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AMENDMENT 1

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Amendement 1

Disjoncteurs à courant alternatif à haute tension

Amendment 1

High-voltage alternating-current circuit-breakers

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FOREWORD

This amendment has been prepared by Sub-Committee 17A: High-voltage switchgear and controlgear, of IEC Technical Committee No. 17: Switchgear and controlgear.

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

DIS	Report on Voting
17A(CO)199 17A(CO)208 17A(CO)223 17A(CO)224 17A(CO)226 17A(CO)227 17A(CO)235	17A(CO)205 17A(CO)210 17A(CO)231 17A(CO)232 17A(CO)236 17A(CO)237 17A(CO)243

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

Page 43

4.101.2 *D.C. component of the rated short-circuit breaking current*

Replace the first line of the note on page 45 by the following:

NOTE - Depending on the characteristics of the system, for example if a circuit-breaker is close to a generator, the percentage d.c. component .....

Page 105

6. Type tests

Replace the brackets with the text (see subclauses 6.103 to 6.110) *of the second dash by:*
(see subclauses 6.102 to 6.110).

Page 109

6.1.7 *Power-frequency voltage tests*

The two notes of 6.1.7 shall be numbered:

NOTE 1 – In the case of dead tank circuit-breakers, ...

NOTE 2 – For special applications, ...

Page 115

6.101.1.3 *Condition of the circuit-breaker during and after the tests*

Add a sixth indent on page 117:

– after the tests the insulating properties of the circuit-breaker in the open position shall be in essentially the same condition as before the tests. Visual inspection of the circuit-breaker after the tests is usually sufficient for verification of the insulating properties. In case of doubt, the condition checking test according to 6.1.11 of IEC 694 is deemed sufficient to prove the insulating properties. For circuit-breakers with sealed-for-life interrupters the condition checking test is mandatory.

Page 121

6.101.3.3 *Low temperature test*

Amend Item b), on page 123, as follows:

b) Characteristics and settings of the circuit-breaker shall be recorded in accordance with 6.101.1.2 and at an ambient air temperature of (20 ± 5) °C (T_A). The tightness test (if applicable) shall be performed according to EE1.4 of appendix EE.

Amend Item f) as follows:

f) The low temperature behaviour of the circuit-breaker and its alarms and lock-out systems shall be verified by disconnecting the supply of heating devices for a duration t_x. During this interval, occurrence of the alarm is acceptable but lock-out is not. At the end of the interval t_x, an opening order, at rated values of supply voltage and operating pressure, shall be given. The circuit-breaker shall then open. The opening time shall be recorded (and the contact velocity measured, if feasible) to allow assessment of the interrupting capability.

The manufacturer shall state the value of t_x up to which the circuit-breaker is still operable without auxiliary power to the heaters. In the absence of such a statement, this value shall be equal to 2 h.

Add after Item k), on page 125, a new paragraph as follows:

The accumulated leakage during the complete low temperature test sequence from Item *b)* to Item *k)* shall not be such that lock-out pressure is reached without gas-replenishment (whereas reaching alarm pressure is allowed).

Page 125

6.101.3.4 *High temperature test*

Amend Item m) as follows:

m) Characteristics and settings of the circuit-breaker shall be recorded in accordance with 6.101.1.2 and at an ambient air temperature of (20 ± 5) °C (T_A). The tightness test (if applicable) shall be performed according to EE1.4 of Appendix EE.

Add after Item u), on page 127, a new paragraph as follows:

The accumulated leakage during the complete high temperature test sequence from Item *m)* to Item *u)* shall not be such that lock-out pressure is reached without gas-replenishment (whereas reaching alarm pressure is allowed).

Page 141

6.102.4 *Synthetic tests*

Replace the existing text by the following:

Synthetic testing methods can be applied for making and breaking tests as required in 6.106 to 6.111. Synthetic testing techniques and methods are described in IEC 427.

Page 145

6.102.8.1 *General*

Replace the text by the following:

The circuit-breaker may be inspected after any test duty. Its mechanical parts and insulators shall be in essentially the same condition as before the test duty. Visual inspection is usually sufficient for verification of the insulating properties. In case of doubt, the condition checking test according to 6.1.11 of IEC 694 is deemed sufficient to prove the insulating properties. For circuit-breakers with sealed-for-life interrupters and when the demounting affects the inspection result, as may be the case for certain GIS breakers, the condition checking test is mandatory.

Page 147

6.102.9 *Circuit-breakers with short arcing times*

Amend the first two paragraphs as follows:

It is recognized that, when breaking tests are made on circuit-breakers having short arcing times, there may be great variation in actual severity of tests with the same circuit setting due to the point on the current wave at which contact separation occurs. For this reason, the testing procedure for circuit-breakers with arcing times (to the extinction of the main arc for circuit-breakers with switching resistors) not exceeding one cycle for the first pole to clear is given below under Items (A) and (B).

The tests under Items (A)2) and (B)2) consist of three valid breaking operations independent of the rated operating sequence. After the number of operations provided for in accordance with the rated operating sequence the circuit-breaker may be reconditioned in accordance with 6.102.8.5.

NOTE - The same test procedure may be applied also for circuit-breakers having longer arcing times than one cycle.

(A) *Three-phase tests*

The text remains unchanged.

(B) *Single-phase tests*

Amend Item (B) as follows:

The aim of the following single-phase tests is to satisfy the conditions of the first-pole-to-clear and the last-pole-to-clear for each test duty in one test circuit.

1) Single-phase tests in substitution for three-phase conditions in an isolated neutral system.

Test-duties Nos. 1, 2, 3, 4 and 4b (6.106.1. to 6.106.4)

The first valid breaking operation shall demonstrate the first possible clearance after contact separation. This is obtained when any extra delay in the separation of the contacts with respect to a zero passage of the current causes the breaking to occur at the next zero passage of the current.

NOTE - The resultant arcing time has been termed the minimum arcing time.

For the second breaking operation, the setting of the control of the tripping impulse shall be approximately 60 electrical degrees earlier than that of the first valid breaking operation. The resultant clearance should occur at the same current zero as the first valid breaking operation.

The control of the tripping impulse for the third breaking operation shall be earlier than that of the second breaking operation by further (90 electrical degrees – dt) where dt is less than 18 electrical degrees.

2) Single-phase tests in substitution for three-phase conditions in an earthed neutral system and short-line fault tests.

Test-duties Nos. 1, 2, 3, 4 and 4b and short-line fault tests (6.106.1 to 6.106.4, 6.108 and 6.109.5).

The first valid breaking operation shall demonstrate the first possible clearance after contact separation. This is obtained when any extra delay in the separation of the contacts with respect to a zero passage of the current causes the breaking to occur at the next zero passage of the current.

NOTE - The resultant arcing time has been termed the minimum arcing time.

For the second breaking operation, the setting of the control of the tripping impulse shall be earlier than that of the first operation by (180 electrical degrees – dt) where dt is less than 18 electrical degrees.

For the third breaking operation, the setting of the control of the tripping impulse shall be 90 electrical degrees earlier than that of the first valid breaking operation.

The sequence for performing the three valid operations is not specified.

Both conditions 1) and 2) may be demonstrated by combining the above in one test series. The transient and power frequency recovery voltages to be used shall be those applicable to the isolated neutral system and the arcing times shall be those applicable to the earthed neutral system.

3) Test-duty No. 5 (6.106.5)

Wording to remain as existing Item (B)2) of 6.102.9.

4) Out-of-phase test-duties (6.110.4)

Wording to remain as existing item (B)3) of 6.102.9 except that the last paragraph starting "For direct tests ...." *shall be deleted.*

Page 157

6.104.2 *Short-circuit (peak) making current*

Replace the existing text by the following:

The ability of the circuit-breaker to make the rated short-circuit making current is proven in test-duty No. 4 (see 6.106.4).

The circuit-breaker shall be able to make the current with pre-strike of the arc occurring at any point on the voltage wave. Two extreme cases are specified as follows (see figure 1):

– Making at the peak of the voltage wave, leading to a symmetrical short-circuit current and the longest pre-striking arc.

– Closing at the zero of the voltage wave, without pre-striking, leading to a fully asymmetrical short-circuit current.

The test procedure as outlined below aims to demonstrate the ability of the circuit-breaker to fulfil the following two requirements:

a) the circuit-breaker can close against a symmetrical current as a result of pre-arcing commencing at a peak of the applied voltage. This current shall be the rated short-circuit breaking current (see 4.101);

b) The circuit-breaker can close against a fully asymmetrical short-circuit current. This current shall be the rated short-circuit making current (see 4.103).

A standard circuit-breaker shall be able to operate at voltages below its rated voltage (see 4.101 *a*) at which it may actually make with a fully asymmetrical current. The lower limit of voltage, if any, shall be stated by the manufacturer. Test voltages lower than this voltage limit shall not be used without the consent of the manufacturer.

NOTES

1 If the d.c. component does not exceed 20%, the short-circuit current is considered to be symmetrical.

2 For circuit-breakers having a pre-arcing time exceeding 10 ms, more than two making operations may be necessary to meet the most onerous condition.

3 Due to non-simultaneity of poles the instants of contacts touching during closing may differ such as to provoke an even higher peak making current in one pole (see also 5.101). This is particularly the case if in one pole the current begins to flow about 1/4 of a cycle later than in the other two poles, provided that there is no pre-arcing.

Test procedure

1) *Three-phase tests*

For three-phase tests on a three-pole circuit-breaker it is assumed that the requirements outlined in items *a)* and *b)* above are adequately demonstrated during the normal test-duty No. 4.

The control of the timing shall be such that at least in one of the two close-open (CO) operations of test-duty No. 4 the rated short-circuit making current is obtained.

Where a circuit-breaker exhibits pre-arcing to such an extent that the rated short-circuit making current is not attained during the first CO operation of test-duty No. 4 and, even after adjustment of the timing, the rated short-circuit making current is not achieved during the second CO operation, a third CO operation shall be carried out at reduced voltage. Before this operation the circuit-breaker may be reconditioned.

2) *Single-phase tests*

For single-phase tests, test-duty No. 4 or 4a shall be carried out in such a way that the requirement outlined in Item *a)* above is met in one and that of Item *b)* in the other closing operation. The sequence of these operations is not specified. If during test-duty No. 4 or 4a one of the requirements outlined in Items *a)* and *b)* has not been adequately demonstrated, an additional CO operation is necessary. It may be made with a reconditioned circuit-breaker.

This additional CO operation shall, depending on the results obtained during the normal test-duty No. 4 or 4a, demonstrate either:

- requirement in Item *a)* or *b)* above, or
- evidence that the short-circuit making currents attained are representative of the conditions to be met in service due to the pre-arcing characteristics of the circuit-breaker.

If during the normal test-duty No. 4 or 4a the rated short-circuit making current has not been attained due to the characteristics of the circuit-breaker, the additional CO test may be made at a lower applied voltage (see note 3).

If during the normal test-duty No. 4 or 4a no symmetrical current has been obtained, as required in Item *a)* above, the additional CO test may be made at an applied voltage within the margins stated in 6.104.1.

6.104.3 *Short-circuit breaking current*

Delete the last paragraph on page 159.

Page 173

6.104.7 *Power-frequency recovery voltage*

Delete the third paragraph.

Page 175

6.105.1 *Time interval between tests*

Amend the first two paragraphs as follows:

The basic short-circuit tests and, if applicable, short-line fault tests, consist of the series of test-duties specified in 6.106 and 6.109.

The time intervals between individual operations of a test-sequence shall be the time intervals of the rated operating sequence of the circuit-breaker, which is given in 4.104, subject to the following provision:

Page 177

6.106 *Basic short-circuit test-duties*

Amend the text as follows:

The basic short-circuit test series shall consist of the test-duties Nos. 1 to 5 specified below.

The breaking current may depart from the specified values by not more than 20 % of the specified values for test-duties Nos. 1 and 2 and by not more than 10 % for test-duty No. 3.

The peak short-circuit current during the breaking-current tests of test-duties Nos. 4, 4b and 5 shall not exceed 110 % of the rated short-circuit making current of the circuit-breaker.

For test-duties No. 1, 2 and 3, it is permissible to omit the making operation before any breaking operation for convenience in testing. The time intervals between the individual operations shall be the time intervals of the rated operating sequence of the circuit-breaker (see 6.105.1).

6.106.1 *Test-duty No. 1*

Test-duty No. 1 consists of the rated operating sequence at 10 % of the rated short-circuit breaking current with a d.c. component of less than 20 % and a transient and power frequency recovery voltage as specified in 6.104.5.5 and 6.104.7 (see also Tables XVIA, XVIB and XVII).

6.106.2 *Test-duty No. 2*

Test-duty No. 2 consists of the rated operating sequence at 30 % of the rated short-circuit breaking current with a d.c. component of less than 20 % and a transient and power frequency recovery voltage as specified in 6.104.5.4, Tables XVIA, XVIB, XVIC and 6.104.7.

6.106.3 *Test-duty No. 3*

Test-duty No. 3 consists of the rated operating sequence at 60 % of the rated short-circuit breaking current with a d.c. component of less than 20 % and a transient and power frequency recovery voltage as specified in 6.104.5.3, Tables XVA, XVB, XVC, XVD, XVE and 6.104.7.

6.106.4 *Test-duty No. 4*

The text remains unchanged.

6.106.4.1 *Test-duty No. 4a, making tests*

- C-*t'*-C in case of a rated operating sequence O-*t*-CO-*t'*-CO;
- C-*t*"-C in case of a rated operating sequence CO-*t*"-CO,

with one closing operation against the rated short-circuit making current and one closing operation against a symmetrical current according to 6.104.2, both at an applied voltage as specified in 6.104.1.

6.106.4.2 *Test-duty No. 4b, breaking tests*

The text remains unchanged.

6.106.5 *Test-duty No. 5*

Test-duty No. 5 shall be applied only to circuit-breakers having a time interval τ, determined in accordance with 4.101.2, of less than 80 ms.

Test-duty No. 5 consists of three opening operations at 3 min intervals at 100 % of the rated short-circuit breaking current with a percentage d.c. component equal to the appropriate rated value specified in 4.101, and transient and power frequency recovery voltages as specified in 6.104.5.2 and 6.104.7 (see also 6.104.6). (For table references see 6.106.4.)

However, for a circuit-breaker which is of such a design that it may not reach its closed position when being closed against a short-circuit current, test-duty No. 5 shall be made with the rated operating sequence.

For circuit-breakers intended to be used where it can be expected that the percentage of the d.c. component will be greater than that corresponding to figure 9, as may occur in the vicinity of centres of generation, testing shall be subject to agreement between manufacturer and user (see note of 4.101.2 and 8.103.1).

Page 187

6.109.5 *Test-duties*

Amend the text as follows:

The standard tests shall be a series of test-duties as specified below, each consisting of three opening operations at 3 min intervals.

a) Test-duty No. L_{90}

At (90 $^{+5}_{0}$) % of the rated short-circuit breaking current and the appropriate prospective TRV

b) Test-duty No. L_{75}

At (75 ± 5) % of the rated short-circuit breaking current and the appropriate prospective TRV.

Page 191

6.111.2 *General*

Delete Note 5 on page 193.

Page 199

6.111.8.1 *Test conditions corresponding to normal service conditions*

Delete Table XX on page 201 and the preceding sentence: "Breaking tests may alternatively be ... page 247."

Page 203

6.111.9 *Test results*

Renumber the existing 6.111.9 as 6.111.10.

Insert a new 6.111.9 as follows:

6.111.9 *Tests with specified TRV*

As an alternative to using the test circuits defined in 6.111.3 to 6.111.5, breaking tests may be performed in circuits which fulfil the following requirements for the prospective recovery voltage:

a) Test-duties 1 and 2

With the envelope of the prospective test recovery voltage defined by u'_1, t'_1, u'_c and t'_2 as shown in Figure 32a, the following relations shall be fulfilled:

$$u'_1 \leq u_1$$
$$t'_1 \geq t_1$$
$$u'_c \geq u_c$$
$$t'_2 \leq t_2$$

where u_1, t_1, u_c and t_2 define the reference line of specified recovery voltage and are given in Table XX.

b) Test-duties 3 and 4

With the envelope of the prospective test recovery voltage defined by u'_c and t'_2 as shown in Figure 32b, the following relations shall be fulfilled:

$$u'_c \geq u_c$$

$$t'_2 \leq t_2$$

In addition the initial part of the prospective recovery voltage shall remain below the line from the origin to the point defined by u_1 and t_1.

Specified values of u_1, t_1, u_c et t_2 are given in table XX.

Table XX

Test-duties	Recovery voltage values of figure 32 in relation to the peak value of the test voltage		Time values of figure 32		
	u_c	u_1	t_1	t_2 ms	
				50 Hz	60 Hz
1 and 2	1.95	0.14	t_1 or t_3 of 6.104.5.4	8.7	7.3
3 and 4	2.0	0.01	t_1 or t_3 of 4.102.3	8.7	7.3

Pages 236 and 237

Figure 19 and Figure 20

Replace "E" in the bottom figures on page 236 and 237 by "U" (in 24 places).

Page 245

Figure 28

Replace "E" at the top trace by "U".

Page 246

Figure 29 and Figure 30

Replace "U'" in figures 29 and 30 by "U".

Page 247

Figure 32

Replace figure 32 by the following figures 32a and 32b:

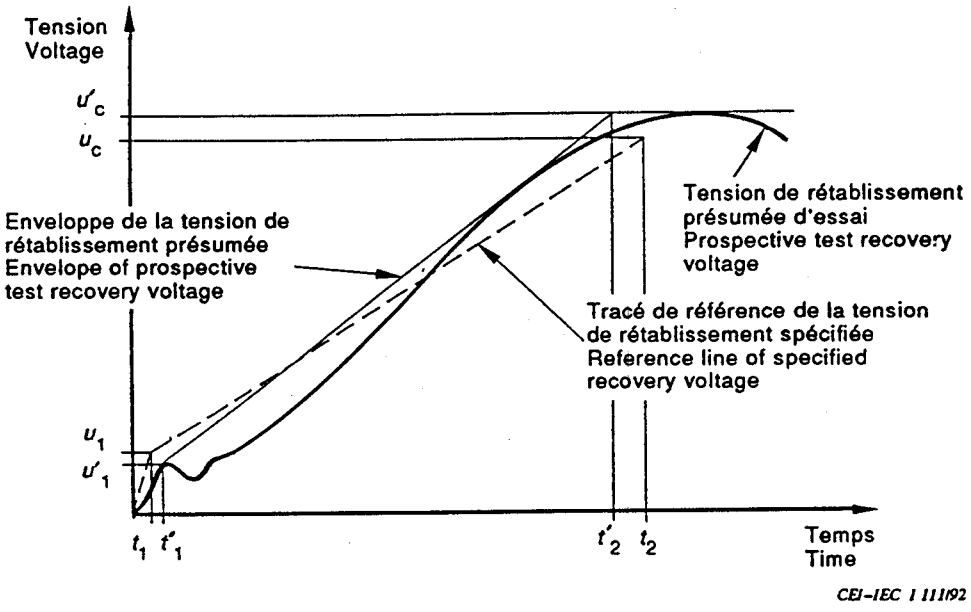

Figure 32a –Tension de rétablissement pour les essais de coupure de courants capacitifs, séquences d'essais 1 et 2
Recovery voltage for capacitive current-breaking tests, test-duties 1 and 2

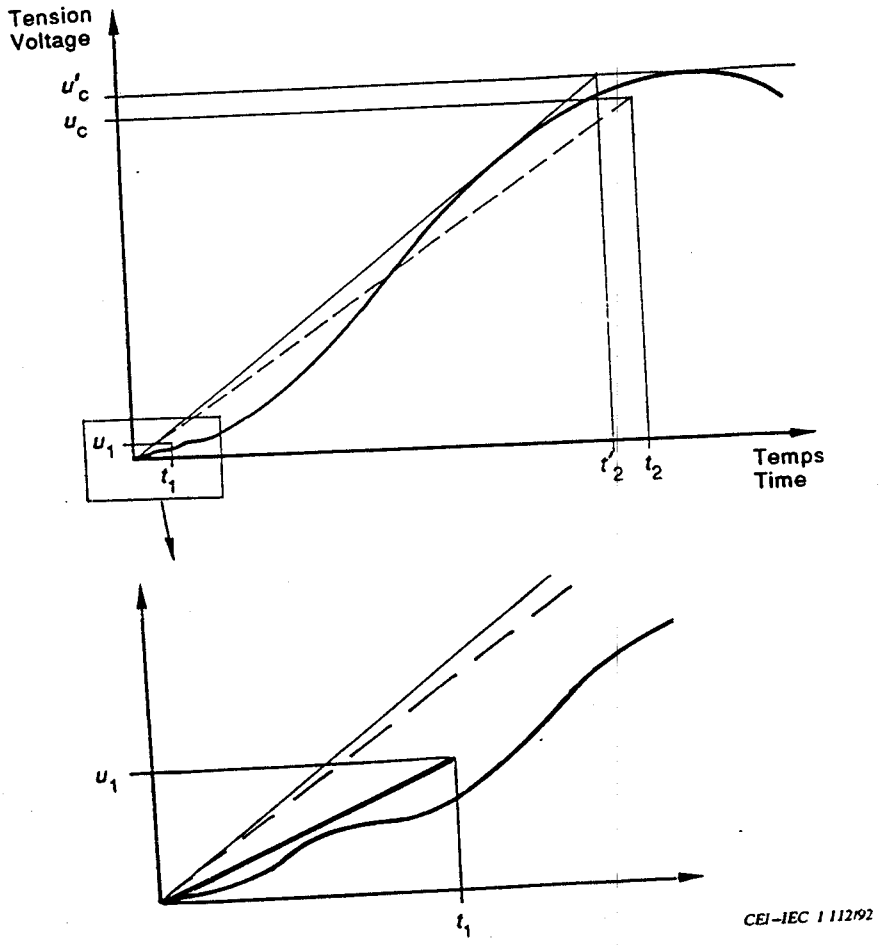

Figure 32b – Tension de rétablissement pour les essais de coupure de courants capacitifs, séquences d'essais 3 et 4
Recovery voltage for capacitive current-breaking tests, test-duties 3 and 4

Page 256

Figure AA1

Replace "$u_s - u_L$* " in the top figure on page 256 by "$u_s - u_L$".

Page 279

APPENDIX EE

EE1.4.1.1 *Type tests*

Amend the first two paragraphs as follows:

The tightness test shall be performed in conjunction with the mechanical operation test according to 6.101.2, and the low and high temperature tests according to 6.101.3.

An increased leakage rate at extreme temperatures and/or during operations is acceptable provided that this rate resets to a value not exceeding the specified value F_P after the temperature is returned to normal ambient air temperature, is thermally stable, and/or after the operations are performed.

The increased temporary leakage rate at extreme temperatures shall not exceed three times the specified permissible value F_p in closed or open position.

The accumulated leakage during the complete mechanical endurance test shall not be such that lock-out pressure is reached.

Page 319

Figure GG9

Replace the inequality of Item a) of the note by:

a) $f_1 \leq \frac{f_e}{8}$