LOVAG
TEST INSTRUCTION IEC/EN 60439-1 Ed. 4.1a

LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

Part 1: Type-tested and partially type-tested assemblies

This test instruction is based on the following Standard:

General Rules:

IEC 60439-1: Ed.4.1 (2004)

EN 60439-1 (1999) + A1 (2004)

Specific Requirements:

As above

It complies with this standard in all respects, and provides additional information ensuring a suitable degree of repeatability of the tests between the different test stations.

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1. PREAMBLE

For convenience in the use of this test instruction, the paragraphs are numbered according to the clauses in the IEC document.

Tests must be carried out according to the standard; the test instruction only adds a few specific details.

2. DEFINITIONS

2.1.1.2 Partially type-tested low-voltage and controlgear assembly (PTTA).

Until such time as the standard details requirements for extrapolation, a Certificate shall relate only to Assemblies for which certification has been undertaken by test. i.e. Type-Tested Assembly (TTA).

7. DESIGN AND CONSTRUCTION

7.3 Temperature rise

Attention is drawn to the Note at the end of the first paragraph, which states that:

'The temperature rise of an element or part is the difference between the temperature of this element or part measured in accordance with Sub-clause 8.2.1.5 and the ambient air temperature outside the ASSEMBLY.'

This means the external ambient temperature. The maximum allowable external ambient temperature according to the Standard is 40°C.

The note in TABLE 2 for Built-in components states that the temperature rise for built-in components will be:

'In accordance with the relevant product standard requirements for the individual components, or, in accordance with the component manufacturer's instructions, taking into consideration the temperature in the ASSEMBLY'.

This is taken to mean the relevant requirements for the individual component shall be the relevant international standard for the component, if any. Alternatively the temperature rise limits may be based on the data given in the manufacturer instructions.

Where the terminals of the built-in component are also the terminals for external insulated conductors the lower of the two temperature rise values shall be applied i.e. the difference between the specified temperature for the terminals of the built-in component and the ambient temperature outside the assembly or 70K whichever is the lower value.

Where applicable, the allowable temperature rise of built-in components, conductors and insulating materials etc shall be specified by the manufacturer and detailed in the test report.

Assuming all other criteria listed in the table 2 are met, a maximum temperature rise of 105K for bare copper busbars and conductors shall not be exceeded. The 105K relates to the temperature above which annealing of copper is likely to occur.

7.5 Short-circuit protection and short-circuit withstand strength.

7.5.2 Information concerning the short-circuit withstand strength

7.5.2.1.1 Refer to Standard

Full details of the short-circuit protective device incorporated in the incoming unit shall be included in the test report. These shall include manufacturers name and reference, rated current, rated voltage, type of device, breaking capacity, cut-off current, I^2t, maximum time-delay setting, current setting as appropriate depending on whether the SCPD is a fuse or current limiting circuit-breaker (with or without time-delay release). Where values of cut-off current and I^2t are specified as above, by the manufacturer, the conditions under which these values were achieved should be established and detailed in the test report e.g. cut - off current may have been measured as a single phase value in the case of a fuse.

7.5.2.1.2 Refer to Standard

Full details of the SCPDs necessary for protection of the assembly when conducting rated conditional short-circuit and rated short time withstand current tests shall be detailed in the test report in accordance with sub-clause 7.5.2.1.1 above.

7.5.4 Co-ordination of short-circuit protective devices. (SCPDs)

If the test circuit incorporates SCPDs, the report shall detail the SCPDs used for test i.e. manufacturer's name and reference, rated current, rated voltage and type of device. In addition, the short-circuit rating of the SCPD shall be stated where this differs from that of the associated connection of the ASSEMBLY.

7.5.5 Circuits within an ASSEMBLY

The requirements of this clause and the related sub-clauses 7.5.5.1.1, 7.5.5.1.2, 7.5.5.2 and 7.5.5.3 are to ensure that bus bars (bare or insulated) and/or conductors are arranged in such a manner that an internal (or integral) short-circuit is not to be expected under normal operating conditions. Further clarification is provided in the sub- clauses that "an internal short-circuit between phases and/or between phases and earth is only a remote possibility". Reference is also made to clause and Table 17, which provides examples of conductor types and installation requirements.

It shall be detailed in the test report how the requirements of this clause are fulfilled.

8. TEST SPECIFICATIONS

8.2 Type Tests

8.2.1 Verification of temperature-rise limits

8.2.1.1 General

Refer to Standard

i) The test shall be carried out at the values of rated current in accordance with sub-clause 8.2.1.3 with the apparatus of the ASSEMBLY installed.

ii) Where heating resistors are utilised the test report shall detail the precautions taken to make the test representative.

iii) Where the manufacturer requires verification of the rated current of an open type assembly, the assembly will be subjected to a temperature rise test.

8.2.1.2 Arrangement of the ASSEMBLY

Refer to Standard and 8.2.1.1

The ASSEMBLY shall be arranged for test in accordance with the manufacturer's instructions and the test arrangement shall be detailed in the test report.

8.2.1.3 Temperature-rise test using current on all apparatus.

Refer to Standard

The test report shall detail the combination of circuits used for test, the diversity factor and details of external conductors. Notes 1, 2 and 3 are applicable and if utilised shall be stated as being so in the test report.

The test shall be made on one or more representative combinations of circuits for which the ASSEMBLY is designed, chosen so as to obtain with reasonable accuracy the highest possible temperature rise.

To fulfil this requirement the test should be carried out taking into account the following suggestions:

I) The incoming circuit should be loaded with its rated current;

II) The choice of the loaded outgoing circuits shall be based on the following rules:

- to select at least one sample for each type of built-in component; type means basic type (e.g. contactor, MCCB, RCCB), or product line of manufacturer, (e.g. “MCCB: type AA, type BB”; “ contactor: type CC, type DD”), and/or additionally differentiated between frame sizes.
- to select the circuits located in the warmest zones (in general those located in the upper zone of the switchboard);
- to select the circuits which temperature rise of the terminal of the built-in components is considered to be close to its limits defined by their relevant Standards. As alternative the circuits which produce the highest power losses will be selected.

8.2.1.3.2 For values of test current higher than 400A but not exceeding 800A.

Refer to Standard

8.2.1.3.3 For values of test current higher than 800A but not exceeding 3150A

Refer to 8.2.1.3.2

8.2.1.3.4 For values of test current higher than 3150A

Refer to 8.2.1.3.2

8.2.1.4 Temperature-rise test using heating resistors with an equivalent power loss

Refer to Standard and 8.2.1.1. The tests shall not be conducted using only heating resistors. The tests shall be conducted using a combination of heating resistors and representative circuits.

8.2.1.5 Measurement of temperatures

Refer to Standard

The positions at which measurements are made and the method of temperature measurement shall be detailed in the test report.

8.2.1.6 Ambient air temperatures

Refer to 8.2.1.5

8.2.1.7 Results to be obtained

Refer to Standard

The results of the measurements taken shall be detailed in the test report.

8.2.3 Verification of the short-circuit withstand strength

8.2.3.2.1 Test arrangements

Refer to Standard

All parts of the ASSEMBLY which may affect the results of the test or be affected by the test shall be fitted for the test e.g. enclosure covers, withdrawable outgoing units etc and this shall be stated in the test report.

Where such fitments are not incorporated on equipment provided for test the results of any relevant tests shall not be utilised for the assignment of ratings.

8.2.3.2.2 Performance of the test: General

Refer to Standard

Where an ASSEMBLY incorporates or is intended to incorporate a built-in component e.g. circuit-breaker and the interconnections to this device are to be included in the test report, then the device shall be closed for test as in normal service OR the interconnections must be short-circuited for test up to and including the point at which the circuit-breaker is 'terminated', such that the interconnections are part of the electrical circuit to be tested. Whatever has been tested must be clearly and unambiguously stated in the test report.

For the verification of all conditional and short time withstand withstand ratings (see 7.5.2.1.2) a calibration of the test circuit shall be conducted at 1.05 Ue in accordance with the standard. The actual test must be conducted at 1.05 Ue and lower test voltages are not permitted. The prospective current in each phase,

determined from the calibration oscillogram, shall be within the tolerance of+5% and 0% of the rated value.

For the verification of the short time withstand and peak withstand current ratings the standard also states that a calibration of the test circuit shall be conducted at 1.05 Ue and the actual test conducted at maximum operational voltage (1.05 Ue).

The calibration current is the actual test current and the current in each phase shall be within the tolerance of+5% and 0% of the rated value. However, in the event 'of a test station difficulty (refer to clause 8.2.3.2.4 b) of the standard) the test may be conducted at any convenient lower voltage. In this case, the actual test current is the rated current and the average of the current in each phase shall be within the tolerance +10% and 0% of the rated value. When this test is conducted at a lower voltage, this shall be stated in the test report.

The standard specifies that the prospective fault current in the fusible - element circuit shall be 1500A with a tolerance of+10%, except as stated in notes 2 and 3. Note 3 states that prospective fault current of less than 1500A +10% may be accepted subject to the agreement of the manufacturer and the relationship between the prospective fault current and the diameter of the copper wire is given in Table 12. The tolerance of+10% will apply to whatever value of prospective fault current is used for test in the fusible - element circuit.

8.2.3.2.3 Testing of the main circuits

Refer to Standard

For the test to Sub-clause 8.2.3.2.3 c) the standard requires the value of the short-circuit current to be the same as that for the main bars. This shall be taken to relate to the magnitude of rms and peak currents including the associated duration, and to the busbars to which the interconnections are made, not withstanding the designations of figures Dl to D5 of Annex D.

For the test to Sub-clause 8.2.3.2.3 d) the standard requires the value of test current to be 60% of the phase current and to be also agreed between the manufacturer and user if different to this. For the purposes of testing the term 'phase current' shall be taken to mean the rated short-time withstand, rated conditional short-circuit or rated short time withstand current as applicable, assigned to the associated main bus bars.

The relationship between the peak and rms current for the test to Sub-clause 8.2.3.2.3 d) shall be as in Table 4. The value of the rms test current, its peak and duration, shall be stated in the test report. The test applies to the main bus bars, bus bars, conductors connecting the bus bars to the outgoing circuit and the outgoing circuits.

Sub-clause 8.2.3.2.3 b) of the standard, details the precise requirements for the positioning of the short-circuit point related to prospective short-circuit current tests on the main bus bars, but does not make this reference for such tests on outgoing circuits (Sub-clause 8.2.3.2.3 a)) or interconnections (Sub-clause 8.2.3.2.3 c)). For the purposes of testing the connection requirements of Sub-clause 8.2.3.2.3 b) do not apply to the tests of Sub-clause 8.2.3.2.3 a) and c). The distance from the calibration point to the relevant short-circuit point(s) shall, however, be detailed within the test report. This may be in the form of a dimensioned diagrammatic representation of the main circuit(s) on page F439-1/03 "Configuration of the Assembly".

Tests on a neutral bar to Clause 8.2.3.2.3 d) shall not be included in a Certificate unless tests on the main bus bar to Clause 8.2.3.2.3 b) are also included.

8.2.3.2.4 Value and duration of the short-circuit current Refer to Standard and G. 8.2.3.2.2

The rated short-circuit currents or short-time withstand currents may be any recognized value provided the Certificate Front Sheet clearly indicates the associated peak factor which in turn must be at least that specified in Table 5 for the relevant short-circuit rating.

For ASSEMBLIES incorporating short-circuit protective devices, whether these be in the incoming circuit or elsewhere, the test voltage shall be applied for a time sufficiently long to enable the short-circuit protective device to operate to clear the fault and, in any case, for not less than 10 cycles.

Note 1 allows, due to test limitations, a different test period to be used providing that the test current is modified in accordance with the formula I^2t = constant, provided that the peak value does not exceed the rated peak withstand current without the manufacturer's consent and that the r.m.s. value of the short-time withstand current is not less than the rated value in at least one phase for at least 0.1 s after current initiation. In this case,

a) the r.m.s. value of the short-time withstand current must not be less than the rated value in at least one phase for at least 0.1 sec after current initiation.

b) the peak value must not exceed the rated peak current without the manufacturer's consent.

c) the value of I^2t in each phase, calculated from the actual test current and actual duration, must not be less than the required I^2t calculated from the rated current and duration.

Note 2 allows the peak withstand current test and short-time withstand current test to be separated. In this case, the rated values of short-time withstand current must be achieved within the tolerance of+10% / - 0% in each phase and the rated peak withstand current must be achieved in at least one phase.

8.2.3.2.5 Results to be obtained

Refer to Standard

The standard specifies that after test, slight deformation of the busbars is acceptable provided that the clearances and creepage distances specified in clause 7.1.2 are complied with. In the case of doubt, creepage and clearances distances shall be verified by measurement.

8.2.4 Verification of the effectiveness of the protective circuit.

8.2.4.1 Verification of the effective connection between the exposed conductive parts of the ASSEMBLY and the protective circuit.

Refer to Standard.

It is noted that according to sub-clause 7.4.3.1, the protective circuit in an ASSEMBLY consists of either a separate protective conductor or the conductive structural parts or both. With respect to clause 8.2.4, the frame of the ASSEMBLY may be considered as the protective circuit when a separate protective conductor is not fitted.

Resistance measurements conducted to verify the effectiveness of connection between the protective conductor and exposed conductive parts shall be carried out using a supply source with a current at least of 10A. The value of resistance shall not be greater than 0.1 ohm.

Verification of the requirements of Clause 8.2.4.1 on ASSEMBLIES coming within the requirements of Sub-clause 8.2.3.2 shall not be included within a Certificate unless verification of the short-circuit strength of the protective circuit by the test of sub-clause 8.2.4.2 is also included.

8.2.4.2 Verification of the short-circuit strength of the protective circuit by test.

When an ASSEMBLY is provided with a protective conductor and outgoing circuits then several short-circuit tests have to be conducted, both on the protective

conductor and on each representative outgoing circuit.

When an ASSEMBLY is only supplied with a protective conductor and no outgoing circuits, then only one test is conducted on the protective conductor.

8.2.4.3 Results to be obtained

Refer to Standard

It is noted that according to Note 2 of sub-clause 8.2.4.3, the resistance of the protective circuit under test, may be measured, before and after each test i.e. between the incoming terminal of the protective circuit and the outgoing terminal of the protective conductor of the circuit concerned, to give an indication that characteristics of the protective circuit have not been impaired. The values of resistance shall be detailed in the test report.

8.2.5 Verification of clearances and creepage distances.

Refer to Standard

The standard requires that clearances and creepage distances comply with the values specified in Sub-clause '7.1.2 which, in turn requires that the apparatus forming part of the ASSEMBLY shall have distances complying with those specified in their relevant specifications. It also requires that when arranging apparatus within the ASSEMBLY, the specified creepage distances and clearances or impulse withstand voltages shall be complied with, taking into account the relevant service conditions.

Clearances may be verified by measurement or by impulse voltage tests. Where clearances are verified by measurement, such measurements shall be conducted in accordance with the requirements of clauses 8.2.5 and 7.1.2.3.4 (with reference to Annex F) and shall be sufficient for the circuits to withstand the test voltage (impulse withstand voltage), according to clauses 7.1.2.3.2 and 7.1.2.3.3, with reference to the values given in Table 14 corresponding to a pollution degree as specified in clause 6.1.2.3. The pollution degree must be declared by the manufacturer and stated in the test report.

Clearances may be verified by measurement or by impulse voltage tests. If verification by impulse withstand voltage test is made, then only clearances according to table 14, case B, pollution degree 1 can be verified. Where clearances are verified by measurement, such measurements shall be conducted in accordance with the requirements of clauses 8.2.5 and 7.1.2.3.4 (with reference to Annex F) and shall be sufficient for the circuits to withstand the test voltage (impulse withstand voltage), according to clauses 7.1.2.3.2 and 7.1.2.3.3, with reference to the values given in Table 14 corresponding to a pollution degree as specified in clause 6.1.2.3. The pollution degree must be declared by the manufacturer and stated in the test report.

8.2.7 Verification of degree of protection

Refer to Standard

With reference to IEC 60529, when the equipment submitted for test is larger than the base of the drip box or a representative sample meeting this requirement cannot be supplied, LOVAG considers that the conditions for verifying compliance to IPX1 and IPX2 cannot be achieved. However, in accordance with the standard, if the conditions can be met by testing the sample in 'sections', it is permissible to inspect the sample and wipe the sample dry between tests that are, of necessity, repeated on the same area of the sample.

Clause 8.2.7 of IEC 60439-1 states that "The degree of protection provided in accordance with 7.2.1 and 7.7 shall be verified in accordance with IEC 60529 .....". Clause 7.2.1 refers to the IP rating of the ASSEMBLY. Clause 7.7 refers to internal barriers/partitions and forms of separation such that different IP ratings may be assigned to different parts of the ASSEMBLY. In the case where the manufacturer only declares an IP rating for the ASSEMBLY or different parts of the ASSEMBLY but not both, then what has been verified by test must be clearly stated on the certificate front sheet and in the test report. For example, if the manufacturer declares and IPXX rating for the ASSEMBLY only then the certificate front sheet shall state "External Degree of Protection of the Assembly (Clause 7.2.1)-IPXX."

Clause 8.2.7 of IEC 60439-1 specifies "If traces of water are readily observable within the enclosure immediately after the test for water ingress, then the dielectric properties shall be verified in accordance with 8.2.2." LOVAG interprets this requirement as a power frequency voltage test for duration of one minute in accordance with Clause 8.2.2 and not impulse voltage tests.

However, LOVAG also considers that this requirement does not take into account the possibility of water falling onto or into built-in components such as circuit breakers, fuse-switches and the like. It is also considered that a dielectric strength test is not adequate as the properties of "wet" equipment may be time dependent and the result of such a test can be affected favorably or otherwise with the passage of time e.g. soaking of insulation as opposed to drying out.

8.2.8 EMC tests

Refer to Standard

No EMC immunity or emission tests are required on final ASSEMBLIES if the following conditions are fulfilled:

a) The incorporated devices and components are in compliance with the requirements for EMC for the stated environment (see 7.10.1) as required by the relevant product or generic EMC standard.

b) The internal installation and wiring is carried out in accordance with the devices and component manufacturers‘ instructions (arrangement with regard to mutual influences, cable, screening, earthing etc.).

In all other cases the EMC requirements shall be verified by tests as mentioned in H.8.2.8.

8.2.8.1 Immunity tests

Refer to Standard

8.2.8.2 Emission tests

Refer to Standard

8.2.9 Verification of the resistance of insulating materials to abnormal heat and fire (glow-wire test)

Refer to Standard

Remark: Changes to the previous edition no. 4.1 are marked by turquoise colour