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PERFORMANCE REQUIREMENTS FOR GENERAL PURPOSE PUSH-PULL SINGLE-POLE CIRCUIT-BREAKERS FOR AIRCRAFT

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BRIEF HISTORY

The ISO Recommendation R 1467, *Performance requirements for general purpose push-pull single-pole circuit-breakers for aircraft,* was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles,* the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of Draft ISO Recommendation No. 1467, which was circulated to all the ISO Member Bodies for enquiry in March 1968. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Italy	Thailand
Belgium	Netherlands	Turkey
Brazil	New Zealand	U.A.R.
Canada	Poland	United Kingdom
Czechoslovakia	Portugal	U.S.S.R.
France	South Africa, Rep. of	Yugoslavia
India	Spain	
Israel	Switzerland	

No Member Body opposed the approval of the Draft.

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

ISO Recommendation | R 1467 | October 1970

PERFORMANCE REQUIREMENTS FOR GENERAL PURPOSE PUSH-PULL SINGLE-POLE CIRCUIT-BREAKERS FOR AIRCRAFT

1. SCOPE

This ISO Recommendation states the performance requirements for push-pull, trip-free circuit-breakers having an inverse time/current characteristic, of normal ratings up to and including 35 A, for use in nominal 28 V d.c. and/or 115 V single-phase 400 Hz a.c. line to neutral circuits.

NOTE. – It is not envisaged that single-phase circuit-breakers will be required for 200 V a.c. line to line circuits. Tests outside the scope of this ISO Recommendation will be necessary if the circuit-breaker is required in such applications.

2. DEFINITIONS

2.1 *Push-pull circuit-breaker.* A circuit-breaker with a single button to trip and reset the breaker, by pushing to make and pulling to break.

2.2 *Trip-free circuit-breaker.* A circuit-breaker so designed that holding the push button in the closed position will not override the tripping mechanism and will not permit subsequent closure of the contacts until the push button has been returned to the open position and the tripping mechanism has reset.

3. DESIGN REQUIREMENTS

3.1 The circuit-breaker should be suitable for use at ambient temperatures from − 40 to + 55 °C and at altitudes up to 18 300 m.

3.2 The circuit-breaker should be operated by a single button, pushed to make and pulled to break the circuit, the button being perpendicular to the plane of the mounting panel. The portion of the button visible when the circuit-breaker is in the closed position should be black. A white band on the button should be exposed when the circuit-breaker is in the open position.

3.3 The circuit-beaker should be suitable for through-panel mounting, preferably by single-hole fixing, and should operate satisfactorily when mounted in any attitude.

3.4 The circuit-breaker should be trip-free, and should incorporate an automatic over-current tripping device.

3.5 At the values of current stated in section 8, the circuit-breaker contacts should open automatically within the time limits stated and the manual operating device should move to the open or off position.

3.6 The circuit-breaker should be so designed that, after tripping on overload, it cannot reclose automatically.

4. DIMENSIONS

The envelope and fixing dimensions for the circuit-breakers should comply with ISO Recommendation R 530, *Dimensions for general purpose push-pull single-pole circuit-breakers for aircraft.*

5. CONSTRUCTION

5.1 The push button should be insulated from all current-carrying parts, and should not remain in an intermediate position, or give a false indication.

5.2 The circuit-breaker should be so constructed that the forces required to operate it manually do not exceed the following values :

Closing force	Tripping force
N	N
55	40

It is envisaged that in any particular design of circuit-breaker the actual value will be controlled to close limits.

5.3 The portion of the circuit breaker visible when mounted should have a non-glaring finish.

5.4 The circuit-breaker should be so constructed that tampering with the calibration is not possible without dismantling the device or breaking a seal.

5.5 Each terminal screw or stud should be size No. 6 UNC, or M4 × 0.7 and each should be capable of accepting two tag-type terminations.

5.6 The circuit-breaker should be mounted by means of a threaded bush suitable for use with the panel mounting hole specified in ISO Recommendation R 530. Two hexagon mounting nuts, one locating washer and one internal shakeproof washer should be provided with each circuit-breaker.

6. VOLTAGE AND CURRENT RATINGS

6.1 Voltage

The circuit-breaker should be suitable for operation in a nominal 28 V d.c. and/or 115 V single-phase 400 Hz a.c. supply (line to neutral circuit in a 200 V three-phase, 400 Hz a.c. system) having the characteristics described in ISO Recommendation R 1540, *Characteristics of aircraft electrical power systems.* *

6.2 Current ratings

The preferred normal current ratings of the circuit-breakers are listed in Table 1.

TABLE 1 – Normal current ratings

A	A
1	10
2	15
3	20
5	25
7.5	35

* At present Draft ISO Recommendation.

7. ENVIRONMENT

The circuit-breakers should comply with the requirements of ISO Recommendation R . . .,* *Environmental and operational conditions of aircraft equipment,* including vibration, acceleration, crash-landing, climatic, explosion proofness and magnetic influence. They should not support mould growth and should not deteriorate even after storage for long periods in the tropics.

8. TIME/CURRENT CHARACTERISTICS

The time/current characteristics of each circuit-breaker should be within the limits shown in Table 2, which represent envelope characteristics to cover all manufacture. It is expected that the limits for circuit-breakers of an individual manufacturer would conform to closer tolerances.

TABLE 2 – **Limits for time/current characteristics**

Circuit-breaker normal current rating (per line)	Ambient temperature	Tripping current	Tripping time
A	°C	% normal current	s
1 to 35	20 ± 2	200	12 to 60
		400	2 to 7.5
		600	1 to 3.5
		1000	0.35 to 1.2
1 to 5	– 40 ± 2	200	70 to 350
		400	5 to 15
		600	2 to 6
		1000	0.7 to 2
7.5 to 35	– 40 ± 2	200	27 to 200
		400	3.5 to 12
		600	1.5 to 5
		1000	0.5 to 1.75
1 to 35	55 ± 2	200	8 to 45
		400	0.8 to 7
		600	0.6 to 3
		1000	0.2 to 1

9. MAKING AND BREAKING CAPACITY

The circuit-breaker should have a making and breaking capacity appropriate to the relevant categories shown in Tables 3 and 4, when tested under the conditions described in clause 12.15.

TABLE 3 – **d.c. categories**

Rupturing capacity category	Calibrated test current (A) (prospective current)			
1.5 D	–	–	1500	1000
3 D	–	3000	1500	1000
6 D	6000	3000	1500	1000

* To be prepared.

TABLE 4 – a.c. categories

Rupturing capacity category	Calibrated test current (A) (prospective current)			
1 A	–	–	1000*	750**
2 A	–	–	1000**	750**
3.5 A	3500*	2000**	1000**	750**

* 0.4 to 0.5 lagging power factor.

** Unity power factor.

10. ENDURANCE

The circuit-breaker, when carrying current, should be capable of withstanding 10 000 cycles of manual close and open operations at the fastest practical rate, but at not less than two complete cycles per minute, with a ratio of time closed to time open of approximately 1 : 1 under the conditions described in clause 12.14.

11. TESTS

11.1 Except where specific details are listed below, tests should be in accordance with the practice and requirements of relevant national specifications for aircraft circuit-breakers. Evidence should be available to the purchaser that circuit-breakers identical to those supplied as covered by this ISO Recommendation have satisfactorily passed type tests conducted in accordance with section 12. In order that a consistent standard of quality be maintained, the manufacturer should conduct production tests in accordance with section 13, and quality tests in accordance with section 14.

11.2 The tests should be made with the covers on. With the exception of the making and breaking capacity test (see clause 12.15), for which the test circuit is prescribed, all tests should be performed with the circuit-breaker connected on each side by a copper-cored cable complying with ISO Recommendations R 469, *Dimensions and conductor resistance of general purpose electrical cables with copper conductors, for aircraft,* and R 474, *Performance requirements for general purpose electrical cables with copper conductors for aircraft,* of the appropriate size, as follows :

Circuit-breaker rating A	Cable size
1 to 5	22
7.5	20
10	18
15	16
20	14
25	12
35	10

Each cable should be at least 915 mm in length and should be attached to the circuit-breaker by a crimped termination of approved design.

11.3 Unless otherwise stated :

(*a*) before each individual calibration check, the circuit-breaker and its connected cables should be maintained at the appropriate temperature for 1 hour prior to the commencement of the test;

(*b*) except for the calibration checks, the tests in clauses 12.3, 12.4, 12.6, 12.7, 12.8, 12.10, 12.11, 12.14, 12.15, 14.3, and 14.5 should be made at a temperature between 15 and 30 °C.

12. TYPE TESTS

12.1 The tests should be made on representative samples of each particular design and rating of circuit-breaker unless agreement has been obtained to the omission of specific tests on intermediate ratings.

12.2 With the exception that a separate circuit-breaker may be used for the fungus growth test (see clause 12.5), the tests prescribed in clauses 12.3, 12.4.1 and 12.5 should be performed on the same circuit-breaker in the order stated. The tests in clause 12.4.2 and clauses 12.7 to 12.16 may be performed on another circuit-breaker or other circuit-breakers, except that the tests in clauses 12.10 and 12.14.2 or 12.14.3 should be made on one circuit-breaker. Every circuit-breaker used for type test purposes should previously have passed the production tests (see section 13). At the end of the test, or group of type tests, to which each circuit-breaker is subjected, it should be tested in accordance with clause 12.6.2 and should then be stripped and examined in accordance with clause 14.6.

12.3 Vibration test

The circuit-breaker should be subjected to the appropriate vibration tests described in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment.*

The resonance tests should be conducted with the circuit-breaker in both the open and closed positions, with normal rated voltage or current applied, as appropriate, and in each case oscilloscopic methods should be used to check that there is no inadvertent opening or closing of the contacts throughout the test. 10 % of the vibration endurance tests (fatigue tests) should be performed with the circuit-breaker in the open position, and 90 % with the circuit-breaker in the closed position and carrying 100 % normal rated current. At intervals of not greater than 3 hours during the latter test the voltage drop across the circuit-breaker terminals should be measured and should not exceed the limits shown in Table 6.

At the end of the test a cooling period of not less than 2 hours should be allowed, followed by calibration check at 200 % rated current. Tripping should occur within the time limit shown in Table 2 for 20 °C.

12.4 Acceleration test

12.4.1 The circuit-breaker should be subjected to the appropriate acceleration tests described in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment,* for a period of not less than 1 minute, with the circuit-breaker in both the open and closed positions with normal rated voltage or current applied, as appropriate. A check should be made to ensure that there is no inadvertent opening or closing of the contacts throughout the tests.

At the end of the test a cooling period of 2 hours in free air should be allowed, followed by a calibration check at 200 % normal rated current. Tripping should occur within the time limit shown in Table 2 for 20 °C.

12.4.2 The circuit-breaker should be subjected to the appropriate crash tests described in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment,* both in the closed position and carrying normal rated current, and in the open position. In addition, it should remain closed or open, as appropriate, during this test.

12.5 Climatic test

The circuit-breaker should be subjected to the appropriate climatic tests described in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment.*

Functioning tests as described in (*a*), (*b*) and (*c*) below should be made in accordance with the requirements of the relevant national specification during the course of climatic testing. At the conclusion of the tropical exposure and fungus growth tests, tests (*a*), (*b*) and (*c*) should be made.

(*a*) A calibration check at 200 % rated current. Tripping should occur within the time limits shown in Table 2 appropriate to the particular ambient temperature.

* To be prepared.

(*b*) Ten make and break operations performed over a period of 1 minute, at rated voltage and 100 % rated current or declared current, when the test is made at 70 °C with a resistive load. The voltage drop across the circuit-breaker terminals should be measured carrying 100 % rated current and should not exceed the limits shown in Table 6.

(*c*) The circuit-breaker should carry the declared current in an ambient temperature of 70 °C for 1 hour without tripping.

12.6 High voltage and insulation tests

The circuit-breaker should be subjected to tests in accordance with clauses 12.6.1 and 12.6.2.

12.6.1 *High voltage test.* A test voltage of not less than 1500 V r.m.s. 50 Hz or 60 Hz or eight times rated operating voltage, whichever is the greater, should be applied for a period of between 5 and 10 seconds between

(*a*) the terminals with the circuit-breaker in the open position;

(*b*) the terminals connected together with a metallic mounting plate to which the circuit-breaker is fastened by its normal mounting arrangement, with the circuit-breaker in the open and closed positions;

(*c*) the terminals connected together and all exposed metal parts;

(*d*) the tip of the actuating device(s) and the terminals connected together with the circuit-breaker in the open and closed positions.

The voltage should be increased and decreased gradually.

12.6.2 *Insulation resistance tests.* Immediately following the tests described in clause 12.6.1, the insulation resistance should be measured at a potential of 500 V d.c. between the same points as in clause 12.6.1 (*a*) to (*d*), and the results should comply with the relevant requirements of ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment.*

12.7 Test of explosion-proofness

The circuit-breaker should be subjected to the test described in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment,* for explosion-proof equipment.

12.8 Measurement of magnetic influence

The compass safe distance relative to the circuit-breaker when carrying 100 % rated current should be measured in the manner described in ISO Recommendation R . . .*, *Environmental and operational conditions of aircraft equipment.*

12.9 Tests of temperature rise and minimum and maximum limit of ultimate trip current

12.9.1 The circuit-breaker, in conditions of still air, should be submitted to the tests detailed in Table 5. Immediately on completion of the final test, with the circuit-breaker still hot in an ambient temperature of 55 °C, the circuit-breaker should be subjected to a test in accordance with clause 12.6.2.

TABLE 5 – **Tripping currents and tripping times**

Ambient temperature	Tripping current	Tripping time
°C	% normal current	
+ 20 ± 2	115	For 1 hour (see Note)
+ 20 ± 2	140	Not more than 1 hour
− 40 ± 2	140	Greater than 1 hour
− 40 ± 2	180	Not more than 1 hour
+ 55 ± 2	100	Greater than 1 hour
+ 55 ± 2	130	Not more than 1 hour

NOTE. – For this test the temperature rise of external parts should be measured and should not exceed the figures quoted in clauses 12.9.2 and 12.9.3.

The temperature rise in the attached cable (measured with a suitable thermocouple, when the temperature reading becomes stable, at the surface of the conductor beneath the insulation at a point 25 mm from the end of the insulation) should not exceed 55 °C.

* To be prepared.

12.9.2 The temperature of any component part of the circuit-breaker which may normally be accessible to, or inadvertently touched by, occupants of the aircraft under operating conditions should not exceed 100 °C at maximum ambient temperature.

12.9.3 The temperature rise of any part which is necessarily handled and which is made from, or covered with, material which is a poor thermal conductor, should not exceed 20 °C. If such a part is made from metal the temperature rise should not exceed 10 °C.

12.10 Operating forces test

The maximum and minimum forces necessary for the operation of the circuit-breaker to both the open and closed positions should be determined and declared. The force should be applied in the line of travel of the push-button. The force required to operate the circuit-breaker should not exceed the relevant value specified in clause 5.2.

During this test it should be established that the circuit-breaker has a positive action and will not remain with the button in an intermediate position when operating to the open and closed positions. It should also be established that the point of maximum pressure occurs before the contacts close or open, and that the pressure decreases rapidly thereafter.

12.11 Mechanical tests

12.11.1 *Strength of terminations.* All terminations should be subjected for not less than 1 minute to

(*a*) a 45 N pull in each of the following directions :

- parallel to the long axis of the terminal screw;
- at right angles to the long axis of the terminal screw;

(*b*) a torque of 1.8 N·m applied to the terminal screw.

12.11.2 *Strength of push button.* A force of 90 N should be applied to the end of the push-button for not less than 1 minute under each of the following conditions, during which the circuit-breaker should be connected electrically to check contact operation :

(*a*) perpendicular to the axis of travel of the push-button in both directions along the major and minor axes of the body of the circuit-breaker in both the open and closed positions;

(*b*) co-axial with the push-button axis toward and away from the circuit-breaker body throughout the entire range of push-button travel.

For the test in (*a*) the load should be applied 3 mm from the end of the push-button.

12.11.3 *Strength of panel mounting bush.* A tightening torque of 3.6 N·m should be applied for not less than 1 minute to the mounting nut with the circuit-breaker mounted in a panel and located by means of the locating washer and key-way.

12.11.4 There should be no damage or distortion to the threads, keyway, locating washer, locknut or circuit-breaker as a result of the tests described in clauses 12.11.1, 12.11.2 and 12.11.3, immediately following which the circuit-breaker should :

(*a*) satisfy the requirements of the insulation resistance test (clause 12.6.2);

(*b*) carry 100 % normal rated current in a temperature of 20 ± 2 °C for 1 hour without tripping;

(*c*) trip within the time limits shown in Table 2 for 20 °C when carrying 200 % normal rated current.

12.12 Test of calibration of overload trip

12.12.1 The circuit-breaker should be subjected to a series of tripping tests in ambient temperatures of 20 ± 2 °C, – 40 ± 2 °C and 55 ± 2 °C, to confirm its compliance with the performance requirements stated in Table 2.

12.12.2 In addition, to determine completely this characteristic, tripping times should be recorded and declared for currents of 20 and 30 times normal current on circuit-breakers rated 3 to 10 A. Each tripping time should be measured at least three times, a cooling period of not less than 2 hours being allowed between checks.

12.13 Overload and reclosure test

12.13.1 The circuit-breaker should be connected to control a resistive load carrying 200 % normal rated current, and should be operated as follows :

Close – trip automatically – reclose within 20 seconds of automatic trip.

These operations should be repeated 50 times.

12.13.2 Immediately following reclosing of the circuit-breaker at the end of the last operation in clause 12.13.1, the load should be reduced to 115 % normal rated current and should then be carried for a period of 1 hour without automatic tripping.

The voltage drop across the circuit-breaker terminals should be measured at the end of this test carrying 100 % rated current and should not exceed the limits specified in clause 12.4.

12.13.3 At the end of the tests described in clauses 12.13.1 and 12.13.2, a cooling period of not less than 2 hours should be allowed, followed by calibration checks on the same circuit-breaker at 200 %, 400 % and 600 % normal rated current. Tripping should occur within the time limits shown in Table 2.

12.14 Endurance tests

12.14.1 A single circuit-breaker should be checked for compliance with the requirements for the limits of ultimate trip (see clause 12.9) and the operating force test (clause 12.10) and should be subjected to 10 000 cycles of manual close and open operations at the fastest practical rate, but not less than two complete cycles per minute, divided as stated in clause 12.14.2 or 12.14.3. If the circuit-breaker has both an a.c. and a d.c. rating, separate samples may be used for these tests. The time closed should be approximately equal to the time open.

The manual operation may be performed mechanically but should simulate normal correct manual operation of the circuit-breaker including overtravel where this is a feature of the design.

12.14.2 *d.c. test conditions*

(1) 2400 cycles at 100 % normal rated current resistive load at sea level;

(2) 2500 cycles at 1 A, 0.6 H inductive load at sea level;

(3) 2500 cycles at 100 % normal rated current resistive load at a pressure corresponding to 18 300 m altitude;

(4) 2500 cycles at 1 A, 0.6 H inductive load at a pressure corresponding to 18 300 m altitude;

(5) 50 cycles at 100 % normal rated current, with an inductive load as shown in Table 6, at sea level;

(6) 50 cycles at 100 % normal rated current, with an inductive load as shown in Table 6 at a pressure corresponding to 18 300 m altitude.

The test voltage should be maintained at $28 \begin{smallmatrix} +2 \\ 0 \end{smallmatrix}$ V d.c. throughout.

12.14.3 *a.c. test conditions*

(1) 2500 cycles at 100 % normal rated current resistive load at sea level;

(2) 2500 cycles at 100 % normal rated current in a circuit of 0.75 power factor lagging at sea level;

(3) 2500 cycles at 100 % normal rated current resistive load at a pressure corresponding to 18 300 m altitude;

(4) 2500 cycles at 100 % normal rated current in a circuit of 0.75 power factor lagging at a pressure corresponding to 18 300 m altitude.

The test supply should be maintained at $115^{+\,10}_{\ 0}$ V 380 to 420 Hz a.c. throughout.

12.14.4 During the tests described in clause 12.14.2 or 12.14.3, the voltage drop across the circuit-breaker terminals should be measured, at 100 % normal rated direct current, prior to commencement of the test, at every 500 cycles of operation and on completion of the test, and should at no time exceed the limits shown in Table 6.

At the conclusion of the endurance test, the circuit-breaker should be subjected to a check calibration of minimum and maximum limits of ultimate trip current as in clause 12.9. The tripping time should also be checked at 200 % rated current, and should be within the limits shown in Table 2 for 20 °C.

TABLE 6 – **Voltage drop and inductance of load**

Normal rated current	Voltage drop across terminals (max)	Inductance of load for d.c. tests
A	mV	H
1	1500	1.0
2	1000	0.5
3	750	0.4
5	300	0.2
7.5	300	0.15
10	300	0.1
15	225	0.07
20	200	0.05
25	200	0.04
35	160	0.03

NOTE. – It is preferable to use air-cored coils for the inductive loads. When a ferro-magnetic circuit is used, the inductance values should be measured, using a direct current of the appropriate value.

12.14.5 Upon completion of the tests described in clauses 12.14.1 to 12.14.4, the circuit-breaker should be retested in accordance with clause 12.10.

12.15 Making and breaking capacity tests

12.15.1 Tests should be performed at the prospective test currents stated in Table 3 or 4 appropriate to the declared rupturing capacity of the circuit-breaker under test.

More than one circuit-breaker may be used for these tests, but tests at a particular test current and air pressure should be made on the same sample.

The circuit-breaker should be tested at an air pressure corresponding to sea level and at an air pressure corresponding to an altitude of 18 300 m, by inserting it into the calibrated test circuit and testing as follows :

Break test current – make and break test current – make and break test current.

NOTE. – Sufficient force should be applied to the operating button to achieve normal closing of the circuit-breaker : a suggested minimum rate of travel of the button is 12.7 mm/s.

During the calibration tests the cable terminations normally connected to the circuit-breaker under test should be clamped together without an intermediate link. A fine fuse wire (0.122 mm diameter) should be connected between the circuit-breaker mounting face and the system neutral or negative. A typical test circuit is shown in the Figure, page 15.

The actual time of rise of the test current should be recorded during the calibration tests and this value should be stated in the test reports.

Oscillograph records of the test current during these tests should be made.

The open circuit voltage should be maintained across the circuit-breaker terminals for a minimum period of 5 seconds after recovery to stable conditions, and there should be no current flow or arcing between the contacts during this period.

During the test there should be no leakage current as indicated by melting of the fine fuse wire.

12.15.2 *d.c. test conditions.* A source of power capable of providing current of the values stated in Table 3 should be calibrated to conform with the following requirements :

(*a*) the open circuit voltage should be $28 \, ^{+4}_{0}$ V d.c.

(*b*) the transient open circuit recovery voltage after interruption of test currents should be as follows :

- recovery to 28 V to occur within 0.002 second;
- maximum voltage not to exceed 50 V;
- subsequent excursion above or below the nominal voltage to constitute a damped oscillation;

(*c*) the relevant prospective currents should be reached as follows :

- currents up to 3000 A in not more than 0.005 second;
- current of 6000 A in 0.010 to 0.030 second.

12.15.3 *a.c. test conditions.* A source of power capable of providing current of the values specified in Table 4 should be calibrated to conform with the following requirements :

(*a*) the open circuit voltage should be $115 \, ^{+10}_{0}$ V r.m.s. at 400 ± 20 Hz;

(*b*) the transient open circuit recovery voltage after interruption of the test current should be 120 V within three cycles, 150 V within six cycles, and should not exceed 165 V;

(*c*) the relevant prospective current should be reached between 10 and 25 cycles;

(*d*) the frequency during the test should be between 350 and 450 Hz.

12.15.4 At the conclusion of the tests described in clause 12.15.2 or 12.15.3 and after a cooling period of not less than 1 hour, each circuit-breaker should have a tripping time within 120 % of the maximum and 80 % of the minimum times stated in Table 2. The high voltage and insulation resistance tests specified in clause 12.6 should then be repeated.

12.16 Test of self re-closing at low temperature

The circuit-breaker should be tripped automatically under overload conditions in a ambient temperature of − 50 ± 2 °C and should be kept at this temperature for 1 hour during which it should not re-close automatically.