SLOVENSKI STANDARD
SIST IEC/TR 60099-3:1998

01-april-1998

Prenapetostni odvodniki - 3. del: Preskušanje prenapetostnih odvodnikov ob umetnem onesnaženju

Surge arresters. Part 3: Artificial pollution testing of surge arresters

Parafoudres. Troisième partie: Essais de pollution artificielle des parafoudres

Ta slovenski standard je istoveten z: IEC/TR 60099-3

ICS:

29.120.50	Varovalke in druga medtokovna zaģļ ita	Fuses and other overcurrent protection devices
29.240.10	Transformatorske postaje. Prenapetostni odvodniki	Substations. Surge arresters

SIST IEC/TR 60099-3:1998 **en**

RAPPORT TECHNIQUE
TECHNICAL REPORT

CEI
IEC
99-3

Première édition
First edition
1990-08

Parafoudres

Partie 3:
Essais de pollution artificielle des parafoudres

Surge arresters

Part 3:
Artificial pollution testing of surge arresters

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE L

Pour prix, voir catalogue en vigueur
For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SURGE ARRESTERS

Part 3: Artificial pollution testing of surge arresters

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This Technical Report has been prepared by IEC Technical Committee No. 37: Surge arresters.

It replaces and cancels Appendix D of Publication 99-1 (1970). A new edition of Publication 99-1 is being prepared..

The text of this report is based on the following documents:

Six Months' Rule	Report on Voting
37(CO)24	37(CO)27

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

SURGE ARRESTERS

Part 3: Artificial pollution testing of surge arresters

1 Scope

This Technical Report gives the basic principles of artificial pollution testing of non-linear resistor type (valve type) surge arresters, together with details of pollutant compositions and methods of application and the test procedures associated with each mode of pollution.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 99-1: 1970, Lightning arresters – Part 1: Non-linear resistor type arresters for a.c. systems.

IEC 507: 1975, Artificial pollution tests on high-voltage insulators to be used on a.c. systems.

3 Basic principles

It is well known that a surge arrester can fail at normal service voltage under certain pollution conditions, owing to the setting up of a very uneven voltage distribution on its external surface and/or because of very rapid changes in this distribution. These two stages arise as a consequence of the formation under such conditions of an initially nearly continuous conducting surface layer consisting typically of an aqueous solution of electrolyte formed under high humidity by the moisture pick-up of hygroscopic solid particles or liquid droplets deposited on the surface. Dusts may also be present, affecting the washing and drying characteristics of the surface. It is well established also that the effect of leakage current heating the surface layer, when the conductivity is high enough, is to cause "dry bands" to form, across which most of the voltage drop occurs and that surges of leakage-current occur when these bands are temporarily bridged by an arc.

These phenomena can result in the voltage applied across some of the gaps exceeding their sparkover value, with consequential failure, in some cases, through disturbance of the gap potentials caused by capacitive coupling between electrodes and wet bands.

It is consequently the primary purpose of artificial pollution testing of surge arresters to simulate relevant pollution conditions, representative of those occurring in service and establishing that when subjected to these, the surge arrester, energized at appropriate power-frequency voltage does not suffer gap sparkover.

Pollution flashover of the surge arrester surface is a serious matter operationally, and the performance in this respect also must be determined. This is discussed in the following paragraphs.

There is now evidence both from service and testing that the pollution conditions which may result in surge arrester sparkover can be generally different from those leading to surface flashover. The latter is associated typically with severe conditions characterized by frequent high-amplitude leakage-current surges, whereas gap sparkover is typically associated with pollution onset or drying-out of the pollutant. Accordingly, separate tests for these two distinct modes of failure may be needed, at least with some test methods.

Some artificial pollution test methods for surface flashover of high-voltage insulators have been developed to a stage where they are generally accepted as giving a valid indication of pollution performance. These are fully described in IEC 507. The essential common feature of the tests, even though there are differences in the polluting techniques, are the repeatable production of various degrees or "severities" of pollution, measured, for example, in terms of specific conductance of the pollutant, application of a suitable test voltage and consequent determination of the performance in terms of a given severity.

The mode of operation of surge arresters, however, is such that the methods used for insulator testing are not directly applicable to surge arresters, especially in respect of arrester sparkover. The tests described in this report, though broadly based on those of IEC 507, are essentially aimed at meeting the special requirements for surge arrester operation and bear specifically on gap sparkover.

The methods of IEC 507 are directly applicable to surface flashover of insulation, and it is accordingly recommended that they should be used to determine performance in this respect.

It should be noted that the tests according to IEC 507 with respect to such surface flashover performance and those proposed here to check sparkover performance are recommended only for surge arresters exposed to natural pollution, possibly with live washing, and not for those subject to periodic cleaning or greasing.

From the foregoing account of the failure mechanism it follows that for pollution tests of both kinds, it is essential that they be performed on a complete service surge arrester assembly.

When sufficient experience has been gained from the tests described in the following clauses, this experience will form the basis of a type test.

NOTE – In service, surge arresters sometimes suffer long-term deterioration associated with internal corona discharges. The tests described in this report do not demonstrate the performance of the surge arrester in this respect.

4 Test objective

The objective of the test is to establish that the surge arrester can withstand a specified severity of pollution without sparkover when energized at a specified voltage or voltage-application mode, both severity and voltage mode being representative of service conditions.

5 General requirements

5.1 *Test arrester*

The test shall be made on a complete arrester, with all normal spark-gaps, grading resistors and any grading ring, etc., which may significantly affect the voltage distribution of the arrester. However, for pollution tests, it is not generally necessary to mount the arrester on a pedestal. This is because the conductive surface layer and the internal processes determine the voltage distribution and its variations in this case, as opposed to that of tests for impulse sparkover performance in the normal unpolluted state, for example, where the distribution, though partly controlled by grading resistors, series capacitance of the gaps, etc., can also be affected by the distributed capacitance to the earth plane and high-voltage lead, etc.

The dry arrester power-frequency sparkover value and grading current measured at the operating voltage should be measured prior to and after the test.

5.2 *Cleaning*

Before the arrester is tested for the first time, the surface shall be carefully cleaned (using a detergent solution such as trisodium phosphate) and thoroughly rinsed (using tap or mains water) so that all traces of surface contamination, particularly grease, are removed before testing. Care must be taken to avoid touching the cleaned arrester.

NOTE – It may be necessary in some cases, particularly when spraying salt pollutants, to paint the metal parts and cement to ensure that no corrosion products wash down onto the insulating surface during the test.

5.3 *Installation*

The cleaned arrester shall be erected so that the minimum distance between any part of it and any earthed object other than the jets, and a ceiling or a wall is not less than one-half of the length of the arrester. The arrester shall be in thermal equilibrium with the ambient air at the start of the test and the temperature shall be noted. The temperature shall not be below 5 °C or greater than 40 °C.

5.4 *Arrangements for arrester current monitoring*

For test result diagnostic purposes according to 7.5 the surface leakage and internal current paths shall be separately connected to the earth terminal of the test voltage source so that the surface leakage and internal currents can be separately monitored. If the arrester is not provided with an internal current lead isolated from the bottom flange, a surface leakage current collecting band is fitted above the flange and the insulation surface between the band and the flange should be greased. Band/flange spacing should be as small as possible, subject to provision of the necessary insulation, to minimize encroachment on the leakage path. For most designs of arrester housing these requirements are met by fitting the band immediately above the bottom shed.

In the case of a multi-unit arrester, the band is applied only to the bottom unit.

5.5 *Test circuit requirements*

The impedance of the whole circuit, including the transformer and regulator, should not be so great that sparkover is inhibited by a drop in the voltage, or distortion of the wave shape.

This condition is met when the regulation of the source is such as to maintain the specified voltage on the arrester except for infrequent, non-consecutive, half-cycle voltage dips of no more than 5% during leakage current pulses.

It is also met by compliance with IEC 507.

The values in IEC 507 for the circuit *R/X* values and minimum short-circuit current are given in Table 1.

Table 1

R/X at test voltage	Minimum short-circuit current at test voltage A
<0,05	5
0,05 to 0,15	7
0,15 to 0,5	10
0,5 to 1,5	15

NOTES

1 The values in the above table are based on investigations on a small number of insulators. They represent the best suggestion that can be given at present, but may be modified with further experience.

2 In the case of large diameter housings, it may be necessary to increase the source short-circuit current to values higher than those specified in the table, in order to avoid premature extinction of the arcs bridging dry bands in the pollution layer.

3 One method of determining the *R/X* value of the circuit is to measure:

a) The short-circuit current I_{sc} corresponding to an open circuit voltage U_o equal to the specified test voltage.

b) The voltage U_L existing when the current passes through a load whose resistance is such that the r.m.s. value I_L of the current is equal to 1 A.

R/X can be found from the following formula:

$$R/X = \frac{U_o^2[1 - (I_L/I_{sc})^2] - U_L^2}{\sqrt{4U_o^2\, U_L^2\, (I_L/I_{sc})^2 - \{U_o^2[1 - (I_L/I_{sc})^2] - U_L^2\}^2}}$$