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TECHNICAL REPORT

colour inside

High-voltage switchgear and controlgear – Part 305: Capacitive current switching capability of air-insulated disconnectors for rated voltages above 52 kV

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IEC 62271-305, which is a technical report, has been prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
17A/872/DTR	17A/885/RVC

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

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

A list of all parts of the IEC 62271 series, published 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 publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of June 2017 have been included in this copy.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 305: Capacitive current switching capability of air-insulated disconnectors for rated voltages above 52 kV

1 Scope

This technical report applies to high-voltage air-insulated disconnectors for rated voltages above 52 kV. The report describes the capacitive current switching duty and provides guidance on laboratory testing to demonstrate the switching capability. Air-insulated disconnectors equipped with auxiliary interrupting devices are included under this scope.

NOTE For manually operated disconnectors, the in-service safety of the operator should be considered and it should be recognized that the results of the switching tests described herein (performed using motor-operated disconnectors) are not necessarily representative of the performance of such disconnectors in actual service. Due diligence should be exercised if the switching tests indicate that prolonged arc durations are probable.

2 Normative references

The following referenced documents are indispensable for the application 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 62271-1: *High-voltage switchgear and controlgear – Part 1: Common specifications*

IEC 62271-102:2001, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

3 Terms and definitions

For purposes of this part of IEC 62271 the terms and definitions in IEC 62271-1 and IEC 62271-102 apply.

4 Background and purpose

Disconnectors do not have current interrupting ratings but, by virtue of having one or more moving contacts during opening operations, they have a certain current switching capability. For capacitive currents and air-insulated disconnectors, this capability has in the past been taken as 0,5 A or less and no testing was defined. For gas-insulated disconnectors, the required capacitive current switching capability and test requirements are specified in Annex F of IEC 62271-102.

User requirements for capacitive current switching using air-insulated disconnectors frequently exceed the above-stated 0,5 A. The purpose, therefore, of this report is to provide an analysis of the switching duty (refer to Annex A) and to define testing procedures.

5 Switching tests

5.1 Arrangement of the disconnector for tests

The disconnector under test should be completely mounted on its own support or on an equivalent support. For safety reasons and to obtain consistent results, only motor operation should be used. Motor operation should be at the minimum supply voltage.

Before commencing switching tests, resistance measurement of the main circuit and no-load operations should be made and details of the operating characteristics of the disconnector such as contact separation (arc initiation), closing time and opening time, should be recorded. Only singe-phase tests on one pole of a three-pole disconnector need be performed provided that the pole is not in a more favourable condition than the complete three-pole disconnector with respect to

- closing time;
- opening time;
- influence of adjacent phases.

NOTE Single-phase tests are adequate to demonstrate the switching performance of a disconnector provided that the arcing time and arc reach are such that there is no possibility of involvement of an adjacent phase. If excessive arc reach is encountered during single-phase testing, then three-phase testing should be performed. A reach of the tip of the arc towards an adjacent phase equal to or greater than half the metal-to-metal spacing between phases is to be considered as excessive.

5.2 Earthing of the test circuit and disconnector

The frame of the disconnector should be earthed and the current to earth should be measured.

5.3 Test frequency

Disconnectors may be tested using either 50 Hz or 60 Hz since both frequencies are considered to be equivalent.

5.4 Test voltage

The test voltage should be the phase-to-earth voltage based on the rated voltage of the disconnector. In the event of three-phase testing, the test voltage should be the rated voltage of the disconnector applied on a three-phase basis.

NOTE Due to laboratory limitations, testing on one break of double break disconnectors at half the test voltage is permissible. An even voltage distribution across the two breaks can be assumed.

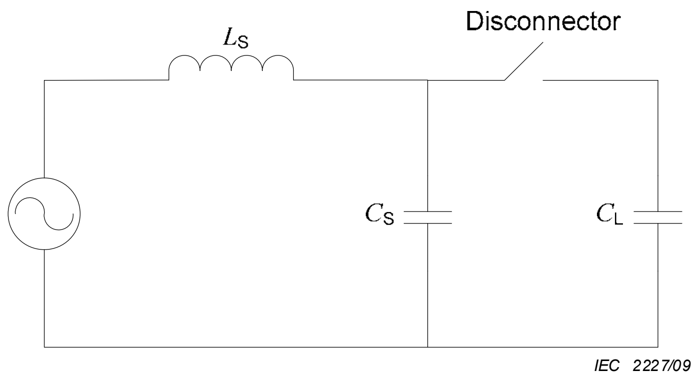
5.5 Test current

The test current, or currents if more than one current level is to be tested, should be as agreed between the manufacturer and the user.

NOTE Typical capacitive charging current values for station equipment and lines are shown in Annex B.

5.6 Test circuit

The test circuit in principle should be as shown in Figure 1.



Key

L_S Short-circuit inductance

C_S Supply side capacitance

C_L Load side capacitance

Figure 1 – Test circuit in principle for capacitive current switching

L_S should be based on the rated short-time withstand current at the rated voltage of the disconnector under test. However this will require a circuit with a strong source, which is impractical in many cases. An alternative circuit is described in Annex C.

For each test current, the ratio C_S/C_L should be agreed between the manufacturer and the user.

The permissible tolerances for the test quantities are as shown in Table 1.

Table 1 – Test tolerances

Test quantity	Tolerance
Test voltage	±5 %
Test current	±10 %
C_S/C_L	±20 %

5.7 Tests

5.7.1 Test duties and measurements

Twenty CO operations should be made for each test current with no trapped charge on the load capacitance prior to closing. Twenty such operations are considered to be statistically acceptable. The recovery voltage shall be maintained for ten seconds (10 s) after the disconnector reaches its fully open position.

The following measurements should be made during the test:

a) power frequency source voltage and load side dc and transient overvoltages;

b) current;

c) arc duration;

d) video recordings of arc propagation (the intent is to record the extreme vertical and horizontal reach of the arc as viewed along the longitudinal line of the disconnector).

NOTE If the tests are performed outdoors, atmospheric conditions should be recorded to include wind direction and velocity, humidity, air pressure and ambient temperature. No corrections for such elements are required.

5.7.2 Behaviour of disconnector during tests

The disconnector shall meet the following requirements during the tests:

a) the disconnector shall interrupt the current before the moving blade or blades reach their fully open position;

b) no earth faults, or phase-to-phase faults in the event of three-phase testing, shall occur.

5.7.3 Condition of disconnector after tests

The disconnector shall meet the following requirements after the tests:

a) a visual inspection is considered sufficient to verify that the mechanical parts and insulators are in essentially the same condition as before the tests;

b) the condition of the main contacts, in particular with regard to wear, contact area, pressure and freedom of movement, shall be such that they are capable of carrying the rated normal current of the disconnector;

c) the resistance of the main circuit after the test shall not exceed that before the test by more than +10 %;

d) the operating times before and after the tests shall be essentially the same.

5.8 Test reports

The results of all tests should be recorded in test reports. Sufficient information should be included so that the essential parts of the disconnector tested can be identified.

The test report should at least contain the following information:

a) typical oscillographic or similar records of the tests performed;

b) test circuit;

c) test currents;

d) test voltages including overvoltages;

e) arc durations;

f) arc extreme reach in vertical and horizontal directions;

g) number of CO operations;

h) record of the condition of the of the main and arcing contacts after test;

i) resistance of the main circuit before and after the test sequence;

j) operating times before and after the tests.

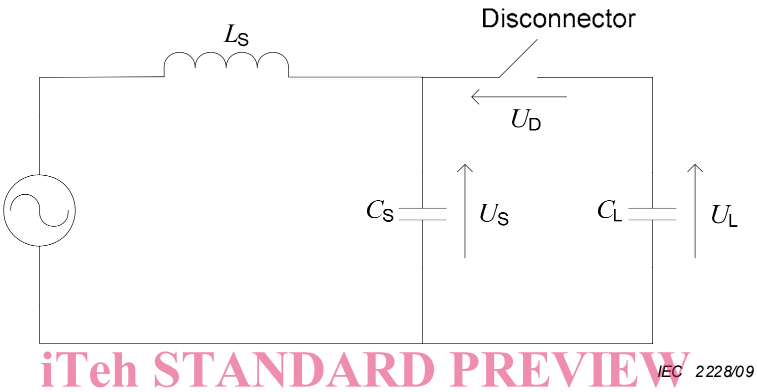
k) Atmospheric conditions: ambient temperature, air pressure, humidity and, if outdoors, wind velocity and direction.

General information concerning the supporting structure of the disconnector should be included. The type of operating device employed during the tests should be recorded.

Annex A
(informative)

Analysis

Capacitive current switching is a circuit and arc interactive event with varying severities of restriking and arc duration. The severity of restriking both in terms of frequency, current and overvoltage magnitudes, is dependent on the relative values of the source side (C_S) and load side (C_L) capacitances as shown in the basic capacitive current switching circuit Figure A.1.



Key

L_S Short-circuit inductance

C_S Supply side capacitance

C_L Load side capacitance

U_S Source side voltage

U_L Load side voltage

U_D Voltage across disconnector

Figure A.1 – Basic capacitive current switching circuit

Typical test oscillograms are shown in Figure A.2 and this behaviour is explained in the following.