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INTERNATIONAL STANDARD

colour inside

Surge arresters –
Part 5: Selection and application recommendations

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FOREWORD

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International Standard IEC 60099-5 has been prepared by committee 37: Surge arresters.

This second edition cancels and replaces the first edition published in 1996 and its amendment 1 published in 1999. This edition constitutes a technical revision.

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

a) Expanded discussion of different types of arresters and their application, including additions of discussion on:
   - transmission of line arresters
   - arresters for shunt capacitor switching
   - arresters for series capacitor protection
   - application of arresters between phases
   - connecting arresters in parallel
b) Addition of section on asset management, including:

– managing surge arresters in the power grid
– arrester maintenance
– significantly expanded discussion of performance diagnostic tools
– end-of-life considerations

c) New annexes dealing with:

– arrester modelling for system studies
– example of data needed for specifying arresters

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

FDIS	Report on voting
37/405/FDIS	37/408/RVD

Full information on the voting for the approval of this standard 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.

The committee has decided that the contents of this publication will remain unchanged until the stability 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

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- withdrawn,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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

SURGE ARRESTERS –

Part 5: Selection and application recommendations

1 Scope

This part of IEC 60099 is not a mandatory standard but provides information, guidance, and recommendations for the selection and application of surge arresters to be used in three-phase systems with nominal voltages above 1 kV. It applies to gapless metal-oxide surge arresters as defined in IEC 60099-4, to surge arresters containing both series and parallel gapped structure – rated 52 kV and less as defined in IEC 60099-6 and metal-oxide surge arresters with external series gap for overhead transmission and distribution lines (EGLA) as defined in IEC 60099-8. In Annex H, some aspects regarding the old type of SiC gapped arresters are discussed.

The principle of insulation coordination for an electricity system is given in IEC 60071 and IEC 60071-2 standards. Basically the insulation coordination process is a risk management aiming to ensure the safe, reliable and economic design and operation of high voltage electricity networks and substations. The use of surge arrester helps to achieve a system and equipment insulation level and still maintaining an acceptable risk and the best economic of scale.

The introduction of analytical modelling and simulation of power system transients further optimise the equipment insulation level. The selection of surge arresters has become more and more important in the power system design and operation. It is worthwhile to note that the reliability of the power system and equipment is dependent on the safety margin adopted by the user in the design and selection of the equipments and surge arresters.

Surge arrester residual voltage is a major parameter of which most users have paid a lot of attention to when selecting the type and rating. The typical maximum surge arresters residual voltage are given in Annex F. It is likely, however, that for some systems, or in some countries, the system reliability requirements and design are sufficiently uniform that the recommendations of the present standard may lead to the definition of narrow ranges of arresters. The user of surge arresters will, in that case, not be required to apply the whole process introduced here to any new installation and the selection of characteristics resulting from prior practice may be continued.

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 60071-1:2006, *Insulation coordination – Part 1: Definitions, principles and rules*

IEC 60071-2:1996, *Insulation coordination – Part 2: Application guide*

IEC/TR 60071-4, *Insulation coordination – Part 4: Computational guide to insulation coordination and modelling of electrical networks*

IEC 60099-4:2009, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 60099-6:2002, *Surge arresters – Part 6: Surge arresters containing both series and parallel gapped structures – Rated 52 kV and less*

IEC 60099-8:2011, *Surge arresters – Part 8: Metal-oxide surge arresters with external series gap (EGLA) for overhead transmission and distribution lines of a.c. systems above 1 kV*

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 intended for use in polluted conditions – Part 1: Definitions, information and general principles*

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/TS 60815-3, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems*

IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications*

IEC 62271-200, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 62271-203, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

3 Terms and definitions

For the purposes of this document, the following terms and abbreviations are used.

NOTE These terms follow standard definitions as close as possible, but are not in all cases exact citations of definitions in other IEC standards.

3.1
arrester – dead-front type, dead-front arrester
arrester assembled in a shielded housing providing system insulation and conductive earth shield, intended to be installed in an enclosure for the protection of underground and padmounted distribution equipment and circuits

Note 1 to entry: Most dead-front arresters are load-break arresters.

Note 2 to entry: The use of dead-front arresters is common in the USA.

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
arrester – liquid-immersed type
arrester designed to be immersed in an insulating liquid

3.4
arrester – separable type, separable arrester
arrester assembled in an insulated or screened housing providing system insulation, intended to be installed in an enclosure for the protection of distribution equipment and systems.

Electrical connection may be made by sliding contact or by bolted devices; however, all separable arresters are dead-break arresters

Note 1 to entry: The use of separable arresters is common in Europe.

3.5
back flashover rate
BFOR
characteristics of an overhead line or system with respect to the number of back flashovers typically given per 100 km and year

3.6
bending moment
horizontal force acting on the arrester housing multiplied by the vertical distance between the mounting base (lower level of the flange) of the arrester housing and the point of application of the force

3.7
continuous current of an arrester
current flowing through the arrester when energized at the continuous operating voltage

Note 1 to entry: The continuous current, which consists of a resistive and a capacitive component, may vary with temperature, stray capacitance and external pollution effects. The continuous current of a test sample may, therefore, not be the same as the continuous current of a complete arrester.

Note 2 to entry: The continuous current is, for comparison purposes, expressed either by its r.m.s. or peak value.

3.8
continuous operating voltage of an arrester
U_c
designated permissible r.m.s. value of power-frequency voltage that may be applied continuously between the arrester terminals in accordance with IEC 60099-4 and 60099-6

3.9
dead-break arrester
arrester which can be connected and disconnected from the circuit only when the circuit is de-energized

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 include 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
externally gapped line arresters
EGLA
a line surge arrester designed with an external spark gap in series with a SVU part to protect the insulator assembly from lightning caused fast-front overvoltages only

Note 1 to entry: This is accomplished by raising the sparkover level of the external series gap to a level that isolates the arrester from power frequency overvoltages and from the worst case slow-front overvoltages due to switching and fault events expected on the line to which it is applied.

3.13
fast-front overvoltage
FFO
transient overvoltage usually unidirectional, with time to peak between 0,1 μs to 20 μs, and tail duration < 300 μs

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
flashover rate
FOR
characteristics of an overhead line or system with respect to total number of flashovers typically given per 100 km and year

3.17
follow current
the current immediately following an impulse through an EGLA with the power frequency voltage as the source

Note 1 to entry: The external series gap shall be able to interrupt follow current due to external leakage current on a polluted SVU as well as due to internal resistive current through the non-linear metal oxide resistors; that is, the performance of the EGLA under polluted conditions is introduced by the gap resealing performance under wet and polluted condition, and it is verified by the follow current interruption test.

3.18
follow current of an arrester
the current from the connected power source which flows through an arrester following the passage of discharge current

3.19
gas-insulated metal enclosed surge arrester
GIS-arrester
gas-insulated metal-enclosed metal-oxide surge arrester without any integrated series or parallel spark gaps, filled with gas other than air and used in gas-insulated switchgears

Note 1 to entry: The gas pressure is normally higher than 1 bar = 10^5 Pa.

3.20
grading current
current flowing through the arrester while a power frequency voltage is applied

3.21
grading ring of an arrester
metal part, usually circular in shape, mounted to modify electro-statically the voltage distribution along the arrester

3.22
high current impulse
peak value of discharge current having a 4/10 or 2/20 impulse shape, which is used to test the withstand capability of the SVU on extreme lightning occasions

3.23
highest voltage for equipment
***U*$_m$**
highest value of the phase-to-phase voltage (r.m.s. value) for which the equipment is designed in respect of its insulation as well as other characteristics which relate to this voltage in the relevant equipment Standards. Under normal service conditions specified by the relevant apparatus committee this voltage can be applied continuously to the equipment

3.24
highest voltage of a system
***U*$_s$**
highest value of the phase-to-phase operating voltage (r.m.s. value) which occurs under normal operating conditions at any time and at any point in the system

3.25
impulse protective levels of an arrester tested in accordance with IEC 60099-6 – fast-front protective level
highest of either the steep current residual voltage or the front-of-wave impulse sparkover voltage at I_n

3.26
impulse protective levels of an arrester tested in accordance with IEC 60099-6 – standard lightning impulse protective level
highest of the residual voltage at nominal discharge current or 1,2/50 lightning impulse sparkover voltage at I_n

3.27
impulse protective levels of an arrester tested in accordance with IEC 60099-6 – switching impulse protective level
highest of either the maximum residual voltage for the specified switching current or the specified switching impulse sparkover voltage

3.28
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

Note 1 to entry: The parameters which define a voltage or current impulse are polarity, peak value, front time and time to half-value on the tail.

3.29
impulse sparkover voltage-time curve
a curve which relates the impulse sparkover of the voltage to the time to sparkover

3.30
insulation coordination
selection of the dielectric strength of equipment in relation to the operating voltages and overvoltages which can appear on the system for which the equipment is intended and taking into account the service environment and the characteristics of the available preventing and protective devices

3.31
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 on the tail

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 IEC 60099-4:2009, 8.3).

3.32
lightning [or switching] impulse protective level
U_{pl} (LIPL) [or U_{ps} (SIPL)]
maximum peak voltage on the terminals of a surge arrester subjected to lightning [or switching] impulses under specific conditions

3.33
lightning impulse withstand voltage
LIWV
Standard rated lightning impulse withstand voltage of an equipment or insulation configuration

3.34
line surge arresters
LSA
a type of arrester that is applied to overhead lines of power systems to reduce the risk of insulator flashover during lightning overvoltages. It is not generally used to protect the insulator from other types of transients such as switching surges

3.35
load-break arrester
arrester which can be connected and disconnected when the circuit is energized

3.36
mean breaking load
MBL
the average breaking load for porcelain or cast resin-housed arresters determined from tests

3.37
metal-oxide surge arrester with gapped structures
an arrester having non-linear metal-oxide resistors connected in series and/or in parallel with any internal series or shunt spark gaps

3.38
nominal discharge current of an arrester
I_n
peak value of lightning current impulse which is used to classify an arrester in IEC 60099-4, 60099-6, and 60099-8

3.39
nominal voltage of a system
U_n
suitable approximate value of voltage used to identify a system

3.40
non gapped line arresters
NGLA
a line surge arrester designed without any external gapped structures to protect the line insulator assembly from lightning caused fast-front overvoltages

Note 1 to entry: It may also protect the line insulators against switching surges if so selected.

Note 2 to entry: NGLA are generally equipped with a disconnector device that facilitates fast reclosing in case of an arrester overloading.

3.41
non-linear metal-oxide 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