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High-voltage switchgear and controlgear – Part 101: Synthetic testing

Appareillage à haute tension – Partie 101: Essais synthétiques

IEC 62271-101:2006+A1:2010

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 101: Synthetic testing

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This consolidated version of IEC 62271-101 consists of the first edition (2006) [documents 17A/753/FDIS and 17A/755/RVD] and its amendment 1 (2010) [documents 17A/907/FDIS and 17A/919/RVD]. It bears the edition number 1.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 62271-101 has been prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This publication shall be read in conjunction with IEC 62271-100. The numbering of the subclauses of Clause 6 is the same as in IEC 62271-100. However, not all subclauses of IEC 62271-100 are addressed; merely those where synthetic testing has introduced changes.

The IEC 62271-100 series consists of the following parts, under the general title *High-voltage switchgear and controlgear:*[1]

Part 100: High-voltage alternating-current circuit-breakers

Part 101: Synthetic testing

Part 102: Alternating current disconnectors and earthing switches

Part 104: Alternating current switches for rated voltages of 52 kV and above

Part 105: Alternating current switch-fuse combinations

Part 107: Alternating current fused circuit-switchers for rated voltages above 1 kV up to and including 52 kV

Part 108: High voltage alternating current disconnecting circuit-breakers for rated voltages of 72,5 kV and above

Part 109: Alternating-current series capacitor by-pass switches

Part 110: Inductive load switching

A list of the other parts belonging to the IEC 62271 series can be found on the IEC website http://www.iec.ch. Further information is available on http://tc17.iec.ch.

The committee has decided that the contents of the base publication and its amendments 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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[1] Some of these parts are still in the process of being developed.

INTRODUCTION
(to amendment 1)

This amendment cancels and replaces IEC 61633.

The original edition of IEC 62271-101 (2006) makes extensive reference to IEC 62271-100:2001. Since then, a new edition of IEC 62271-100 has been published (2008). Within this amendment, references are made to IEC 62271-100:2008. Unless they are explicitly mentioned in this amendment, all of the references in the original edition of IEC 62271-101 (2006) still make reference to IEC 62271-100:2001. A second amendment to IEC 62271-101, which will update all cross-references to the new IEC 62271-100:2008, is under consideration.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 101: Synthetic testing

1 Scope

This part of IEC 62271 mainly applies to a.c. circuit-breakers within the scope of IEC 62271-100. It provides the general rules for testing a.c. circuit-breakers, for making and breaking capacities over the range of test duties described in 6.102 to 6.111 of IEC 62271-100, by synthetic methods.

NOTE Circuits for the test duties described in 6.111 have not yet been standardized. However, present methods are given in Annex G.

It has been proven that synthetic testing is an economical and technically correct way to test high-voltage a.c. circuit-breakers according to the requirements of IEC 62271-100 and that it is equivalent to direct testing.

The methods and techniques described are those in general use. The purpose of this standard is to establish criteria for synthetic testing and for the proper evaluation of results. Such criteria will establish the validity of the test method without imposing restraints on innovation of test circuitry.

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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 61633:1995, *High-voltage alternating current circuit-breakers – Guide for short-circuit and switching test procedures for metal-enclosed and dead tank circuit-breakers*~~

IEC 62271-100:~~2001~~ 2008, *High-voltage switchgear and controlgear – Part 100: ~~High-voltage~~ Alternating current circuit-breakers* [2]

IEC 62271-308:2002, *High-voltage switchgear and controlgear – Part 308: Guide for asymmetrical short-circuit test duty T100a*

3 Terms and definitions

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

3.1
direct test
test in which the applied voltage, the current and the transient and power-frequency recovery voltages are all obtained from a circuit having a single-power source, which may be a power system or special alternators as used in short-circuit testing stations or a combination of both

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2 Unless explicitly otherwise mentioned, all of the references to IEC 62271-100 make reference to IEC 62271-100:2001. A second amendment to IEC 62271-101, which will update all cross-references to the new IEC 62271-100:2008, is under consideration.

3.2
synthetic test
test in which all of the current, or a major portion of it, is obtained from one source (current circuit), and in which the applied voltage and/or the recovery voltages (transient and power frequency) are obtained wholly or in part from one or more separate sources (voltage circuits)

3.3
test circuit-breaker
circuit-breaker under test (see 6.102.2 of IEC 62271-100:2001)

3.4
auxiliary circuit-breaker(s)
circuit-breaker(s) forming part of a synthetic test circuit used to put the test circuit-breaker into the required relation with various circuits

3.5
current circuit
that part of the synthetic test circuit from which all or the major part of the power-frequency current is obtained

3.6
voltage circuit
that part of the synthetic test circuit from which all or the major part of the applied voltage and/or recovery voltage is obtained

3.7
prospective current (of a circuit and with respect to a circuit-breaker)
current that would flow in the circuit if each pole of the test and auxiliary circuit-breakers were replaced by a conductor of negligible impedance

[IEV 441-17-01, modified]

3.8
actual current
current through the test circuit-breaker (prospective current modified by the arc voltage of the test and auxiliary circuit-breakers)

3.9
distortion current
calculated current equal to the difference between the prospective current and the actual current

3.10
post-arc current
current which flows through the arc gap of a circuit-breaker when the current and arc voltage have fallen to zero and the transient recovery voltage has begun to rise

3.11
current-injection method
synthetic test method in which the voltage circuit is applied to the test circuit-breaker before power-frequency current zero

3.12
initial transient making current
ITMC
transient current which flows through the circuit-breaker at the moment of voltage breakdown prior to the initiation of current from the current circuit during making

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3.13
injected current
current supplied by the voltage circuit of a current injection circuit when it is connected to the circuit-breaker under test

3.14
voltage-injection method
synthetic test method in which the voltage circuit is applied to the test circuit-breaker after power frequency current zero

3.15
reference system conditions
conditions of an electrical system having the parameters from which the rated and test values of IEC 62271-100 are derived

3.16
time delay of making device
t_m
time interval, during synthetic making test, between the instant of breakdown of the applied voltage and the initiation of current from the current circuit

3.17
minimum clearing time
sum of the minimum opening time, minimum relay time (½ cycle), and the minimum arcing time for the minor loop of the first-pole-to-clear, during test duty T100a only, as declared by the manufacturer. This definition should be used only for the determination of the test parameters for test duty T100a.

NOTE 1 The minimum clearing time obtained during the tests should not be lower than the value declared by the manufacturer. Prior to the tests, the minimum opening time should be measured at maximum trip coil voltage maximum pressure for operation and minimum pressure for interruption. If the minimum opening time measured prior to the tests is lower than the one declared by the manufacturer, this lower value should be used for the determination of the required test parameters.

NOTE 2 This definition assumes that the minimum clearing time obtained with the minimum pressure for interruption is similar to the one that would be obtained with the maximum pressure for interruption. Normally, the minimum clearing time is obtained with the maximum pressure for interruption. If such pressure condition is giving a minimum clearing time such that the minimum clearing time range applicable (as given in Tables 1a to 2d of IEC 62271-308:2002) for tests is different than the one obtained at minimum pressure for interruption, then it is permissible to verify the minimum clearing time by using the maximum pressure for interruption.

3.18
pre-strike
voltage breakdown between the contacts during a making operation which initiates current flow

4 Synthetic testing techniques and methods for short-circuit breaking tests

4.1 Basic principles and general requirements for synthetic breaking test methods

Any particular synthetic method chosen for testing shall adequately stress the test circuit-breaker. Generally, the adequacy is established when the test method meets the requirements set forth in the following subclauses.

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A circuit-breaker has two basic positions: closed and open. In the closed position a circuit-breaker conducts full current with negligible voltage drop across its contacts. In the open position it conducts negligible current but with full voltage across the contacts. This defines the two main stresses, the current stress and the voltage stress, which are separated in time.

If closer attention is paid to the voltage and current stresses during the interrupting process (Figure 1), three main intervals can be recognized:

– High-current interval

  The high-current interval is the time from contact separation to the start of the significant change in arc voltage. The high-current interval precedes the interaction and high-voltage intervals.

– Interaction interval

  The interaction interval is the time from the start of the significant change in arc voltage prior to current zero to the time when the current including the post-arc current, if any, ceases to flow through the test circuit-breaker (see also Clause B.2).

– High-voltage interval

  The high-voltage interval is the time from the moment when the current including the post-arc current, if any, ceases to flow through the test circuit-breaker to the end of the test.

4.1.1 High-current interval

During the high-current interval the test circuit-breaker shall be stressed by the test circuit in such a way that the starting conditions for the interaction interval, within tolerances to be specified, are the same as under reference system conditions.

In synthetic test circuits the ratio of the power-frequency voltage of the current circuit to the arc voltage is low in comparison with tests at reference system conditions due to:

– the voltage of the current circuit being a fraction of the system voltage;

– the fact that the arc voltages of the test circuit-breaker and of the auxiliary circuit-breaker are added.

As a result the duration of the current loop and the peak value of the current will be reduced. This distortion of the current is outlined in Annex A.

Considerations with respect to the arc energy released in the test circuit-breaker lead to a maximum permissible influence in terms of tolerances on two characteristic values of the shape of the current, i.e. current-peak value and current-loop duration (see Annex A).

The tolerance on the amplitude and the power frequency of the prospective breaking current is given in 6.103.2 and 6.104.3 of IEC 62271-100. Therefore, the following conditions concerning the actual current through the test circuit-breaker shall be met:

– for symmetrical testing the current amplitude and final loop duration shall not be less than 90 % of the required values based on rated current;

– for asymmetrical testing, the current amplitude and final loop duration shall be between 90 % and 110 % of the required values, based on rated current and time constant (see Tables ~~I.1a to I.2d~~ 15 through 22 of IEC 62271-100:2008).

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