

STN	Zvodiče prepätia Časť 5: Odporúčania na voľbu a použitie	STN EN IEC 60099-5 35 4870
------------	---	--

Surge arresters - Part 5: Selection and application recommendations

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 01/19

Obsahuje: EN IEC 60099-5:2018, IEC 60099-5:2018

Oznámením tejto normy sa od 23.02.2021 ruší
STN EN 60099-5 (35 4870) z augusta 2014

127805

EUROPEAN STANDARD

EN IEC 60099-5

NORME EUROPÉENNE

EUROPÄISCHE NORM

March 2018

ICS 29.120.50; 29.240.10

Supersedes EN 60099-5:2013

English Version

**Surge arresters - Part 5: Selection and application
recommendations
(IEC 60099-5:2018)**

Parafoudres - Partie 5: Recommandations pour le choix et
l'utilisation
(IEC 60099-5:2018)

Überspannungsableiter - Teil 5: Anleitung für die Auswahl
und die Anwendung
(IEC 60099-5:2018)

This European Standard was approved by CENELEC on 2018-02-23. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 60099-5:2018 (E)**European foreword**

The text of document 37/437/FDIS, future edition 3 of IEC 60099-5, prepared by IEC/TC 37 "Surge arresters" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60099-5:2018.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2018-11-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2021-02-23

This document supersedes EN 60099-5:2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60099-5:2018 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60071-1	2006	Insulation co-ordination -- Part 1: Definitions, principles and rules	EN 60071-1	2006
+ A1	2010		+ A1	2010
IEC 60071-2	1996	Insulation co-ordination -- Part 2: Application guide	EN 60071-2	1997
IEC 60099-4	2004	Surge arresters -- Part 4: Metal-oxide surge arresters without gaps for a.c. systems	EN 60099-4	2004
+ A1	2006		+ A1	2006
+ A2	2009		+ A2	2009
IEC 60099-4	2014	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems	EN 60099-4	2014
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	EN 60099-8	2011
IEC 60507	-	Artificial pollution tests on high-voltage ceramic and glass insulators to be used on a.c. systems	EN 60507	-
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	EN 62271-200	-
IEC 62271-203	-	High-voltage switchgear and controlgear -- Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV	EN 62271-203	-
IEC/TR 60071-4	-	Insulation co-ordination -- Part 4: Computational guide to insulation co-ordination and modelling of electrical networks	-	-
IEC/TS 60815-1	2008	Selection and dimensioning of high-voltage-insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles	-	-



IEC 60099-5

Edition 3.0 2018-01

INTERNATIONAL STANDARD



Surge arresters – Part 5: Selection and application recommendations





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.



IEC 60099-5

Edition 3.0 2018-01

INTERNATIONAL STANDARD



Surge arresters – Part 5: Selection and application recommendations

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.120.50; 29.240.10

ISBN 978-2-8322-5075-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	9
1 Scope	11
2 Normative references	11
3 Terms and definitions	12
4 General principles for the application of surge arresters	21
5 Surge arrester fundamentals and applications issues	22
5.1 Evolution of surge protection equipment	22
5.2 Different types and designs and their electrical and mechanical characteristics	23
5.2.1 General	23
5.2.2 Metal-oxide arresters without gaps according to IEC 60099-4	24
5.2.3 Metal-oxide surge arresters with internal series gaps according to IEC 60099-6	34
5.2.4 Externally gapped line arresters (EGLA) according to IEC 60099-8	36
5.2.5 Application considerations	39
6 Insulation coordination and surge arrester applications	52
6.1 General	52
6.2 Insulation coordination overview	52
6.2.1 General	52
6.2.2 IEC insulation coordination procedure	53
6.2.3 Overvoltages	53
6.2.4 Line insulation coordination: Arrester Application Practices	59
6.2.5 Substation insulation coordination: Arrester application practices	64
6.2.6 Insulation coordination studies	68
6.3 Selection of arresters	70
6.3.1 General	70
6.3.2 General procedure for the selection of surge arresters	70
6.3.3 Selection of line surge arresters, LSA	84
6.3.4 Selection of arresters for cable protection	93
6.3.5 Selection of arresters for distribution systems – special attention	95
6.3.6 Application and coordination of disconnectors	96
6.3.7 Selection of UHV arresters	98
6.4 Standard and special service conditions	99
6.4.1 Standard service conditions	99
6.4.2 Special service conditions	99
7 Surge arresters for special applications	103
7.1 Surge arresters for transformer neutrals	103
7.1.1 General	103
7.1.2 Surge arresters for fully insulated transformer neutrals	103
7.1.3 Surge arresters for neutrals of transformers with non-uniform insulation	103
7.2 Surge arresters between phases	104
7.2.1 General	104
7.2.2 6-arrester arrangement	104
7.2.3 4-arrester (Neptune) arrangement	104
7.3 Surge arresters for rotating machines	105
7.4 Surge arresters in parallel	106

7.4.1	General	106
7.4.2	Combining different designs of arresters	107
7.5	Surge arresters for capacitor switching	107
7.6	Surge arresters for series capacitor banks	109
8	Asset management of surge arresters	110
8.1	General.....	110
8.2	Managing surge arresters in a power grid	110
8.2.1	Asset database.....	110
8.2.2	Technical specifications	110
8.2.3	Strategic spares	110
8.2.4	Transportation and storage	111
8.2.5	Commissioning	111
8.3	Maintenance	111
8.3.1	General	111
8.3.2	Polluted arrester housing.....	112
8.3.3	Coating of arrester housings.....	112
8.3.4	Inspection of disconnectors on surge arresters	112
8.3.5	Line surge arresters.....	112
8.4	Performance and diagnostic tools	112
8.5	End of life	113
8.5.1	General	113
8.5.2	GIS arresters.....	113
8.6	Disposal and recycling	113
Annex A (informative)	Determination of temporary overvoltages due to earth faults	114
Annex B (informative)	Current practice	118
Annex C (informative)	Arrester modelling techniques for studies involving insulation coordination and energy requirements	119
C.1	Arrester models for impulse simulations.....	119
C.2	Application to insulation coordination studies	120
C.3	Summary of proposed arrester models to be used for impulse applications	120
Annex D (informative)	Diagnostic indicators of metal-oxide surge arresters in service.....	122
D.1	General.....	122
D.1.1	Overview	122
D.1.2	Fault indicators	122
D.1.3	Disconnectors.....	122
D.1.4	Surge counters	122
D.1.5	Monitoring spark gaps	123
D.1.6	Temperature measurements	123
D.1.7	Leakage current measurements of gapless metal-oxide arresters	123
D.2	Measurement of the total leakage current	128
D.3	Measurement of the resistive leakage current or the power loss.....	129
D.3.1	General	129
D.3.2	Method A1 – Using the applied voltage signal as a reference	129
D.3.3	Method A2 – Compensating the capacitive component using a voltage signal	130
D.3.4	Method A3 – Compensating the capacitive component without using a voltage signal	131
D.3.5	Method A4 – Capacitive compensation by combining the leakage current of the three phases	131

D.3.6	Method B1 – Third order harmonic analysis	132
D.3.7	Method B2 – Third order harmonic analysis with compensation for harmonics in the voltage	133
D.3.8	Method B3 – First order harmonic analysis	133
D.3.9	Method C – Direct determination of the power losses	133
D.4	Leakage current information from the arrester manufacturer	133
D.5	Summary of diagnostic methods	135
Annex E (informative) Typical data needed from arrester manufacturers for proper selection of surge arresters.....		136
Annex F (informative) Typical maximum residual voltages for metal-oxide arresters without gaps according to IEC 60099-4.....		137
Annex G (informative) Steepness reduction of incoming surge with additional line terminal surge capacitance		138
G.1	General.....	138
G.2	Steepness reduction factor	138
G.3	Equivalent capacitance associated with incoming surge fronts	140
G.3.1	General	140
G.3.2	Examples of incoming surge steepness change, f_S , using typical 550 kV & 245 kV circuit parameters.....	141
G.3.3	Change in coordination withstand voltage, U_{CW} , with steepness reduction, f_S :	142
G.4	EMTP & capacitor charging models for steepness change comparisons at line open terminal	142
G.5	Typical steepness ($S_0 = 1000 \text{ kV}/\mu\text{s}$), change comparisons with C_0 & C_S	143
G.6	Faster steepness ($2000 \text{ kV}/\mu\text{s}$), change comparisons with C_0 & C_S	145
Annex H (informative) Comparison of the former energy classification system based on line discharge classes and the present classification system based on thermal energy ratings for operating duty tests and repetitive charge transfer ratings for repetitive single event energies.....		147
H.1	General.....	147
H.2	Examples.....	150
Annex I (informative) Estimation of arrester cumulative charges and energies during line switching		155
I.1	Simplified method of estimating arrester line switching energies	155
I.1.1	Introduction	155
I.1.2	Simplified method calculation steps	156
I.1.3	Typical line surge impedances with bundled conductors	158
I.1.4	Prospective switching surge overvoltages.....	158
I.1.5	Use of IEC 60099-4:2009 to obtain values for surge impedance and prospective surge voltages	159
I.2	Example of charge and energy calculated using line discharge parameters.....	160
I.3	Arrester line switching energy examples	164
I.3.1	General	164
I.3.2	Case 1 – 145 kV	167
I.3.3	Case 2 – 242 kV	167
I.3.4	Case 3 – 362 kV	167
I.3.5	Case 4 – 420 kV	168
I.3.6	Case 5 – 550 kV	168
Annex J (informative) End of life and replacement of old gapped SiC-arresters.....		180
J.1	Overview.....	180
J.2	Design and operation of SiC-arresters	180

J.3	Failure causes and aging phenomena	180
J.3.1	General	180
J.3.2	Sealing problems	180
J.3.3	Equalization of internal and external pressure and atmosphere	181
J.3.4	Gap electrode erosion	181
J.3.5	Ageing of grading components.....	182
J.3.6	Changed system conditions	182
J.3.7	Increased pollution levels	182
J.4	Possibility to check the status of the arresters	182
J.5	Advantages of planning replacements ahead	182
J.5.1	General	182
J.5.2	Improved reliability	183
J.5.3	Cost advantages.....	183
J.5.4	Increased safety requirements.....	183
J.6	Replacement issues.....	183
J.6.1	General	183
J.6.2	Establishing replacement priority	183
J.6.3	Selection of MO arresters for replacement installations	184
	Bibliography.....	185

Figure 1	– Example of GIS arresters of three mechanical/one electrical column (middle) and one column (left) design and current path of the three mechanical/one electrical column design (right)	29
Figure 2	– Typical deadfront arrester	30
Figure 3	– Internally gapped metal-oxide surge arrester designs.....	35
Figure 4	– Components of an EGLA acc. to IEC 60099-8	36
Figure 5	– Typical arrangement of a 420 kV arrester.....	41
Figure 6	– Examples of UHV and HV arresters with grading and corona rings	42
Figure 7	– Same type of arrester mounted on a pedestal (left), suspended from an earthed steel structure (middle) or suspended from a line conductor (right).....	43
Figure 8	– Installations without earth-mat (distribution systems)	44
Figure 9	– Installations with earth-mat (high-voltage substations)	45
Figure 10	– Definition of mechanical loads according to IEC 60099-4:2014.....	47
Figure 11	– Distribution arrester with disconnecter and insulating bracket.....	48
Figure 12	– Examples of good and poor connection principles for distribution arresters	50
Figure 13	– Typical voltages and duration example for differently earthed systems	54
Figure 14	– Typical phase-to-earth overvoltages encountered in power systems.....	55
Figure 15	– Arrester voltage-current characteristics	56
Figure 16	– Direct strike to a phase conductor with LSA	61
Figure 17	– Strike to a shield wire or tower with LSA	62
Figure 18	– Typical procedure for a surge arrester insulation coordination study	69
Figure 19	– Flow diagrams for standard selection of surge arrester	73
Figure 20	– Examples of arrester TOV capability	74
Figure 21	– Flow diagram for the selection of NGLA	87
Figure 22	– Flow diagram for the selection of EGLA.....	91
Figure 23	– Common neutral configurations	96

Figure 24 – Typical configurations for arresters connected phase-to-phase and phase-to-ground	105
Figure A.1 – Earth fault factor k on a base of X_0/X_1 , for $R_1/X_1 = R_1 = 0$	114
Figure A.2 – Relationship between R_0/X_1 and X_0/X_1 for constant values of earth fault factor k where $R_1 = 0$	115
Figure A.3 – Relationship between R_0/X_1 and X_0/X_1 for constant values of earth fault factor k where $R_1 = 0,5 X_1$	115
Figure A.4 – Relationship between R_0/X_1 and X_0/X_1 for constant values of earth fault factor k where $R_1 = X_1$	116
Figure A.5 – Relationship between R_0/X_1 and X_0/X_1 for constant values of earth fault factor k where $R_1 = 2X_1$	116
Figure C.1 – Schematic sketch of a typical arrester installation	119
Figure C.2 – Increase in residual voltage as function of virtual current front time	120
Figure C.3 – Arrester model for insulation coordination studies – fast-front overvoltages and preliminary calculation (Option 1)	121
Figure C.4 – Arrester model for insulation coordination studies – fast-front overvoltages and preliminary calculation (Option 2)	121
Figure C.5 – Arrester model for insulation coordination studies – slow-front overvoltages	121
Figure D.1 – Typical leakage current of a non-linear metal-oxide resistor in laboratory conditions	124
Figure D.2 – Typical leakage currents of arresters in service conditions	125
Figure D.3 – Typical voltage-current characteristics for non-linear metal-oxide resistors	126
Figure D.4 – Typical normalized voltage dependence at +20 °C	126
Figure D.5 – Typical normalized temperature dependence at U_c	127
Figure D.6 – Influence on total leakage current by increase in resistive leakage current	128
Figure D.7 – Measured voltage and leakage current and calculated resistive and capacitive currents ($V = 6,3$ kV r.m.s)	130
Figure D.8 – Remaining current after compensation by capacitive current at U_c	131
Figure D.9 – Error in the evaluation of the leakage current third harmonic for different phase angles of system voltage third harmonic, considering various capacitances and voltage-current characteristics of non-linear metal-oxide resistors	132
Figure D.10 – Typical information for conversion to "standard" operating voltage conditions	134
Figure D.11 – Typical information for conversion to "standard" ambient temperature conditions	134
Figure G.1 – Surge voltage waveforms at various distances from strike location (0,0 km) due to corona	139
Figure G.2 – Case 1: EMTP Model: Thevenin equivalent source, line (Z, c) & substation bus (Z, c) & Cap(C_S)	142
Figure G.3 – Case 2: Capacitor Voltage charge via line Z : $u(t) = 2 \times U_{\text{surge}} \times (1 - \exp[-t/(Z \times C)])$	143
Figure G.4 – EMTP model	143
Figure G.5 – Simulated surge voltages at the line-substation bus interface	144
Figure G.6 – Simulated Surge Voltages at the Transformer	145
Figure G.7 – EMTP model	145
Figure G.8 – Simulated surge voltages at the line-substation bus interface	146
Figure G.9 – Simulated surge voltages at the transformer	146

Figure H.1 – Specific energy in kJ per kV rating dependant on the ratio of switching impulse residual voltage (U_a) to the r.m.s. value of the rated voltage U_r of the arrester	148
Figure I.1 – Simple network used for Arrester Line Discharge Calculation and Testing according to IEC 60099-4:2009	155
Figure I.2 – Linearized arrester equation in the typical line switching current range (voltage values shown are for a 372 kV rated arrester used on a 420 kV system)	156
Figure I.3 – Graphical illustration of linearized line switching condition and arrester characteristic	157
Figure I.4 – Range of 2 % slow-front overvoltages at the receiving end due to line energization and re-energization	159
Figure I.5 – Arrester class 2 & 3 voltages calculated by EMTP calculations: U_{ps2} and U_{ps3} ($V \times 10^5$)	162
Figure I.6 – Class 2 & 3 arrester currents calculated by EMTP studies: I_{ps2} and I_{ps3} (A)	162
Figure I.7 – Arrester Class 2 & 3 cumulative charges calculated by EMTP simulation: Q_{rs2} and Q_{rs3} (C)	163
Figure I.8 – Arrester Class 2 & 3 cumulative absorbed energies calculated by EMTP simulation: W_{s2} and W_{s3} (kJ/kV U_r)	163
Figure I.9 – Typical Line Reclosing Computer Simulation Network	164
Figure I.10 – Typical 550 kV Reclose Switching Overvoltage Profile along 480 km Line	165
Figure I.11 – IEC LD based charge transfer, Q_{rs} with varying arrester protective ratios	166
Figure I.12 – IEC LD based switching energy, W_{th} with varying arrester protective ratios	166
Figure I.13 – U_{ps} for 145 kV system simulation ($V \times 10^5$)	170
Figure I.14 – I_{ps} for 145 kV system simulation (A)	170
Figure I.15 – 1 Cumulative charge (Q_{rs}) for 145 kV system simulation (C)	171
Figure I.16 – Cumulative energy (W_{th}) for 145 kV system simulation (kJ/kV U_r)	171
Figure I.17 – U_{ps} for 245 kV system simulation ($V \times 10^5$)	172
Figure I.18 – I_{ps} for 245 kV system simulation (A)	172
Figure I.19 – Cumulative charge (Q_{rs}) for 245 kV system simulation (C)	173
Figure I.20 – Cumulative energy (W_{th}) for 245 kV system simulation (kJ/kV U_r)	173
Figure I.21 – U_{ps} for 362 kV system simulation ($V \times 10^5$)	174
Figure I.22 – I_{ps} for 362 kV system simulation (A)	174
Figure I.23 – Cumulative charge (Q_{rs}) for 362 kV system simulation (C)	175
Figure I.24 – Cumulative energy (W_{th}) for 362 kV system simulation (kJ/kV U_r)	175
Figure I.25 – U_{ps} for 420 kV system simulation ($V \times 10^5$)	176
Figure I.26 – I_{ps} for 420 kV system simulation (A)	176
Figure I.27 – Cumulative charge (Q_{rs}) for 420 kV system simulation (C)	177
Figure I.28 – Cumulative energy (W_{th}) for 420 kV system simulation (kJ/kV U_r)	177
Figure I.29 – U_{ps} for 550 kV system simulation ($V \times 10^5$)	178
Figure I.30 – I_{ps} for 550 kV system simulation (A)	178
Figure I.31 – Cumulative charge (Q_{rs}) for 550 kV system simulation (C)	179
Figure I.32 – Cumulative energy (W_{th}) for 550 kV system simulation (kJ/kV U_r)	179
Figure J.1 – Internal SiC-arrester stack	181
Table 1 – Minimum mechanical requirements (for porcelain-housed arresters)	46

Table 2 – Arrester classification	78
Table 3 – Definition of factor A in formulas (14 and 15) for various overhead lines	82
Table 4 – Examples for protective zones calculated by formula (16) for open-air substations	83
Table 5 – Example of the condition for calculating lightning current duty of EGLA in 77 kV transmission lines	90
Table 6 – Probability of insulator flashover in Formula (18).....	93
Table D.1 – Summary of diagnostic methods	135
Table D.2 – Properties of on-site leakage current measurement methods	135
Table E.1 – Arrester data needed for the selection of surge arresters	136
Table F.1 – Residual voltages for 20 000 A and 10 000 A arresters in per unit of rated voltage.....	137
Table F.2 – Residual voltages for 5 000 A, and 2 500 A arresters in per unit of rated voltage.....	137
Table G.1 – C_S impact on steepness ratio f_S and steepness S_n	141
Table G.2 – Change in coordination withstand voltage, U_{CW}	142
Table H.1 – Peak currents for switching impulse residual voltage test.....	147
Table H.2 – Parameters for the line discharge test on 20 000 A and 10 000 A arresters.....	148
Table H.3 – Comparison of the classification system according to IEC 60099-4:2009 and to IEC 6099-4 2014	149
Table I.1 – Typical Arrester Switching (U_{ps} vs I_{ps}) Characteristics	156
Table I.2 – Typical line surge impedances (Z_S) with single and bundled conductors	158
Table I.3 – Line Parameters Prescribed by IEC 60099-4:2009 Line Discharge Class Tests	159
Table I.4 – Line surge impedances and prospective surge voltages derived from line discharge tests parameters of IEC 60099-4:2009 for different system voltages and arrester ratings	160
Table I.5 – Comparison of energy and charge calculated by simplified method with values calculated by EMTP simulation – Base parameters from Table I.4, used for simplified method and for EMTP simulation.....	161
Table I.6 – Comparison of energy and charge calculated by simplified method with values calculated by EMTP simulation – Calculations using simplified method	161
Table I.7 – Comparison of energy and charge calculated by simplified method with values calculated by EMTP simulation – I.5.(c) Results from EMTP studies	161
Table I.8 – Results of calculations using the different methods described for different system voltages and arrester selection	169

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SURGE ARRESTERS –

Part 5: Selection and application recommendations

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition regarding the new surge arrester classification introduced in IEC 60099-4:2014:

- a) Expanded discussion of comparison between the old and new classification and how to calculate or estimate the corresponding charge for different stresses.
- b) New annexes dealing with:
 - Comparison between line discharge classes and charge classification
 - Estimation of arrester cumulative charges and energies during line switching

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

FDIS	Report on voting
37/437/FDIS	37/439/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.

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 publication will remain unchanged until the stability date indicated on the IEC website 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 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 J, some aspects regarding the old type of SiC gapped arresters are discussed.

Surge arrester residual voltage is a major parameter to which most users have paid a lot of attention to when selecting the type and rating. Typical maximum residual voltages are given in Annex F. It is likely, however, that for some systems, or in some countries, the requirements on system reliability and design are sufficiently uniform, so 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.

Annexes H and I present comparisons and calculations between old line discharge classification and new charge classification.

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 60071-1:2006, *Insulation co-ordination – Part 1: Definitions, principles and rules*
IEC 60071-1:2006/AMD1:2010

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

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

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

IEC 60099-4:2014, *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 ceramic and glass insulators to be used on a.c. systems*

IEC TS 60815-1:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles*

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*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN