IEC/TR 62271-302

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TECHNICAL REPORT

RAPPORT TECHNIQUE

colour inside

High-voltage switchgear and controlgear –
Part 302: Alternating current circuit-breakers with intentionally non-simultaneous pole operation

Appareillage à haute tension –
Partie 302: Disjoncteurs à courant alternatif à fonctionnement intentionnellement non simultané des pôles

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CONTENTS

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Part 302: Alternating current circuit-breakers with intentionally non-simultaneous pole operation

FOREWORD

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IEC 62271-302, which is a technical report, has been prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

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

Enquiry draft	Report on voting
17A/888/DTR	17A/909/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.

This standard is to be read in conjunction with IEC 62271-100:2008, to which it refers and which is applicable, unless otherwise specified. In order to simplify the indication of corresponding requirements, the same numbering of clauses and subclauses is used as in IEC 62271-100. Amendments to these clauses and subclauses are given under the same references, whilst additional subclauses are numbered from 101.

The committee has decided that the contents of this publication will remain unchanged until the stability 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

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- replaced by a revised edition, or
- amended.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 302: Alternating current circuit-breakers with intentionally non-simultaneous pole operation

1 General

Clause 1 of IEC 62271-100 is applicable with the following modifications.

1.1 Scope

This part of IEC 62271 provides guidance on the design, construction, specification and testing of circuit-breakers with intentional non-simultaneous pole operation which are excluded from the scope of IEC 62271-100. In all other respects the scope of this technical report is identical to that of IEC 62271-100. This technical report provides supplementary information and guidance for this type of circuit-breaker and is intended to be used in conjunction with IEC 62271-100.

Intentional non-simultaneous pole operation may be implemented by mechanical or electrical means and both methods are within the scope of this technical report. Where the implementation is by purely electrical means, for example for independent pole operated circuit-breakers, adequate precautions should be taken in the application to prevent operation outside the proven capability of the circuit-breaker.

Circuit-breakers with intentional non-simultaneous pole operation are mainly used for the implementation of controlled switching, and this technical report primarily addresses the requirements of circuit-breakers for such applications. More detailed information regarding the use of controlled switching can be found in CIGRE Technical Brochures 262 [1][1)], 263 [2] and 264 [3]. Requirements for associated protection and/or control facilities are not covered unless these form an integral part of the circuit-breaker.

This technical report considers two basic system configurations for achieving non-simultaneous operation:

- a circuit-breaker intended for non-simultaneous operation which is supplied and tested independent from any particular controller;
- a circuit-breaker intended for non-simultaneous operation with a dedicated controller (which may be integrated into the circuit-breaker) and necessary sensors and auxiliary equipment which form part of the tested equipment.

The basic requirements in each case are identical, however the interpretation of the test results depends upon whether the intended controller is included in the test programme. Further details on this aspect are incorporated into Clause 6 of this technical report.

For the purposes of this technical report, it has been assumed that there is no significant interaction between the effects of the various parameters (for example ambient temperature, control voltage etc) which are considered to affect the mechanical performance of the circuit-breaker. This has not been proven for all combinations however service experience with controlled switching suggests this assumption is valid in practice for most commonly used drive technologies. Annex F provides some examples in support of this assumption.

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1) Figures in square brackets refer to the bibliography.

1.2 Normative references

No normative references are made in this technical report. The normative references of IEC 62271-100 apply and are used as necessary to supplement the guidance presented herein.

2 Normal and special service conditions

Clause 2 of IEC 62271-100 is applicable.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-100 as well as the following terms and definitions apply.

3.1 General terms

3.1.1
idle time
time between consecutive operations (either close or open) of a circuit-breaker during which the circuit-breaker remains static

3.1.2
compensation
predictive correction for changes in operating time taking account of ambient, drive and supply conditions

3.1.3
adaption
correction for changes in operating time based on past operating pattern

3.2 Assemblies

3.2.1
controlled switching system
combination of circuit-breaker, controller and necessary sensors and auxiliary equipment required to achieve controlled switching

NOTE Necessary sensors refers to those required to provide inputs to the controlled system and may include voltage transformers, current transformers, temperature sensors etc.

3.3 Parts of assemblies

No particular definitions.

3.4 Switching devices

No particular definitions.

3.5 Parts of circuit-breakers

No particular definitions.

3.6 Operation

3.6.1
controlled switching
operation of a switching device at a specific, pre-determined point in relation to the power frequency current or voltage

NOTE The terms point-on-wave switching and point-on-cycle switching are also in widespread use to describe controlled switching.

3.6.2
intentional non-simultaneous pole operation
operation of a circuit-breaker with a specific, pre-determined time delay or delays between the operation of the individual poles

NOTE Non-simultaneity is typically measured and expressed in milliseconds or electrical degrees with relation to the first pole to operate e.g. 0 ms, 0 ms, 5 ms or 0°, 0°, 90°.

3.6.3
mechanically staggered circuit-breaker
circuit-breaker with fixed, mechanically implemented, non-simultaneous pole operation

3.7 Characteristic quantities

When interpreting definition 3.7.133 (opening time), 3.7.136 (closing time) and 3.7.137 (make time) of IEC 62271-100, delays introduced by controlled switching equipment are excluded from the assessment of these quantities.

3.7.1
opening time (IEC 62271-100, 3.7.133 modified)
opening time of a circuit-breaker defined according to the tripping method as stated below and with any time delay device forming an integral part of the circuit-breaker adjusted to its minimum setting:

a) for a circuit-breaker tripped by any form of auxiliary power, the interval of time between the instant of energising the opening release, the circuit-breaker being in the closed position, and the instant when the arcing contacts have separated in all poles;

b) for a self-tripping circuit-breaker, the interval of time between the instant at which, the circuit-breaker being in the closed position, the current in the main circuit reaches the operating value of the overcurrent release and the instant when the arcing contacts have separated in all poles.

NOTE 1 The opening time may vary with the breaking current

NOTE 2 For circuit-breakers with more than one interrupting unit per pole, the instant when the arcing contacts have separated in all poles is determined as the instant of contact separation in the first unit of the last pole.

NOTE 3 The opening time includes the operating time of any auxiliary equipment necessary to open the circuit-breaker and forming an integral part of the circuit-breaker. Delays introduced by controlled switching equipment are excluded from the opening time.

NOTE 4 For circuit-breakers with mechanically staggered poles separate opening times should be quoted for each pole.

3.7.2
closing time
interval of time between energising the closing circuit, the circuit-breaker being in the open position, and the instant when the contacts touch in all poles

NOTE 1 The closing time includes the operating time of any auxiliary equipment necessary to close the circuit-breaker and forming an integral part of the circuit-breaker. Delays introduced by controlled switching equipment are excluded from the closing time.

NOTE 2 For circuit-breakers with mechanically staggered poles separate closing times should be quoted for each pole.

[IEC 62271-100, definition 3.7.136, modified]

3.7.3
make time
interval of time between energising the closing circuit, the circuit-breaker being in the open position, and the instant when the current begins to flow in the first pole

NOTE 1 The make time includes the operating time of any auxiliary equipment necessary to close the circuit-breaker and forming an integral part of the circuit-breaker. Delays introduced by controlled switching equipment are excluded from the make time.

NOTE 2 The make time may vary, for example due to the variation of the pre-arcing time.

[IEC 62271-100, definition 3.7.137, modified]

3.7.4
mechanical scatter
random statistical variation of the mechanical operating time of a circuit-breaker excluding the influence of external variables and the effect of long term wear and/or drift

NOTE For the purposes of this definition the term “external variables” includes all variables which might have a systematic effect on the operating time for example ambient temperature, operating pressure, control voltage.

3.7.5
rate-of-decay of dielectric strength (RDDS)
voltage withstand reduction as a function of time or contact gap during closing of a circuit-breaker

3.7.6
rate-of-rise of dielectric strength (RRDS)
voltage withstand increase as a function of time or contact gap during opening of a circuit-breaker

3.7.7
target point for closing
prospective instant of contact touch during a controlled closing operation

3.7.8
target point for making
prospective instant of current initiation during a controlled closing operation

3.7.9
target point for opening
prospective instant of contact separation during a controlled opening operation

3.7.10
making window
time interval around the target point for making

NOTE Making within a correctly chosen making window will lead to a pre-determined making voltage. For practical values of RDDS, the centre of the making window may not correspond to the target point for making.

3.7.11
closing window
time interval around the target point for closing

3.7.12
making voltage
voltage at which current is initiated during the close operation of a circuit-breaker

3.7.13
delta c, auxiliary (Δc_{aux})
time difference between the operation of the arcing contact and the operation of an auxiliary contact

4 Ratings

Clause 4 of IEC 62271-100 is applicable with the following addition.

Rated characteristics to be given for circuit-breakers for operation with intentionally non-simultaneous poles

a) Rated making window

4.101 Rated making window of a circuit-breaker

The rated making window of a circuit-breaker is the making window that can be achieved reliably by the given circuit-breaker for a particular switching condition and over the full range of specified service conditions and the full range of specified drive and auxiliary supply conditions.

Preferred values are 2 ms, 3 ms and 4 ms.

The rated making window of a circuit-breaker is defined assuming proper compensation for systematic variables such as the effects of ambient temperature and control voltage.

The rated making window assessed in this way is an indication of the best controlled switching performance that can reliably be achieved with the given circuit-breaker. Service performance will also be affected by the performance of the associated control and compensation equipment.

4.102 Rated short-circuit making current

The following guidance should be used to supplement Subclause 4.103 of IEC 62271-100.

Circuit-breakers intended for non-simultaneous pole closure in non-effectively earthed neutral systems may, in the event of closing onto a three-phase fault, experience higher peak making conditions in comparison with the simultaneous closure case. The rated short-circuit making current should be defined taking into account the non-simultaneity.

As an example, the conditions associated with voltage zero closing in a non-effectively earthed neutral system are detailed in Table 1. The targeting angles are 0, 0 and +90 electrical degrees (hereafter referred to as °) for the three poles. In this case the short-circuit making rating of the circuit-breaker designed for non-simultaneous closing should be chosen from Table 1 taking into account the rated frequency and the specified dc time constant.

Table 1 – Required short-circuit peak making current factors for circuit-breakers with non-simultaneous pole closure for use in non-effectively earthed neutral systems

X/*R* value		Time constant (ms)	Peak making factor	
50 Hz	60 Hz		50 Hz	60 Hz
14	17	45	3,0	3,0
19	23	60	3,0	3,1
24	28	75	3,1	3,1
38	45	120	3,2	3,2

NOTE 1 For circuit-breakers intended to be used for voltage zero closing in effectively earthed neutral systems no enhanced making current will exist however full asymmetry will be developed in each phase when closing onto a pre-existing fault.

NOTE 2 Equipment connected in series with the circuit-breaker will also be exposed to enhanced peak currents if they occur.

5 Design and construction

Clause 5 of IEC 62271-100 is applicable with the additions indicated below.

5.1 Requirements for liquids in circuit-breakers

Subclause 5.1 of IEC 62271-100 is applicable.

5.2 Requirements for gases in circuit-breakers

Subclause 5.2 of IEC 62271-100 is applicable.

5.3 Earthing of circuit-breakers

Subclause 5.3 of IEC 62271-100 is applicable.

5.4 Auxiliary equipment

Subclause 5.4 of IEC 62271-100 is applicable with the following addition:

Any auxiliary equipment incorporated for the purposes of controlled closing should not compromise the operation of the anti-pumping functionality.

5.5 Dependent power closing

Subclause 5.5 of IEC 62271-100 is applicable.

5.6 Stored energy closing

Subclause 5.6 of IEC 62271-100 is applicable.

5.7 Independent manual operation

Subclause 5.7 of IEC 62271-100 is applicable with the following addition:

NOTE Circuit-breakers tested in accordance with this report and intended to be used with a controller should be able to operate on an occasional basis without suffering damage under conditions where the controller is bypassed i.e. uncontrolled operations. However, such operations may have unacceptable power system implications.