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IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)

STANDARDS

IEEE Power and Energy Society

Developed by the
Surge Protective Devices Committee

IEEE Std C62.11™-2020
(Revision of IEEE Std C62.11-2012)

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IEEE SA Standards Board

Abstract: Metal-oxide surge arresters (MOSAs) designed to repeatedly limit the voltage surges on 48 Hz to 62 Hz power circuits (>1000 V) by passing surge discharge current and automatically limiting the flow of system power current are addressed in this standard. This standard applies to devices for separate mounting and to devices supplied integrally with other equipment. The tests demonstrate that an arrester is able to survive the rigors of reasonable environmental conditions and system phenomena while protecting equipment and/or the system from damaging overvoltages caused by lightning, switching, and other undesirable surges.

Keywords: charge transfer, discharge current, discharge voltage, IEEE C62.11™, lightning protection, maximum continuous operating voltage, MCOV, metal-oxide disk, metal-oxide surge arrester, MOSA, single-impulse charge transfer rating, surge arrester, thermal charge transfer rating, thermal energy, withstand rating, TOV

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Introduction

This introduction is not part of IEEE Std C62.11-2020, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV).

Metal-oxide surge arresters (MOSAs) described in this standard represent the predominant surge arrester technology applied on ac power systems above 1 kV. This standard presents minimum criteria for the testing of such surge arresters. Matters of application of this type of surge arrester are covered in IEEE Std C62.22™.[1] For testing and application of surge protective devices for use in low-voltage circuits (1 kV and below), other standards in the IEEE C62 series are available.

This edition contains the following significant changes from IEEE Std C62.11™-2012:

Clause 2	Added Reference to CIGRE TB 696
Clause 2	Added Reference to IEC 60071-2
Clause 3 Duty-cycle Voltage	Modified definition to indicate it is an obsolete term.
Clause 3 Single Impulse Charge transfer rating	Modified the definition of single impulse withstand rating to reflect charge transfer withstand and term Q_{rs}
Clause 3 Thermal Charge Transfer Rating	Added thermal charge transfer rating definition Q_{th}
Clause 3 Thermal Energy Withstand Rating	Added thermal energy withstand rating definition and term W_{th}
4.1.2 c)	Change usual service conditions to 1000 m (3281 ft) from 1800 m.
4.2.1 c)	Changed unusual service conditions to altitude exceeding 1000 m (3281 ft). Removed any specific ranges above 1000 m.
Clause 5	Modified Table 1 to reflect the trend toward elimination of duty-cycle voltage rating that is being replaced with MCOV as the relevant voltage rating of an arrester.
Clause 6 Table 2	Modified to agree with the final changes made to the test requirements.
Clause 6 Table 3, Table 4, Table 5	Created Arrester Classification Table 3, Table 4, and Table 5 that replaces previous Table 6, Table 7, Table 12, and Table 13. Also removed reference to system voltage and converted to MCOV levels instead.
7.2.2.3.3	Modified the type of voltage that can be used to heat the metal-oxide disks from only ac to include ac and dc.
8.1.2.1 a)1), a)2)	Modified test parameters for distribution arresters to align with IEC 60099-4 Added option to waive test with sufficient strike distance.
8.1.2.1 b)	Modified test parameters for distribution arresters to align with IEC 60099-4 and add option to waive test.
8.1.2.3	Modified Deadfront arrester test level table. Eliminated dc test and brought it in line with IEEE Std 386™.

[1]Information on references can be found in Clause 2.

8.1.2.4	Modified test parameters and test methods for insulation withstand voltages for arrester housings. Changed parameters for arresters with MCOV < 140 kV Changed test method to switching impulse from power frequency tests for arrester with MCOV ≥ 140 kV and < 460 kV. For arresters applied to systems above 800 kV the test voltage will be negotiated between supplier and customer. Made provision for no test if the strike distance of the arrester is above a specific level. (Adopted a less conservative level than IEC in anticipation of the future change to the IEC formula.) Added reference to IEEE Std 4™ and requirement for 15 impulses.
8.2.2.1	Deleted old Table 6 and rolled it into Summary Table 4.
8.2.2.2	Deleted old Table 7 and rolled it into Summary Table 4.
8.4.2.1.1	Modified Table 8 to reflect MCOV instead of rated voltage, and deleted less than 3 kV row since there are no ratings below that.
8.8.2.3	Replaced new paragraph e) that was dropped by mistake and added clearer test sequence. Also removed the requirement to inspect the internal components.
Previous Subclause 8.11	Eliminated Subclause 8.11 Partial Discharge Test as a design test since it is a routine test.
Previous Subclause 8.12	Eliminated the high-current short-duration test as a stand-alone test and folded it into the new Operating Duty Test.
Previous Subclause 8.13	Eliminated the low-current long-duration test for distribution arresters since they are now included in the Q_{rs} test.
Previous Subclause 8.14, new Subclause 8.11	The switching impulse energy rating test was modified by eliminating the preconditioning surges at lower currents, since it has been demonstrated in technical studies that low current surges such as these do not age MOSA type arresters. A V_{ref} test is included at the start of the test to verify the MCOV rating of the sample. The 10 s TOV at the start of the thermal recovery portion of the test was modified to 1.25 × MCOV to reflect the goal of eliminating duty cycle voltage as a test parameter in this standard. A graphic test procedure summary was added for clarity of the test procedure.
Previous Subclause 8.15, new Subclause 8.12	Adopted the term charge transfer rating Q_{rs} as the single-impulse withstand rating of arresters. Included distribution arresters in this test series. A test procedure graphic was added for clarity. Added distribution arresters to the tested classes to replace LCLD test. Both 8/20 and rectangular waveshapes allowed for distribution arresters.
Previous Subclause 8.16, new Subclause 8.13	The duty cycle test was revised as follows: Station and intermediate arresters exempt since this is a redundant test to switching impulse withstand test. Q_{th} parameter adopted as the charge transfer characteristic. Name changed to Operating Duty Test to distance this standard from the duty cycle rating parameter. Removed 20 impulse preconditioning test for non-gapped MOV, since studies have shown that low current impulses < 20 kA do not age MOSA arresters. Added high current impulse to preconditioning test to replace 20 lower current impulses. Changed thermal recovery voltage to MCOV or higher for all distribution arresters instead of just HD. (Text of draft accepted in March meeting.) Revised non-gapped graphic of test timeline and correlated to verbiage with labels (Draft 9). Added separate graphic of timeline and verbiage for gapped arresters. Added new subclause for gapped MOV arresters that combines some parts of IEC 60099-6 and IEEE Std C62.11-2012.

Previous 8.17, new Subclause 8.14	The TOV test was modified as follows: Eliminated the 0.01s TOV, since it is not likely to happen in the real world and tests laboratories cannot actually test this short time. Added V_{ref} test as an initial test to verify specimen MCOV. Reduced the longest required time down to 3600 s and required it instead of 10000 s. This better represents the real world based on input from utilities. Adopted the prior duty energy to be W_{th}. Modified wording to require a start temp of 60 °C not allowing for a 10 min delay between removing form oven and starting the test. Added procedure graphic for clarification of test. Changed pass criteria of discharge voltage to ± 5% from 10% to make consistent with other design tests.
Previous Subclause 8.21, new Subclause 8.18	Eliminated ODC, HCSD, and LCLD withstand tests and added single impulse charge transfer tests in their place and operating duty tests.
Previous Subclause 9.5	Eliminated subclause because there is no need to specify both creep distance and withstand voltage of a sample. Withstand voltage requirement remains.
Clause 11	Eliminated the clause based on lack of use and no rationale to keep.
Table C.1	Split table into Table C.1 and Table C.2, added new Q_{rs} and W_{th} values, and removed reference to rated voltage.
D.8.1	Modified rationale for most of the insulation withstand tests.
D.8.9	Updated historical note with more information.
Rationale removed	Low-current long-duration test, partial discharge test, high-current short-duration.
D.8.11	Updated to new procedure.
D.8.12	Updated to new procedure.
D.8.13	Updated to new procedure.
D.8.14	Updated to modified procedure.

Contents

IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)

1. Overview

1.1 Scope

This standard applies to metal-oxide surge arresters (MOSAs) designed to repeatedly limit the voltage surges on 48 Hz to 62 Hz power circuits (>1000 V) by passing surge discharge current and automatically limiting the flow of system power current. This standard applies to devices for separate mounting and to devices supplied integrally with other equipment.

1.2 Purpose

To define tests that demonstrate that an arrester can survive the rigors of reasonable environmental conditions and system phenomena while protecting equipment and/or the system from damaging overvoltages caused by lightning, switching, and other system disturbances.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ASTM A153/153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.[2]

ASTM D750, Standard Test Method for Rubber Deterioration in Carbon-Arc Weathering Apparatus.

ASTM D1499, Standard Practice for Operating Light and Water Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics.

ASTM D2565, Standard Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Applications.

[2]ASTM publications are available from the American Society for Testing and Materials (http://www.astm.org/).