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INTERNATIONAL STANDARD

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colour inside

AMENDMENT 2
AMENDEMENT 2

High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers

Appareillage à haute tension – Partie 100: Disjoncteurs à courant alternatif

IEC 62271-100:2008-04/AMD2:2017-06(en-fr)

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High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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FOREWORD

This amendment has been prepared by subcommittee 17A: Switching devices, of IEC technical committee 17: High-voltage switchgear and controlgear.

The text of this amendment is based on the following documents:

FDIS	Report on voting
17A/1135/FDIS	17A/1139/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this amendment and the base 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of January 2018 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION to the Amendment

This amendment includes the following significant technical changes:

– the rated TRV has been replaced by a rated first-pole-to-clear factor;

– the rated time quantities have been moved to Clause 5 (Design and construction) and are no longer ratings. The determination of the break time has been moved to IEC 62271-306;

– the number of test specimens has been removed;

– new test procedure for test-duty T100a;

– TRVs for circuit-breakers having a rated voltage of 52 kV and below used in effectively earthed neutral systems have been added;

– 6.111 (capacitive current switching) has been rewritten;

– a number of informative annexes have been moved to IEC TR 62271-306.

_____

1.1 Scope

Add, after the third existing paragraph, the following paragraph:

This standard only covers direct testing.

1.2 Normative references

Replace, in the existing list, the reference to IEC 60137 by the following new reference:

IEC 60137:2008, *Insulated bushings for alternating voltages above 1 000 V*

Add, to the existing list, the following reference:

IEC 60270, *High-voltage test techniques – Partial discharge measurements*

3 Terms and definitions

3.1.132
cable system

*Replace the existing references to "*Table 1*" (2 occurrences) to "*Tables 24 and 44*".*

3.1.133
line system

Replace the existing definition by the following new definition, without modifying the notes.

system in which the TRV during breaking of terminal fault at 100 % of short-circuit breaking current does not exceed the two-parameter envelope derived from Tables 25 and 45 of this standard

Add, after the existing definition 3.1.133, the following new terms and definitions:

3.1.134
belted cable
multi-conductor cable in which part of the insulation is applied to each conductor individually, and the remainder is applied over the assembled cores

[IEV 461-06-11]

3.1.135
individually screened cable
radial field cable
cable in which each core is covered with an individual screen

[IEV 461-06-12]

3.4.120
circuit-breaker class S2

Replace the existing definition by the following new definition:

circuit-breaker used in a line-system

Add, after definition 3.4.120, the following new term and definition:

3.4.121
current chopping
current interruption prior to the natural power frequency current zero of the circuit connected

3.7.133
opening time

Replace the existing term, definition and notes as follows:

opening time (of a mechanical switching device)

[IEV 441-17-36]

3.7.134
arcing time (of a multipole switching device)

Replace the existing term, definition and source as follows:

arcing time (of a pole)
interval of time between the instant of the initiation of an arc in a pole and the instant of final arc extinction in that pole

[IEV 441-17-37]

3.7.135
break-time

Replace the existing definition by the following:

interval of time between the beginning of the opening time of a mechanical switching device and the end of the total arcing time

[IEV 441-17-39, modified]

3.7.136
closing time

Add, after the existing definition, the following new source:

[IEV 441-17-41, modified]

3.7.137
make time

Replace the source of the definition as follows:

[IEV 441-17-40, modified]

3.7.140
dead time (during auto-reclosing)

Add, after the existing note, the following source:

[IEV 441-17-44, modified]

3.7.144
make-break time

Replace the existing definition together with the notes by the following:

interval of time between the initiation of current flow in the first pole during a closing operation and the end of the total arcing time during the subsequent opening operation

[IEV 441-17-43, modified]

3.7.159
minimum clearing time

Replace the definition and note as follows:

sum of the minimum opening time, minimum relay time (0,5 cycle) and the shortest arcing time of a minor loop interruption in the phase with intermediate asymmetry that starts with a minor loop at short-circuit current initiation

NOTE 1 This definition is applicable only for the determination of the test parameters during short-circuit breaking tests according to test duty T100a.

NOTE 2 For testing purposes the minimum arcing time found during test-duty T100s is used.

Add, after the existing definition 3.7.160 added by Amendment 1, the following new terms and definitions:

3.7.161
initiation of (opening or closing) operation
instant of receipt of command for operation at the control circuit

3.7.162
total arcing time
interval of time between the instant of the first initiation of an arc in a pole and the instant of arc extinction in all poles

3.7.163
direct connection to an overhead line
connection between a circuit-breaker and an overhead line having a capacitance less than 5 nF

NOTE When the cable capacitance per unit length is 0,3 nF/m, it corresponds to a length of cable shorter than approximately 17 m. For further information see IEC TR 62271-306.

3.8 Index of definitions

Add, to the existing alphabetical list, the following new lines:

4 Ratings

Replace item l) by the following new item:

l) rated first-pole-to-clear factor;

Replace the existing item o) by the following new item:

o) void.

Replace item q) by the following new item:

q) rated line-charging breaking current, for circuit-breakers switching overhead transmission lines (mandatory for circuit-breakers of rated voltages above 52 kV and circuit-breakers of class S2);

Delete the existing item r) from the end of the second existing list, and place it at the beginning of the third existing list before item s).

4.10 Rated pressures of compressed gas supply for insulation, operation and/or interruption

Replace the title by the following:

4.10 Rated pressure of compressed gas supply for controlled pressure systems

Add, between subclauses 4.10 and 4.101, the following new subclause 4.11:

4.11 Rated filling levels for insulation and/or operation

Subclause 4.11 of IEC 62271-1 is applicable.

4.101 Rated short-circuit breaking current (I_{sc})

Replace, in the first paragraph, "4.102" *by* "6.104.5.1" *and* "4.105" *by* "6.109.3".

4.102 Transient recovery voltage related to the rated short-circuit breaking current

Replace the complete subclause modified by Amendment 1 including Tables 1 to 7 by the following:

4.102 Rated first-pole-to-clear factor

The first-pole-to-clear factor (k_{pp}) is a function of the earthing of the system neutral. The rated values of k_{pp} are:

– 1,2 for terminal fault breaking by circuit-breakers with rated voltages higher than 800 kV in effectively earthed neutral systems;

– 1,3 for terminal fault breaking by circuit-breakers for rated voltages up to and including 800 kV in effectively earthed neutral systems;

– 1,5 for terminal fault breaking by circuit-breakers for rated voltages less than 245 kV in non-effectively earthed neutral systems.

In this standard, it is considered that circuit-breakers with rated voltages up to and including 170 kV can be either in effectively earthed neutral systems or in non-effectively earthed neutral systems. Circuit-breakers with rated voltages higher than 170 kV are in effectively-earthed systems.

NOTE The following associated first-pole-to-clear factors for out-of-phase conditions are not ratings:

– 2,0 for breaking in out-of-phase conditions in systems with effectively earthed neutral;

– 2,5 for breaking in out-of-phase conditions in systems with non-effectively earthed neutral.

4.105 Characteristics for short-line faults

Replace the title and text modified by Amendment 1 of the complete subclause, including Table 8, by the following:

4.105 Short-line fault breaking capability

A short-line fault breaking capability is required for circuit-breakers with a rated short-circuit breaking current exceeding 12,5 kA for direct connection to overhead lines.

4.106 Rated out-of-phase making and breaking current

Replace the existing text by the following:

The rated out-of-phase breaking current is the maximum out-of-phase current that the circuit-breaker shall be capable of breaking under the conditions of use and behaviour prescribed in this standard in a circuit having a recovery voltage as specified below.

The specification of a rated out-of-phase making and breaking current is not mandatory.

If a rated out-of-phase breaking current is assigned, the rated out-of-phase breaking current shall be 25 % of the rated short-circuit breaking current and the rated out-of-phase making current shall be the crest value of the rated out-of-phase breaking current, unless otherwise specified.

The standard conditions of use with respect to the rated out-of-phase making and breaking current are as follows:

– opening and closing operations carried out in conformity with the instructions given by the manufacturer for the operation and proper use of the circuit-breaker and its auxiliary equipment;
– earthing condition of the neutral for the power system corresponding to that for which the circuit-breaker has been tested;
– absence of a fault on either side of the circuit-breaker.

4.107.1 Rated line-charging breaking current

Replace the text by the following:

The rated line-charging breaking current is the line-charging current up to which the circuit-breaker shall be capable of breaking at its rated voltage under the conditions of use and behaviour prescribed in this standard. The associated restrike class (C1 or C2) shall be assigned when a line-charging breaking current is assigned.

4.107.2 Rated cable-charging breaking current

Replace the text by the following:

The rated cable-charging breaking current is the cable-charging current up to which the circuit-breaker shall be capable of breaking at its rated voltage under the conditions of use and behaviour prescribed in this standard. The associated restrike class (C1 or C2) shall be assigned when a cable-charging breaking current is assigned.

4.107.3 Rated single capacitor bank breaking current

Replace the first paragraph by the following:

The rated single capacitor bank breaking current is the single capacitor bank breaking current up to which the circuit-breaker shall be capable of breaking at its rated voltage under the conditions of use and behaviour prescribed in this standard. This breaking current refers to the switching of a shunt capacitor bank where no shunt capacitors are connected to the source side of the circuit-breaker. The associated restrike class (C1 or C2) shall be assigned when a single capacitor bank breaking current is assigned.

Table 9 – Preferred values of rated capacitive switching currents

*In NOTE 2 to the table replace "*Annex H*" by "*IEC TR 62271-306*".*

4.107.4 Rated back-to-back capacitor bank breaking current

Replace the first paragraph by the following:

The rated back-to-back capacitor bank breaking current is the back-to-back capacitor bank current up to which the circuit-breaker shall be capable of breaking at its rated voltage under the conditions of use and behaviour prescribed in this standard. The associated restrike class (C1 or C2) shall be assigned when a back-to-back capacitor bank breaking current is assigned.

4.107.6 Rated back-to-back capacitor bank inrush making current

Replace the existing text by the following:

The rated back-to-back capacitor bank inrush making current is the peak value of the current that the circuit-breaker shall be capable of making at its rated voltage and with a frequency of the inrush current during a simultaneous three-phase making operation (see Table 9).

4.109 Rated time quantities

Replace the title and text of the subclause, including 4.109.1 modified by Amendment 1, by the following:

4.109 Void.

Delete the entire subclause and title, including 4.109.1 modified by Amendment 1.

5.4 Auxiliary equipment

*Delete, in the second dashed paragraph and in Note 2 the word "*rated*".*

5.5 Dependent power closing

Replace the title by the following:

5.5 Dependent power operation

5.6 Stored energy closing

Replace the title by the following:

5.6 Stored energy operation

5.7 Independent manual operation

Replace the title by the following:

5.7 Independent manual or power operation

5.101 Requirements for simultaneity of poles during single closing and single opening operations

Replace the entire text of this subclause by the following:

The following requirements are applicable under rated conditions of the auxiliary and control voltage and pressure for operation:

– The maximum difference between the instants of contacts touching during closing in the individual poles shall not exceed a quarter of a cycle of rated frequency. If one pole consists of more than one interrupter unit connected in series, the maximum difference between the instants of contacts touching within these series connected interrupter units shall not exceed one sixth of a cycle of rated frequency. Where closing resistors are used, the maximum difference between the instants of contacts touching during closing in the individual closing resistors shall not exceed one half cycle of rated frequency. If on one pole more than one individual closing resistor is used, each assigned to one of the interrupter units which are connected in series, the maximum difference between the instants of contacts touching within these series connected closing resistors shall not exceed one third of a cycle of rated frequency;
– The maximum difference between the instants of contacts separating during opening shall not exceed one sixth of a cycle of rated frequency. If one pole consists of more than one interrupter unit connected in series, the maximum difference between the instants of contact separation within these series connected interrupter units shall not exceed one eighth of a cycle of rated frequency.

NOTE For a circuit-breaker having separate poles, the requirement is applicable when these operate in the same conditions; after a single-pole reclosing operation the conditions of operation for the three mechanisms may not be the same.

Add, after 5.104, the new subclauses and the new table as follows:

5.105 Time quantities

Refer to Figures 1, 2, 3, 4, 5, 6 and 7.

Values may be assigned to the following time quantities:

– opening time (no-load);
– break-time;
– closing time (no-load);
– open-close time (no-load);
– reclosing time (no-load);
– close-open time (no-load);
– pre-insertion time (no-load).

Time quantities are based on

– rated supply voltages of closing and opening devices and of auxiliary and control circuits (see 4.8);
– rated supply frequency of closing and opening devices and of auxiliary circuits (see 4.9);
– rated pressure of compressed gas supply for controlled pressure systems (see 4.10);
– rated filling levels for insulation and/or operation (see 4.11);
– an ambient air temperature of 20 °C ± 5 °C.

NOTE 1 It is not practical to assign a value of make-time or of make-break time due to the variation of the arcing time and the pre-arcing time.

NOTE 2 The break-time is determined using the calculation method given in IEC TR 62271-306 [4].

5.106 Static mechanical loads

Outdoor circuit-breakers shall be designed to withstand and operate correctly when mechanically loaded by stresses resulting from ice, wind and connected conductors. If required, this capability is demonstrated by means of calculations.

Ice coating and wind pressure on the circuit-breaker shall be in accordance with 2.1.2 of IEC 62271-1.

Some examples of static forces due to wind, ice and weight on flexible and tubular connected conductors are given as a guidance in Table 14.

The tensile force due to the connected conductors is assumed to act at the outermost end of the circuit-breaker terminal.

The manufacturer shall consider that these forces can be applied simultaneously.

Table 14 – Examples of static horizontal and vertical forces for static terminal load test

Rated voltage range	Rated current range	Static horizontal force F_{th}		Static vertical force
		Longitudinal F_{thA}	Transversal F_{thB}	F_{tv}
U_r	I_r			
kV	A	N	N	N
< 100	800 to 1 250	500	400	500
< 100	1 600 to 2 500	750	500	750
100 to 170	1 250 to 2 000	1 000	750	750
100 to 170	2 500 to 4 000	1 250	750	1 000
245 to 362	1 600 to 4 000	1 250	1 000	1 250
420 to 800	2 000 to 4 000	1 750	1 250	1 500
1 100 to 1 200	4 000 to 6 300	3 500	3 000	2 500

6 Type tests

Move the text currently under 6 (including Table 11 modified by Amendment 1) between 6.1 and 6.1.1.

*Delete, in the second paragraph, the second sentence "*The number of test samples...*".*

*Replace the fifth paragraph starting with "*The uncertainty.....*" and the note by the following:*

The expanded uncertainty of a complete measuring system for determination of the ratings (for example short-circuit current, applied voltage and recovery voltage) shall be ≤ 5 %, evaluated with a coverage probability of 95 % corresponding to a coverage factor k = 2 under the assumption of a normal distribution.

NOTE Procedures for the determination of the uncertainty of measurements are given in ISO/IEC Guide 98-3 [6].

Add, before Table 11 modified by Amendment 1, the following paragraph:

If the circuit-breaker can be equipped with other operating mechanisms, complete type tests according to Table 11 shall be performed on the circuit-breaker equipped with one type of operating mechanism. The other operating mechanisms are considered being alternative operating mechanisms as defined in 3.5.126, provided they fulfil the related requirements as defined in 6.102.7. Tests to be repeated for alternative mechanisms are defined in 6.1.102.

Table 11 – Type tests

Replace the table, modified by Amendment 1, by the following:

Mandatory type tests	Subclauses
Dielectric tests	6.2
Measurement of the resistance of the main circuit	6.4
Temperature-rise tests	6.5
Short-time withstand current and peak withstand current tests	6.6
Additional tests on auxiliary and control circuits	6.10
Mechanical operation test at ambient temperature (class M1)	6.101.2.1 to 6.101.2.3
Short-circuit current making and breaking tests	6.102 to 6.106

Type tests depending on requirements	Condition requiring type test	Subclauses
Radio interference voltage tests	$U_r \geq 245$ kV	6.3
Verification of the degree of protection	Assigned IP class	6.7
Tightness test	Controlled, sealed or closed pressure systems	6.8
EMC tests	Electronic equipment or components are included in the secondary system	6.9
X-ray radiation test	Vacuum circuit-breaker	6.11
Extended mechanical endurance tests on circuit-breakers for special service conditions	Class M2 rating assigned	6.101.2.4
Low and high temperature tests	As required	6.101.3
Humidity test	Insulation subject to voltage stress and condensation	6.101.4
Critical current tests	Circuit-breaker performance against conditions in 6.107.1	6.107
Short-line fault tests	$U_r \geq 15$kV and $I_{sc} > 12{,}5$ kA, in case of direct connection to overhead lines	6.109
Out-of-phase making and breaking tests	Out-of-phase rating assigned	6.110
Electrical endurance tests (only for $U_r \leq 52$kV)	Class E2 rating assigned	6.112
Test to prove operation under severe ice conditions	Outdoor circuit-breakers with moving external parts and ice thickness 10 mm / 20mm	6.101.5
Single-phase fault test	Effectively earthed neutral systems	6.108
Double earth fault test	Non-effectively earthed neutral systems	
Capacitive current switching tests: – line-charging current breaking tests – cable-charging current breaking tests – single capacitor bank switching tests – back-to-back capacitor bank switching tests	Relevant rating and classification (C1 or C2) assigned	6.111
Switching of shunt reactors and motors	As specified	IEC 62271-110
Mandatory type tests, shown in the upper part of the table, are required for all circuit-breakers regardless of rated voltage, design or intended use. Other type tests, shown in the lower part of the table, are required for all circuit-breakers where the associated rating is specified, e.g. out-of-phase switching, or where a specific condition is met, for example RIV is required only for rated voltages of 245 kV and above.		

Add, after Table 12, the following new subclause:

6.1.102 Type tests to repeat for circuit-breakers with alternative operating mechanisms

The following type tests shall be repeated on circuit-breakers with alternative operating mechanisms:

– mechanical operation tests at ambient temperature (according to 6.101.2);
– high and low temperature tests (according to 6.101.3);
– short-circuit making and breaking tests (as defined in 6.102.7);

– short-time withstand current and peak withstand current tests on circuit-breakers having main contacts of the butt type (according to 6.6).

6.2.11 Voltage test as a condition check

*Add, after the paragraph that starts with "*Where after mechanical or environmental tests…*" added by Amendment 1, the following sentences:*

For multi-unit live tank circuit-breakers with identical units according to 6.102.4.2.3 the voltage test as a condition check may be performed as unit test.

Add, after 6.10.5, the following new subclauses:

6.10.6 Dielectric test

Subclause 6.10.6 of IEC 62271-1 is applicable with the following addition:

– the dielectric test shall be performed on the auxiliary and control circuits in new condition;

– during the test the motor(s) shall be disconnected, provided that it was or they were tested separately.

NOTE Repetition of dielectric tests on motor(s) results in accelerated ageing of the motor.

6.11 X-radiation test procedure for vacuum interrupters

Subclause 6.11 of IEC 62271-1 is applicable.

6.101.1.1 Mechanical characteristics

Replace the entire text of this subclause by the following:

At the beginning of the type tests, the mechanical characteristics of the circuit-breaker shall be established. IEC TR 62271-306 gives examples on how to measure the mechanical characteristics. The mechanical characteristics will serve as the reference for the purpose of characterising the mechanical behaviour of the circuit-breaker. Furthermore, the mechanical characteristics shall be used to confirm that the different test samples used during the mechanical, making, breaking and switching type tests behave mechanically in a similar way. The reference mechanical characteristics are also used to confirm that production units behave mechanically in a similar way compared to the test samples used during type tests.

Following is an example of operating characteristics that can be recorded:

– no-load travel curves;

– closing and opening times;

– other mechanical parameters, if necessary.

The mechanical characteristics shall be produced during a no-load test made with a single O operation and a single C operation at rated supply voltage of operating devices and of auxiliary and control circuits, rated functional pressure for operation and, for convenience of testing, at the minimum functional pressure for interruption.

Annex N gives requirements and explanation on the use of mechanical characteristics.

6.101.1.4 Condition of the circuit-breaker during and after the tests

Add, at the end of the list, the following new dashed item:

– the increase of the resistance of the main circuit is less than or equal to 20 %. If the increase in resistance exceeds 20 % then a temperature rise test is applicable to determine if the

test object can carry its rated normal current without exceeding the temperature limits given in Table 3 of IEC 62271-1 by more than 10 K.

6.101.2.1 General

Replace the last paragraph by the following:

During the test, lubrication of parts outside of the main circuit is allowed in accordance with the manufacturer's instructions, but no mechanical adjustment or other kind of maintenance is allowed.

6.101.2.4 Extended mechanical endurance tests on class M2 circuit-breakers for special service requirements

Replace the second dashed item by the following:

– between the test series specified, some maintenance, such as lubrication and mechanical adjustment, is allowed, and shall be performed in accordance with the manufacturer's instructions. Only change of parts outside of the main circuit and not being part of the kinematic chain, that are listed in the program of maintenance, is permitted;

6.101.3.1 General

Add, after NOTE 2, the following text:

For dead-tank circuit-breakers equipped with tank heater(s) for the purpose of avoiding gas liquefaction during low ambient temperature conditions, the test sequence prescribed in 6.101.3.3 is not sufficient to demonstrate that the gas heating element is properly designed to avoid gas liquefaction during low ambient temperature conditions. For such circuit-breakers, the test sequence prescribed in 6.101.3.3 shall be performed with a simulation of an average wind speed of 10 km/h (±20 %) applied perpendicularly to the longitudinal axis of an outer phase of the circuit-breaker. The wind shall be applied from step c) to j) of the test procedure described in 6.101.3.3.

The wind speed shall be measured by at least 5 positions along the longitudinal axis of the circuit-breaker and at a distance of 0,5 m (±0,1 m) to the outer circuit-breaker tank (see Figure 59). Each measurement shall be spaced by approximately 0,3 m. The number of measurements shall be such that the measurement length exceeds the circuit-breaker length by at least 0,5 m on each end. The wind speed for each of the individual measurement shall be within ±50 % of the average wind value.

It is recognised that the wind speed measurements in relatively small climatic room (in relation to the circuit-breaker dimensions) can be difficult and that wind turbulences from the neighbouring test cell walls cannot be avoided. In such cases, greater deviations as required above should be accepted.

The application of a transversal wind may make the measurement of the gas tightness impossible. If this is the case, it is allowed to split the low temperature test procedure in two parts. After having performed the required test sequence with the simulation of the transversal wind, the low temperature test sequence shall be repeated, without transverse wind and without gas heater, at low temperature T_L equal to or lower than the lowest temperature measured during the first test on the circuit-breaker tank surface close to sealing joints. A minimum of ten temperature measuring points shall be used to measure the tank surface temperature close to sealing joints.

6.101.4.1 General

*Replace, in the second paragraph, the word "*specimen*" by "*object*".*