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CONSOLIDATED VERSION

TECHNICAL REPORT

colour inside

HV polymeric insulators for indoor and outdoor use tracking and erosion testing by wheel test and 5 000 h test

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HV POLYMERIC INSULATORS FOR INDOOR AND OUTDOOR USE TRACKING AND EROSION TESTING BY WHEEL TEST AND 5 000H TEST

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 62730 edition 1.1 contains the first edition (2012-03) [documents 36/305/DTR and 36/316A/RVC] and its amendment 1 (2024-06) [documents 36/596/DTR and 36/601/RVDTR].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 62730, which is a technical report, has been prepared by IEC technical committee 36: Insulators.

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

The committee has decided that the contents of this document and its amendment will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

IEC 62217 [1][1] included three different tracking and erosion tests. One, the 1 000 hour salt-fog test, was included in the main text as a default test and two others, the 5 000 hour test and the tracking wheel test, were given in annexes as alternative tests.

Following a decision by TC 36 it was decided that it was desirable to have a single standardised test in IEC 62217; hence a study of the usage and effectiveness of all three tests was undertaken by Working Group 12 of TC 36. The results of this study indicated that, while the 5 000h and the tracking wheel tests each had their advantages, only the 1 000 hour salt fog test was adapted to all insulator types and was more economical to perform.

It was decided by TC 36 to adopt the 1 000 hour salt-fog test as the only standardised test. It was also decided to draft this Technical Report to reproduce the 5 000 hour and the tracking wheel test procedures in order to keep the information on the test methods and parameters available for those wishing to use those tests for research or other purposes.

The tracking and erosion tests given in this technical report are considered as screening tests intended to reject materials or designs which are inadequate. These tests are not intended to predict long-term performance for insulator designs under cumulative service stresses.

Composite insulators are used in both a.c. and d.c. applications. In spite of this fact a specific tracking and erosion test procedure for d.c. applications as a design test has not yet been defined and accepted.

IEC Guide 111 has been followed during preparation of this technical report wherever possible.

[1] Numbers in square brackets refer to the Bibliography.

HV POLYMERIC INSULATORS FOR INDOOR AND OUTDOOR USE TRACKING AND EROSION TESTING BY WHEEL TEST AND 5 000H TEST

1 Scope and object

This technical report is applicable to polymeric insulators whose insulating body consists of one or various organic materials. Polymeric insulators covered by this technical report include both solid core and hollow insulators. They are intended for use on overhead lines and in indoor and outdoor equipment with a rated voltage greater than 1 000 V.

The object of this technical report is:

- to define the common terms used;
- to give the background behind the development and use of the 5 000 h multiple stress test and the tracking wheel test;
- to describe the test methods for the 5 000 h multiple stress test and the tracking wheel tests on polymeric insulators;
- to describe possible acceptance or failure criteria, if applicable;

These tests, criteria and recommendations are intended to give a common basis for the 5 000h multiple stress test and the tracking wheel test when they are used for research or required as a supplementary design test. These tests are not mandatory and their use is subject to prior agreement between the interested parties.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-47:2007, *International Electrotechnical Vocabulary – Part 471: Insulators*

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

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

IEC 60815-2, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for a.c. systems*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60050 (471) and the following apply:

3.1
polymeric insulator
insulator whose insulating body consists of at least one organic based material. Coupling devices may be attached to the ends of the insulating body

Note 1 to entry: Polymeric insulators are also known as non-ceramic insulators.

[SOURCE: IEC 60050-471:2007, 471-01-13, modified]

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

Note 1 to entry: The housing and sheds are not part of the core.

[SOURCE: IEC 60050-471:2007, 471-01-03]

3.3
insulator trunk
central insulating part of an insulator from which the sheds project.

Note 1 to entry: Also known as shank on smaller insulators.

[SOURCE: IEC 60050-471:2007, 471-01-11]

3.4
housing
external insulating part of a composite insulator providing the necessary creepage distance and protects the core from the environment

Note 1 to entry: An intermediate sheath made of insulating material may be part of the housing.

[SOURCE: IEC 60050-471:2007, 471-01-09]

3.5
shed
insulating part, projecting from the insulator trunk, intended to increase the creepage distance.

Note 1 to entry: The shed can be with or without ribs.

[SOURCE: IEC 60050-471:2007, 471-01-15]

3.6
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 to entry: The surface of cement or of any other non-insulating jointing material is not considered as forming part of the creepage distance.

Note 2 to entry: 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.

[SOURCE: IEC 60050-471:2007, 471-01-04]

3.7
interfaces
surface between the different materials. 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;

3.8
tracking
process which forms irreversible degradation by formation of conductive paths (tracks) starting and developing on the surface of an insulating material. These paths are conductive even under dry conditions

3.9
erosion
irreversible and non-conducting degradation of the surface of the insulator that occurs by loss of material. This can be uniform, localized or tree-shaped.

Note 1 to entry: 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.

3.10
crack
any internal fracture or surface fissure of depth greater than 0,1 mm

3.11
puncture
permanent loss of dielectric strength due to a disruptive discharge passing through the solid insulating material of an insulator

[SOURCE: IEC 60050-471:2007, 471-01-14, modified]

4 Background to the tracking and erosion tests

4.1 Difference between the tracking and erosion and accelerated ageing tests on polymeric insulators

Although this Technical Report describes tracking and erosion tests which often may be referred to in the literature as “ageing tests”, it is important to note that they are not accelerated ageing tests in the sense that these tests do not simulate exactly real life degradation conditions nor do they accelerate them to give a life-equivalent test in a short time. Rather they use continuous, cyclic or combined stresses to try to detect potential weaknesses which could compromise the insulators performance in service.

The tests are better described as screening tests, which can be used to reject materials, designs, or combinations thereof which are inadequate.

The ageing mechanisms on a polymeric insulator generally do not cause a progressive reduction of easily measurable ageing-induced properties with time. The transition from “good condition” to “end of life” is frequently rapid with no forewarning and might be observed by, for instance, erosion to depths comparable to those obtained in the 1 000 hour salt fog test defined in IEC 62217 or deep UV-initiated cracks in the surfaces. The time and speed of this transition depends on multiple parameters, both of the insulator material and design and of the operating environment. Hence the use of such ageing tests for true "end of life" prediction is only possible when relevant data on damage and degradation is available for the same or similar insulators in the same or similar environments.

Therefore these tests are used to give a general indication of the quality of the design and materials with respect to the stresses arising in relatively harsh but not extreme environments.

For further information, see [2].

4.2 The wheel test

The tracking wheel test was originally developed in Canada and introduced in the Canadian Electrical Association Light Weight Insulator Working Group CEA LWIWG-01 – Dead-end suspension composite insulator standard in 1991. It was named Tracking Wheel # 2.

The # 1 version was a spray system rather than a dip system.

The original concept was to energize, at 35 V/mm of creepage, the insulator sample which had been dipped in a NaCl solution of 1,40 g/l of water and allowed to drip. It was continuous for the duration of the 30 000 cycles. The original acceptance criteria were: no tracking, no erosion to the core and no shed or housing puncture. Every unit was then tested with a steep front impulse and a power frequency voltage test.

The wheel test was not deemed to be an ageing test by the CEA. Although there were discussions 20 years ago to correlate the aspects of the tested insulators with insulators in the field and to estimate an aging factor, such correlation was never implied in the standard. There was also consideration to modify the test parameters to reflect different pollution severities. This was never introduced.

In the LWIWG-01-1996 version, the description of the test was modified to describe the de-ionized water and introduce a rest period of 24 hours where the dip tank is empty. It was observed during the first part of the 1990s that silicone-based housings did not perform well when the test was uninterrupted. This corresponds to the concept of hydrophobicity recovery which had gained popularity by that time.

In 2010, the test in the standard was re-affirmed in CSA C411.5 with basically the same parameters.

In this IEC version, there are no provisions for a rest period, nor impulse and flashover tests following the 30 000 cycles. There is allocation for test interruptions and a requirement to change the dip tank solution weekly. The IEC version gives precise guidelines as to the acceptable erosion depth.

This test is mandatory in the CSA insulator standards. For more than 20 years, this test has been considered able to detect insulator designs that are not suitable for use on overhead transmission lines. It is not meant as an ageing test with an estimated acceleration factor.

4.3 The 5 000h multiple stress test

The 5 000h multiple stress test was initially developed by CIGRE WG 22.10 which was set up in 1978 to establish a technical basis for minimum requirements for composite insulators. Their work was published in 1983 [3] and included a proposal for a multi-stress 5 000 hour test combining cycles of humidity, heating, rain, salt fog and solar radiation on energised insulators. The intention of the test was to reproduce any synergy between the multiple stresses seen by insulators in service that might not be present in a single stress test. Later work by EDF in France using the same "CIGRE" cycles reported varying acceleration factors with respect to different test station environments [4] and classed the test as an accelerated ageing test.

A similar, but not identical, test cycle was used in Italy as an accelerated ageing test and it was deemed necessary to "fix" the test parameters by including it in IEC 61109:1992 [5]. At this point it was given as an alternative to the 1 000h salt-fog test for insulators intended for extreme conditions. IEC 61109:1992 did not mention any acceleration factors.

When it was decided to group common tests for composite insulators into IEC 62217:2005, the test was included an alternative tracking and erosion test, not an accelerated ageing test. The version of the test in 62217:2005 had been revised by IEC TC 36 WG12 on the basis of work between Sweden and France to improve the reproducibility of the test which had been shown to be problematic [6]. The main improvement involved calibration of the salt-fog cycle by using standard dummy insulators at each test position to set up fog distribution and flow rate.

The procedure included in this Technical Report includes some minor alterations to further improve reproducibility.

5 Classification of tests

Previously, these tests were alternative or supplementary design tests.

6 General requirements for insulator test specimens

Insulator test specimens for tests of polymeric insulators shall be checked prior to tests:

- for correct assembly, for example by applying the mechanical routine test specified in the relevant product standard,
- by visual examination according to the relevant product standard;
- for conformance of dimensions with the actual drawing.

For dimensions d without tolerances the following tolerances are acceptable:

- $\pm$ (0,04 $\times$ d + 1,5) mm when $d \leq 300$ mm;
- $\pm$ (0,025 $\times$ d + 6) mm when $d > 300$ mm with a maximum tolerance of 50 mm.

The measurement of creepage distances shall be related to the design dimensions and tolerances as determined from the insulator drawing, even if this dimension is greater than the value originally specified. When a minimum creepage is specified, the negative tolerance is also limited by this value.

The housing colour of the test specimens shall be approximately as specified in the drawing.

The number of test specimens, their selection and dimensions are specified in the relevant product standard or agreed upon by the interested parties.

7 The tests

7.1 Wheel test

7.1.1 Test specimens

Two test insulators of identical design with a creepage distance between 500 mm and 800 mm shall be taken from the production line. If such insulators cannot be taken from the production line, special test specimens shall be made from other insulators so that the creepage distance falls between the given values. These special test specimens shall be fitted with standard production end fittings.

Up to two pairs of test specimens can be tested simultaneously on one wheel. It is recommended not to mix widely differing materials on the same wheel.

The test samples shall be properly marked so that the pairs can be easily identified at the end of the test.

7.1.2 Procedure

The test specimens shall be cleaned with de-ionized water before starting the test. The test specimens are mounted on the wheel as shown in Figure 1. They go through four positions in one cycle. Each test specimen remains stationary for about 40 s in each of the four positions. The 90° rotation from one position to the next takes about 8 s. In the first part of the cycle the insulator is dipped into a saline solution. The second part of the test cycle permits the excess saline solution to drip off the specimen, ensuring that the light wetting of the surface gives rise to sparking across dry bands that will form during the third part of the cycle. In that part the specimen is submitted to a power frequency voltage. In the last part of the cycle the surface of the specimen that had been heated by the dry band sparking is allowed to cool.