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TECHNICAL SPECIFICATION

Low-voltage switchgear and controlgear assemblies - Internal arc-fault protection of low-voltage switchgear and controlgear assemblies in accordance with the IEC 61439 series

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IEC TS 61641 has been prepared by subcommittee SC 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee TC 121: Switchgear and controlgear and their assemblies for low voltage. It is a Technical Specification.

This edition cancels and replaces IEC TR 61641:2014 and IEC TS 63107:2020. This edition constitutes a technical revision.

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

a) Introduction of the term "arcing class zone", using the term "arcing classes" from the previous document IEC TR 61641:2014.

b) Structured using of the terms "zone" and "area". "Area" is used to describe the place of installation and the accessibility of the assembly (macro-environment). "Zone" is used in this document to describe a defined space within the assembly (micro-environment).

c) Assembly protection is classified into two levels.

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

Draft	Report on voting
121B/228/DTS	121B/232/RVDTS

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 Specification 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.

This document is to be used in conjunction with the IEC 61439 series.

It supplements or modifies the corresponding clauses in the IEC 61439 series.

The following numbering system is used:

– subclauses, tables and figures that are numbered starting from 101 are additional to those in the IEC 61439 series;

– unless notes are in a new subclause or involve notes in the IEC 61439 series, they are numbered starting from 101, including those in a replaced clause or subclause;

– additional annexes are lettered AA, BB, etc.

The reader's attention is drawn to the fact that Annex GG lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

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.

INTRODUCTION

This document deals with the internal arc-fault protection of low-voltage switchgear and controlgear assemblies.

The IEC 61439 series of documents identifies rules and requirements for the interface characteristics, service conditions, construction, performance and verification of low-voltage switchgear and controlgear assemblies, hereafter called an assembly. The main objective of the IEC 61439 series of documents is to provide assemblies that operate safely under normal operating conditions. An internal arc-fault is not considered as a normal operating condition. Therefore, no characteristics, design and verification requirements are given dealing with an internal arc-fault within an assembly.

Assemblies built, operated and maintained according to the IEC 61439 series cannot exclude the risk of occurrence of an internal arc-fault. On the rare occasions that they do occur, internal arc-faults result from circumstances including:

– foreign objects inadvertently left in the assembly during manufacture, installation or maintenance operations, e.g. a tool;
– faults in construction materials and components;
– entry of small animals like mice, snakes, etc.;
– use of an inappropriate assembly for the application resulting in incorrect operation, overheating, accelerated ageing of insulation;
– unforeseen operating conditions or lack of maintenance;
– human error, poor or faulty workmanship whether under energized or de-energized conditions.

Avoiding all of the above and similar circumstances results in a remote possibility of an internal arc-fault. Any of these circumstances creates a higher possibility of an internal arc-fault, which should be considered in a risk assessment.

The ignition of an internal arc-fault within an assembly generates various phenomena, such as extreme overheating resulting in high overpressure inside the assembly and emission of hot materials, gases and flame which may endanger people in close proximity to the assembly causing burns from the potential projection of these hot materials and/or gases from the assembly as well as impacts from suddenly opening doors, and damage to the assembly.

Due to the risk of personal injury, damage and loss of power availability because of an arc-fault there is a demand for internal arc-fault verified assemblies.

There are various methods of mitigating the effects of internal arc-faults. Assemblies often use several methods for protection against the risk of injury, damage and loss of power availability as a consequence of an arc-fault.

This document describes the verification of an assembly under conditions of arcing in air due to an internal failure where the mechanical construction of the assembly provides arc-fault resistance, commonly called "passive" arc-fault protection, and an assembly which is fitted with an internal arc-fault mitigation system (IAMS), commonly called "active" arc-fault protection.

The aim of the integration of the IAMS into assemblies is to reduce the released energy in case of an internal arc-fault by using the activation of an internal arc-fault reduction device (IARD) in order to:

– improve the ability of assemblies to reduce the risk of injury to personnel;
– reduce the consequential damage to assemblies;
– improve the power availability from assemblies for further service after an internal arc-fault.

The above-mentioned improvements are related only to an assembly complying with certain parts of the IEC 61439 series.

The ability of an assembly to pass tests according to this document is only one aspect when assessing the potential risk due to an internal arc-fault within an assembly. Risk assessments should be carried out considering for example, the skill of personnel having access to the assembly, any protective measures required, the working procedures applied and the conditions in the location where the assembly is installed.

General information about internal arc-fault considerations and possible protective measures from the perspective of the user of an assembly is given in IEC TR 61439-0:2022, Clause D.2 and Annex AA and Annex BB of this document.

1 Scope

This document identifies methods used to verify the ability of the assembly:

– to limit the risk of injury to personnel during an internal arc-fault;
– to limit the damage to an acceptable level as a result of an internal arc-fault;
– to improve the power availability following an internal arc-fault.

This document takes into consideration:

– the effects of the internal overpressure acting on covers, doors, etc.;
– the thermal effects of the internal arc-fault or its roots on the enclosures and of ejected hot gases and glowing particles.
– the correct function of the IAMS within the assembly;
– the prevention of unintended operation of the IAMS within the assembly, for example caused by switching arcs;
– the functioning behaviour of the IAMS immediately after the assembly is energized.

This document describes different methods to assess the performance of an assembly or zones of an assembly in respect of arcing in air due to an internal failure:

– with "passive" arc-fault protection (provided by mechanical construction, e.g. suitable door locks, hinges, pressure relief devices, barriers);

NOTE 1 This approach corresponds to the method according to IEC TR 61641:2014.

– with "active" arc-fault protection (with the integration of IAMS);

NOTE 2 This approach corresponds to the method according to IEC TS 63107:2020.

– with the use of an arc ignition protected zone (to make the ignition of an arc-fault an extremely remote possibility).

NOTE 3 This approach corresponds to the method according to IEC TR 61641:2014.

IAMS consist of internal arc-fault control devices (IACD), e.g. optical-based IACD's in accordance with IEC 60947-9-2 and internal arc-fault reduction devices (IARD), e.g. arc quenching devices (AQDs) in accordance with IEC 60947-9-1 and short-circuit protection devices SCPD's in accordance with IEC 60947-2 (see Figure EE.1). IAMS can be provided by a combined-type device according to IEC 60947-9-2.

IEC 60364-4-42:2024 (Clause 427) provides guidance on the need for internal arc-fault protection.

This document does not supersede any individual product standard. Individual devices are required to comply with their relevant standard.

This document does not apply to integration of arc fault detection devices (AFDD) according to IEC 62606.

Informative Annex AA gives guidance for the user (see IEC 61439-1:2020, 3.11) on internal arc-fault mitigation.

Informative Annex BB gives guidance for the user (see IEC 61439-1:2020, 3.11) of assemblies with "active" arc-fault protection (with the integration of IAMS).

Informative Annex CC gives guidance for the original manufacturer of an assembly when incorporating an integrated IAMS.

This document does not consider other effects which can constitute a risk, such as emission of toxic gases, loud noises and/or intense light. Furthermore, this document does not consider conditions during maintenance work and the personal protective equipment used.

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 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60947-9-1:2019, *Low-voltage switchgear and controlgear - Part 9-1: Active arc-fault mitigation systems - Arc quenching devices*

IEC 60947-9-2:2021, *Low-voltage switchgear and controlgear - Active arc-fault mitigation systems - Part 9-2: Optical-based internal arc-detection and mitigation devices*

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies - Part 1: General rules*

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

Bibliography

The bibliography of IEC 61439-1:2020 is applicable except as follows.

Addition:

IEC 60269-2:2013, *Low-voltage fuses - Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) - Examples of standardized systems of fuses A to K*
IEC 60269-2:2013/AMD1:2016

IEC 60364-4-42:2024, *Low-voltage electrical installations - Part 4-42: Protection for safety - Protection against thermal effects*

IEC 60947-6-1:2021, *Low-voltage switchgear and controlgear - Part 6-1: Multiple function equipment - Transfer switching equipment*

IEC TR 61439-0:2022, *Low-voltage switchgear and controlgear assemblies - Part 0: Guidance to specifying assemblies*

IEC TR 61641:2014, *Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault*

IEC 62606, *General requirements for arc fault detection devices*

IEC TS 63107:2020, *Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC-assemblies) according to IEC 61439-2*

IEC TR 63482:2024, *Maintenance of low voltage switchgear and controlgear and their assemblies*

EN 50110 (all parts), *Operation of electrical installations*

IEEE C37.20.7 - IEEE Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults

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