IEC 60099-6

Edition 2.0 2019-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Surge arresters –
Part 6: Surge arresters containing both series and parallel gapped structures – System voltage of 52 kV and less

Parafoudres –
Partie 6: Parafoudres contenant des structures à éclateurs en série et en parallèle – Tension de réseau inférieure ou égale à 52 kV

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CONTENTS

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FOREWORD

International Standard IEC 60099-6 has been prepared by IEC technical committee 37: Surge arresters.

This second edition cancels and replaces the first edition published in 2002. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) A new concept of arrester classification and energy withstand testing was introduced: the line discharge classification was replaced by a classification based on repetitive charge transfer rating (Q_{rs}) and thermal charge transfer rating (Q_{th}). The new concept clearly differentiates between impulse and thermal energy handling capability, which is reflected in the requirements as well as in the related test procedures.

b) Power-frequency voltage versus time tests – with and without prior duty – were introduced as type tests.

c) Requirements and tests on disconnectors were added.

d) Definitions for new terms have been added.

e) Clause 10 contains particular requirements for polymer-housed surge arresters. These are indicated in the form of replacements, additions or amendments to the original clauses or subclauses concerned.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
37/450/FDIS	37/451/RVD

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

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

A list of all parts in the IEC 60099 series, published under the general title *Surge arresters*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This part of IEC 60099 presents the minimum criteria for the requirements and testing of metal-oxide surge arresters containing gapped structures that are applied to AC power systems with U_s above 1 kV up to and including 52kV.

Arresters covered by this document can be applied to overhead installations in place of the non-linear type arresters covered in IEC 60099-4.

An accelerated ageing procedure is incorporated in this document to simulate the long-term effects of voltage and temperature on the arrester. This is necessary since during the arrester's service life the gaps and resistor elements will have portions of the system power frequency voltage continuously applied across them.

SURGE ARRESTERS –

Part 6: Surge arresters containing both series and parallel gapped structures – System voltage of 52 kV and less

1 Scope

This part of IEC 60099 applies to non-linear metal-oxide resistor type surge arresters with spark gaps designed to limit voltage surges on AC power circuits with system voltages U_s above 1 kV up to and including 52 kV. This document basically applies to all metal-oxide distribution class surge arresters with internal series and/or parallel gaps and housed in either porcelain or polymeric housings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

IEC 60068-2-11:1981, *Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60071-2:2018, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

IEC TS 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*

IEC 62217, *Polymeric HV insulators for indoor and outdoor use – General definitions, test methods and acceptance criteria*

ISO 4287, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*

ISO 4892-1, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 4892-3, *Plastics – Methods of exposure to laboratory light sources – Part 3: Fluorescent UV lamps*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
acceptance test
test made on arresters or representative samples after agreement between manufacturer and user

3.2
arrester disconnector
device for disconnecting an arrester from the system in the event of arrester failure, to prevent a persistent fault on the system and to give visible indication of the failed arrester

Note 1 to entry: Clearing of the fault current through the arrester during disconnection generally is not a function of the device.

3.3
bending moment
force perpendicular to the longitudinal axis of an arrester multiplied by the vertical distance between the mounting base (lower level of the flange) of the arrester and the point of application of the force

3.4
breaking load
force perpendicular to the longitudinal axis of a porcelain-housed or cast resin arrester leading to mechanical failure of the arrester housing

3.5
cast resin housed arrester
arrester using a housing made from only one organic based material (e.g. cycloaliphatic epoxy) that fractures similarly to a porcelain housing under mechanical overstress

3.6
continuous current of an arrester
current flowing through the arrester when energized at the continuous operating voltage

3.7
continuous operating voltage of an arrester
U_c
designated permissible RMS value of power-frequency voltage that may be applied continuously between the arrester terminals in accordance with 8.5

3.8
damage limit
<mechanical>
lowest value of a force perpendicular to the longitudinal axis of a polymer-housed arrester leading to mechanical failure of the arrester housing

3.9
designation of an impulse shape
combination of two numbers, the first representing the virtual front time (T_1) and the second the virtual time to half-value on the tail (T_2)

Note 1 to entry: This is written as T_1/T_2, both in microseconds, the sign "/" having no mathematical meaning.

3.10
discharge current of an arrester
impulse current which flows through the arrester

3.11
disruptive discharge
phenomenon associated with the failure of insulation under electric stress, which includes a collapse of voltage and the passage of current

Note 1 to entry: The term applies to electrical breakdowns in solid, liquid and gaseous dielectric, and combinations of these.

Note 2 to entry: A disruptive discharge in a solid dielectric produces permanent loss of electric strength. In a liquid or gaseous dielectric the loss may be only temporary.

3.12
distribution class arrester
arrester intended for use on distribution systems, typically of $U_s \leq$ 52 kV, to protect components primarily from the effects of lightning

Note 1 to entry: Distribution class arresters may have nominal discharge currents, I_n, of 2,5 kA; 5 kA or 10 kA.

Note 2 to entry: Distribution arresters are classified as “Distribution DH”, “Distribution DM” and “Distribution DL” (see Table 1).

3.13
electrical unit
portion of an arrester in which each end of the unit is terminated with an electrode which is exposed to the external environment

3.14
fault indicator
device intended to provide an indication that the arrester is faulty and which does not disconnect the arrester from the system

3.15
flashover
disruptive discharge over a solid surface

3.16
follow current
current from the connected power source that flows through an arrester during and following the passage of discharge current

3.17
front of an impulse
part of an impulse which occurs prior to the peak

3.18
high current impulse
<of an arrester> peak value of discharge current having a 4/10 impulse shape which is used to test the stability of the arrester on direct lightning strokes

3.19
housing
external insulating part of an arrester, which provides the necessary creepage distance and protects the internal parts from the environment

Note 1 to entry: A housing may consist of several parts providing mechanical strength and protection against the environment.

3.20
impulse
unidirectional wave of voltage or current which, without appreciable oscillations, rises rapidly to a maximum value and falls, usually less rapidly, to zero with small, if any, excursions of opposite polarity, with defining parameters being polarity, peak value, front time and time to half-value

3.21
insulating base
a short insulator (or set of insulators) on which the arrester is mounted to provide a means of connecting a current monitoring device between the base of the arrester and earth

3.22
internal grading components of an internally gapped arrester
grading impedances, connected in parallel with the internal gap(s), to control the voltage across the gap section

3.23
internal parts
MO resistor with supporting structure and internal grading system, if equipped

3.24
lightning current impulse
8/20 current impulse with limits on the adjustment of equipment such that the measured values are from 7 μs to 9 μs for the virtual front time and from 18 μs to 22 μs for the time to half-value

Note 1 to entry: The time to half-value is not critical and may have any tolerance during the residual voltage type tests (see 8.3.2.3).

3.25
lightning impulse discharge
an approximately sine half-wave current impulse having a time duration within 200 μs to 230 μs during which the instantaneous value of the impulse current is greater than 5 % of its peak value

3.26
lightning impulse protection level
LIPL or U_{pl}
the maximum residual voltage of the arrester for the nominal discharge current

3.27
long-duration current impulse
rectangular current impulse which rises rapidly to maximum value, remains substantially constant for a specified period and then falls rapidly to zero, with defining parameters being polarity, peak value, virtual duration of the peak and virtual total duration.

3.28
mean breaking load
MBL
the average breaking load for porcelain or cast resin-housed arresters determined from tests

3.29
mechanical unit
portion of an arrester in which the MO resistors within the unit are mechanically restrained from moving in an axial direction

Note 1 to entry: An arrester may contain more than one mechanical units within an electrical unit (see Figure 5).

Note 2 to entry: A mechanical unit may have more than one electrical unit (see Figure 5).

3.30
mounting bracket
means by which a distribution class arrester is physically attached to a pole or other structure

Note 1 to entry: For polymer housed distribution class arresters, the mounting bracket is typically of an insulating material and is typically attached to the bottom (ground) end of the arrester; for porcelain-housed distribution class arresters, the bracket is typically metal (often steel) and is connected by a “belly band” around the porcelain housing at some distance from the ground end of the arrester.

3.31
I_n
nominal discharge current of an arrester
peak value of lightning current impulse, which is used to classify an arrester

3.32
MO resistor
part of the surge arrester which, by its non-linear voltage versus current characteristics, acts as a low resistance to overvoltages, thus limiting the voltage across the arrester terminals, and as a high resistance at normal power-frequency voltage

3.33
peak value of an impulse
crest value of an impulse
maximum value of a voltage or current impulse

Note 1 to entry: Superimposed oscillations may be disregarded.

3.34
peak value of opposite polarity of an impulse
crest value of opposite polarity of an impulse
maximum amplitude of opposite polarity reached by a voltage or current impulse when it oscillates about zero before attaining a permanent zero value

3.35
polymer-housed surge arrester
arrester using polymeric and composite materials for housing

Note 1 to entry: Designs with an enclosed gas volume are possible. Sealing may be accomplished by use of the polymeric material itself or by a separate sealing system.

3.36
porcelain-housed surge arrester
arrester using porcelain as housing material, with fittings and sealing systems

3.37
power-frequency voltage versus time characteristic
<of an arrester> maximum time durations for which corresponding power-frequency voltages may be applied to arresters without causing damage or thermal instability, under specified conditions in accordance with 6.10

3.38
pressure-relief device
<of an arrester> means for relieving internal pressure in an arrester and preventing violent shattering of the housing following prolonged passage of fault current or internal flashover of the arrester

3.39
prospective current
<of a circuit> current that would flow at a given location in a circuit if it were short-circuited at that location by a link of negligible impedance

3.40
protective characteristics
<of an arrester> combination of lightning impulse protection level (LIPL), switching impulse protection level (SIPL) and steep current impulse protection level (STIPL)

3.41
puncture
breakdown
disruptive discharge through a solid

3.42
rated frequency of an arrester
frequency of the power system on which the arrester is designed to be used

3.43
I_s
rated short-circuit current
highest tested power-frequency current that may develop in a failed arrester as a short-circuit current without causing violent shattering of the housing or any open flames for more than two minutes under the specified test conditions

3.44
U_r
rated voltage of an arrester
maximum permissible 10 s power frequency RMS overvoltage that can be applied between the arrester, as verified in the TOV test and the operating duty test

Note 1 to entry: The rated voltage is used as a reference parameter for the specification of operating characteristics.

3.45
repetitive charge transfer rating
Q_{rs}
maximum specified charge transfer capability of an arrester, in the form of a single event or group of surges that may be transferred through an arrester without causing mechanical failure or unacceptable electrical degradation to the MO resistors

Note 1 to entry: The charge is calculated as the absolute value of current integrated over time. For the purpose of this document this is the charge that is accumulated in a single event or group of surges lasting for not more than 2 s and which may be followed by a subsequent event at a time interval not shorter than 60 s.

3.46
U_{res}
residual voltage of an arrester
peak value of voltage that appears between the terminals of an arrester during the passage of discharge current

Note 1 to entry: The term "discharge voltage" is used in some countries.

3.47
routine tests
tests made on each arrester, or on parts and materials, as required, to ensure that the product meets the design specifications

3.48
seal
<gas/water tightness>
ability of an arrester to avoid ingress of matter affecting the electrical and/or mechanical behaviour

3.49
series gap
intentional gap(s) between spaced electrodes, in series with the valve element of the arrester, substantially isolating the element from line or ground, or both, under normal line-voltage conditions

3.50
section of an arrester
<prorated section>
complete, suitably assembled part of an arrester necessary to represent the behaviour of a complete arrester with respect to a particular test

Note 1 to entry: A section of an arrester is not necessarily a unit of an arrester. For certain tests, a MO resistor alone constitutes a section.

3.51
shed
insulating part projecting from the housing, intended to increase the creepage distance

3.52
specified long-term load
SLL
force perpendicular to the longitudinal axis of an arrester, allowed to be continuously applied during service without causing any mechanical damage to the arrester

3.53
specified short-term load
SSL
greatest force perpendicular to the longitudinal axis of an arrester, allowed to be applied during service for short periods and for relatively rare events (for example, short-circuit current loads and extreme wind gusts) without causing any mechanical damage to the arrester

Note 1 to entry: SSL does not relate to mechanical strength requirements for seismic loads. See C.2.

3.54
steep current impulse
current impulse with a virtual front time of 1 µs with limits in the adjustment of equipment such that the measured values are from 0,9 µs to 1,1 µs and the virtual time to half-value on the tail is not longer than 20 µs

Note 1 to entry: The time to half-value on the tail is not critical and may have any tolerance during the residual voltage type tests (see 8.3.2.2).

3.55
steep current impulse protection level
STIPL
maximum residual voltage of the arrester for a steep current impulse of magnitude equal to the magnitude of the nominal discharge current

3.56
tail of an impulse
part of an impulse which occurs after the peak

3.57
terminal line force
force perpendicular to the longitudinal axis of the arrester measured at the centre line of the arrester

3.58
thermal charge transfer rating
Q_{th}
maximum specified charge that may be transferred through an arrester or arrester section within 3 minutes in a thermal recovery test without causing a thermal runaway

Note 1 to entry: This rating is verified by the operating duty type test.

3.59
thermal runaway
<of an arrester>ituation when the sustained power loss of an arrester exceeds the thermal dissipation capability of the housing and connections, leading to a cumulative increase in the temperature of the MO resistor elements culminating in failure

3.60
thermal stability
<of an arrester> state of an arrester if, after an operating duty causing temperature rise, the temperature of the MO resistors decreases with time when the arrester is energized at specified continuous operating voltage and at specified ambient conditions

3.61
torsional loading
each horizontal force at the top of a vertical mounted arrester housing which is not applied to the longitudinal axis of the arrester

3.62
type tests
design tests
tests which are made upon the completion of the development of a new arrester design to establish representative performance and to demonstrate compliance with the relevant standard

Note 1 to entry: Once made, these tests need not be repeated unless the design is changed so as to modify its performance. In such a case, only the relevant tests need be repeated.

3.63
unipolar sine half-wave current impulse
unipolar current impulse consisting of one half-cycle of an approximately sinusoidal current

3.64
unit of an arrester
arrester unit
completely housed part of an arrester which may be connected in series and/or in parallel with other units to construct an arrester of higher voltage and/or current rating

3.65
T_1
virtual front time of a current impulse
time in microseconds equal to 1,25 multiplied by the time in microseconds for the current to increase from 10 % to 90 % of its peak value

Note 1 to entry: If oscillations are present on the front, the reference points at 10 % and 90 % should be taken on the mean curve drawn through the oscillations.

3.66
virtual origin
<of an impulse> point on a graph of voltage versus time or current versus time determined by the intersection between the time axis at zero voltage or zero current and the straight line drawn through two reference points on the front of the impulse

Note 1 to entry: For current impulses the reference points shall be 10 % and 90 % of the peak value.

Note 2 to entry: This definition applies only when scales of both ordinate and abscissa are linear.

Note 3 to entry: If oscillations are present on the front, the reference points at 10 % and 90 % should be taken on the mean curve drawn through the oscillations.

3.67
virtual steepness of the front of an impulse
quotient of the peak value and the virtual front time of an impulse

3.68
virtual time to half-value on the tail of an impulse
T_2
time interval between the virtual origin and the instant when the voltage or current has decreased to half its peak value, expressed in microseconds

4 Identification and classification

4.1 Arrester identification

Metal-oxide surge arresters containing gapped structures shall be identified by the following minimum information which shall appear on a nameplate permanently attached to the arrester:

– designation of arrester (see Table 1)
– continuous operating voltage;
– rated voltage;
– rated frequency, only if other than one of the standard frequencies, see 5.2;
– nominal discharge current;
– rated short-circuit current in kiloamperes (kA). For arresters for which no short-circuit rating is claimed, the value "0" shall be indicated;
– manufacturer's name or trade mark, type and identification of the complete arrester;
– year of manufacture:
– if sufficient space is available the nameplate should also contain:
– repetitive charge transfer rating, Q_{rs}.

4.2 Arrester classification

Distribution class arresters are classified as indicated in Table 1, and they shall meet at least the test requirements and performance characteristics specified in Table 3.