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NORME INTERNATIONALE

AMENDMENT 2
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Voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) power transmission – Electrical testing

Valves à convertisseur de source de tension (VSC) pour le transport d'énergie en courant continu à haute tension (CCHT) – Essais électriques

IEC 62501:2009-06/AMD2:2017-09(en-fr)

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FOREWORD

This amendment has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

The text of this amendment is based on the following documents:

CDV	Report on voting
22F/438/CDV	22F/457/RVC

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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.

1 Scope

Delete the third paragraph, added by IEC 62501:2009/AMD1:2014.

2 Normative references

Delete, in the reference IEC 60270:2000, *High-voltage test techniques – Partial discharge measurements, added by IEC 62501:2009/AMD1:2014, the publication year.*

Replace the existing reference IEC 60700-1 and its footnote by the following new reference:

IEC 60700-1:2015, *Thyristor valves for high voltage direct current (HVDC) power transmission – Part 1: Electrical testing*

Add the following new reference:

IEC 62747, *Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems*

3 Terms and definitions

Replace the existing first sentence by the following new sentence:

For the purposes of this document, the terms and definitions given in IEC 62747 and the following apply

3.5.5
valve base electronics

Delete this term and its definition, modified by IEC 62501:2009/AMD1:2014.

4.1.2 Test object

Replace the existing title of 4.1.2 by the following new title:

4.1.2 Selection of test object

Replace, in letter b) of the first paragraph, the word "tested" *by* "operational type tested".

Table 1 – Minimum number of valve levels to be tested as a function of the number of valve levels per valve

Replace the existing title of Table 1 by the following new title:

Table 1 – Minimum number of valve levels to be operational type tested as a function of the number of valve levels per valve

Add, after Table 1, the following new paragraphs:

The minimum number of valve levels to be dielectric type tested can be equal to or lower than the number specified for the operational type test.

The minimum number of valve levels, however, shall be representative to the valve dielectric design. Details can be found in 9.2.

4.1.6 Frequency for testing

Delete the note, added by IEC 62501:2009/AMD1:2014.

4.4.1 General

Add, at the end of the last sentence of the existing paragraph, the words "and providing that the failed valve level permits the rest of the valve or valve section to continue operating without degraded performance".

6.2 Test object

Replace, in the second paragraph, the second existing sentence by the following new sentence:

For the valves with valve surge arrester, a proportionally scaled valve arrester may be included.

6.4 Maximum continuous operating duty test

Replace the paragraph starting with "The test current" by the following new paragraphs:

The test current, in r.m.s., shall be determined taking into account harmonics current and any other additional current through the valve.

The test current value shall incorporate a test safety factor of 1,05.

Add, in the paragraph starting with "The test voltage", in the definition of U_{dmax}, the words "of the valve" *after* "DC voltage".

7.3.1 Valve support d.c. voltage test

Replace, in the first paragraph, the reference "IEC 60700-1" *by* "IEC 60700-1:2015".

Replace, in the last paragraph, modified by IEC 62501:2009/AMD1:2014, the key "k_3 = 1,1" *by the following new key:*

k_3 = 1,10 for 1 min test;

k_3 = 1,15 for 3 h test;

7.3.2 Valve support a.c. voltage test

Replace the last paragraph by the following new paragraph:

The valve support a.c. test voltage U_{tas} shall be determined in accordance with the following:

1 min test:

$$U_{tas} = \frac{U_{mS1}}{\sqrt{2}} \cdot k_4 \cdot k_t$$

30 min test

$$U_{tas} = \frac{U_{mS2}}{\sqrt{2}} \cdot k_4$$

where:

U_{mS1} is the peak value of maximum voltage appearing on the valve support in service, particularly in system fault condition and valve fault operation condition. The over-voltage limiting effect of phase arrester or other over-voltage protection means, if any, shall be taken into account to derive this over-voltage;

U_{mS2} is the peak value of the maximum repetitive operating voltage across the valve support during steady-state operation, including switching overshoot;

k_4 is a test safety factor;

k_4 = 1,10;

k_t is the atmospheric correction factor according to 4.2.

8.3.1 MVU d.c. voltage test to earth

Replace, in the last paragraph, modified by IEC 62501:2009/AMD1:2014, the key "k_5 = 1,1" *by the following new key:*

k_5 = 1,10 for 1 min test;

k_5 = 1,15 for 3 h test;

8.3.2 MVU AC voltage test

Replace the last paragraph by the following new paragraph:

The MVU AC test voltage U_{tam} shall be determined in accordance with the following:

1 min test

$$U_{tam} = \frac{U_{mm1}}{\sqrt{2}} \cdot k_6 \cdot k_t$$

30 min test

$$U_{tam} = \frac{U_{mm2}}{\sqrt{2}} \cdot k_6$$

where

U_{mm1} is the peak value of maximum voltage between the terminals of the MVU in service, particularly in system fault condition and valve fault operation condition. The over-voltage limiting effect of phase arrester or other over-voltage protection means, if any, shall be taken into account to derive this over-voltage;

U_{mm2} is the peak value of the maximum repetitive operating voltage between the terminals of the MVU during steady-state operation, including switching overshoot;

k_6 is a test safety factor;

k_6 = 1,10;

k_t is the atmospheric correction factor according to 4.2.

9 Dielectric tests between valve terminals

9.3.1 Valve a.c. – d.c. voltage test

Delete Note 1, Note 4, Note 5 and Note 6, added by IEC 62501:2009/AMD1:2014.

Add the following new subclauses:

9.4 Test methods

9.4.1 General

Performing the valve dielectric test presents considerable practical difficulties on controllable voltage source type VSC valves because of the high current drawn by the in-built capacitance. For this reason, following valve dielectric test methods are acceptable.

9.4.2 Method one

Temporary substitution of a reduced capacitance but the same physical size test capacitor is permissible. This test capacitor shall allow a test voltage build-up across the test object during test.

Also, it may be necessary to disable gate electronics or other auxiliary circuits in this test or provide independent means for powering them, in order to prevent interference with partial discharge measurement, for example, from gate unit power supply circuits.

When gate electronics or other auxiliary circuits are disabled for the 10 s test, the active voltage control function, if any, provided by gate electronics or other auxiliary circuits on each IGBT level may be represented by other means, for example, high resistance shunt resistors across test IGBT levels for appropriate voltage sharing.

In the event that it is not possible to disable gate electronics or other auxiliary circuits in this test and interference can be proven to be caused by electronics circuit, then this interference may be deducted from measurement.

9.4.3 Method two

Valve dielectric test is done by two steps.

Step one focuses on the component level and step two on the valve or valve section. In step one, module levels are tested independently. In step two, the test is done with submodule levels short-circuited, interconnections between adjacent submodules removed, and valve or valve section voltage distribution controlled by an external grading circuit, for example a resistor array, capacitor array or RC array.

Atmospheric correction to the specific test voltages can be added in step two.

10.3 Test requirements

Add, in the second paragraph, in the definition of U_{dtemp}, *the words* "of the valve" *after* "d.c. over-voltage".

11.1 Purpose of tests

Replace, in the existing paragraph, modified by IEC 62501:2009/AMD1:2014, the 2 occurrences of the word "should" *by* "shall".

11.3 Test requirements

Replace the existing second paragraph by the following new paragraphs:

The fault current amplitude, duration and the number of cycles shall be the maximum values expected in the actual field operation.

Alternative test waveform may be used, provided that the amplitude and energy accumulation are representative of those in fault conditions.

Add, after the last paragraph, the following new paragraph:

Considering the difficulty in test laboratory to perform this test in generation of the recovery voltage between cycles of fault current, this test may, subjected to the agreement between purchaser and manufacturer, be performed on component level.

A.3 Overview of main types of VSC valve

Replace, in the first bullet point of the second paragraph, the words "VSC valves of the "switch" type" *by* "Switch type VSC valves".

Replace, in the second bullet point of the second paragraph, the words "VSC valves of the "controllable voltage source" type" *by* "Controllable voltage source type VSC valves".

A.4 VSC valves of the "switch" type

Replace the existing title by the following new title:

A.4 Switch type VSC valve

A.5 VSC valves of the "controllable voltage source" type

Replace the existing title by the following new title:

A.5 Controllable voltage source type VSC valve

Figure A.8 – A single VSC phase unit with valves of the "controllable voltage source" type

Replace the existing title of Figure A.8 by the following new title:

Figure A.8 – A single VSC phase unit with controllable voltage source type VSC valves

Annex B – Valve component fault tolerance

Replace, in letter a) of the first paragraph, the words "Short circuit of a VSC valve" *by* "Failure of an IGBT or diode".

Add, after letter d), the following new letter:

e) Cell internal short-circuit current

Either misfiring of IGBT, short-circuit of IGBT-diode pair or insulation failure may lead to an internal capacitor discharge current. Under these short-circuit conditions, the cell shall be self-contained without impacting the normal operation of adjacent cells.

Bibliography

Delete, in the reference "IEC 60146-2:1999, *Semiconductor converters – Part 2: Self-commutated semiconductor converters including direct d.c. converters", the publication year*

Replace the reference "IEC PAS 61975:2004, *System tests for high-voltage direct current (HVDC) installations*" *by* "IEC 61975, *High-voltage direct current (HVDC) installations – System tests*"

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