IEC TS 62271-304

Edition 2.0 2019-03

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

High-voltage switchgear and controlgear –
Part 304: Classification of indoor enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV related to the use in special service conditions with respect to condensation and pollution

Appareillage à haute tension –
Partie 304: Classification de l'appareillage d'intérieur sous enveloppe pour tensions assignées supérieures à 1 kV et jusqu'à 52 kV inclus relatives à l'utilisation dans des conditions spéciales de service en ce qui concerne la condensation et la pollution

IEC TS 62271-304:2019-03(en-fr)

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

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FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62771-304, which is a Technical Specification, has been prepared by subcommittee 17C: Assemblies, of IEC technical committee 17: High-voltage switchgear and controlgear.

This second edition cancels and replaces the first edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the description of the several service conditions under condensation and pollution;
b) the classification of enclosed switchgear and controlgear, according to the testing procedure does not cover polluted service conditions P_L and P_H;
c) a wider description in Annex B of typical indoor environments based on ISO/IEC standards;
d) a new Annex C giving guidance on precautions to improve indoor operating conditions;
e) a new Annex D dedicated to the optional items such as records of mechanical characteristics;
f) a new Annex E, giving additional combinations of environments with condensation and pollution, as well as a proposal of testing procedure of ageing test, is provided to create experience on correlation between ageing effects in laboratory and ageing effects at site conditions.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
17C/679/DTS	17C/691/RVDTS

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62271 series, under the general title *High-voltage switchgear and controlgear*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 304: Classification of indoor enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV related to the use in special service conditions with respect to condensation and pollution

1 Scope

This part of IEC 62271, which is a Technical Specification, applies to indoor enclosed switchgear and controlgear complying with IEC 62271-200 and IEC 62271-201, intended to be used in special service conditions with respect to condensation and pollution deviating from the normal service conditions specified in IEC 62271-1.

The test detailed in this document has been designed primarily to classify the electrical insulation performance of equipment having high-voltage electrical insulation exposed to indoor service conditions, mainly in presence of condensation. The assessment of mechanical components, such as mechanisms, interlocks and enclosure is also considered.

In this document, the term "equipment" is used in accordance with the scope for an "enclosed assembly of switchgear and controlgear" (see IEC 60050-441:2000, 441-12- 02).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60721-3-3, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weatherprotected locations*

IEC TS 60815-1, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles*

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-200, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 62271-201, *High-voltage switchgear and controlgear – Part 201: AC solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62271-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Definition of indoor service conditions under condensation and pollution

Indoor equipment is designed to be installed in an operating room inside a building or other housing and thus has a certain level of protection from the outdoor environmental conditions.

In addition of the protection given by the building or other housing construction, precautions (see Annex C) to minimize the amount of deposits inside the switchgear and controlgear can be taken by the choice of an appropriate degree of protection of the enclosed switchgear and controlgear.

Condensation can occur due to rapid temperature changes inside the operating room. Pollution inside the operating room can be present depending on location and surrounding activity. In addition, the occurrence of condensation and the site pollution severity inside the operating room depend on the layout and the protection given by the building or other housing construction.

The presence of condensation and pollution has the potential to impact the voltage withstand capability of clearances and creepage distances, and possibly the insulating material itself. The concern is that there may be the creation of a full or partial conductive path between live parts or between live parts and conductive parts not intended to be live (enclosure, etc.).

In this document, the indoor service conditions with respect to condensation and pollution around the enclosed switchgear and controlgear are defined, with typical examples:

C_0: Condensation does not normally occur (not more than twice a year)

- Rooms with continuous humidity and/or temperature control in order to avoid condensation. The building or other housing provides protection from daily variations in outside climate.
- Rooms not having humidity or temperature control. Nevertheless, the building or other housing construction provides protection from daily variations in outside climate, and condensation is not more than twice a year.

C_L: Non-frequent condensation (not more than twice a month)

- Rooms not having humidity or temperature control. The building or other housing construction provides protection from daily variations in outside climate, but condensation cannot be excluded.

C_H: Frequent condensation (more than twice a month)

- Rooms not having humidity nor temperature control. The building or other housing provides only minimal protection from daily variations of outside climate, so that frequent condensation may occur.

P_0: Very light pollution (as given in 4.1.2, item d), of IEC 62271-1:2017). The ambient air of the operating room is not significantly polluted by dust, smoke, corrosive and/or flammable gases, vapours or salt and would be considered as having site pollution severity class (SPS) “very light” according to IEC TS 60815-1.

- Rooms in areas without significant pollution.

- Rooms in areas with pollution (see Annex B) with precautions against pollution (see Annex C) to recover indoor normal service conditions.
- Rooms with precautions against pollution (see Annex C). The building or other housing construction provides adapted protection from outside pollution. The control of the air conditions may be switched off for periods.

P_L: Light pollution is considered as site pollution severity class (SPS) "light" according to IEC TS 60815-1 for solid deposit and/or pollution classification 3C1 according to IEC 60721-3-3.

- Rooms without precautions against pollution. The building or other housing construction is exposed to ambient air in rural and some urban areas with industrial activities or with moderate traffic.

P_H: Heavy pollution (any pollution level exceeding P_L)

- Rooms without precautions against pollution. The building or other housing construction is exposed to ambient air in urban areas with industrial activities or with heavy traffic.

5 Classification of enclosed switchgear and controlgear

Classification of enclosed switchgear and controlgear for use in special service conditions with respect to condensation, within this document, is limited to equipment intended for use in a polluted environment classified as P_0. The available classes are:

Class 0: C_0P_0

Class 1: C_LP_0

Class 2: C_HP_0

Test procedures are defined to demonstrate conformance with the requirements of C_L and C_H. Class 0 corresponds to normal indoor service conditions defined in IEC 62271-1.

Most of the existing artificial pollution testing procedures [2] [3] [4] [5][1] are mainly dedicated to glass, ceramic, and polymeric insulators exposed to outdoor service conditions. There is no mature testing methodology, representative of ageing under polluted indoor service conditions. Therefore, no testing procedure is provided in this document for polluted environments P_L and P_H.

However, Annex E gives other possible combinations of environments with condensation and pollution, and a proposal for testing procedure of ageing test, in order to create experience on correlation between ageing effects in laboratory and ageing effects at site conditions. Pollution at the site should be recorded.

6 Test procedure for classification

Class 0 is considered to be equivalent to the indoor normal service conditions specified in IEC 62271-1, therefore no test is required.

Satisfactory performance under special service conditions of equipment complying with Class 1 or 2 is verified by testing the equipment.

Enclosed switchgear and controlgear is considered to belong to Class 1 if it is subjected to the level 1 ageing test according to 9.1 and satisfies the criteria of the electrical assessment. Optional mechanical assessment is described in Annex D.

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[1] Numbers in square brackets refer to the Bibliography.

Enclosed switchgear and controlgear is considered to belong to Class 2 if it is submitted to the level 2 ageing test according to 9.2 and satisfies the criteria of the electrical assessment. Optional mechanical assessment is described in Annex D.

The level 1 and level 2 ageing tests require the repeated application of identical cycles followed by the electrical assessment. Optional mechanical assessment is described in Annex D. The level 2 ageing test is identical to the level 1 ageing test except that for level 2 a larger number of cycles is to be applied.

This classification procedure is illustrated in the flow chart, Figure 1.

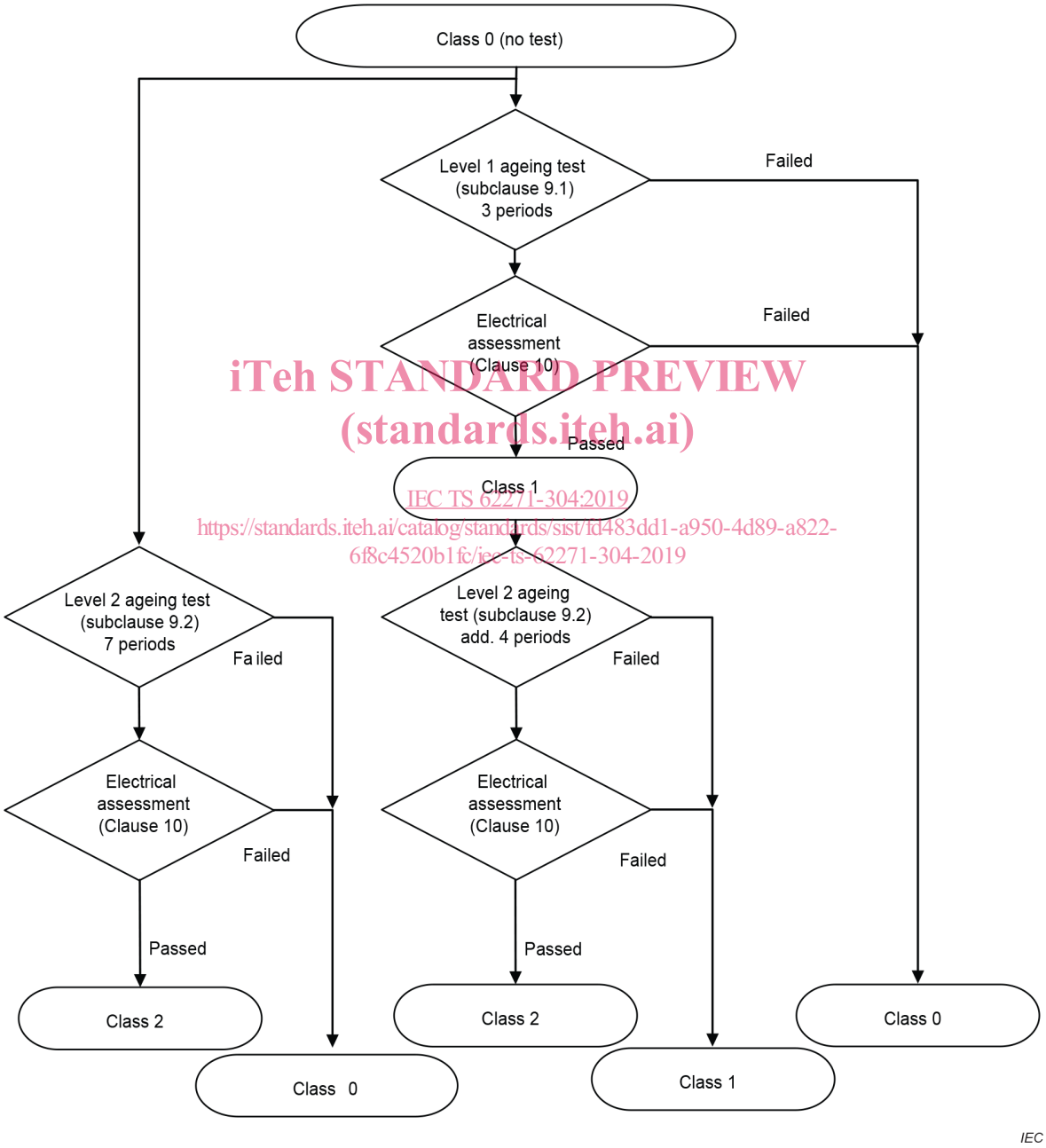

Figure 1 – Flow chart for classification testing procedure

7 Test facilities and associated requirements

7.1 Climatic test room

A climatic test room is required which shall be of sufficient size to accommodate the equipment to be tested. The equipment shall be installed in the climatic test room at a height of not less than 0,5 m from the ground in a manner to permit the circulation of the ambient air. The clearance between the walls and ceiling of the test room and the test object shall be more than 1,0 m. When this requirement cannot be met, the laboratory shall provide evidence that the ambient conditions meet the requirements according to 7.2.

Precautions shall be taken to prevent condensed water on the walls and ceiling of the test chamber from falling on the equipment.

The distribution of temperature and humidity in the whole volume of the chamber is assumed to be homogenous when the clearance is more than 1 m. Annex A provides a figure illustrating the arrangement of a test object inside a climatic test room.

Water utilized to maintain humidity shall have an electrical conductivity of not more than 20 µS/cm.

NOTE The value of water conductivity comes from IEC 60068-2-78 [6].

7.2 Measurement and control requirements

The air temperature control system of the test chamber shall be able to keep the required temperatures with a tolerance of ±3 K. During the tests, it shall be varied cyclically between 30 °C and 50 °C. The temperature gradient shall be at least 0,5 K/min.

The relative humidity shall be controlled to be within the specified limits given in Clause 9.

Where the clearance defined in 7.1, between the test room and the test object is not met, the laboratory shall verify the temperature and humidity surrounding the test object at the middle of the concerned clearances.

7.3 Energizing facilities

A three-phase high-voltage source, star connection with neutral connected to earth, shall be provided to energize the equipment during the ageing test. This source shall be able to maintain the rated voltage of the equipment with a tolerance of 0 % to –5 % during the ageing cycles. The voltage shall be monitored continuously during the full duration of the tests to detect possible disruptive discharge.

A source is required for applying test voltages up to at least the dry power-frequency withstand voltage of the equipment to be tested. This source shall comply with IEC 60060-1.

Each source shall have a protective device operating in less than 0,1 s in the event of a disruptive discharge.

7.4 Information to be included in the test report

The results of the tests shall be recorded in the test report, which shall contain sufficient data to fully identify and describe the test object in terms of its essential parts and its ratings, as specified in the relevant indoor enclosed switchgear standard. In particular, the following information shall be included:

- manufacturer;
- type designation and serial number of the test object;

- rated characteristics of the test object as specified in the relevant IEC standard;
- general description of the test object, including number of poles;
- manufacturer, type, serial numbers and ratings of essential parts, where applicable (for example, drive mechanisms, interrupters, shunt impedances);
- general details of the supporting structure of the enclosed switchgear;
- details of the operating-mechanism and devices employed during tests, where applicable;
- photographs to illustrate the condition of the test object before and after the test;
- sufficient outline drawings and data schedules to represent the test object;
- reference numbers of all drawings including the revision number submitted to identify the essential parts of the test object;
- statement that the test object complies with the drawings submitted;
- details of the testing arrangements (including diagram of the test circuit);
- statements of the behaviour of the test object during tests, and its condition after tests;
- records of the test quantities during each test as specified in this document;
- conductivity of water used;
- location, laboratory name where the tests were conducted and date of test.

8 Arrangement of the equipment for test

The ageing test shall be made on the equipment completely assembled and fitted with all its components as for service, instrument transformers included. The equipment and its components shall be new and clean.

The equipment to be tested shall be installed in the climatic test room and connected as in service, in its normal operating position and normal installation condition. The frame and other parts of the equipment intended to be earthed in service shall be earthed for testing.

The representative floor of the test installation conditions and/or bottom plates (if used) of the switchgear and controlgear shall be used and described within the test report.

9 Ageing test

9.1 Level 1 ageing test

The equipment shall be installed in the climatic test room and subjected during three identical test periods of seven days (see Figure 2), to 2 h damp heat cycles described by zones as follows:

Zone 1: to rise from 30 °C to 50 °C within 40 min, with the relative humidity above 95 %.

Zone 2: to maintain 50°C during 20 min with the relative humidity above 95 %.

Zone 3: to decrease from 50°C to 30 °C within 40 min, with any convenient value of humidity.

Zone 4: to maintain 30 °C during 20 min, with the relative humidity above 80 %.

The test period of seven days duration is made up as follows:

For five days, the equipment to be tested is energized at its rated voltage and subjected to 60 damp heat cycles as described above. The application of rated voltage means U_r between phases and $U_r/\sqrt{3}$ between phase and earth.

After these five days the test is stopped at the end of the last cycle at 30 °C. The equipment is de-energized.

For two days, the equipment shall be maintained in an atmosphere close to the reference atmosphere mentioned in IEC 60060-1, i.e. with temperature at 20°C and relative humidity 60 % approximately.

After the completion of three test periods, the performance of the equipment shall be evaluated in accordance with the electrical assessment. The optional mechanical assessment is described in Annex D.

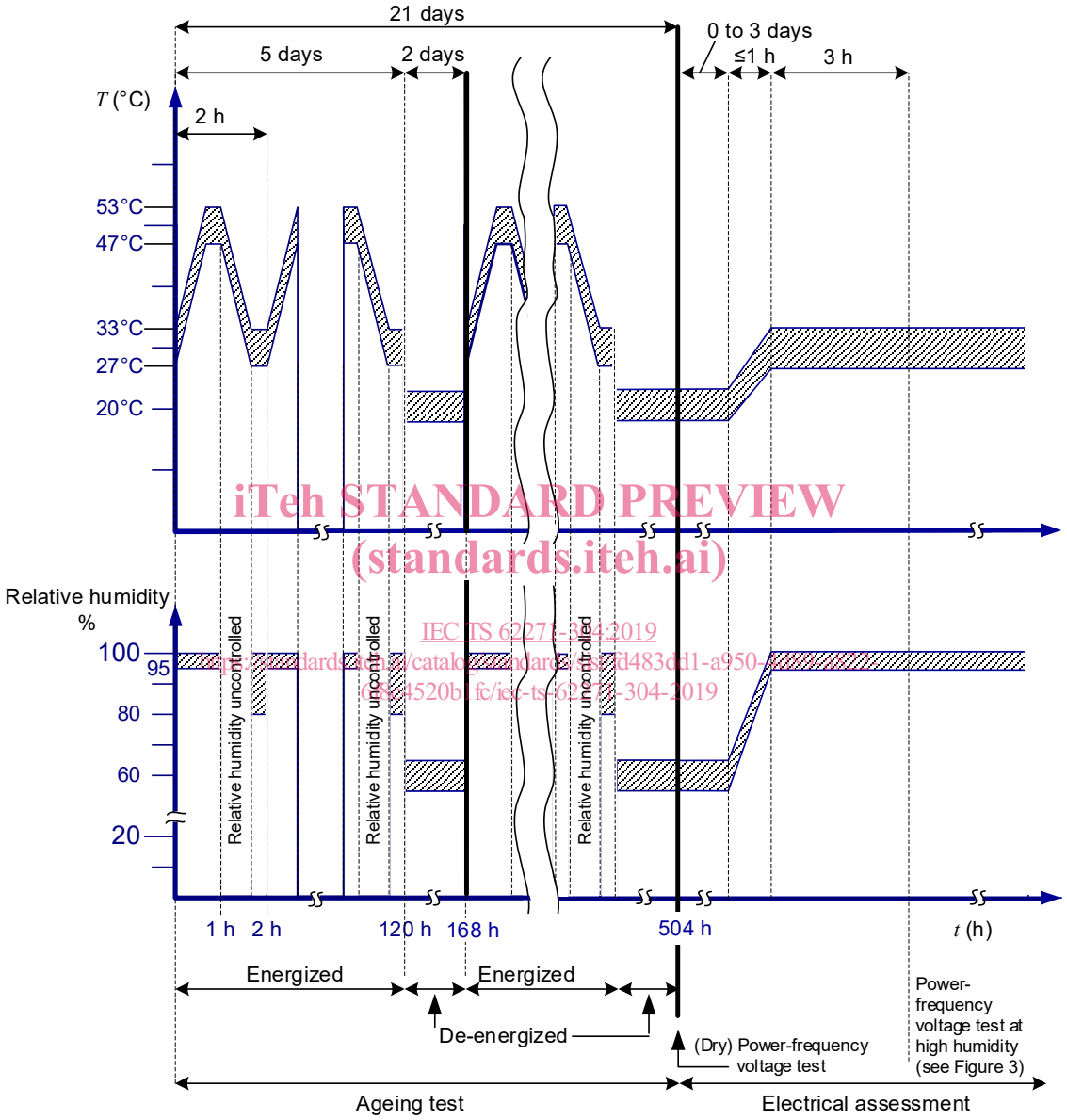

Figure 2 – Climatic conditions for ageing test for level 1 and electrical assessment

9.2 Level 2 ageing test

The level 2 ageing test comprises a total of seven identical test periods of seven days, as defined in 9.1, followed by the electrical assessment. The optional mechanical assessment is described in Annex D.

If the test object has already been successfully subjected to the level 1 ageing test, it is permitted to continue the test immediately after the electrical assessment, applying four additional test periods of seven days.

10 Electrical assessment after ageing test

10.1 General

After the conclusion of the ageing tests, and reaching ambient temperature, the equipment shall be subjected to dielectric tests as follows without any special treatment like cleaning, extra drying, etc. The voltage transformers shall be disconnected before the electrical assessment. The overvoltage protective devices may be disconnected or removed before electrical assessment.

The equipment with the main switching device(s) in closed position if any, is first subjected to the dry 1 min power-frequency withstand voltage test at its rated value according to IEC 62271-1.

After the dry power-frequency test, it is permissible to maintain the same ambient conditions for a maximum of 3 days before continuing the electrical assessment.

The voltage shall be removed and the temperature in the climatic test room shall be increased to 30 °C and the humidity at least to 95 % in less than 1 h. After 3 h in these conditions, the following dielectric test is performed (see Figure 3).

One phase is energized at $U_r/\sqrt{3}$ with a tolerance of ±3 %, where U_r is the rated voltage of the equipment, the other two phases being earthed.

After 1 h, the voltage is raised to $\sqrt{3}\,U_r$ with a tolerance of ±1 %, and maintained during 30 s (voltage rise in accordance with 6.3.1 of IEC 60060-1:2010).

The voltage test sequence is repeated successively on the other two phases. If each phase is fully separated from the others by earthed partitions or fully surrounded by earthed screens, the three phases may be energized together.

Photos of the test object shall be included in the test report, showing traces of tracking on insulating surfaces, if any.