IEC/TS 60815-3

Edition 1.0 2008-10

TECHNICAL SPECIFICATION

Selection and dimensioning of high-voltage insulators intended for use in polluted conditions –
Part 3: Polymer insulators for a.c. systems

IEC/TS 60815-3:2008(E)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE R

ICS 29.080.10

ISBN 978-2-88910-303-4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 60815-3, which is a technical specification, has been prepared by technical committee 36: Insulators.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
36/266/DTS	36/272A/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the future IEC 60815 series, under the general title *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

SELECTION AND DIMENSIONING OF HIGH-VOLTAGE INSULATORS INTENDED FOR USE IN POLLUTED CONDITIONS –

Part 3: Polymer insulators for a.c. systems

1 Scope and object

IEC/TS 60815-3, which is a technical specification, is applicable to the selection of polymer insulators for a.c. systems, and the determination of their relevant dimensions, to be used in high voltage systems with respect to pollution.

This part of IEC/TS 60815 gives specific guidelines and principles to arrive at an informed judgement on the probable behaviour of a given insulator in certain pollution environments.

The contents of this technical specification are based on CIGRE 33.13 TF 01 documents [1], [2][1], which form a useful complement to this technical specification for those wishing to study in greater depth the performance of insulators under pollution.

This technical specification does not deal with the effects of snow or ice on polluted insulators. Although this subject is dealt with by CIGRE [3], current knowledge is very limited and practice is too diverse.

The object of this technical specification is to give the user means to

- determine the reference unified specific creepage distance (USCD) from site pollution severity (SPS) class,
- choose appropriate profiles,
- apply correction factors for altitude, insulator shape, size and position, etc. to the reference USCD.

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 – Part 471: Insulators*

IEC/TS 60815-1, *Selection and dimensioning of high-voltage insulators for polluted conditions – Part 1: Definitions, information and general principles*

IEC/TR 62039, *Selection guide for polymeric materials for outdoor use under HV stress*

IEC/TS 62073, *Guidance on the measurement of wettability of insulator surfaces*

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1 Figures in square brackets refer to the bibliography.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms, definitions and abbreviations apply. The definitions given below are those which either do not appear in IEC 60050-471 or differ from those given in IEC 60050-471.

3.1.1
unified specific creepage distance
USCD
creepage distance of an insulator divided by the r.m.s. value of the highest operating voltage across the insulator

NOTE 1 This definition differs from that of specific creepage distance where the line-to-line value of the highest voltage for the equipment is used (for a.c. systems usually $U_m/\sqrt{3}$). For line-to-earth insulation, this definition will result in a value that is √3 times that given by the definition of specific creepage distance in IEC/TR 60815 (1986).

NOTE 2 For 'U_m' see IEV 604-03-01 [3].

NOTE 3 It is generally expressed in mm/kV and usually expressed as a minimum.

3.1.2
reference unified specific creepage distance
RUSCD
initial value of unified specific creepage distance for a pollution site before correction for size, profile, mounting position, etc. according to this technical specification and generally expressed in mm/kV

3.2 Abbreviations

CF	creepage factor
ESDD	equivalent salt deposit density
HTM	hydrophobicity transfer material
NSDD	non-soluble deposit density
SDD	salt deposit density
SES	site equivalent salinity
SOR	safe operating regions
SPS	site pollution severity
USCD	unified specific creepage distance
RUSCD	reference unified specific creepage distance

4 Principles

The overall process of insulation selection and dimensioning can be summarized as follows:

Firstly, using IEC/TS 60815-1:

- determine the appropriate approach 1, 2 or 3 as a function of available knowledge, time and resources;
- collect the necessary input data, notably system voltage, insulation application type (line, post, bushing, etc.);
- collect the necessary environmental data, notably site pollution severity and class.

At this stage a preliminary choice of possible candidate insulators suitable for the applications and environment may be made.

Then, using this technical specification:

- refine choice of possible candidate polymer insulators suitable for the environment;
- determine the reference USCD for the insulator types and materials, either using the indications in the this technical specification, or from service or test station experience in the case of approach 1 (Clause 7);
- choose suitable profiles for the type of environment (Clause 8);
- verify that the profile satisfies certain parameters, with correction or action according to the degree of deviation (Clause 9);
- modify, where necessary (approaches 2 and 3), of the reference USCD by factors depending on the size, profile, orientation, etc. of the candidate insulator (Clauses 10 and 11);
- verify that the resulting candidate insulators satisfy the other system and line requirements such as those given in Table 2 of IEC/TS 60815-1 (e.g. imposed geometry, dimensions, economics);
- verify the dimensioning, if required in the case of approach 2, by laboratory tests (see Clause 12).

NOTE Without sufficient time and resources (i.e. using approach 3), the determination of the necessary USCD will have less accuracy.

5 Materials

5.1 General information on common polymer housing materials

The present practice is to use housings manufactured from several base polymers, for instance silicone rubbers based on dimethyl siloxane, cross linked polyolefins such as EPDM rubber, or semi-crystalline ethylene copolymers such as EVA, or rigid highly cross-linked epoxy resins based on cycloaliphatic components.

None of these polymers will give satisfactory performance in an outdoor environment without a sophisticated additive package to modify their behaviour. Typically, such additives include anti-tracking agents, UV screens and stabilizers, antioxidants, ionic scavengers, etc. Within each material type the base material, the additives and even their processing can have a significant influence on material performance.

Some polymer insulators can collect more pollutants compared to ceramic and glass insulators due to their surface characteristics.

Polymer materials which exhibit hydrophobicity and the capability to transfer hydrophobicity to the layer of pollution are referred to in this technical specification as hydrophobicity transfer materials (HTM); materials which do not exhibit hydrophobicity transfer are referred to as non-HTM. Hydrophobicity may be lost in certain conditions (see 5.2), either temporarily or in some cases permanently. IEC/TS 62073 gives guidance on the measurement of wettability of insulator surfaces.

5.2 Issues specific to polymer housing materials under pollution

5.2.1 Reduction of creepage distance

Polymeric insulators present certain advantages over ceramic and glass insulators due to their form and materials. These advantages include a generally improved pollution withstand behaviour when compared to similar ceramic or glass insulators of equal creepage distance; this improvement is even more enhanced by use of HTM. In principle and purely from a pollution withstand or flashover point of view, it can thus be concluded that a reduced creepage distance may be used for such insulators. However, compared to traditional insulating materials, polymer materials are more susceptible to degradation by the environment, electric fields and arc activity which may, in certain conditions, reduce insulator pollution performance or lifetime. Annex A gives more information on this effect, including the following points:

- Reduced creepage distance may, in certain site conditions, result in increased discharge activity and negate any advantage in pollution performance if hydrophobicity is totally lost, and may lead in some cases to flashover or degradation.
- Conversely, risk of material changes or degradation due to localized arc activity may be increased when creepage distance per unit length is excessive.

Other points of importance are as follows:

- Use of grading rings is generally necessary at high voltages, the exact voltage level at which they become necessary depends on design and materials.
- More pollution may accumulate on some polymer surfaces, and may reduce their pollution performance advantage over comparable glass and porcelain insulators.
- Some polymers can be subject to fungal growths which affect hydrophobicity.
- HTM polymeric insulators generally show less influence of diameter and air density on their pollution performance; this influence may increase if the surface becomes hydrophilic.

Therefore, in many cases, it could be advisable to accept improved pollution performance and avoid degradation or flashover problems by using the same creepage distance as recommended for porcelain and glass insulators.

Nevertheless, the use of reduced creepage distance can be envisaged in certain circumstances or conditions. These circumstances cannot be precisely defined since they depend on a large number of factors; however, some general examples of conditions (or combinations thereof) in which the use of reduced creepage distance can be adopted are given below. It is important that, whenever possible, the decision to use reduced creepage be discussed and agreed by all interested parties.

Examples include:

- Proof by line trial, test station or historic data with the same design, materials and electric stress.
- The pollution is predominately type A, with no risk of extreme events (wetting or pollution deposition).
- There is no frequent or daily cyclic wetting or other environmental effects liable to prolong or inhibit HTM recovery.
- The HTM has a proven history of good encapsulation and recovery characteristics.
- Regular inspection, maintenance, washing or cleaning is envisaged.
- There is a short lifetime requirement (e.g. emergency/temporary lines).
- There is no other solution possible due to dimensional constraints.
- The profile has a good conformance with Clause 9 of this technical specification.

5.2.2 Extreme pollution

Under certain extreme pollution conditions it may be recommendable to increase the creepage distance of composite insulators beyond that determined by the use of this technical specification, mainly to avoid damage to the surface or housing by permanent or frequent localised arcing.

It is important to remember that increasing creepage distance by using a profile that supplies more creepage distance per unit length may be self-defeating since it can increase the risk of local arcing (see Annex A).

6 Site severity determination

For the purposes of standardization, five classes of pollution characterizing the site severity are qualitatively defined in IEC/TS 60815-1, from very light pollution to very heavy pollution, as follows:

a – Very light;

b – Light;

c – Medium;

d – Heavy;

e – Very heavy.

NOTE 1 These letter classes do not correspond directly to the previous number classes of IEC/TR 60815:1986.

The SPS class for the site is determined according to IEC/TS 60815-1, using the standard glass or porcelain reference insulator, and is used to determine the reference USCD for polymeric insulators.

NOTE 2 It is not recommended to use polymeric insulators for site severity determination. As mentioned in Clause 5, polymeric surfaces may have a different pollution collection and self-cleaning behaviour compared to glass or ceramic surfaces. Additionally, some polymer materials may exhibit surface tack or roughness which can further affect short- or long-term pollution collection.

7 Determination of the reference USCD

Figure 1 shows the relation between SPS class and RUSCD for polymer insulators, for normal cases (see 5.2). The bars are preferred values representative of a minimum requirement for each class and are given for use with approach 3 as described in IEC/TS 60815-1. If the estimation of SPS class tends towards the neighbouring higher class, then the curve may be followed.

If exact SPS measurements are available (approach 1 or 2), it is recommended to take an RUSCD which corresponds to the position of the SPS measurements within the class by following the curve in Figure 1.

NOTE It is assumed that the final USCD resulting from the application of the corrections given hereafter to the RUSCD will not correspond exactly to a creepage distance available for catalogue insulators. Hence it is preferred to work with exact figures and to round up to an appropriate value at the end of the correction process.

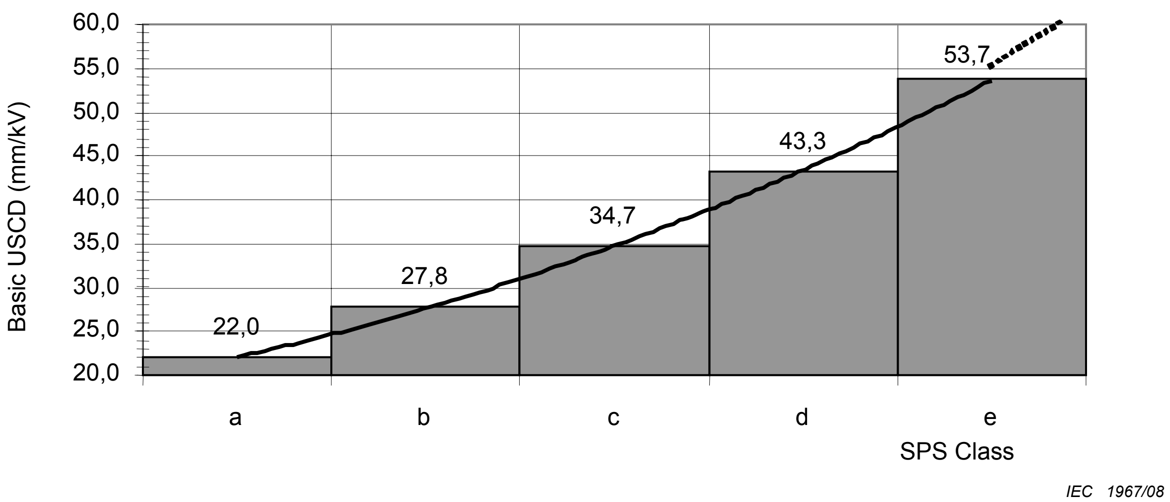

Figure 1 – RUSCD as a function of SPS class