When selecting circuit-breakers for service, it is also necessary to take into account their characteristics in respect of transient phenomena and overvoltages. Experience shows that the unfavourable effects of transient phenomena and the risk of overvoltages for certain critical cases of application can be minimised by

– appropriate selection of the type of circuit-breaker;
– changes in the system or the use of additional equipment for damping and limiting transient phenomena (RC circuits, overvoltage arresters, non-linear resistances, etc.).

These precautions shall be discussed with the manufacturer for individual cases. Special tests can be agreed for evaluating the selected solution.

8.102.3 Rated frequency

The manufacturer should be consulted if a circuit-breaker is to be used at any frequency other than its rated frequency (see 4.3 of IEC 60694).

When circuit-breakers rated 50 Hz are tested at 60 Hz and vice versa, care should be exercised in the interpretation of the test results, taking into account all significant facts such as the type of circuit-breaker and the type of test performed.

8.102.4 Selection of rated normal current

The rated normal current of a circuit-breaker should be selected from the standard values given in 4.4.

It should be noted that circuit-breakers have no specified continuous over-current capability. When selecting a circuit-breaker therefore, the rated normal current should be such as to make it suitable for any load current that may occur in service. Where intermittent over-currents are expected to be frequent and severe, the manufacturer should be consulted.

8.102.5 Local atmospheric and climatic conditions

The normal atmospheric and climatic conditions for circuit-breakers are given in clause 2.

A distinction is made between classes "minus 5 indoor", "minus 15 indoor", "minus 25 indoor", "minus 10 outdoor", "minus 25 outdoor" and "minus 40 outdoor" circuit-breakers, these being suitable for differing minimum ambient air temperatures. The manufacturer should be consulted if a circuit-breaker is to be located where the ambient air temperature may fall below –25 °C for an indoor circuit-breaker, and below –40 °C for an outdoor circuit-breaker, or where the temperature may exceed 40 °C (or if the 24 h average value exceeds 35 °C).

For outdoor circuit-breakers, the atmospheric conditions in certain areas are unfavourable on account of smoke, chemical fumes, salt-laden spray and the like. Where such adverse conditions are known to exist, special consideration should be given to the design of those parts of the circuit-breaker, especially the insulators, normally exposed to the atmosphere.

The performance of an insulator in such atmospheres also depends on the frequency of washing or cleaning operations and on the frequency of natural washing by rain. Since the performance of an insulator under such conditions is dependent on so many factors, it is not possible to give precise definitions of normal and heavily polluted atmospheres. Experience in the area where the insulator is to be used is the best guide.

The manufacturer should be consulted when the circuit-breaker is to be located where the wind pressure exceeds 700 Pa.

Three different classes of circuit-breakers are specified with regard to ice-coating. These classes correspond to an ice-coating not exceeding 1 mm, 10 mm and 20 mm. If a circuit-breaker is to be located where an ice-coating exceeding 20 mm is expected, agreement should be reached between manufacturer and user as to the ability of the circuit-breaker to perform correctly under such conditions.

Where applicable, the seismic qualification levels referred to in 2.2.4 of IEC 60694 should be taken into account.

For indoor installations, the humidity conditions are given in 2.1.1e) of IEC 60694. When selecting the circuit-breaker for service, it is recommended to indicate the cases, where the high values of humidity are expected and condensation can occur. The responsibility and the amount of precaution to be taken against the occurrence of condensation mentioned in note 3 of 2.1.1e) of IEC 60694 should be agreed between the manufacturer and user.

For indoor circuit-breakers, the manufacturer should be consulted for any special service conditions, for example when chemical fumes, aggressive atmosphere, salt laden spray, etc., are present.

8.102.6 Use at high altitudes

The normal service conditions specified in clause 2 of IEC 60694 provide for circuit-breakers intended for use at altitudes not exceeding 1 000 m.

For installation at altitudes above 1 000 m, 2.2.1 of IEC 60694 is applicable.

8.103 Selection of rated values for fault conditions

8.103.1 Selection of rated short-circuit breaking current

As stated in 4.101, the rated short-circuit breaking current is expressed by two values:

a) the r.m.s. value of its a.c. component;

b) the percentage d.c. component (for explanations, see I.2).

The percentage d.c. component varies with time from the incidence of the short-circuit. When the circuit-breaker meets the standard requirements stated in 4.101.2, the percentage d.c. component that the circuit-breaker can deal with is defined by the values given in figure 9, at the end of the time interval corresponding to the shortest possible opening time of the circuit-breaker plus, for a circuit-breaker to be tripped solely by a form of auxiliary power, a minimum relay time of one half-cycle of rated frequency. The curves in figure 9 are based on a constant a.c. component and on the short-circuit power factors stated in table 23, corresponding to the standard time constant τ = 45 ms and the special case time constants 60 ms, 75 ms and 120 ms, respectively.

Tests with a higher d.c. component cover tests at lower d.c. component, provided that the a.c. component is the same or greater and the TRV conditions associated with the lower d.c. component are met.

Table 23 – Relationship between short-circuit power factor, time constant and power frequency

Time constant τ ms	Short-circuit power factor $\cos \varphi$	
	50 Hz	**60 Hz**
45	0,071	0,059
60	0,053	0,044
75	0,042	0,035
120	0,026	0,022

When the location of the installation is sufficiently remote electrically from rotating machines, the decrement of the a.c. component is negligible and it is only necessary to verify that in the case of 50 Hz the short-circuit power factor is not less than 0,071 for the standard time constant τ = 45 ms and the minimum relay time of the protective equipment is not less than one half-cycle of the rated frequency. In these conditions, it is sufficient that the selected circuit-breaker has a rated short-circuit breaking current not less than the r.m.s. value of the short-circuit current at the point where the circuit-breaker is to be installed.

The basic short-circuit test-duties (6.106), together with the critical current tests (6.107) and, where applicable, short-line fault tests (6.109), have been chosen to prove the circuit-breaker for all values of current up to the rated short-circuit breaking current. Therefore, for situations where the prospective short-circuit current is lower, it is not necessary to perform a short-circuit test series based on a lower rated short-circuit breaking current.

In some cases, the percentage d.c. component may be higher than the values given in figure 9. For instance, when circuit-breakers are close to centres of generation, the a.c. component may decrease more quickly than in the normal case. The short-circuit current may then not have a current zero for a number of cycles. In such circumstances the duty of the circuit-breaker can be eased, for example, by delaying its opening, or by connecting an additional damping device with another circuit-breaker and opening the circuit-breakers in sequence. If the standard values of percentage d.c. component cannot be adhered to, the required percentage should be specified in the enquiry and testing should be subject to agreement between manufacturer and user. Attention is drawn to item b) of 8.103.2.

NOTE The current zero can be advanced by the effects of the arc voltages of the circuit-breaker and/or the interruptions of the short-circuit currents in the other phases with earlier current zeros. For such circumstances, standard circuit-breakers are applicable, subject to careful investigation.

The rated short-circuit breaking current should be selected from the standard values given in 4.101.1.

A2 8.103.2 Selection of rated transient recovery voltage (TRV) for terminal faults, first-pole-to-clear factor and characteristics for short-line faults

The prospective transient recovery voltage (TRV), of the system should not exceed the reference line representing the rated transient recovery voltage specified for the circuit-breaker; it should cross the specified delay line close to zero voltage but should not re-cross it later (see 4.102.2). Standard values are shown in 6.104.5.

NOTE 1 The transient recovery voltages which appear when breaking the highest short-circuit currents are not necessarily more severe than those which appear in other cases. For example, the rate-of-rise of transient recovery voltage may be higher when breaking smaller short-circuit currents. A2

A2 In the range of rated voltages higher than 1 kV and less than 100 kV, in order to cover all types of networks (distribution, industrial and sub-transmission) and for standardisation purposes, two types of systems are defined:

– cable systems (see 3.4.119);
– line systems (see 3.4.120).

The following considerations should facilitate the choice by the user of the class of circuit-breaker for rated voltages higher than 1 kV and less than 100 kV:

– standard values of TRVs specified in edition 1.1 (ed.1 + A1) of IEC 62271-100 can still be required by specifying class S1 (these standard values of TRVs are given in Table 24);
– to cover all cases of cable systems and line systems, except those mentioned in a) , b) and c) below, class S2 of circuit-breakers has to be specified (standard values of TRVs are given in Table 25).

NOTE 2 In the special cases where the total length of cable (or equivalent length when capacitors are also present) on the supply side of the circuit-breaker is between 20 m and 100 m, the system is considered as a line system except if a calculation can show that the actual TRV is covered by the envelope defined from Table 24. If the TRV is covered the system is then considered as a cable system.

The standard values given for rated voltages below 100 kV are applicable to a first-pole-to-clear factor 1,5. For rated voltages 100 kV to 800 kV, the first-pole-to-clear factor is 1,3 since most systems at 100 kV and above are effectively earthed. For rated voltages 100 kV to 170 kV, a choice of a first-pole-to-clear factor 1,5 is provided for those special cases with non-effectively earthed neutrals (see also the Note in 6.104.5.4).

The first-pole-to-clear factor k_{pp} = 1,3 is based on a system with effectively earthed neutral where three-phase faults not involving earth are considered highly improbable. For applications in non-effectively earthed neutral systems, the first-pole-to-clear factor 1,5 should be used. For applications in systems with effectively-earthed neutral in cases where the probability of three-phase faults not involving earth cannot be disregarded, and for applications in systems other than with effectively-earthed neutral systems, a first-pole-to-clear factor of 1,5 may be necessary.

Generally it will not be necessary to consider alternative transient recovery voltages as the standard values specified cover the majority of practical cases.

More severe conditions may occur in some cases, for example:

a) One case is when a short-circuit occurs close to a transformer but on the opposite side to the circuit-breaker and where there is no appreciable additional capacitance between the transformer and the circuit-breaker. In this case both the peak voltage and rate-of-rise of transient recovery voltage may exceed the values specified in this standard.

   NOTE 3 Care should also be taken when selecting a circuit-breaker for the primary side of a transformer which may have to interrupt a short circuit on the secondary side.

   For circuit-breakers with rated voltages less than 100 kV, such cases are covered in Annex M.

   NOTE 4 For circuit-breakers with rated voltages 100 kV and higher, values for TRVs for transformer limited faults are proposed in ANSI C37.06.1 [16] for fast transient recovery voltage rise times.

b) Circuit-breakers being used next to current-limiting reactors may fail to interrupt due to the high natural frequency of these reactors (see 8.103.7).
c) In the case of a short-circuit on circuit-breakers close to generators, the rate-of-rise of transient recovery voltage may exceed the values specified in this standard. A2

A2 In such cases it may be necessary for special TRV characteristics to be agreed between manufacturer and user.

Short-line fault tests are applicable only to circuit-breakers designed for direct connection to overhead lines, irrespective of the type of network on the source side, having a rated voltage of 15 kV and above and a rated short-circuit breaking current exceeding 12,5 kA. When circuit-breakers are required for installations necessitating the assignment of rated characteristics for short-line faults, the line on which they are to be used should have a surge impedance and peak-factor not greater than, and a time delay not less than, the standard values of rated line characteristic given in Table 4. However, if this should not be the case, it is still possible that a standard circuit-breaker is suitable, especially if the short-circuit current of the system is less than the rated short-circuit breaking current of the circuit-breaker. This can be established by calculating the prospective TRV for short-line faults from the rated characteristics by the method given in Annex A and comparing this with the prospective TRV derived from the actual characteristics of the system.

If special characteristics for short-line faults are required, they should be agreed between manufacturer and user. A2

8.103.3 Selection of out-of-phase characteristics

The requirements of this standard cater for the great majority of applications of circuit-breakers intended for switching during out-of-phase conditions. Several circumstances would have to be combined to produce a severity in excess of those covered by the tests of the standard and, as switching during out-of-phase conditions is rare, it would be uneconomical to design circuit-breakers for the most extreme conditions.

The actual system conditions should be considered when frequent out-of-phase switching is expected or where excessive stresses are probable.

A special circuit-breaker, or one rated at a higher voltage, may sometimes be required. As an alternative solution, the severity of out-of-phase switching duty is reduced in several systems by using relays with coordinated impedance-sensitive elements to control the tripping instant, so that interruption will occur either substantially after or substantially before the instant the phase angle reaches 180°.

A2 A higher rate of rise than specified in Tables 24, 25, 1b, 1c and 1d may occur when one circuit-breaker terminal is transformer-connected. Circuit-breakers tested in accordance with this standard are considered to comply with this higher rate-of-rise requirement, provided they have satisfied test-duty T30 of the basic short-circuit test series (see 6.106.2). A2

8.103.4 Selection of rated short-circuit making current

As stated in 4.103, the rated short-circuit making current shall correspond to the rated voltage and is related to the rated frequency and the d.c. time constant of the system. For a rated frequency of 50 Hz and based on the standard time constant τ = 45 ms, it shall be 2,5 times (i.e. approximately 1,8$\sqrt{2}$ times) the a.c. component of the rated short-circuit breaking current of the circuit-breaker. For a rated frequency of 60 Hz and based on the standard time constant τ = 45 ms, it shall be 2,6 times the a.c. component of the rated short-circuit breaking current of the circuit-breaker.

If one of the special case d.c. time constants (60 ms, 75 ms or 120 ms) stated in 4.101.2 applies, taking the explanations given in I.2 into account, the rated short-circuit making current shall be 2,7 times the a.c. component of the rated short-circuit breaking current of the circuit-breaker, for both 50 Hz and 60 Hz whatever the rated frequency.

The selected circuit-breaker should have a rated short-circuit making current not less than the highest peak value of the short-circuit currents expected at the application point.

In some cases, for example when induction motors are electrically close, the maximum peak value of the fault current may be more than the a.c. component of the short-circuit current multiplied by the factors given above. In such cases, a special design should be avoided and a standard circuit-breaker having a suitable rated short-circuit making current should be selected.

8.103.5 Operating sequence in service

The rated operating sequence of a circuit-breaker should be one of the operating sequences given in 4.104. Unless otherwise specified, the values of the time intervals given in 4.104 apply and the rated operating sequences provided for are as follows:

a) O - 3 min - CO - 3 min - CO;

b) CO - 15 s - CO;

c) O - 0,3 s - CO - 3 min - CO (for circuit-breakers intended for rapid auto-reclosing).

NOTE Instead of 3 min, other time intervals, namely 15 s for rated voltages less than or equal to 52 kV and 1 min are also used for circuit-breakers intended for rapid auto-reclosing. The interval to be chosen depends in principle upon system requirements such as continuity of service.

If the short-circuit current, which the circuit-breaker is capable of breaking on auto-reclosing, is less than the rated short-circuit breaking current, this should be specified by the manufacturer.

When the operating sequence in service is more severe than is provided for in this standard, this should be specified by the user in his enquiry and/or order in such a way that the manufacturer may modify the rating of the circuit-breaker appropriately. Examples of circuit-breakers for special duty are those used for controlling arc furnaces, electrode boilers and, in certain cases, rectifiers. Single-pole operation of a multipole circuit-breaker, for example with a view to single-phase making and breaking, is also a special duty.

8.103.6 Selection of rated duration of short-circuit

The standard value of rated duration of short-circuit (4.7 of IEC 60694) is 1 s.

If, however, a lower or higher duration is necessary, the recommended values of 0,5 s, 2 s and 3 s should be selected as the rated value.

For short-circuit durations greater than the rated duration, the relation between current and time, unless otherwise stated by the manufacturer, is in accordance with the formula:

$$I^2 \times t = \text{constant}$$

For self-tripping circuit-breakers, a rated duration of short-circuit shall be assigned only if the maximum time-lag is greater than the prospective one. In such a case, it shall be defined as above.

A2 8.103.7 Series reactor faults

Due to the very small inherent capacitance of a number of series reactors, the natural frequency of transients involving these reactors can be very high. A circuit-breaker installed immediately in series with such type of reactor will face a high frequency TRV when clearing a terminal fault (reactor at supply side of circuit-breaker) or clearing a fault behind the reactor (reactor at load side of circuit-breaker). The resulting TRV frequency generally exceeds by far the standardised TRV values.

In these cases, it is necessary to take mitigation measures, such as the application of capacitors in parallel to the reactors or connected to earth. The available mitigation measures are very effective and cost efficient. It is strongly recommended to use them, unless it can be demonstrated by tests that a circuit-breaker can successfully clear faults with the required high frequency TRV.

The mitigation method should be such that the rate-of-rise of TRV for the fault current, as limited by the series reactor, is reduced to a value lower than the standard values given in Tables 26 or 27, depending on the circuit-breaker ratings. It has to be considered that the fault current can be close to 100 % of the rating of the circuit-breaker.

Based on the preceding considerations, no rated values of TRV and no special test duty are specified for this fault case. A2

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

A circuit-breaker class E2 is defined in 3.4.113. 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 conditions of use on an overhead-line connected network, including auto-reclosing duty, a low-maintenance circuit-breaker capable of meeting the electrical endurance requirements specified in 6.112 is recommended.

8.105 Selection for capacitive current switching

Caution is required where capacitor banks are to be installed at substations where cables are already installed, and vice versa, as this can inflict back-to-back switching duties on the controlling circuit-breakers for these circuits. The back-to-back duty may be similar to that detailed in subclause 4.107.4.

9 Information to be given with enquiries, tenders and orders

9.101 Information to be given with enquiries and orders

When enquiring for or ordering a circuit-breaker, the following particulars should be supplied by the enquirer:

a) particulars of systems, i.e. nominal and highest voltages, frequency, number of phases and details of neutral earthing;

b) service conditions including minimum and maximum ambient air temperatures, altitude if over 1 000 m and any special conditions likely to exist or arise, for example unusual exposure to water vapour, moisture, fumes, explosive gases, excessive dust or salt air (see 8.102.5 and 8.102.6);

c) characteristics of circuit-breaker

The following information should be given:

	Type of information	Reference
1)	number of poles	
2)	class: indoor or outdoor	8.102.1
3)	rated voltage	8.102.2
4)	rated insulation level where a choice exists between different insulation levels corresponding to a given rated voltage, or, if other than standard, the desired insulation level	
5)	rated frequency	8.102.3
6)	rated normal current	8.102.4
7)	rated short-circuit breaking current	8.103.1
8)	first-pole-to-clear factor	8.103.2
9)	if other than standard, desired transient recovery voltage for terminal faults	8.103.2
10)	if other than standard, desired characteristics for short-line faults	8.103.2
11)	if other than standard, desired short-circuit making current	8.103.4
12)	rated operating sequence	8.103.5
13)	if other than standard, desired duration of short-circuit	8.103.6
14)	break-time	4.109
15)	if applicable, restrike performance during capacitive current switching (class C1 or C2)	4.107
16)	if applicable, characteristics for capacitive switching conditions (for example, earthing conditions, type of capacitive load, etc.)	4.107
17)	if applicable, rated line-charging breaking current	4.107.1
18)	if applicable, rated cable-charging breaking current	4.107.2
19)	if applicable, rated single capacitor bank breaking current	4.107.3
20)	if applicable, rated back-to-back capacitor bank breaking current	4.107.4
21)	if applicable, rated single capacitor bank inrush making current	4.107.5
22)	if applicable, rated back-to-back capacitor bank inrush making current	4.107.6
23)	if applicable, rated out-of-phase making and breaking current	4.106
24)	the type tests specified under special request (for example artificial pollution and radio interference, etc.)	6.2.8 and 6.3
25)	the frequency of mechanical operations (class M1 or M2)	4.110
26)	if applicable, characteristic for electrical endurance (class E1 or E2 (with/without auto-reclosing duty))	4.111
27)	if applicable, small inductive breaking current	4.108
28)	if applicable, any test exceeding the standardised type, routine and commissioning tests	

d) characteristics of the operating mechanism of circuit-breaker and associated equipment, in particular:
   1) method of operation, whether manual or power;
   2) number and type of spare auxiliary switches;
   3) rated supply voltage and rated supply frequency;
   4) number of releases for tripping, if more than one;
   5) number of releases for closing, if more than one.

e) requirements concerning the use of compressed gas and requirements for design and tests of pressure vessels.

NOTE The enquirer should give information of any special conditions not included above, that might influence the tender or order (see also the note in 8.101).

9.102 Information to be given with tenders

When the enquirer requests technical particulars of a circuit-breaker, the following information (those which are applicable) should be given by the manufacturer, with the descriptive matter and drawings:

a) rated values and characteristics:

	Type of information	Reference
1)	number of poles	
2)	class: indoor or outdoor, temperature, ice-coating	8.102.5
3)	rated voltage	8.102.1
4)	rated insulation level	8.102.2
5)	rated frequency	8.102.3
6)	rated normal current	8.102.4
7)	rated short-circuit breaking current	8.103.1
8)	first-pole-to-clear factor	8.103.2
9)	transient recovery voltage for terminal faults	8.103.2
10)	characteristics for short-line faults	8.103.2
11)	rated short-circuit making current	8.103.4
12)	rated operating sequence	8.103.5
13)	rated duration of short-circuit	8.103.6
14)	rated opening time, rated break-time and rated closing time	4.109
15)	restrike performance during capacitive current switching (Class C1 or C2)	4.107
16)	characteristics for capacitive current switching conditions	4.107
17)	rated line-charging breaking current	4.107.1
18)	rated cable-charging breaking current	4.107.2
19)	rated single capacitor bank breaking current	4.107.3
20)	rated back-to-back capacitor bank breaking current	4.107.4
21)	rated single capacitor bank inrush making current	4.107.5
22)	rated back-to-back capacitor bank inrush making current	4.107.6
23)	rated out-of-phase making and breaking current	4.106
24)	the type tests specified under special request (for example artificial pollution and radio interference, etc.)	6.2.8 and 6.3
25)	class M1 or class M2 for mechanical endurance	4.110
26)	class E1 or class E2 (with/without auto-reclose) for electrical endurance	4.111
27)	A2 class S1, S2 circuit-breakers (circuit-breakers with rated voltage less than 100 kV)	6.104.5
28)	small inductive breaking current	4.108 A2

b) type tests:

   certificate or report on request;

c) constructional features:

   The following details are required where they are applicable to the design:

   1) mass of complete circuit-breaker without fluids for insulation, interruption and operation;
   2) mass/volume of fluid for insulation, its quality and operating range, including the minimum functional value;
   3) mass/volume of fluid for interruption (where different fluid to items 2) and/or 4)), its quality and operating range, including the minimum functional value;
   4) mass/volume of fluid for operation (where different fluid to items 2) and/or 3)), its quality and operating range, including the minimum functional value;
   5) tightness qualification;
   6) mass/volume of fluids per pole to fill to a level sufficient to prevent deterioration of internal components during storage and transportation;
   7) number of units in series per pole;
   8) minimum clearances in air:
      – between poles;
      – to earth;
      – the safety boundaries during a breaking operation, for circuit-breakers with an external exhaust for ionised gasses or flame;
   9) any special arrangements (for example heating or cooling) to maintain the rated characteristics of the circuit-breaker at the required temperatures of the ambient air;

d) operating mechanism of circuit-breaker and associated equipment:

   1) type of operating mechanism;
   2) whether the circuit-breaker is suitable for trip-free or fixed trip operation and whether it is provided with a lock-out device preventing closing;
   3) rated supply voltage and/or pressure of closing mechanism, pressure limits where different to or expanding data required in c) 4) of 9.102;
   4) current required at rated supply voltage to close the circuit-breaker;
   5) energy expended to close the circuit-breaker, for example measured as a fall in pressure;
   6) rated supply voltage of shunt opening release;
   7) current required at rated supply voltage for shunt opening release;
   8) number and type of spare auxiliary switches;
   9) current required at rated supply voltage by other auxiliaries;
   10) setting of high and low pressure interlocking devices;
   11) number of releases for tripping, if more than one;
   12) number of releases for closing, if more than one;

e) overall dimensions and other information:

   The manufacturer should give the necessary information as regards the overall dimensions of the circuit-breaker and details necessary for the design of the foundation.

   General information regarding maintenance of the circuit-breaker and its connections should be given.

10 Rules for transport, storage, installation, operation and maintenance

Clause 10 of IEC 60694 is applicable, with the following additions:

10.1 Conditions during transport, storage and installation

Subclause 10.1 of IEC 60694 is applicable.

10.2 Installation

Subclauses 10.2.1 to 10.2.4 of IEC 60694 are applicable, with the following addition:

10.2.101 Guide for commissioning tests

After a circuit-breaker has been installed and all connections have been completed, commissioning tests are recommended to be performed. The purpose of these tests is to confirm that transportation and storage have not damaged the circuit-breaker. In addition, when a large part of the assembly and/or of the adjustment is performed on site, as identified in 7.101, the tests are required to confirm compatibility of the sub-components and the satisfactory nature of both the site work and the functional characteristics dependent upon it.

In addition to the requirements of 10.2.102, a minimum of 50 no-load operations shall be performed on site on the circuit-breaker where major sub-assemblies are combined at site without previous routine tests on the complete circuit-breaker. These operations shall be performed after assembly, all connections and checks having been made and the programme of commissioning tests having been completed. These operations may include deferred routine test operations forming part of the commissioning programme only where they are made after all site adjustments and tightness checks are complete. The purpose of these tests is to reduce occurrences of maloperation and failure early in the operational life of the circuit-breaker.

The manufacturer shall produce a programme of site commissioning checks and tests. Repetition of the full programme of routine tests, already performed in the factory, shall be avoided as the purpose of commissioning tests is for confirmation of

– absence of damage;
– compatibility of separate units;
– correct assembly;
– correct performance of the assembled circuit-breaker.

In general, this is achieved when the commissioning tests include, but are not limited to, the programme given in 10.2.102. The results of the tests shall be recorded in a test report.