

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

**Parafoudres –
Partie 4: Parafoudres à oxyde métallique sans éclateurs pour réseaux à courant alternatif**

IEC 60099-4:2004

<https://standards.iteh.ai/standards/iec/186be61b-b79c-47cc-a314-db5dc20ae2df/iec-60099-4-2004>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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.

- Catalogue of IEC publications: www.iec.ch/searchpub

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

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

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

**Parafoudres –
Partie 4: Parafoudres à oxyde métallique sans éclateurs pour réseaux à courant alternatif**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE **CU**
CODE PRIX

ICS 29.240.10; 29.120.50

ISBN 978-2-88910-057-6

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references.....	10
3 Terms and definitions.....	11
4 Identification and classification.....	19
4.1 Arrester identification.....	19
4.2 Arrester classification.....	19
5 Standard ratings and service conditions.....	19
5.1 Standard rated voltages.....	19
5.2 Standard rated frequencies.....	20
5.3 Standard nominal discharge currents.....	20
5.4 Service conditions.....	20
6 Requirements.....	21
6.1 Insulation withstand of the arrester housing.....	21
6.2 Reference voltage.....	21
6.3 Residual voltages.....	21
6.4 Internal partial discharges.....	21
6.5 Seal leak rate.....	21
6.6 Current distribution in a multi-column arrester.....	22
6.7 Thermal stability.....	22
6.8 Long-duration current impulse withstand.....	22
6.9 Operating duty.....	22
6.10 Power-frequency voltage versus time characteristics of an arrester.....	25
6.11 Short-circuit.....	25
6.12 Disconnectors.....	25
6.13 Requirements for auxiliary equipment such as grading components.....	25
6.14 Mechanical loads.....	25
6.15 Electromagnetic compatibility.....	26
6.16 End of life.....	26
6.17 Lightning impulse discharge capability.....	26
7 General testing procedure.....	26
7.1 Measuring equipment and accuracy.....	26
7.2 Reference voltage measurements.....	27
7.3 Test samples.....	27
8 Type tests (design tests).....	27
8.1 General.....	27
8.2 Insulation withstand tests on the arrester housing.....	29
8.3 Residual voltage tests.....	30
8.4 Long-duration current impulse withstand test.....	33
8.5 Operating duty tests.....	34
8.6 Tests of arrester disconnectors/fault indicators.....	44
8.7 Short-circuit tests.....	46
8.8 Internal partial discharge tests.....	56

8.9	Test of the bending moment	56
8.10	Environmental tests	56
8.11	Seal leak rate test	59
8.12	Radio interference voltage (RIV) test	59
9	Routine tests and acceptance tests	60
9.1	Routine tests	60
9.2	Acceptance tests	61
10	Test requirements on polymer-housed surge arresters	63
10.1	Scope	63
10.2	Normative references	63
10.3	Terms and definitions	63
10.4	Identification and classification	63
10.5	Standard ratings and service conditions	63
10.6	Requirements	63
10.7	General testing procedure	63
10.8	Type tests (design tests)	63
11	Test requirements on gas-insulated metal enclosed arresters (GIS-arresters)	80
11.1	Scope	80
11.2	Normative references	80
11.3	Terms and definitions	80
11.4	Identification and classification	80
11.5	Standard ratings and service conditions	80
11.6	Requirements	81
11.7	General testing procedures	82
11.8	Type tests (design tests)	82
11.9	Routine tests	87
11.10	Test after erection on site	87
12	Separable and dead-front arresters	90
12.1	Scope	90
12.2	Normative references	90
12.3	Terms and definitions	90
12.4	Identification and classification	90
12.5	Standard ratings and service conditions	90
12.6	Requirements	90
12.7	General testing procedure	91
12.8	Type tests (design tests)	91
12.9	Routine tests and acceptance tests	97
13	Liquid-immersed arresters	97
13.1	Scope	97
13.2	Normative references	97
13.3	Terms and definitions	97
13.4	Identification and classification	97
13.5	Standard ratings and service conditions	97
13.6	Requirements	98
13.7	General testing procedure	98
13.8	Type tests (design tests)	98
13.9	Routine tests and acceptance tests	105

Annex A (normative) Abnormal service conditions	106
Annex B (normative) Test to verify thermal equivalency between complete arrester and arrester section	107
Annex C (normative) Requirements for high lightning duty arresters for voltage range 1 kV to 52 kV	108
Annex D (normative) Procedure to verify the power-frequency voltage-versus-time characteristics of an arrester	111
Annex E (informative) Guide to selection of line discharge class	113
Annex F (normative) Artificial pollution test with respect to the thermal stress on porcelain-housed multi-unit metal-oxide surge arresters	115
Annex G (informative) Typical information given with enquiries and tenders	130
Annex H (informative) Typical circuit for high current impulse operating duty test (see 8.5.4)	132
Annex I (informative) Typical circuit for a distributed constant impulse generator for the long duration current impulse withstand test (see 8.4)	134
Annex J (informative) Typical maximum residual voltages	135
Annex K (informative) Ageing test procedure – Arrhenius law – Problems with higher temperatures	136
Annex L (informative) Guide for the determination of the voltage distribution along metal-oxide surge arresters	138
Annex M (normative) Mechanical considerations	146
Annex N (normative) Test procedure to determine the lightning impulse discharge capability	151
Bibliography	154
Figure 1 – Operating duty test on 10 000 A line discharge Class 1, 5 000 A, 2 500 A and 1 500 A arresters (see 8.5.4)	23
Figure 2 – Operating duty test on 10 000 A arresters line discharge Classes 2 and 3 and 20 000 A arresters line discharge Classes 4 and 5 (see 8.5.5)	24
Figure 3 – Power losses of the arrester at elevated temperatures versus time	37
Figure 4 – Thermal stability test on 10 000 A line discharge Class 1, 5 000 A, 2 500 A and 1 500 A arresters	62
Figure 5 – Thermal stability test on 10 000 A arresters line discharge Classes 2 and 3 and 20 000 A arresters line discharge Classes 4 and 5	62
Figure 6 – Thermomechanical test	74
Figure 7 – Example of the test arrangement for the thermomechanical test and direction of the cantilever load	75
Figure 8 – Water immersion	76
Figure 9 – Example of an accelerated weather ageing cycle under operating voltage (according to IEC 61109)	79
Figure 10 – Another example of an accelerated weather ageing cycle	80
Figure 11 – Test set-up for insulation withstand test of separable arresters in insulating housings	92

Figure 12 – Power losses of arrester at elevated temperatures versus time	101
Figure 13 – Examples of arrester units	54
Figure 14 – Short-circuit test setup	55
Figure 15 – Example of a test circuit for re-applying pre-failing circuit immediately before applying the short-circuit test current	56
Figure C.1 – Operating duty test on 20 000 A high lightning duty arresters	110
Figure C.2 – Thermal stability test on 20 000 A high lightning duty arresters (see 9.2.2).....	110
Figure D.1 – Test on 10 000 A line discharge class 1, 5 000 A, 2 500 A and 1 500 A arresters	111
Figure D.2 – Test on 20 000 A high lightning duty arresters	112
Figure D.3 – Test on 10 000 A arresters, line discharge Classes 2 and 3 and 20 000 A arresters, line discharge Classes 4 and 5.....	112
Figure E.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.....	114
Figure F.1 – Flow-chart showing the procedure for determining the preheating of a test sample	118
Figure H.1 – Typical test circuit diagram for high current impulse operating duty test.....	132
Figure I.1 – Typical distributed constant impulse generator for the long-duration impulse test.....	134
Figure L.1 – Typical three-phase arrester installation.....	143
Figure L.2 – Simplified multi-stage equivalent circuit of an arrester.....	143
Figure L.3 – Geometry of arrester model.....	144
Figure L.4 – Example of voltage-current characteristic of metal-oxide resistors at +20 °C in the leakage current region.....	145
Figure L.5 – Calculated voltage stress along the resistor column in case B.....	145
Figure M.1 – Bending moment – multi-unit surge arrester	146
Figure M.2 – Surge arrester unit	148
Figure M.3 – Surge arrester dimensions	149
Table 1 – Arrester classification	19
Table 2 – Steps of rated voltages.....	20
Table 3 – Arrester type tests ^a	28
Table 4 – Peak currents for switching impulse residual voltage test	32
Table 5 – Parameters for the line discharge test on 20 000 A and 10 000 A arresters	33
Table 6 – Requirements for the long-duration current impulse test on 5 000 A and 2 500 A arresters	34
Table 7 – Determination of elevated rated and continuous operating voltages	37
Table 8 – Requirements for high current impulses	41
Table 14 – Test requirements	52
Table 15 – Required currents for short-circuit tests	53

Table 8 – Requirements for high current impulses	66
Table 9 – 10 000 A and 20 000 A three-phase GIS-arresters – Required withstand voltages	88
Table 10 – 1 500 A, 2 500 A and 5 000 A three – phase – GIS arresters – Required withstand voltages	89
Table 11 – Insulation withstand test voltages for unscreened separable arresters.....	92
Table 12 – Insulation withstand test voltages for dead-front arresters or separable arresters in a screened housing.....	92
Table 8 – Requirements for high current impulses	94
Table 13 – Partial discharge test values for separable and dead-front arresters.....	97
Table 7 – Determination of elevated rated and continuous operating voltages	101
Table 8 – Requirements for high current impulses	102
Table C.1 – Test requirements on 20 000 A high lightning duty arresters ^a	109
Table F.1 – Mean external charge for different pollution severities.....	119
Table F.2 – Characteristic of the sample used for the pollution test.....	120
Table F.3 – Requirements for the device used for the measurement of the charge.....	121
Table F.4 – Requirements for the device used for the measurement of the temperature.....	122
Table F.5 – Calculated values of $\Delta T_{z \max}$ for the selected example.....	128
Table F.6 – Results of the salt fog test for the selected example.....	128
Table F.7 – Calculated values of ΔT_z and of T_{OD} after 5 cycles for the selected example.....	129
Table F.8 – Calculated values of ΔT_z and of T_{OD} after 10 cycles for the selected example.....	129
Table J.1 – Residual voltages for 20 000 A and 10 000 A arresters in per unit of rated voltage.....	135
Table J.2 – Residual voltages for 5 000 A, 2 500 A and 1 500 A arresters in per unit of rated voltage.....	135
Table K.1 – Minimum demonstrated lifetime prediction	136
Table K.2 – Relationship between test durations at 115 °C and equivalent time at upper limit of ambient temperature.....	137
Table L.1 – Results from example calculations	142

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SURGE ARRESTERS –**Part 4: Metal-oxide surge arresters without gaps
for a.c. systems**

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 60099-4 has been prepared by IEC technical committee 37: Surge arresters.

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

- Clauses 1, 2 and 3 contain common subclauses that cover all arrester types. Clauses 4 to 9 contain subclauses that apply to porcelain-housed arresters. To a great extent, the content of Clauses 4 to 9 also applies to arrester types other than porcelain-housed. Any exceptions that apply to polymer-housed, GIS, separable and dead-front, and liquid-immersed arresters are included in Clauses 10 to 13 as entire subclauses, not as parts of subclauses. That is, if any subclause of Clauses 4 to 9 does not apply in its entirety to a particular type of arrester, then a replacement subclause is given in its entirety in the appropriate Clauses 10, 11, 12, or 13. This avoids the necessity for the user of the document to judgwhich part of a clause has been amended.

- Table 1 has been modified. The previous Table 1 included references to subclauses for type testing. Such references are really not appropriate in Clause 4 and have been transferred to a new table in Clause 8.
- Clauses 6, 8, 11, 12 and 13: modifications have been made to short-circuit requirements.
- Requirements of Clause 13 (mechanical considerations) have been incorporated into Clauses 5, 6, 8, 10, 11, 12 and 13, and Annex A of this new edition.

This consolidated version of IEC 60099-4 consists of the second edition (2004) [documents 37/298/FDIS and 37/300/RVD] and its amendment 1 (2006) [documents 37/324/FDIS and 37/325/RVD] and its amendment 2 (2009) [documents 37/354/FDIS and 37/357/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 2.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

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

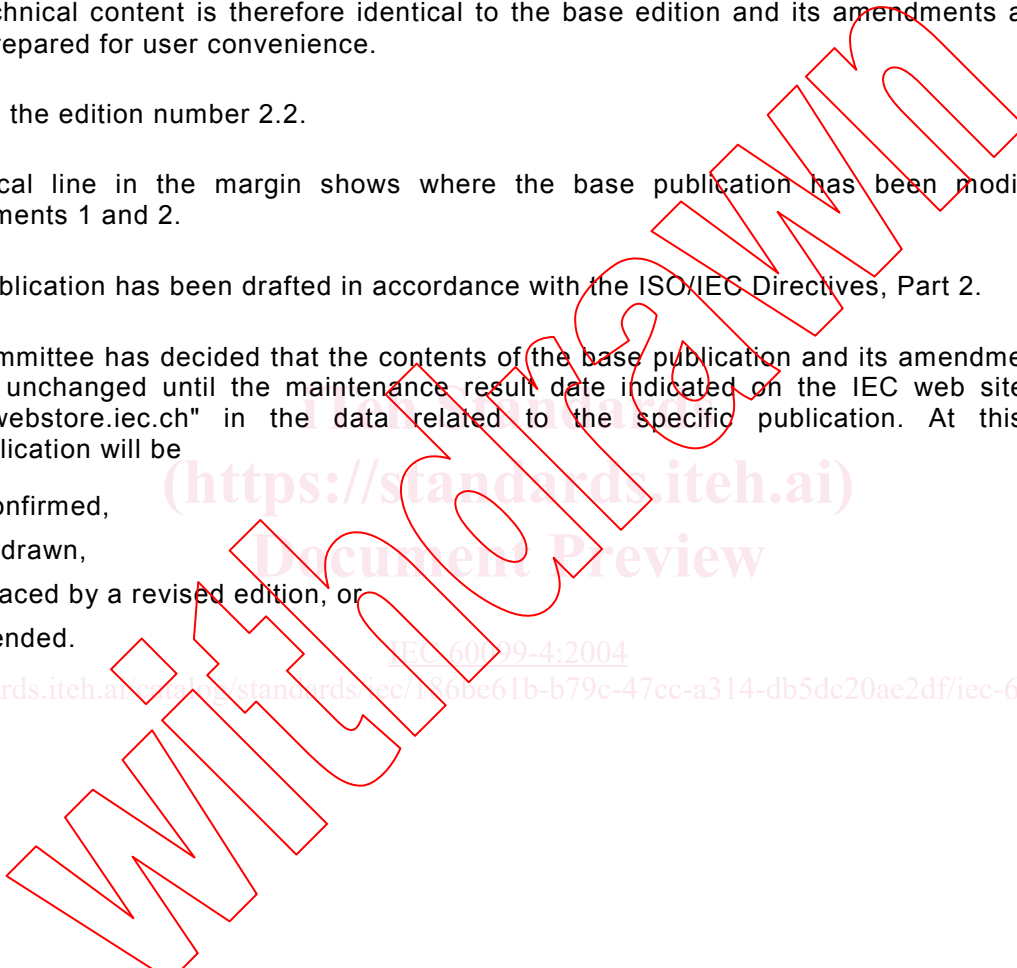
The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

(<https://standards.iteh.ai>)
Document Preview

IEC 60099-4:2004

<https://standards.iteh.ai> <https://standards.itec.org/standards/iec/186be61b-b79c-47cc-a314-db5dc20ae2df/iec-60099-4-2004>



INTRODUCTION

This part of IEC 60099 presents the minimum criteria for the requirements and testing of gapless metal-oxide surge arresters that are applied to a.c. power systems.

Arresters covered by this standard are commonly applied to live/front overhead installations in place of the non-linear resistor-type gapped arresters covered in IEC 60099-1.

Withdrawing

iTech Standards
(<https://standards.itih.ai>)
Document Preview

IEC 60099-4:2004
<https://standards.itih.ai/standards/iec/1860e61b-b79c-47cc-a314-db5dc20ae2df/iec-60099-4-2004>

SURGE ARRESTERS –

Part 4: Metal-oxide surge arresters without gaps for a.c. systems

1 Scope

This part of IEC 60099 applies to non-linear metal-oxide resistor type surge arresters without spark gaps designed to limit voltage surges on a.c. power circuits.

2 Normative references

The following referenced documents are indispensable for the application 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 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2:1994, *High-voltage test techniques – Part 2: Measuring systems*

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

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

IEC 60068-2-42:2003, *Environmental testing – Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60071-1:1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

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

IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements*

IEC 60507:1991, *Artificial pollution tests on high-voltage insulators to be used on a.c. systems*

IEC 60815:1986, *Guide for the selection of insulators in respect of polluted conditions*

IEC 61109:1992, *Composite insulators for a.c. overhead lines with a nominal voltage greater than 1 000 V – Definitions, test methods and acceptance criteria*

IEC 61166:1993, *High-voltage alternating current circuit-breakers – Guide for seismic qualification of high-voltage alternating current circuit-breakers*

IEC 61330:1995, *High-voltage/low-voltage prefabricated substations*

IEC 62271-200:2003, *High-voltage switchgear and controlgear – Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 62271-203:2003, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

CISPR 18-2:1986, *Radio interference characteristics of overhead power lines and high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits*

3 Terms and definitions

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

3.1

metal-oxide surge arrester without gaps

arrester having non-linear metal-oxide resistors connected in series and/or in parallel without any integrated series or parallel spark gaps

3.2

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

3.3

internal grading system of an arrester

grading impedances, in particular grading capacitors connected in parallel to one single or to a group of non-linear metal-oxide resistors, to control the voltage distribution along the metal-oxide resistor stack

3.4

grading ring of an arrester

metal part, usually circular in shape, mounted to modify electrostatically the voltage distribution along the arrester

3.5

section of an arrester

complete, suitably assembled part of an arrester necessary to represent the behaviour of a complete arrester with respect to a particular test

NOTE A section of an arrester is not necessarily a unit of an arrester.

3.6

unit of an arrester

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

NOTE A unit of an arrester is not necessarily a section of an arrester.

3.7

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

3.8 rated voltage of an arrester

U_r

maximum permissible r.m.s. value of power-frequency voltage between its terminals at which it is designed to operate correctly under temporary overvoltage conditions as established in the operating duty tests (see 8.5)

NOTE 1 The rated voltage is used as a reference parameter for the specification of operating characteristics.

NOTE 2 The rated voltage as defined in this standard is the 10 s power-frequency voltage used in the operating duty test after high-current or long-duration impulses. Tests used to establish the voltage rating in IEC 60099-1, as well as some national standards, involve the application of repetitive impulses at nominal current with power-frequency voltage applied. Attention is drawn to the fact that these two methods used to establish rating do not necessarily produce equivalent values (a resolution to this discrepancy is under consideration).

3.9 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 8.5

3.10 rated frequency of an arrester

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

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

NOTE 2 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 puncture breakdown

disruptive discharge through a solid

3.13 flashover

disruptive discharge over a solid surface

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

3.15 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 It is written as T_1/T_2 , both in microseconds, the sign "/" having no mathematical meaning.