NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI
IEC
56

1987

AMENDEMENT 3
AMENDMENT 3

1996-09

Amendement 3

Disjoncteurs à courant alternatif à haute tension

Amendment 3

High-voltage alternating-current circuit-breakers

Bureau central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE
R

Pour prix, voir catalogue en vigueur
For price, see current catalogue

IEC

VOL. 2

FOREWORD

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

This third amendment cancels and replaces the amendments 1 (1992) and 2 (1995).

The text of this amendment is based on Amendment 1 (1992), Amendment 2 (1995) and on the following documents:

DIS	Report on voting
17A/467/FDIS	17A/480/RVD

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

Annexes JJ and KK are for information only.

Page 5

Add the following new subclause 8.104:

8.104 *Selection for electrical endurance in networks of rated voltage above 1 kV, and up to and including 52 kV*

Add the new appendices JJ and KK to the contents as follows:

Appendix JJ: Some remarks regarding multipliers for TRV values for second and third clearing poles, of Table IIF

Annex KK: Rationale behind introduction of circuit-breakers class B

Page 17

Add the following new subclauses:

3.102.13 *Circuit-breaker class A*

A circuit-breaker not falling into the category of class B as defined in 3.102.14.

3.102.14 *Circuit-breaker class B*

A circuit-breaker designed so as not to require maintenance of the interrupting parts of the main circuit during the expected operating life of the circuit-breaker, and only minimal maintenance of its other parts.

NOTES

1 Minimal maintenance may include lubrication, replenishment of gas and cleaning of external surfaces, where applicable.

2 This definition is restricted to circuit-breakers having a rated voltage up to and including 52 kV. See annex KK for rationale behind introduction of class B.

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 51

Introduce a new table IIF as follows:

Table IIF – Multipliers for transient recovery voltage values for second and third clearing poles for rated voltages above 72,5 kV, to be applied at three-phase testing

First-pole-to-clear factor	Multipliers			
	2nd clearing pole		3rd clearing pole	
	RRRV	u_c	RRRV	u_c
1,5	0,70	0,58	0,70	0,58
1,3	0,95	0,98	0,70	0,77
RRRV: Rate-of-rise of recovery voltage.				

In order to obtain the values of RRRV and u_c for the second and third clearing poles, the multiplier shall be applied to the values of RRRV and u_c of the first clearing pole at the relevant first-pole-to-clear factor.

The RRRV-multipliers are related to u_1/t_1; the times t_1 and t_2 are the same for the first, second and last clearing poles.

NOTES

1 For rated voltage for 72,5 kV and below, the values are under consideration.

2 See also appendix JJ.

3 This table is valid for test duty 1, 2, 3, 4 and 5. For test duty 5 the same reduction method shall be applied as indicated in IEC 427 for the first clearing pole. The figures are an approximation for test duties 1, 2 and 3 and are subject to further consideration.

4 The values are rounded values, depending on Z_0/Z_1 of the TRV-circuits, the time constant of the system and the rated voltages.

5 Values of table IIF for 1,5 first-pole-to-clear factor are only valid to breakers having less than one-quarter of a cycle difference in pole simultaneity.

Page 105

6 Type tests

Amend the text of the second dash as follows:

– short-circuit current making and breaking tests including, where applicable, terminal fault tests, short-line fault tests, electrical endurance tests, and also out-of-phase tests (see 6.102 to 6.110.5).

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 117

6.101.2.1 *General*

Delete, on page 119, the last paragraph.

Page 119

Add, after subclause 6.101.2.3, the following new subclause 6.101.2.4:

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

For special service requirements in the case of frequently operated circuit-breakers, extended mechanical endurance tests may be carried out, as follows:

a) The tests shall consist of 10 000 operating cycles comprising five times the relevant test series specified in table XII.

Between the test series, some maintenance, such as lubrication and mechanical adjustment, is allowed, and shall be performed in accordance with the manufacturer's instructions. Change of contacts is not permitted.

The programme of maintenance during the tests shall be defined by the manufacturer before the tests and recorded in the test report.

b) Before and after the total test programme, the following operations shall be performed:

- five close-open operating cycles at the rated supply voltage and/or pressure;
- five close-open operating cycles at the minimum supply voltage and/or pressure;
- five close-open operating cycles at the maximum supply voltage and/or pressure;
- five close-open manual operations.

During these operating cycles, operating characteristics (see 6.101.1.2) shall be recorded or evaluated, if applicable. It is not necessary to publish all the oscillogrammes recorded.

In addition, the following checks and measurements shall be performed (see appendix HH):

- measurements of characteristic operating fluid pressures and of consumption during operations, if applicable;
- verification of the rated operating sequence;
- checks of certain specific operations, if applicable.

The variation between the mean values of each parameter measured before and after the extended mechanical endurance tests shall be within the tolerance given by the manufacturer.

c) After each series of 2 000 operating cycles or at maintenance intervals, some significant operating characteristics selected in subclause 6.101.1.2 should be recorded or evaluated.

d) After the total test programme the condition of the circuit-breaker shall be in accordance with subclause 6.101.1.3.

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 133

6.102.2 *Arrangement of circuit-breaker for tests*

Replace the text of 6.102.2 a) by:

a) Single-enclosure type

A three-pole circuit-breaker having all its arcing contacts supported within a common enclosure shall be tested in line with IEC 1633.

Page 135

6.102.2 *b) Multi-enclosure type*

Add after "rigidity of structure" *a new paragraph as follows:*

Metal enclosed and dead tank circuit-breakers shall be tested in accordance with IEC 1633.

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

6.102.8.5 *Reconditioning after a short-circuit test duty and other test series*

Replace the text of this subclause by the following new text:

It may be necessary to carry out maintenance work on the circuit-breaker after performing a short-circuit test duty or other test series in order to restore it to the original condition specified by the manufacturer. For example, the following may be necessary:

a) repair or replacement of the arcing contacts and any other renewable parts recommended by the manufacturer;

b) renewal or filtration of the oil, or of any other extinguishing medium, and the addition of any quantity of the medium necessary to restore its normal level or density;

c) removal of deposit, caused by the decomposition of the extinguishing medium, from internal insulation.

A class B circuit-breaker shall not be reconditioned during the basic short-circuit test duties, given in 6.106.

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 – d*t*) 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 – d*t*) 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

6.105.5 *Invalid tests*

Add, after the existing note, the following new note:

NOTE 2 – A class B circuit-breaker may be reconditioned, but in this event the entire test series should be repeated.

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*

Replace the existing text by the following:

– 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*

Replace the existing text by the following:

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

Add, after subclause 6.110.4, the following new subclause 6.110.5:

6.110.5 *Additional tests for class B circuit-breakers intended for auto-reclosing duty on overhead line connected networks of rated voltages above 1 kV, and up to and including 52 kV*

These circuit breakers shall perform an electrical endurance test in accordance with, and in the order specified in, the following table XXII:

Table XXII – Operating sequence for electrical endurance test on class B circuit-breakers

Testing current (% of rated short-circuit breaking current)	Operating cycle	Number of operating cycles (list 1) [1]	Number of operating cycles (list 2) [1]
10 %	O O-0,3 s-CO O-0,3 s-CO-*t*-CO	84 14 6 [2]	12 6 4 [2]
30 %	O O-0,3 s-CO O-0,3 s-CO-*t*-CO	84 14 6 [2]	12 6 4 [2]
60 %	O O-0,3 s-CO-*t*-CO	2 2 [2]	8 8 [2]
100 % (symmetrical)	O-0,3 s-CO	2 [2]	4 [2]

[1] List 1 is preferred. List 2 may be used as an alternative for circuit-breakers used for solidly earthed systems.

[2] When no reconditioning is made on the sample after the basic short-circuit test sequences in 6.106, the test already carried out may be taken into account in determining the number of additional operating cycles required to satisfy the requirements of table XXII. In practice, this means reducing these figures marked [2] by 1.

The test shall be carried out on a circuit-breaker, which is in a clean and new condition and identical to that which has been submitted to the basic short-circuit tests, given in 6.106. No intermediate maintenance shall be carried out. The test parameters shall be given in accordance with 6.106 except as follows:

a) in the case of gas-filled circuit-breakers, the tests shall be made at the rated filling pressure;

b) the values of *t* shall be chosen for convenience of testing;

c) the minimum time interval between operating cycles should be stated by the manufacturer.

Arcing times shall be at random for the 10 % and 30 % tests. Adjustment of the arcing times shall be made in accordance with 6.102.9 for the 60 % and 100 % tests.

The condition of the circuit-breaker after the test shall comply with 6.102.8.2 and 6.102.8.3.

NOTE – See notes table XXII.

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 and 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		
			t_1	t_2 ms	
	u_c	u_1		50 Hz	60 Hz
1 et 2	1,95	0,14	t_1 or t_3 of 6.104.5.4	8,7	7,3
3 et 4	2,0	0,01	t_1 or t_3 of 4.102.3	8,7	7,3

Page 221

Add, after subclause 8.103.6, the following new subclause 8.104:

8.104 *Selection for electrical endurance in networks of rated voltage above 1 kV, and up to and including 52 kV*

Subclause 3.102.14 defines a circuit-breaker class B. Its electrical endurance capability for such service is demonstrated by performing the short-circuit test duties of 6.106 without intermediate maintenance. This electrical endurance is considered to be sufficient for circuit-breakers used on cable-connected networks where auto-reclosing is not required.

For the more severe condition of use on an overhead-line connected network, including auto-reclosing duty, a class B circuit-breaker capable of meeting the electrical endurance requirements, as specified in 6.110.5, is recommended.

NOTE – Different requirements may apply for other applications.

Pages 236 and 237

Figures 19 and 20

Change figures 19 and 20 by removing the squares representing TRV-networks by combinations of capacitances and resistances.

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

Figures 29 and 30

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

Page 247

Figure 32

Remplacer la figure 32 par les figures 32a et 32b suivantes:

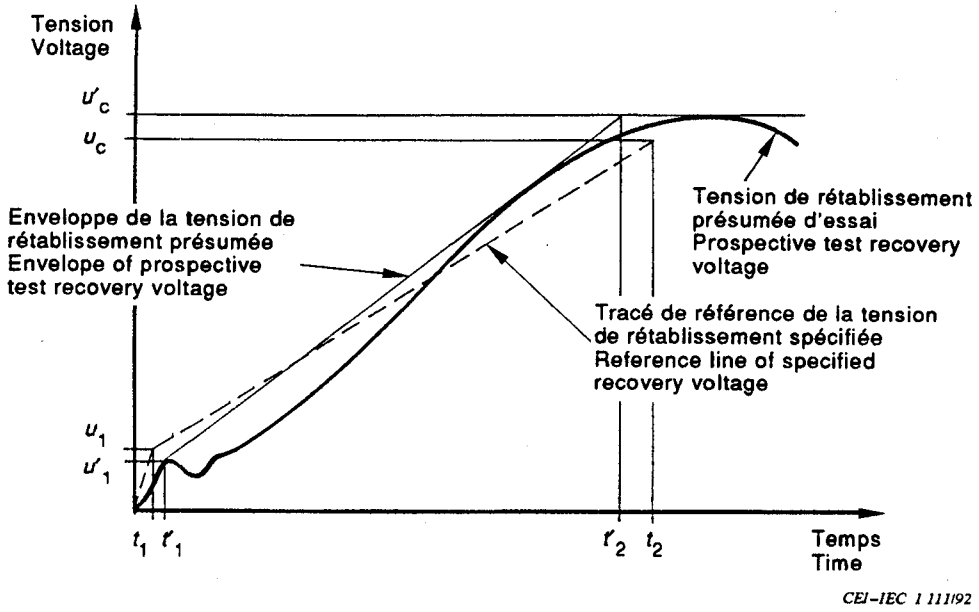


Figure 32a – Tension de rétablissement pour les essais de coupure de courants capacitifs, séquences d'essais 1 et 2
Recovery voltage for capacitive current-breaking tests, test-duties 1 and 2

Page 256

Figure AA1

Remplacer «$u_s - u_L$*» par «$u_s - u_L$» dans la figure du haut.

Page 278

ANNEXE EE

EE1.4.1.1 *Essais de type*

Modifier les deux premiers alinéas comme suit:

L'essai d'étanchéité est effectué en association avec l'essai de fonctionnement mécanique (voir 6.101.2), et les essais à basse et à haute températures (voir 6.101.3).

Page 247

Figure 32

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

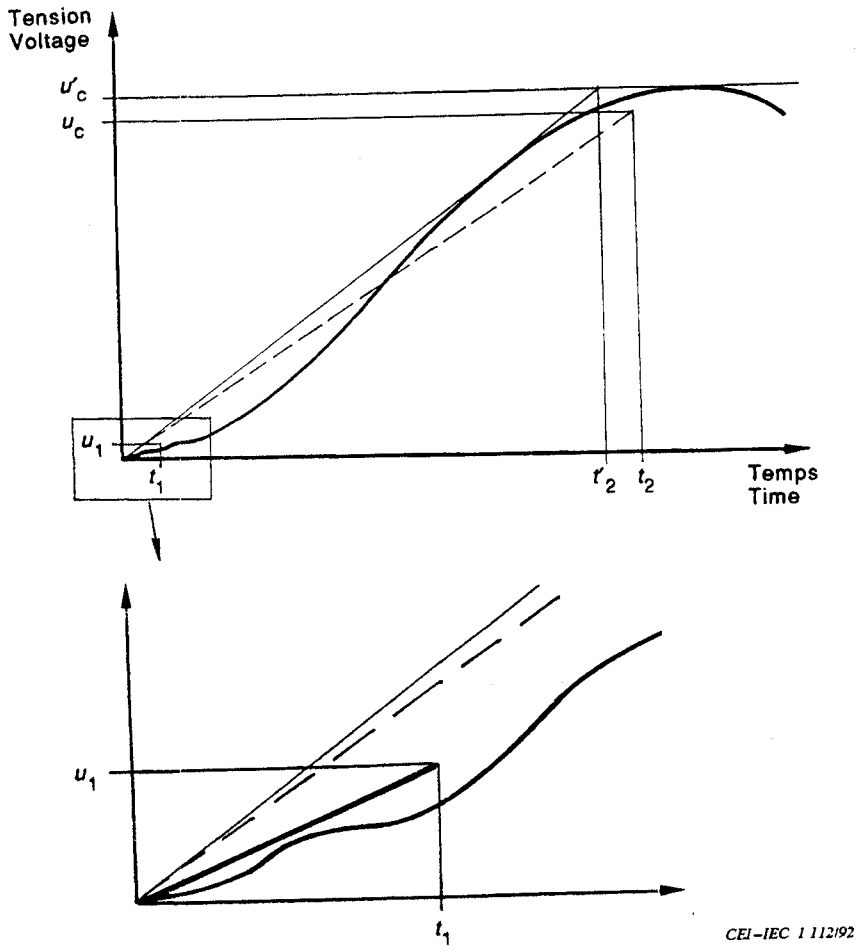


Figure 32b – Tension de rétablissement pour les essais de coupure de courants capacitifs, séquences d'essais 3 et 4
Recovery voltage for capacitive current-breaking tests, test-duties 3 and 4

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

Page 331

Add a new appendix JJ as follows:

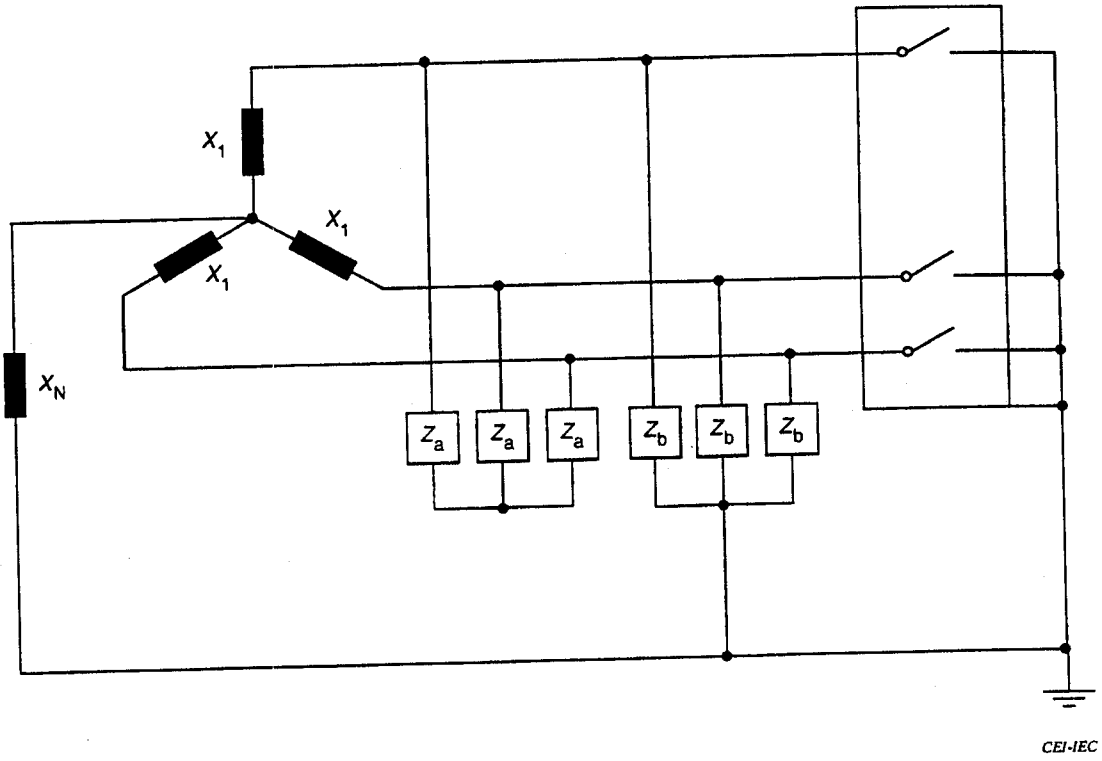
Appendix JJ
(informative)

Some remarks regarding multipliers for TRV values for second and third clearing poles, of table IIF

The TRV values for the 2nd and 3rd clearing poles are given in table IIF, for the first-pole-to-clear factor 1,3 and 1,5, by multipliers related to the TRV values of the first clearing poles. The multipliers for rated voltage of 72,5 kV and below are under consideration. The following conditions were assumed.

- Only three-phase earthed faults are considered.
- The rate of rise of recovery voltage (RRRV) at 100 % short-circuit currents is mainly determined by overhead lines and can be calculated as the product of d*i*/d*t* at current zero and the equivalent surge impedance.
- The equivalent surge impedance is calculated from the zero (Z_0) and positive sequence (Z_1) surge impedances seen from the terminals of the circuit-breaker. For the relation of Z_0/Z_1 a value of approximately 2,0 has been chosen.
- The peak value of TRV (u_c) is proportional to the instantaneous value of power-frequency recovery voltage at interruption.

See also figures JJ1 and JJ2.



CEI-IEC 131/95

X_N = ∞ pour facteur de premier pôle à couper = 1,5

X_N = 0,75 X_1 pour facteur de premier pôle à couper = 1,3

pour $Z_0/Z_1 = 2$:

$Z_a = Z_b = 2Z_1$

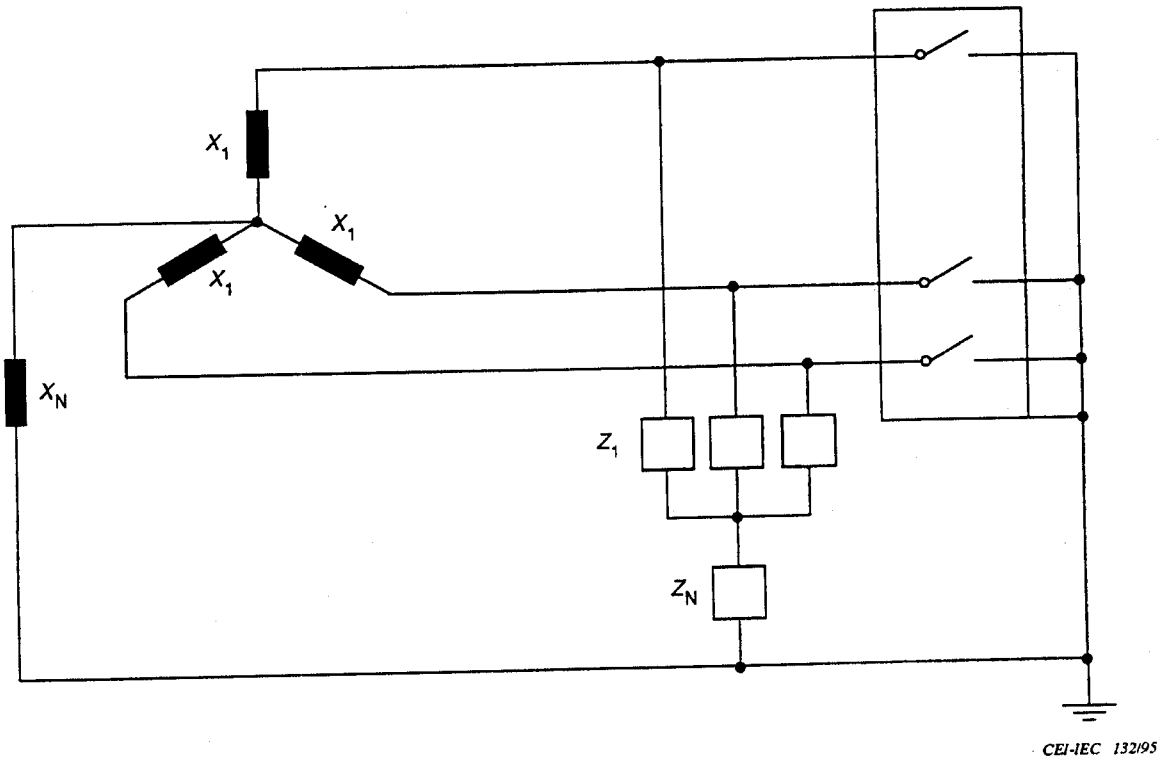
X_N = ∞ for first-pole-to-clear factor of 1,5

X_N = 0,75 X_1 for first-pole-to-clear factor of 1,3

for $Z_0/Z_1 = 2$:

$Z_a = Z_b = 2Z_1$

Figure JJ1 – Représentation d'un court-circuit triphasé
Three-phase short-circuit representation



pour $Z_0/Z_1 = 2$:

$Z_N = 1/3\ Z_1$

for $Z_0/Z_1 = 2$:

$Z_N = 1/3\ Z_1$

Figure JJ2 – Représentation équivalente à la figure JJ1
Alternative representation of figure JJ1

Add, after appendix JJ, a new annex as follows:

Annex KK
(informative)

Rationale behind introduction of circuit-breakers class B

KK.1 It should be noted that the proposal to introduce class B circuit-breakers is restricted to distribution circuit-breakers. IEC 56 already has cases where some tests are restricted to voltage ranges, so no problems should arise in adding the electrical endurance test only to circuit-breakers of rated voltage up to and including 52 kV.

KK.2 The majority of circuit-breakers made today are of the sealed type or closed type, only anticipating top-up of gas (where applicable), not internal maintenance. Traditional circuit-breakers do not need to fulfil low-maintenance requirements, but the user may wish (and in very many cases does wish) to specify a circuit-breaker class B for sound economic reasons.

KK.3 There are therefore two choices: either use a circuit-breaker having maintainable internal parts and maintain as needed during its expected working life, or use a circuit-breaker class B but expect a more onerous testing regime to check its capability.

KK.4 The proposed electrical endurance test for cable-connected networks is a full series of test duties 1 to 5 without intermediate maintenance. It is almost certain that all distribution circuit-breakers of the sealed SF_6 or vacuum type have been tested like this for a number of years. No extra tests are therefore required to the normal short-circuit type test.

Adjustment of arcing time is rarely needed in practice for the testing of such circuit-breakers, but, in any case, if it is required it must have already been done.

KK.5 For overhead-line networks the standard type test must be done separately. The proposed extra test is based on user requirements already applied and based on statistics of service experience.

KK.6 Care needs to be taken in comparing different test programmes. The current versus wear relationship is not a simple one as it might appear.

KK.7 Finally, it should be noted that the extra tests are optional, at the user's request, to satisfy these applications.