

TECHNICAL REPORT



Surge arresters –
Part 10: Rationale for tests specified by IEC 60099-4:2014

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

[IEC TR 60099-10:2024](https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr60099-10-2024)

<https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr60099-10-2024>



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 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 Secretariat
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 corrigendum or an amendment might have been published.

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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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 Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

International
Standards
Document Preview
standards.iteh.ai

[IEC TR 60099-10:2024](https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024)

<https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024>

TECHNICAL REPORT



Surge arresters –
Part 10: Rationale for tests specified by IEC 60099-4:2014

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

[IEC TR 60099-10:2024](https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024)

<https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.120.50; 29.240.10

ISBN 978-2-8322-8969-3

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

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references	10
3 Terms and definitions	10
4 Structure of the document	10
4.1 Content of each individual test rationale.....	10
4.2 Relation between each test of IEC 60099-4:2014 and this document	11
5 Insulation withstand tests rationale.....	12
5.1 Arrester type for which the tests are applicable.....	12
5.2 Purpose of the tests.....	12
5.3 Historical notes.....	12
5.4 Tests rationale.....	12
5.4.1 General	12
5.4.2 Sample selection rationale.....	13
5.4.3 Test procedure rationale.....	15
5.4.4 Evaluation rationale.....	18
5.4.5 Common misunderstandings.....	18
6 Residual voltage tests rationale.....	19
6.1 Arrester type for which the tests are applicable.....	19
6.2 Purpose of the tests.....	19
6.3 Historical notes.....	19
6.4 Tests rationale.....	19
6.4.1 General	19
6.4.2 Sample selection rationale.....	20
6.4.3 Tests procedures rationale.....	20
6.4.4 Evaluation rationale.....	23
7 Test to verify long term stability under continuous operating voltage rationale.....	23
7.1 Arrester type for which the test is applicable.....	23
7.2 Purpose of the test.....	23
7.3 Historical notes.....	23
7.4 Test rationale.....	24
7.4.1 General	24
7.4.2 Sample selection rationale.....	25
7.4.3 Test procedure rationale.....	26
7.4.4 Evaluation rationale.....	26
8 Test to verify the repetitive charge transfer rating (Q_{RS}) rationale.....	26
8.1 Arrester type for which the test is applicable.....	26
8.2 Purpose of the test.....	26
8.3 Historical notes.....	26
8.4 Test rationale.....	27
8.4.1 General	27
8.4.2 Sample selection rationale.....	27
8.4.3 Test procedure rationale.....	27
8.4.4 Evaluation rationale.....	28
8.4.5 Common misunderstandings.....	28

9	Heat dissipation behavior of test sample rationale	29
9.1	Arrester type for which the test is applicable	29
9.2	Purpose of the test.....	29
9.3	Historical notes	29
9.4	Test rationale.....	29
9.4.1	General	29
9.4.2	Sample selection rationale.....	30
9.4.3	Test procedure rationale.....	30
9.4.4	Evaluation rationale	30
10	Operating duty test rationale.....	31
10.1	Arrester type for which the test is applicable	31
10.2	Purpose of the test.....	31
10.3	Historical notes	31
10.4	Test rationale.....	32
10.4.1	General	32
10.4.2	Sample selection rationale.....	32
10.4.3	Test procedure rationale.....	32
10.4.4	Evaluation rationale	34
10.4.5	Common misunderstandings	35
11	Power-frequency voltage-versus-time test rationale.....	35
11.1	Arrester type for which the test is applicable	35
11.2	Purpose of the test.....	35
11.3	Historical notes	36
11.4	Test rationale.....	36
11.4.1	General	36
11.4.2	Sample selection rationale.....	36
11.4.3	Test procedure rationale.....	36
11.4.4	Evaluation rationale	37
11.4.5	Common misunderstandings	37
12	Tests of arrester disconnecter rationale.....	37
12.1	Arrester type for which the tests are applicable.....	37
12.2	Purpose of the tests	37
12.3	Historical notes	38
12.4	Tests rationale	38
12.4.1	General	38
12.4.2	Sample selection rationale.....	38
12.4.3	Tests procedure rationale	38
12.4.4	Evaluation rationale	38
13	Short-circuit tests rationale	39
13.1	Arrester type for which the test is applicable	39
13.2	Purpose of the test.....	39
13.3	Historical notes	39
13.4	Test rationale.....	40
13.4.1	General	40
13.4.2	Sample selection rationale.....	41
13.4.3	Test procedure rationale.....	41
13.4.4	Evaluation rationale	43
13.4.5	Common misunderstandings.....	44

14	Test of the bending moment of porcelain-housed arresters rationale	44
14.1	Arrester type for which the test is applicable	44
14.2	Purpose of the test.....	44
14.3	Historical notes	44
14.4	Test rationale.....	45
14.4.1	General	45
14.4.2	Sample selection rationale.....	46
14.4.3	Test procedure rationale.....	46
14.4.4	Evaluation rationale	46
15	Test of the bending moment of polymer-housed arresters rationale	47
15.1	Arrester type for which the test is applicable	47
15.2	Purpose of the test.....	47
15.3	Historical notes	47
15.4	Test rationale.....	48
15.4.1	General	48
15.4.2	Sample selection rationale.....	48
15.4.3	Test procedure rationale.....	49
15.4.4	Evaluation rationale	49
16	Environmental tests rationale.....	49
16.1	Arrester type for which the tests are applicable.....	49
16.2	Purpose of the tests	49
16.3	Historical notes	50
16.4	Test rationale.....	50
16.4.1	General	50
16.4.2	Sample selection rationale.....	50
16.4.3	Test procedure rationale.....	50
16.4.4	Evaluation rationale	50
17	Seal leak rate test rationale	51
17.1	Arrester type for which the test is applicable	51
17.2	Purpose of the test.....	51
17.3	Historical notes	51
17.4	Test rationale.....	51
17.4.1	General	51
17.4.2	Sample selection rationale.....	51
17.4.3	Test procedure rationale.....	51
17.4.4	Evaluation rationale	51
18	Radio interference (RIV) test rationale.....	51
18.1	Arrester type for which the test is applicable	51
18.2	Purpose of the test.....	52
18.3	Historical notes	52
18.4	Test rationale.....	52
18.4.1	General	52
18.4.2	Sample selection rationale.....	52
18.4.3	Test procedure rationale.....	52
18.4.4	Evaluation rationale	52

19	Test to verify the dielectric withstand of internal components rationale	52
19.1	Arrester type for which the test is applicable	52
19.2	Purpose of the test.....	52
19.3	Historical notes	53
19.4	Test rationale.....	53
19.4.1	General	53
19.4.2	Sample selection rationale.....	53
19.4.3	Test procedure rationale.....	54
19.4.4	Evaluation rationale	54
20	Tests of internal grading components rationale.....	54
20.1	Arrester type for which the tests are applicable.....	54
20.2	Purpose of the test.....	54
20.3	Historical notes	54
20.4	Test rationale.....	54
20.4.1	General	54
20.4.2	Sample selection rationale.....	55
20.4.3	Test procedure rationale.....	55
20.4.4	Evaluation rationale	55
21	Weather aging tests rationale	55
21.1	Arrester type for which the tests are applicable.....	55
21.2	Purpose of the tests	56
21.2.1	Salt fog test.....	56
21.2.2	UV light test.....	56
21.3	Historical notes	56
21.3.1	Salt fog test.....	56
21.3.2	UV light test.....	56
21.4	Test rationale.....	56
21.4.1	General	56
21.4.2	Sample selection rationale.....	57
21.4.3	Test procedure rationale.....	57
21.4.4	Evaluation rationale	57
22	Routine tests and acceptance tests rationale	57
22.1	Routine tests.....	57
22.2	Acceptance tests	58
	Bibliography.....	60
	Figure 1 – Possible arcing distances (7 paths to consider for this example) for a multi-unit arrester (from CIGRÉ 696-2017)	14
	Figure 2 – Withstand voltage versus duration.....	16
	Figure 3 – Sequence of the test to verify the repetitive charge transfer rating	27
	Figure 4 – Example of cooldown curves of test samples	31
	Figure 5 – Operating duty test sequence.....	33
	Figure 6 – Examples of TOV curves	35
	Figure 7 – Power-frequency versus time test sequence	37
	Figure 8 – Impact of the connecting leads on arc movement and short-circuit test severity.....	43
	Figure 9 – Graphic representation of the relationships between tests in the bending moment tests for porcelain-housed arresters	45

Figure 10 – Examples of MBL and SSL test results 46

Figure 11 – Graphic representation of the relationships between tests in the bending moment tests for polymer-housed arresters 47

Table 1 – Test rationale clause number for each test in 60099-4:2014 11

Table 2 – Calculated minimum life expectancy if MO resistors would perfectly follow the Arrhenius law 25

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

[IEC TR 60099-10:2024](https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024)

<https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SURGE ARRESTERS –**Part 10: Rationale for tests specified by IEC 60099-4:2014**

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 60099-10 has been prepared by IEC technical committee 37: Surge arresters. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
37/XX/DTR	37/XX/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

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

[IEC TR 60099-10:2024](https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024)

<https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024>

INTRODUCTION

This part of IEC 60099, which is a Technical Report, is informative in nature and does not contain requirements. Its primary purpose is to provide information to users of IEC 60099-4 to help them understand the underlying rationale for the tests and the specified test parameters.

A secondary purpose is to keep a record of substantive changes in the rationale over the last few editions of the standard.

This first edition of the Technical Report covers the tests specified in IEC 60099-4:2014. As tests are added, modified or deleted in future editions of IEC 60099-4, it is planned to amend this Technical Report to reflect such changes. It is understood that rationale behind requirements may change significantly over time, for example when a whole new test philosophy is implemented in a standard.

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

[IEC TR 60099-10:2024](https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024)

<https://standards.iteh.ai/catalog/standards/iec/4a53d4d7-b731-4f0d-a2c5-75d865e266c6/iec-tr-60099-10-2024>

SURGE ARRESTERS –

Part 10: Rationale for tests specified by IEC 60099-4:2014

1 Scope

This part of IEC 60099, which is a Technical Report, is applicable to all tests and arrester types included in IEC 60099-4:2014 and explains the rationale behind each test specified in that document.

This document does not contain requirements and is not intended to replace any clauses of IEC 60099-4:2014.

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 60099-4:2014, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60099-4:2014 apply.

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

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

4 Structure of the document

4.1 Content of each individual test rationale

Each test rationale clause (see Clauses 5 to 21), with the exception of the routine and acceptance test rationales (see Clause 22), is structured as follows (with X representing the clause number):

- X.1 Arrester types for which the test is applicable
- X.2 Purpose of the test
- X.3 Historical notes
- X.4 Test rationale
 - X.4.1 General
 - X.4.2 Sample selection rationale
 - X.4.3 Test procedure rationale
 - X.4.4 Evaluation rationale
 - X.4.5 Common misunderstandings (applicable only to Clauses 5, 8, 10, 11 and 13)

Historical notes provide information with regard to the known first use in IEC 60099-4, initial references used to develop the test, and major changes over time.

The "Common misunderstandings" subclauses provide general comments with regard to often misunderstood uses of the characteristics being verified in IEC 60099-4:2014.

4.2 Relation between each test of IEC 60099-4:2014 and this document

All arrester types covered by IEC 60099-4:2014 are covered in this document. A rationale is provided for each test in IEC 60099-4:2014, including the routine and acceptance tests, with the following exceptions because these tests are under consideration by IEC Technical Committee 37 at the moment of publication of this technical report:

- the insulation withstand tests for GIS arresters and separable and dead-front arresters (IEC 60099-10:2014, 11.8.2 and 12.8.2).
- the short-circuit tests for separable and dead-front and liquid-immersed arresters (IEC 60099-10:2014, 12.8.10 and 13.8.10).
- the test after erection on site for GIS arresters (IEC 60099-4:2014, 11.10).
- the internal partial discharge test for separable and dead-front arresters (IEC 60099-4:2014, 12.8.17).

Table 1 shows which clause/subclause of this document applies to each test of IEC 60099-4:2014, for each arrester type.

Table 1 – Test rationale clause/subclause number for each test in 60099-4:2014

Tests in 60099-4:2014		Test rationale clause/subclause number in this document for each arrester type				
Clause/subclause number ^a	Title	Porcelain housed	Polymer housed	Gas insulated metal-enclosed	Separable and dead-front	Liquid immersed
8.2	Insulation withstand tests	5		Not included in this edition		5
8.3	Residual voltage tests	6				
8.4	Test to verify long term stability under continuous operating voltage	7				
8.5	Test to verify the repetitive charge transfer rating, Q_{rs}	8				
8.6	Heat dissipation behavior of test sample	9				
8.7	Operating duty test	10				
8.8	Power-frequency voltage-versus-time test	11				
8.9	Test of arrester disconnecter	12		N/A		
8.10	Short-circuit tests	13			Not included in this edition	
8.11	Test of the bending moment	14	15	N/A		
8.12	Environmental tests	16	N/A			
8.13	Seal leak rate test	17		N/A		

Tests in 60099-4:2014		Test rationale clause/subclause number in this document for each arrester type				
Clause/subclause number ^a	Title	Porcelain housed	Polymer housed	Gas insulated metal-enclosed	Separable and dead-front	Liquid immersed
8.14	Radio interference (RIV) test	18				
8.15	Test to verify the dielectric withstand of internal components	19				
8.16	Test of internal grading components	20				
10.8.17	Weather aging test	N/A	21	N/A		
9	Routine tests and acceptance tests	22				

^a For subclause numbers starting with 8 (ex.: 8.2), equivalent subclauses in Clauses 10, 11, 12 and 13 are also included (e.g. 10.8.2, 11.8.2, 12.8.2 and 13.8.2 are included in the same line as per 8.2)

5 Insulation withstand tests rationale

5.1 Arrester type for which the tests are applicable

Insulation withstand tests apply to all types of arresters. This clause includes the test rationales for porcelain-housed arresters, polymer-housed arresters and liquid-immersed arresters only. Specificities applicable to GIS arresters and separable and dead-front arresters are under consideration in IEC Technical Committee 37 and are not included yet herein.

However, if an arrester has a dry arc distance longer than the specified levels in IEC 60099-4:2014, they are exempt from this test. Also, the switching impulse withstand test is required for arresters applied to systems with $U_s > 245$ kV only.

5.2 Purpose of the tests

The voltage withstand tests demonstrate the voltage withstand capability of the external insulation of arrester housings.

5.3 Historical notes

These tests were added for the first time in IEC 60099-4:1991. There was no reference to this type of test in IEC 60099-1.

Historically, tests on individual housings only were specified irrespective of arrester rating and tests on complete housing assemblies were "under consideration". This was changed in IEC 60099-4:2014 to require tests on arresters for systems with $U_s > 245$ kV to be performed using complete housing assemblies including the external grading systems. For systems with $U_s \leq 245$ kV, tests are still permitted on individual unit housings.

5.4 Tests rationale

5.4.1 General

This test is a procedure to verify that the housing will not experience an external flashover under anticipated transient conditions that may occur over the life of the arrester. This is not a lightning impulse withstand (LIWV) test, a switching impulse withstand voltage (SIWV) nor a power frequency voltage (PFVV) test as applied to other high voltage equipment.