IEC/TS 60815-2

Edition 1.0 2008-10

TECHNICAL SPECIFICATION

Selection and dimensioning of high-voltage insulators intended for use in polluted conditions –
Part 2: Ceramic and glass insulators for a.c. systems

IEC/TS 60815-2:2008(E)

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

Part 2: Ceramic and glass insulators for a.c. systems

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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 60815-2, which is a technical specification, has been prepared by technical committee 36: Insulators.

This first edition of IEC/TS 60815-2, together with IEC/TS 60815-1, cancels and replaces IEC/TR 60815, which was issued as a technical report in 1986. It constitutes a technical revision and now has the status of a technical specification. The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
36/265/DTS	36/271A/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- withdrawn,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 2: Ceramic and glass insulators for a.c. systems

1 Scope and object

IEC/TS 60815-1, which is a technical specification, is applicable to the selection of ceramic and glass 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 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 basis for the structure and approach of this part of IEC 60815 is fully explained in IEC/TS 60815-1.

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

- determine the reference unified specific creepage distance (RUSCD) from site pollution severity (SPS) class;
- evaluate the suitability of different insulator profiles;
- determine the necessary USCD by applying corrections for insulator shape, size, position, etc. to the RUSCD;
- if required, determine the appropriate test methods and parameters to verify the performance of the selected insulators.

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

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

3 Terms, definitions and abbreviations

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 Terms and definitions

3.2
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 [1][1].

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

3.3
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

3.4 Abbreviations

CF creepage factor

ESDD equivalent salt deposit density

NSDD non soluble deposit density

SDD salt deposit density

SES site equivalent salinity

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 the choice of possible candidate ceramic or glass insulators suitable for the environment;

1 References in square brackets refer to the bibliography.

- determine the reference USCD for the insulator types and materials, either using the indications given in 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 RUSCD 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

This technical specification is applicable to ceramic and glass insulators. The guidance given here assumes that the insulators are of standard manufacture without any surface modification or treatment.

Technologies exist intended to improve the performance of such insulators under pollution, for example, semi-conducting glaze and hydrophobic coatings. At present it is not possible to give specific information on the degree and durability of the improvement given by such technologies.

As far as the relative performance of ceramic and glass insulators under pollution is concerned, there is no notable consistent difference between these materials; hence the choice of either glass or ceramic material with respect to the other depends purely on factors (e.g. ageing, operating experience, maintenance procedures) which are out of the scope of this technical specification.

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 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 and is used to determine the reference USCD for glass and ceramic insulators.

7 Determination of the reference unified specific creepage distance (RUSCD)

Figure 1 shows the relation between SPS class and RUSCD for glass and ceramic insulators. 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 a RUSCD which corresponds to the position of the SPS measurements within the class by following the curve in Figure 1.

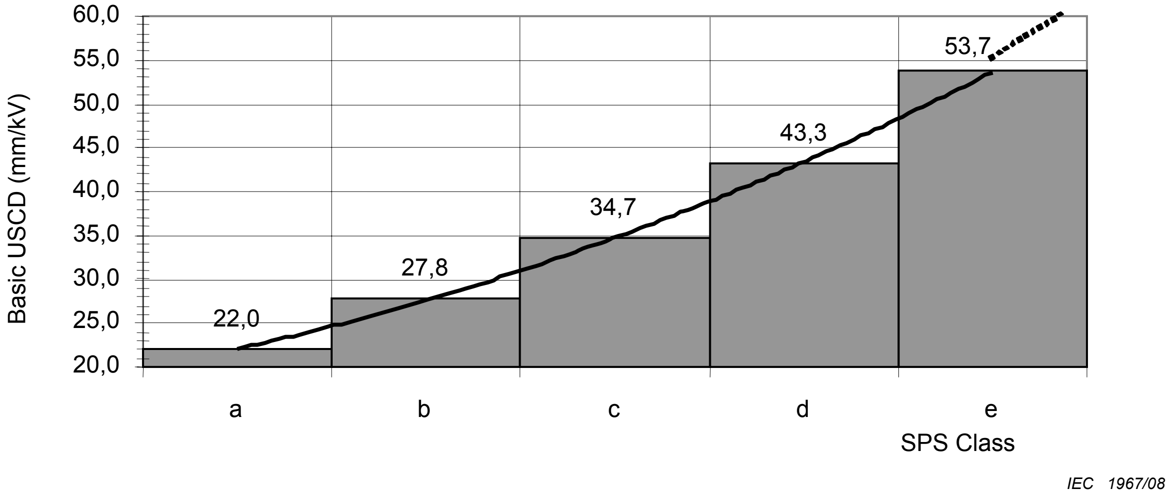


Figure 1 – RUSCD as a function of SPS class

In cases of exceptionally high SPS in, or beyond, class e (see IEC/TS 60815-1, 8.2) the minimum RUSCD may not be adequate. Depending on service experience and/or laboratory test results a higher USCD can be used; in some instances mitigation may be useful (see IEC/TS 60815-1, 9.5.5).

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.

8 Choice of profile

8.1 General recommendations for porcelain and glass profiles

Table 1 below shows a brief summary of the principal advantages and disadvantages of the main profile types with respect to pollution performance.

For standard profiles see Figure 2.

NOTE In the case of long rods, posts and hollows, the typical standard profile shed inclinations are 14° - 24° for the shed top angle α and 8° – 16° for the shed bottom angle β (illustrated in Figure 2b). Smaller angles are generally considered as being aerodynamic, while larger angles are considered as being anti-fog.

Table 1 – Principal advantages (+) and disadvantages (-) of main profile types

Mounting		Standard profile	Open profile	Anti-fog profile	Alternating shed arrangements
Vertical	+	Good experience from use in very light to medium SPS classes where a long creepage distance or aerodynamically effective profile is not required	Collects less pollution, due to aerodynamic profile and good natural cleaning	Prevents wetting of whole under side during rain, mist, etc. Long creepage distance per unit	Represents the relevant advantages and disadvantages of the individual profile types: standard, open or anti-fog with the benefits of - increased creepage distance per unit - good withstand capability under heavy wetting - good withstand capability under icing
	-	Does not avoid collection of wind-born deposits	Total surface collects more pollution in rapid accumulation conditions, such as storms, typhoons, etc., requires longer strings. Good experience from use in very light to medium SPS classes (in particular dry and semidry regions) where aero-dynamically effective profile is required	More wind born deposit accumulates on the under-side due to reduced natural cleaning	
Hori-zontal	+	Collects less pollution because of natural cleaning by wetting	Collects less pollution, as the aerodynamic profile gives a better self-cleaning by wetting and wind	Long creepage distance per unit	
	-	Total surface becomes polluted but is accessible for natural cleaning	Total surface collects more pollution under rapid accumulation conditions, such as storms, typhoons, etc. Requires a longer string length	Wind born deposit accumulates on surfaces with deep under-rib due to reduced natural cleaning	

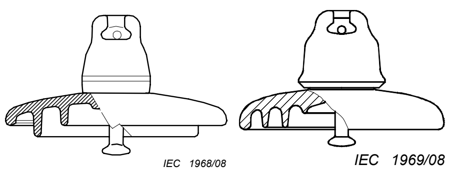


Figure 2a – Cap and pin standard disc insulators

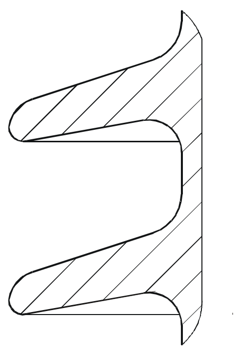
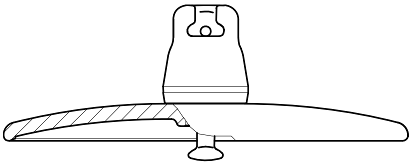


Figure 2b – Standard shed profile – long rod insulators, post insulators, hollow insulators

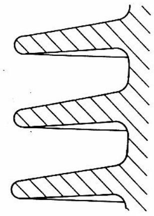
Figure 2 – Typical "standard" profiles

Aerodynamic or open profiles are shown in Figure 3 and anti-fog profiles are shown in Figure 4.



IEC 1971/08

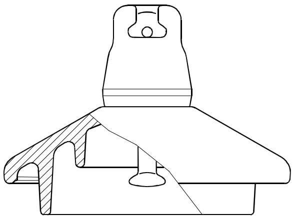
Figure 3a – Aerodynamic disc insulators



IEC 1972/08

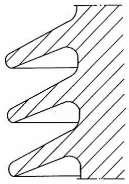
Figure 3b – Aerodynamic sheds – Long rod insulators, post insulators, hollow insulators

Figure 3 – Typical "open" profiles



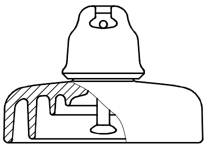
IEC 1973/08

Figure 4a – Steep anti-fog disc insulators



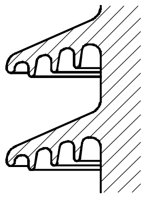
IEC 1974/08

Figure 4b – Steep anti-fog – long rod insulators, post insulators, hollow insulators



IEC 1975/08

Figure 4c – Deep under-ribs disc insulators

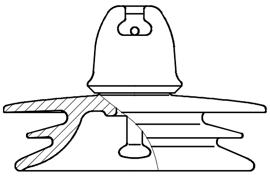


IEC 1976/08

Figure 4d – Deep under-ribs on long rod insulators, post insulators, hollow insulators

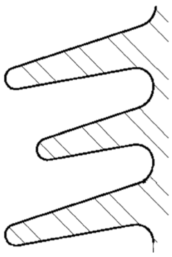
Figure 4 – Typical "anti-fog" profiles

For the purposes of this technical specification, an alternating shed arrangement is defined as having a minimum difference in shed overhang of at least 15 mm (see Figure 5 and 9.4).



IEC 1977/08

Figure 5a – Alternating shed disc insulators



IEC 1978/08

Figure 5b – Alternating sheds on long rod insulators, post insulators, hollow insulators

Figure 5 – Typical "alternating" profiles

Typical pin insulator shed profiles are shown in Figure 6. In general, pin insulator profiles can be assimilated to anti-fog profiles and are therefore not dealt with separately in the following.

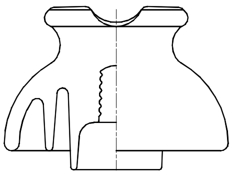


Figure 6a – Single-piece pin insulator

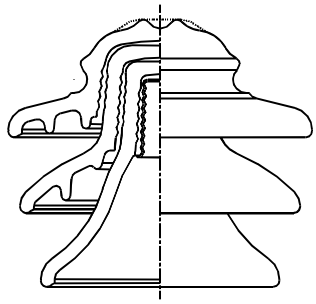


Figure 6b – Multi-element pin insulator

Figure 6 – Typical pin insulator shed profiles

8.2 Profile suitability

Tables 2 and 3 give simple merit values for insulator profiles. In each case the merit value of each profile, relative to a standard profile, for use in specific areas is given as follows:

++ suitable, best choice;

+ suitable;

0 neutral, no particular advantage or disadvantage;

- unsuitable, but can be used;

-- unsuitable, avoid this choice if possible.

Pollution is often not the sole parameter used for the choice of insulator profile. The insulator material, design, manufacturing process or application may preclude certain profiles. Hence the optimal profile may not be available for the combination of insulator/pollution type. Therefore, the choice or use of a less suitable profile is not excluded.

If an unsuitable profile is chosen, then it is recommended that the RUSCD be chosen from Figure 1 towards the upper end of the SPS class or even for the next higher class, unless such a change would cause, or aggravate, a deviation of the profile parameters in Clause 9. If an unsuitable profile is chosen which also has a minor deviation in profile parameters, then it is recommended to treat this profile as if it has a major deviation in profile parameters (see Clause 9).

9 Checking the profile parameters

9.1 Introductory remark

NOTE The profile parameters used in the following sub-clauses are based on the nominal design dimensions figuring on the detailed insulator drawing. They are note intended for verification during normal acceptance testing specified b product standards.

The following profile parameters have a normal (white) range, a grey range where they can reduce performance (minor deviation) and a black range where they can have a serious negative effect on performance under pollution (major deviation). Each parameter shall be calculated and checked according to the following. It is allowed for one parameter to deviate into a grey area, i.e. to have a minor deviation. In the case of a minor deviation, it is recommended that the RUSCD be chosen from Figure 1 towards the upper end of the SPS class or even for the next higher class, unless such a change would further aggravate the deviation. If more than one parameter is in a grey area, or any parameter in a black area, then this is considered as a major deviation and it is recommended to do one of the following:

– consult data from service or test station experience to confirm the performance of the profile;

– find an alternative profile or insulator technology;

– verify the performance of the profile by testing (see Clause 12).

Table 2 – Profile suitability, relative to a standard profile, for porcelain and glass insulators assuming the same creepage distance per unit or string

Environment type	Profile suitability	Standard profile[a] All types	Open profile[b] Disc/ long rod	Open profile[b] Post/hollow	Anti-fog profile All types
Desert	++				
	+		●		
	0	●□	□	●□	□ (Both)
	-				● (Vertical)
	--				● (Horizontal)
Coastal	++				□ (Vertical)
	+				● (Vertical)
	0	●□	● [c]	●□	●□ (Horizontal)
	-		□		
	--				
Industrial	++				
	+		●		
	0	●□	□	●□	□
	-				●
	--				
Agricultural	++				
	+				
	0	●		●	
	-		●		● (Vertical)
	--				● (Horizontal)
Inland (low pollution)	++				
	+				
	0	●	●	●	●
	-				
	--				

KEY

● Type A pollution

□ Type B pollution

[a] The standard profile is taken as the reference "0" level. This does not automatically make the standard profile suitable for all applications, since in certain cases it cannot supply the necessary creepage distance within the required insulating length

[b] Alternating shed arrangements are mainly categorized in open profile.

[c] For the areas where rapid pollution due to typhoons or similar events are anticipated, an open profile will collect more pollutants in a short period than a standard or anti-fog profile, hence its suitability may be reduced.

Table 3 – Profile suitability, relative to a standard profile, for porcelain and glass insulators assuming the same insulating length

Environment type	Profile suitability	Standard profile[a] All types	Open profile[b]		Anti-fog profile All types
			Disc/ long rod	Post/hollow	
Desert	++		●		
	+		□	●□	● (Vertical) □ (Both)
	0	●□			● (Horizontal)
	-				
	--				
Coastal	++				● (Vertical) □ (Vertical)
	+		●[c]	●□	● (Horiz.) □ (Horiz.)
	0	●□	□		
	-				
	--				
Industrial	++				
	+		●		● (Vertical) □
	0	●□	□	●□	● (Horizontal)
	-				
	--				
Agricultural	++				
	+				● (Vertical)
	0	●	●	●	
	-				● (Horizontal)
	--				
Inland (low pollution)	++				
	+				
	0	●	●	●	●
	-				
	--				

KEY

● Type A pollution

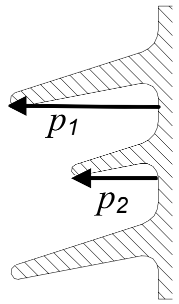
□ Type B pollution

[a] The standard profile is taken as the reference "0" level. This does not automatically make the standard profile suitable for all applications, since in certain cases it cannot supply the necessary creepage distance within the required insulating length.

[b] Alternating shed arrangements are mainly categorized in open profile.

[c] For the areas where rapid pollution due to typhoons or similar events are anticipated, an open profile will collect more pollutants in a short period than a standard or anti-fog profile, hence its suitability may be reduced.

9.2 Alternating sheds and shed overhang



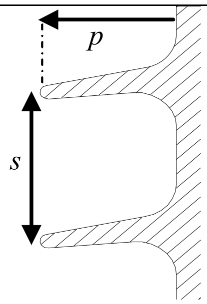
The classification of a profile as being alternating or not is based on difference in shed overhang measured from the insulator trunk to the tips of the largest and smallest sheds.

Shed overhang alone is not an important parameter, as long as the shed angle is not essentially flat (< 5°), or excessive (> 35°). The parameter is useful for defining uniform shed diameter profiles compared to alternating shed diameter profiles. However larger values of difference in shed overhang may be beneficial for vertical insulators in ice, snow and heavy rain conditions.

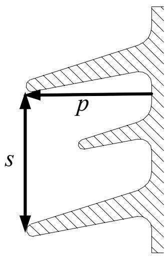
Not applicable to cap and pin insulators or multi-shed pin insulators

	Classification of profile	
	Non-alternating	**Alternating**
All insulators	$p_1 = p_2$ *or* $p_1 - p_2 < 15$ mm	$p_1 - p_2 \geq 15$ mm

9.3 Spacing versus shed overhang



Uniform sheds

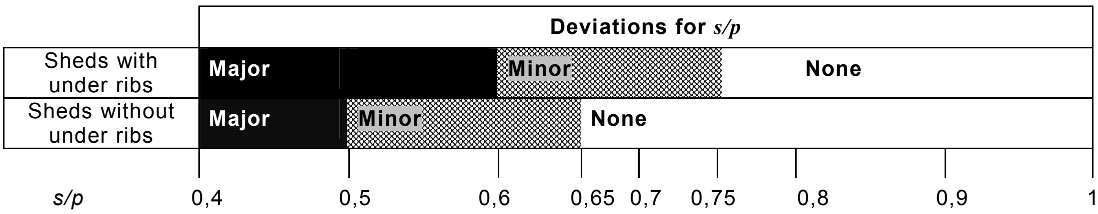


Alternating sheds

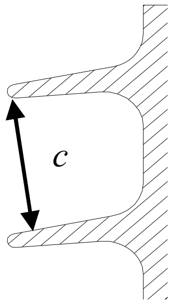
Spacing versus shed overhang is ratio of the vertical distance between two similar points of successive sheds of the same diameter (spacing) and the maximum shed overhang.

This parameter, as well as those described in 9.5, 9.6 and 9.7, involve shed-to-shed spacing and are important for the avoidance of "shorting out" creepage distance bridged by a shed-to-shed arc.

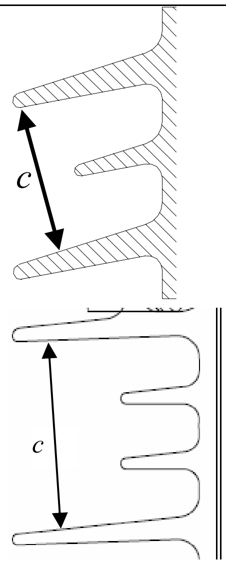
Not applicable to cap and pin insulators or multi-shed pin insulators



9.4 Minimum distance between sheds



Uniform sheds



Alternating sheds

c is the minimum distance between adjacent sheds of the same diameter, measured by drawing a perpendicular from the lowest point of rim of the upper shed to the next shed below of the same diameter.

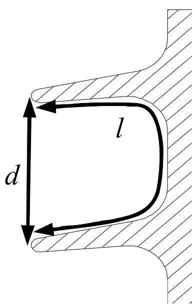
Minimum distance between sheds is one of the more important characteristics for insulator profile evaluation. Shed-to-shed arcing for small shed spacing can negate any effort to improve performance by adding creepage distance.

Not applicable to cap and pin insulators or pin insulators

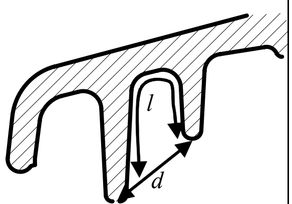
Deviations for *c*

c (mm)	15 – 20	20 – 25	25 – 30	30 – 45
Insulator length >550 mm	**Major**	**Major**	**Minor**	**None**
Insulator length ≤550 mm	**Major**	**Minor**	**None**	**None**

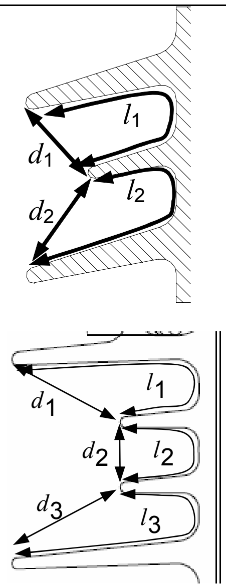
9.5 Creepage distance versus clearance



Plain sheds



Cap and pin



Alternating sheds

d is the straight air distance between two points on the insulating part or between a point on the insulating part and another on a metal part.

l is the part of the creepage distance measured between the above two points.

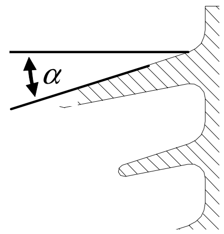
l/d is the highest ratio found on any section, for example on the underside of a cap and pin insulator.

Creepage distance versus clearance is a more localized check of the risk of bridging by arcs when dry bands or uneven hydrophobicity occur. It is also important in avoiding localized pollution build-up in deep and narrow sections of the profile

Deviations for *l/d*

l/d	1 – 5	5 – 6	6 – 7
All profiles	**None**	**Minor**	**Major**

9.6 Shed angle



For rounded sheds, α is measured at the mid-point.

Open profiles allow for more efficient natural washing of insulator surfaces, provided the shed angle is not so low as to impede excess water run-off.

Not applicable to pin insulators

	Deviations for shed angle α			
Vertical insulators	Minor 0° Major	None	Minor	Major
Other positions	None		Minor	Major
α °	0 – 5	5 – 25	25 – 35	35 – 60

α °: 0, 5, 10, 20, 25, 30, 35, 40, 50, 60

9.7 Creepage factor

CF is equal to l/S

where

l is the total nominal creepage distance of the insulator;

S is the arcing distance of the insulator.

For cap and pin insulators, CF is determined for a string of 5 insulators or more.

Creepage factor is a global check of the overall density of creepage distance. If the requirements in 9.1, 9.2 and 9.3 are met, the creepage factor requirement is usually automatically respected

	Deviations for CF		
SPS Class a	None	3,5 Minor	4,25 Major
SPS Class b	None	3,625 Minor	4,4 Major
SPS Class c	None	3,75 Minor	4,55 Major
SPS Class d	None	3,875 Minor	4,7 Major
SPS Class e	None	4,0 Minor	4,85 Major

CF: 2,5, 3, 3,5, 4, 4,5, 5

10 Correction of the RUSCD

10.1 Introductory remark

The following corrections, where applicable, shall be applied to the reference unified specific creepage distance (RUSCD) determined after analysis according to Clause 9 above. All the factors are multipliers, as follows:

$$\text{Corrected USCD} = \text{RUSCD} \times K_a \times K_{ad}$$

10.2 Correction for altitude K_a

The influence of altitude on impulse withstand voltages is generally much greater than on pollution withstand performance. In general, the increase in insulation length necessary for impulse voltages at higher altitudes results in more than sufficient increase in creepage distance. This means, if not otherwise clearly stated by the purchaser of the insulator, usually K_{ad} = 1. If nevertheless, correction is required, notably for altitudes above 1 500 m where there is no previous operating experience, then correction can be used based on [1].

10.3 Correction for insulator diameter K_{ad}

For long rod, post and hollow insulators correct for average diameter D_a by:

K_{ad} = 1 when D_a is smaller than 300 mm;

K_{ad} = 0,000 5 D_a + 0,85 when D_a is equal to or larger than 300 mm

The average diameter D_a is given by

$$D_a = \frac{\int_0^l D(x)\,dx}{l}$$

where D(x) is the value of the diameter at a creepage distance x, measured from one electrode and l is the total nominal creepage distance of the insulator.

The above formula may be approximated in general by the following simple relation:

$$D_a = (2D_t + D_{s1} + D_{s2})/4$$

(D_{s1}=D_{s2} for non-alternating sheds)

For complex shed repetitions, add each extra diameter to the numerator and add 2 to the denominator.

In case of conflict or doubt this approximation shall not be used.

NOTE This correction takes into account both the reduced withstand performance and the reduced pollution accumulation of larger diameter insulators. The dotted line in the following Figure 7 shows the equivalent correction without the influence of reduced pollution accumulation, e.g. for artificial pollution testing.

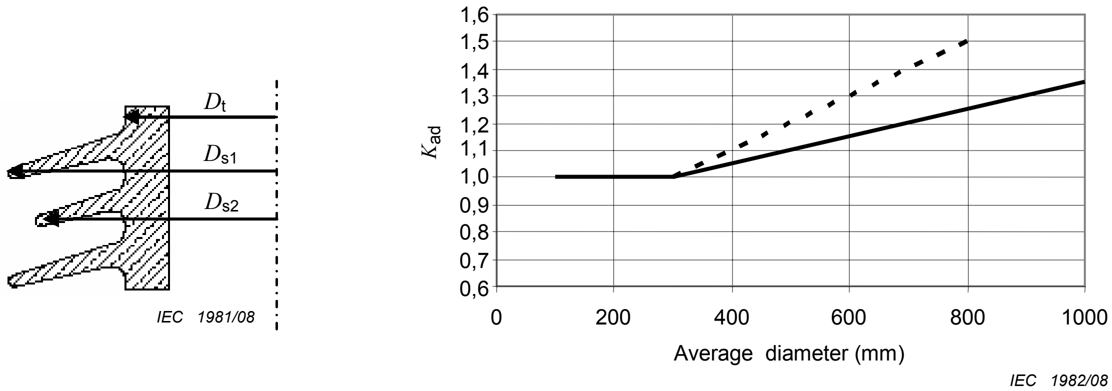


Figure 7 – K_{ad} as a function of insulator diameter

11 Determination of the required minimum nominal creepage distance

Once the RUSCD has been corrected according to Clause 10, the final minimum creepage distance is determined for the candidate insulator by rounding up to the nearest creepage distance available for that type of insulator within the constraints (system, dimensional, etc.).

For example, a final USCD of 36,5 mm/kV is found for a certain candidate cap and pin insulator. The system maximum phase-to-earth voltage is 228 kV. The required minimum creepage distance is therefore 228 mm × 36,5 mm = 8 322 mm. The creepage distance of each cap and pin insulator unit is 380 mm, requiring 21,9 units. Therefore the final minimum creepage distance will be 22 mm × 380 mm = 8 360 mm.

12 Confirmation by testing

12.1 Introductory remark

The general principles of using laboratory testing for insulator selection and dimensioning is described in IEC/TS 60815-1. The laboratory test is specified in terms of the long-duration withstand voltage, and the required pollution severity withstand level.

12.2 Determination of the long-duration withstand voltage

The long-duration withstand voltage at which the laboratory test is performed is equal to the maximum a.c. operating voltage that may appear across the insulator in service.

NOTE 1 For systems where long-duration temporary overvoltages occur, e.g. systems without earth fault clearing, the level of the expected temporary overvoltage should be taken into account when selecting the long-duration withstand voltage.

Tests may be performed on shorter insulator sections under the following conditions:

- the long-duration withstand voltage shall be adjusted to produce at least the same voltage stress per unit insulating length of the insulator;
- multi-unit insulator assemblies shall be tested as an assembly comprising more than one insulator unit;
- cap and pin insulator strings shall comprise at least of 3 insulator units.

NOTE 2 The insulating length refers to the shortest distance between fixing points of the live and earthed metal end fittings, ignoring the presence of any stress control rings, but including intermediate metal parts along the length of the insulator.

12.3 Selection of the standard pollution withstand test type

The relevant test method to be used is selected according to the type of pollution at the site, the type of insulator and the type of energization. The tests given in IEC 60507 are directly applicable to ceramic and glass insulators for a.c. systems.

As a general rule, the solid layer test is recommended for type A pollution and the salt-fog test for type B pollution.

The applicability of the required pollution severity withstand level to a specific site is

- dependent on whether the test method used can be considered representative of the intended environment, and
- restricted by the approximation and limitations inherent to the chosen laboratory test method.

The use of non-standard, or customized, laboratory pollution test methods may be necessary if the site of interest is not adequately represented by a standard laboratory test method. More information on such methods can be found in CIGRÉ 158 [1].

12.4 Artificial pollution test parameters

The determination of the pollution test severity consists of determining the withstand severity of the insulation which will meet the performance criterion when it is subjected to the highest voltage for the equipment.

The pollution test severity for deterministic methods or the performance data necessary for statistical methods are obtained according to the following Table 4.

Table 4 – Artificial pollution test parameters for confirmation by testing

<table>
<tr><th>Test</th><th>Deterministic method
Standard withstand test</th><th>Statistical method</th></tr>
<tr><td>Solid layer tests</td><td>Either:

Carry out a non-standard withstand test at the site ESDD and NSDD. This qualifies the equipment for a specific site.

Or (preferred):

Carry out a standard withstand test at a severity (SDD) chosen from the list below[a], taking the first value above the site ESDD.

For the following parameters, which have an established and quantifiable influence on pollution performance, the test severity can be adjusted as follows:

NSDD: If site NSDD is higher than 0,1 mg/cm^2 – increase test SDD using the following steps:
<table><tr><td>0,1< NSDD ≤0,2 (mg/cm^2)</td><td>0,2< NSDD ≤0,4 (mg/cm^2)</td><td>0,4< NSDD ≤0,8 (mg/cm^2)</td></tr><tr><td>1 SDD step</td><td>2 SDD steps</td><td>3 SDD steps</td></tr></table>If the NSDD is higher than 0,8 mg/cm^2 then perform the non-standard test at the measured NSDD.

Diameter: For insulators with average diameter greater than 400 mm, decrease test SDD by one step

This qualifies the equipment for a SPS class.

Alternatively, the SDD value for laboratory tests can be more accurately determined from ESDD in service using the principles given in Annex F of IEC/TS60815-1.

In other cases it is recommended to consult [1], [2] for information on the influence of salt types, wetting, etc. in order to determine appropriate solid layer test parameters for a representative non-standard test</td><td>Determine U_{50} curve from at least two test results at ESDD either side of the SPS. Use curve parameters in statistical analysis to verify required risk of flashover</td></tr>
<tr><td>[a] Standard SDD values</td><td colspan="2">0,0124 – 0,017 6 – 0,025 – 0,0353 – 0,05 – 0,070 5 – 0,1 – 0,141 – 0,20 – 0,4 – 0,8 – 1,0 – 1;41, 2,0 …(mg/cm^2)</td></tr>
<tr><td>Salt-fog tests</td><td>Carry out a standard withstand test at a salinity value chosen from the list below [b] by taking the first value above the SES.

Alternatively, the salinity value for laboratory tests can be more accurately determined from SES in service using the principles given in Annex F of IEC/TS 60815-1</td><td>Determine U_{50} or the withstand curve from at least two test results at salinity either side of the SES. Use curve parameters in statistical analysis to verify required risk of flashover</td></tr>
<tr><td>[b] Standard salinity values</td><td colspan="2">2,5 – 3,5 – 5 – 7 – 10 – 14 – 20 – 28 – 40 – 56 – 80 – 112 – 160 – 224 (kg/m^3)</td></tr>
</table>

12.5 Criteria of confirmation

Insulators that pass the withstand tests at the required pollution severity, or higher, are deemed be correctly dimensioned for the envisaged application and conditions.

Bibliography

[1] IEC 60050-604, *International Electrotechnical Vocabulary – Part 604: Generation, transmission and distribution of electricity – Operation*

[2] CIGRE Taskforce 33.04.01 – *Polluted insulators: A review of current knowledge*, CIGRE brochure N° 158-2000

[3] CIGRE WG C4.303 – *Outdoor insulation in polluted conditions: Guidelines for selection and dimensioning – Part 1: General principles and the a.c. case*, CIGRE Technical Brochure N° 361-2008

[4] CIGRE Taskforce 33.13.07 – *Influence of Ice and snow on the flashover performance of outdoor insulators – Part 1: Effects of Ice*, ELECTRA No. 187 December 1999, and Part 2: *Effects of Snow*, ELECTRA No. 188 February 2000.

[5] *CIGRE Taskforce 33.04.03 – Insulator pollution monitoring*, Electra 152, February 1994

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