component.

For 50 Hz or 60 Hz systems, the frequency of the test circuit shall be from 45 Hz to 65 Hz. For other system frequencies, the frequency of the test supply shall not in principle deviate from the specified value by more than 10 %. By agreement with the user, tests may be performed at a higher or lower frequency than the intended operating frequency. The frequencies may vary within the above limits during each test.

The test circuit shall be adequate to supply the specified values of arc current (r.m.s) and arc duration. Annex C gives information on no-load voltages suggested to achieve specified current values. Unless agreed otherwise, the permissible tolerance of the arc current with respect to the specified r.m.s. value of the current is ± 10 %.

The actual arc current during the test shall be practically sinusoidal. The r.m.s. value of the test current may be derived from the arithmetic mean of the peak values during the test duration (see Annex B). If the measuring equipment permits, the r.m.s. value may be calculated from the current function.

The test current shall be essentially constant over the arcing time. During the arcing time, the following deviations from the specified value are permissible:

- the arc current crest values shall not deviate from the specified value ($I_n\sqrt{2}$) by more than ± 20 %;
- for arcing times greater than 0,2 s, the above tolerance may be exceeded during not more than 20 % of the total arcing time.

In any case, the product of the actual arc current and duration $I \times t$ shall be within ± 10 % of the product of the specified arc current and duration $I_n \times t_n$.

In cases where the movement of the arc root onto the tower or along the line conductor occurs, these tolerances may be exceeded.

6 Supply and return circuit conditions

The supply and return circuits depend on the service conditions, notably on the location of the insulator set along the line and on the tower geometry. The characteristic cases to be simulated in tests are given in Table 1 and illustrated in Figure 1 for complete sets and in Figure 3 for short strings.

Table 1 – Supply and return conditions

	Balanced supply circuit	Unbalanced supply circuit
Balanced return circuit	A circuit $I_{R1} = I_n/2$ $I_{R2} = I_n/2$ $I_{S1} = I_n/2$ $I_{S2} = I_n/2$ For example: Insulator set in the centre phase window of a tower in the middle of a line	B circuit $I_{R1} = I_n/2$ $I_{R2} = I_n/2$ $I_{S1} = I_n$ $I_{S2} = 0$ For example: Insulator set in the centre phase window of a tower at the extremity of a line
Unbalanced return circuit	C circuit $I_{R1} = I_n$ $I_{R2} = 0$ $I_{S1} = I_n/2$ $I_{S2} = I_n/2$ For example: Insulator set on the lateral phase cross-arm of a tower in the middle of a line	D circuit $I_{R1} = I_n$ $I_{R2} = 0$ $I_{S1} = I_n$ $I_{S2} = 0$ For example: Insulator set on the lateral phase cross-arm of a tower at the extremity of a line

The permissible deviation of the currents I_{R1} and I_{R2} , I_{S1} and I_{S2} from their specified value shall not exceed $\pm 20\%$. This may be verified by a circuit calibration test.

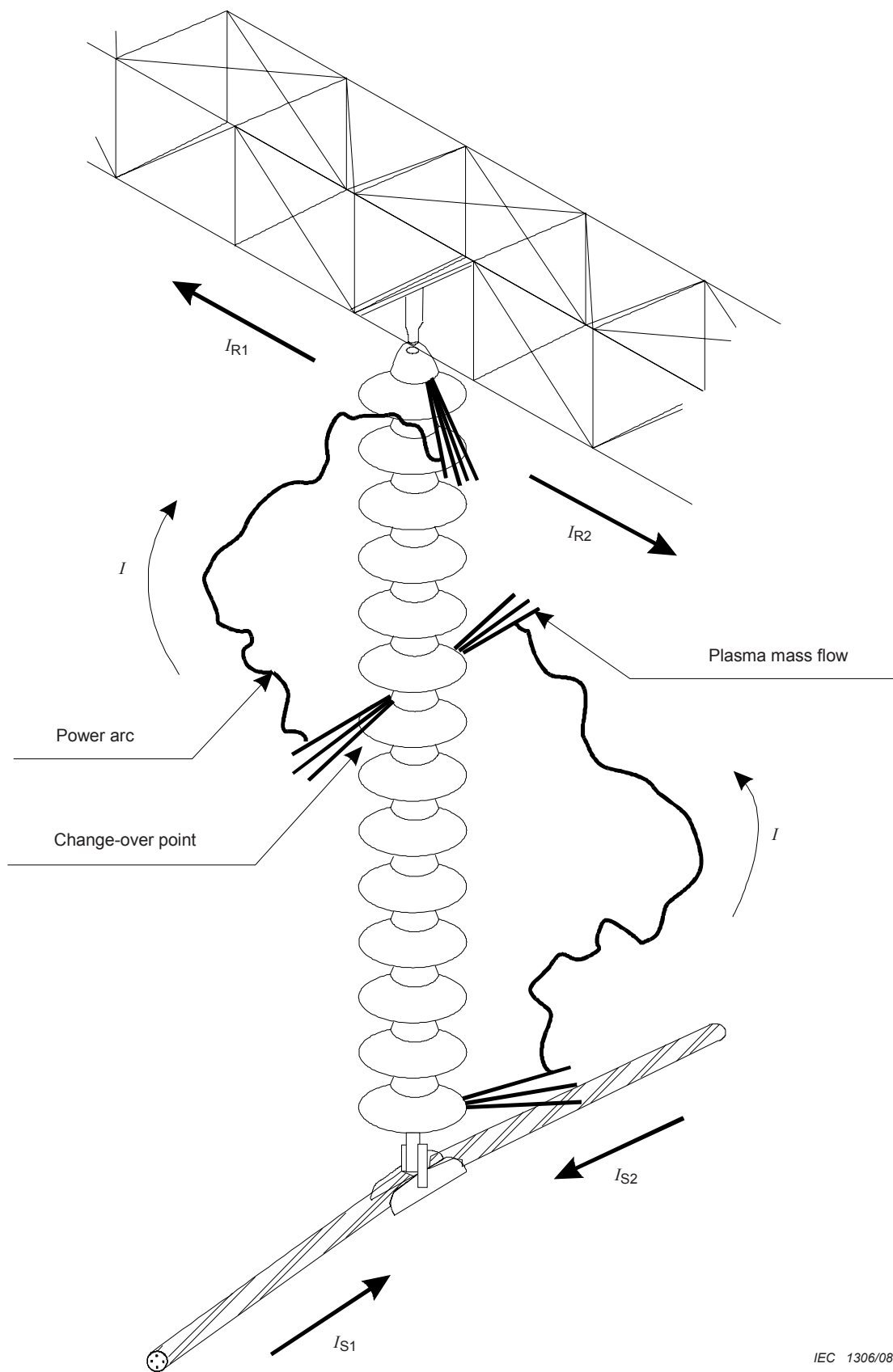


Figure 1 – Illustration of supply and return currents

IEC 1306/08

7 Tests on insulator sets

7.1 General remarks

The test procedure for insulator sets described in this standard consists of two possible series of three power arc applications (sequences) at different current levels and of different duration. This test procedure is intended to cover fault current conditions occurring at representative points along a line. The test procedure is also intended to reproduce pollution-induced power arc flashover, which creates the most severe conditions.

As the test procedure for insulator sets described in this standard is intended to simulate conditions encountered in service, attention is drawn to the fact that it is not possible to extrapolate the behaviour of an insulator set of a given length to that of an insulator set of different length or equipped with fittings of different design or materials.

7.2 Test arrangement

The test arrangement shall duplicate the actual configuration of the complete insulator set and as closely as possible that of the conductor and of the part of the tower nearest to the insulator set. The actual protective fittings shall be used and their position with respect to the insulator units, the clamps and the conductor shall be reproduced. The aim of the true simulation of the actual configuration is to recreate the real electromagnetic field affecting the arc movement.

The distances between the insulator set and the grounded structures simulating the tower shall be the same as for the service configuration. In the case of some insulator sets (e.g. extra high voltage, special configurations), the actual simulation of the tower may be limited by the facilities of test laboratories. In the case of long insulator sets ($L_B > 6$ m), a distance D of 6 m between tower and line conductors is sufficient.

The distance from the conductors to the ground plane shall be at least $L_B/2$ or 3 m for $L_B > 6$ m.

The test arrangement shall include a conductor or conductor bundle having characteristics similar to the one used in service. To create the real electrodynamic forces affecting the arc movement, the conductor length on both sides of the insulator sets shall be at least equal to the insulator set length but its minimum length shall be 2,5 m. In the case of long insulator sets ($L_B > 6$ m), a conductor length L_S of 6 m is sufficient (see Annex A).

Some appropriate test arrangements and tower simulations (return circuit) are shown in Annex A.

In order to avoid poor electrical contacts and to ensure that the insulator set is correctly positioned, a mechanical load shall be applied to the insulator set. In the case of vertical insulator sets, this load can be applied by means of a suitable weight suspended from the suspension clamp or conductor by means of an insulated link. The value of the load shall be at least 5 kN on the complete insulator set. In the case of tension insulator sets, a higher mechanical load may be necessary to reproduce the service angle of the insulator set (see Figure A.4).

7.3 Test current

The characteristics of the test current shall be in accordance with Clause 5.

7.4 Supply and return circuit conditions

The supply and return circuits shall be chosen to represent the service conditions being simulated (see Clause 6).