

TECHNICAL REPORT

RAPPORT TECHNIQUE

Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault

Ensembles d'appareillage à basse tension sous enveloppe – Guide pour l'essai en conditions d'arc dues à un défaut interne

IEC/TR 61641:2008

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ENCLOSED LOW-VOLTAGE SWITCHGEAR
AND CONTROLGEAR ASSEMBLIES –
GUIDE FOR TESTING UNDER CONDITIONS
OF ARCING DUE TO INTERNAL FAULT**

FOREWORD

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IEC 61641, which is a technical report, has been prepared by subcommittee 17D: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 17: Switchgear and controlgear. This second edition cancels and replaces the first edition (1996) and constitutes a technical revision.

The main changes introduced in this new edition are the following:

- the numbering of the clauses has been changed in order to meet the requirements in Part 2 of the ISO/IEC Directives;
- the concept of ASSEMBLY protection under arcing conditions has been introduced;

- existing terms and definitions have been modified and new terms and definitions have been added (3.4 to 3.9);
- Clause 4 (Classification of low-voltage switchgear and controlgear assemblies) and Clause 5 (ASSEMBLY characteristics under arcing conditions) have been added;
- Clause 4 “Test procedure” in the former edition has been split into the new Clauses 6 “Testing” and 7 “Test procedure” with actualised requirements;
- new Table 2 with sizes of the copper ignition wire with current limiting protection device has been added;
- the new criteria 6 and 7 for ASSEMBLY protection have been added in Clause 8.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
17D/352/DTR	17D /353/RVC

Full information on the voting for the approval of this technical report 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.

The French version of this technical report has not been voted upon.

The committee has decided that the contents of this publication 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- withdrawn,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.

INTRODUCTION

The occurrence of arcs inside enclosed low-voltage switchgear and controlgear assemblies - hereafter called ASSEMBLIES - is coupled with various physical phenomena. For example, the arc energy resulting from an arc developed in air at atmospheric pressure within the enclosure will cause an internal overpressure and local overheating which will result in mechanical and thermal stressing of the ASSEMBLY. Moreover, the materials involved may produce hot decomposition products, either gases or vapours, which may be discharged to the outside of the enclosure.

This technical report makes allowance for internal overpressure acting on covers, doors, etc. and also takes into consideration the thermal effects of the arc or its roots on the enclosures and of ejected hot gases and glowing particles, but not damage to internal partitions. It does not cover all effects which may constitute a risk, such as toxic gases. The test procedure simulates only situations when doors and covers are closed and correctly secured.

The interpretation of results is subject to an agreement between the manufacturer and the user.

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ENCLOSED LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES – GUIDE FOR TESTING UNDER CONDITIONS OF ARCING DUE TO INTERNAL FAULT

1 Scope

This technical report applies to enclosed low-voltage switchgear and controlgear assemblies - hereafter called ASSEMBLIES - manufactured according to IEC 60439-1.

The purpose of this technical report is to give guidance on the method of testing of enclosed low-voltage switchgear and controlgear assemblies under conditions of arcing in air due to an internal fault.

The purpose of this test is to assess the ability of the ASSEMBLY to limit the risk of personal injury and damage of ASSEMBLIES resulting from an internal arcing fault.

This is a voluntary test made either at the discretion of the manufacturer, or subject to an agreement between manufacturer and user.

NOTE The recommendations of this report are not acceptable in the USA, nor in Canada, nor in the United Kingdom.

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 60439-1:1999, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*
Amendment 1:2004

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60439-1 apply with the following additions.

3.1 permissible current under arcing conditions

$I_{p \text{ arc}}$

value given by the manufacturer together with a corresponding permissible arc duration (see 3.2) indicating the maximum allowable value of prospective short-circuit current at the terminals of the incoming unit for which the requirements of this test specification are fulfilled

NOTE The value is the r.m.s. value of the a.c. component of the current.

3.2 permissible arc duration

t_{arc}

value given by the manufacturer together with a corresponding permissible current under arcing conditions (see 3.1) indicating the maximum permissible arc duration for which the requirements of this test specification are fulfilled

NOTE The value can be different for different parts of the ASSEMBLY.

3.3

permissible conditional short-circuit current under arcing conditions

$I_{pc\ arc}$

value given by the manufacturer for a circuit of the ASSEMBLY indicating the prospective current for which the ASSEMBLY fulfils the requirements of the test specification (see Clause 7) when the circuit is protected by a current-limiting device as stated by the manufacturer

NOTE The value is the r.m.s. value of the a.c. component of the current.

3.4

arc

short-circuit arising from a fault between active parts of different potential and/or between active parts and other conductive parts resulting in a free burning arc within an ASSEMBLY

3.5

personal protection under arcing conditions

ability of an ASSEMBLY to limit the risk of personal injury caused by the mechanical and thermal effects of an internal arcing fault

NOTE 1 This applies to enclosed low-voltage switchgear and controlgear assemblies when doors and covers are closed and correctly secured.

NOTE 2 It does not cover all effects which may constitute a risk, such as toxic gases.

3.6

ASSEMBLY protection under arcing conditions

ability of an ASSEMBLY to limit the effects of an internal arcing fault on the operation to a defined area inside the ASSEMBLY

3.7

arc free zone

part of a circuit within the ASSEMBLY where it is not possible to apply an ignition wire without destroying the insulation material on conductors

3.8

arc proof zone

part of a circuit where an ignition wire can be applied and fulfilling all relevant criteria for the assessment of the test

3.9

arc proof ASSEMBLY

assembly consisting of arc free zones and/or arc proof zones

4 Classification of low-voltage switchgear and controlgear assemblies

According to their characteristics under arcing conditions low-voltage switchgear and controlgear assemblies can be classified into

- low-voltage switchgear and controlgear assembly providing personal protection under arcing conditions;
- low-voltage switchgear and controlgear assembly providing personal and ASSEMBLY protection under arcing conditions (see Clause 8, criteria 6 and 7).

5 Assembly characteristics under arcing conditions

The following details are to be given by the manufacturer.

- Rated values:
 - permissible current under arcing conditions ($I_{p \text{ arc}}$) and the associated arcing time (t_{arc}), or
 - permissible conditional short-circuit current under arcing conditions ($I_{\text{pc arc}}$)
 - rated operational voltage (U_e).

NOTE The permissible current or permissible conditional short circuit current under arcing conditions may be lower than the rated short time withstand current (I_{cw}) or the rated conditional short circuit current (I_{cc}).

- The defined areas (e.g. section, sub-section) to which the effects of an internal arcing fault are limited in respect of ASSEMBLY protection.
- The characteristics (current rating, breaking capacity, cut-off current, I^2t , etc.) of the current-limiting devices (e.g. current-limiting circuit breakers or fuses) necessary for the protection of the circuit, if applicable.

6 Testing

6.1 General

The test is carried out on representative samples.

The following points should be observed.

- The test should be carried out on a test specimen not previously subjected to an arcing test or on a specimen cleaned and prepared accordingly. The specimen and the equipment in it may be repaired or replaced before each test.

NOTE Degradation of insulation due to carbonization or moderate erosion of metal parts is not necessarily considered to render a unit unsuitable for a further test.

- The mounting conditions should be as close as possible to those of normal service. A mock-up of any room in which the ASSEMBLY could be installed is in general not necessary.
- The test specimen should be fully equipped. Mock-ups of internal components are permitted provided that
 - a) they have the same volume and shape, and a similar external material as the original items;
 - b) any metallic external material is earthed in a similar manner to normal service .
- The assigned measure for protection against electric shock shall be effective (see 7.4 of IEC 60439-1).
- The arcing test is carried out as a three-phase test according to the service conditions.

6.2 Voltage

The applied voltage of the test circuit is 105 % of the rated operational voltage of the ASSEMBLY ± 5 %.

6.3 Current

6.3.1 To test a permissible current under arcing conditions, the test supply is adjusted by making a short-circuit as close as possible to the incoming terminals of the ASSEMBLY.

NOTE For the relationship between peak value and r.m.s. value of short-circuit currents, see 7.5.3 of IEC 60439-1.

6.3.2 To test a permissible conditional short circuit current under arcing conditions the test supply is adjusted by making a short-circuit on the line side of the current limiting device and as close to the device as possible.

6.3.3 In each case, the impedance used to adjust the test supply is the same used during the test.

6.4 Frequency

At a rated frequency of 50 Hz or 60 Hz, the frequency at the beginning of the test should be between 45 Hz and 67 Hz. At other frequencies, it should not deviate from the rated value by more than $\pm 10\%$.

6.5 Duration of the test

The power supply duration of the ASSEMBLY under test is given by the manufacturer. It is chosen according to the time response of the electrical protection devices. If details regarding these devices are not known, a power supply duration of at least 0,1 s is applied. Normally this duration should not exceed 0,5 s.

NOTE When the ASSEMBLY is intended to be fed from a transformer, the permissible arc duration of the incoming switching device should in general be 0,3 s to allow for the operation of the high-voltage protective equipment.

In case of testing with a conditional short-circuit current under arcing conditions and an arcing time limited by the test specimen itself (e.g. by means of non current-limiting switchgear) the applied voltage is maintained for at least 10 more cycles after shut-down.

7 Test procedure

7.1 Supply circuit

The test sample is connected and supplied corresponding to the normal service arrangement. This includes the connection of PE, N and PEN conductors, which are connected directly to the neutral point of the test current source. If the supply can be fed from more than one direction, the direction of feed to be chosen is that one likely to result in the highest stress(es).

7.2 Arc initiation

The arc is initiated between the phases without connection to earth by means of a bare copper ignition wire connecting the adjacent conductors across the shortest distance, and connected to three phases.

With regard to the test current, the sizes of the copper ignition wire given in Table 1 should be used.