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TECHNICAL REPORT

AMENDMENT 1

Guideline for the system design of HVDC converter stations with line-commutated converters

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GUIDELINE FOR THE SYSTEM DESIGN OF HVDC CONVERTER STATIONS WITH LINE-COMMUTATED CONVERTERS

AMENDMENT 1

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Amendment 1 to IEC TR 63127:2019 has been prepared by IEC technical committee 115: High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV.

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

Draft	Report on voting
115/361/DTR	115/364/RVDTR

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

The language used for the development of this Amendment is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications/.

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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Replace, in the first paragraph, "almost half of HVDC projects were commissioned after the year 2000." *with* "more than half of HVDC projects were commissioned after the year 2000."

Add, in the last sentence of the second paragraph, the words "line-commutated converter (LCC)" *before* "HVDC systems".

Replace, in the second sentence of the third paragraph, the value "660 kV" *with* "1 100 kV".

Delete, the last two sentences of the third paragraph, starting from "In addition" *to the end of that paragraph.*

5.2.4 AC/DC interaction and control

Delete, in the second sentence of the last paragraph, the words "and no extra cost added."

6.3.5 Short-circuit current or capacity level

Replace the content of the existing subclause with the following:

The interconnected AC system strength impacts the HVDC system design. A weak AC system will give rise to special requirements and extra costs for HVDC projects, such as special control strategies, need for multiple small reactive power sub-banks and additional synchronous condensers or other static reactive power devices, like synchronous compensator (STATCOM), static var compensator (SVC), TCSC, SCC, etc. The increase in the number of connections of renewable energy sources nowadays is leading to a decrease in system strength.

The short circuit ratio (SCR) is used to evaluate the strength of an AC system terminated to the HVDC link especially in planning stage. Considering the negative contribution of AC filter / shunt capacitor banks on the short-circuit current/capacity, the effective short-circuit ratio (ESCR) is usually given.

A STATCOM installed inside or near the converter station could improve the adaptability of the HVDC system to the AC system. In order to obtain enough ESCR, the capacity of installed STATCOM can be evaluated by the formula ESCR = $(S_{sc} + 2Q_{stat}) / P_{dcN}$, where Q_{stat} is the capacity of STATCOM. The performance of STATCOM should be demonstrated by simulation with real control in detail design.

A capacitor commutated converter (CCC) HVDC converter could improve the adaptability of the HVDC system to a weak AC system, too, as an alternative to STATCOM. This solution can be used to adapt the HVDC system to a weak AC system with an effective short-circuit ratio down to 1.0, as per 5.1.2 of CIGRE TB No. 352.

Both the maximum and the minimum three-phase short-circuit current can be specified for HVDC system design and study. Which short-circuit current will be used for a specific design or study can be decided on a case-by-case basis in order to derive maximum equipment stresses. For example, the maximum short-circuit current is usually used to determine the surge current rating of equipment such as valves and smoothing reactors. The minimum short-circuit current is normally used in studies such as fundamental frequency overvoltage study and AC side transient overvoltage study.

For projects constructed in stages, the short-circuit currents and HVDC power can vary from stage to stage. The SCR can be identified in each stage and scenario.

The calculation of the short-circuit current can be carried out using conventional system stability programs.

7.1.1 Rated power

Replace, in the first paragraph, the values "10 000 MW at ±800 kV" *with* "12 000 MW at 1 100 kV".

7.2.1 Pole and return path

Replace, in the first sentence of the second paragraph, the words "become a bipolar system." *with* "form a bipolar system."

7.2.3.1 General

Replace, in the second paragraph, the words "A neutral bus ground switch (NBES)" *with* "A neutral bus earthing switch (NBES)".

10.2.1 Reactive power consumption calculation

Replace the existing Equation (32)

$$Q_{\text{conv}} = I_{\text{d}} \cdot U_{\text{dio}} \frac{2u + \sin 2\alpha - \sin 2(\alpha + u)}{4\left(\cos\alpha - \cos(\alpha + u)\right)}$$

with the new Equation (32):

$$Q_{\text{conv}} = I_{\text{d}} \cdot U_{\text{dio}} \frac{2\mu + \sin 2\alpha - \sin 2(\alpha + \mu)}{4\left(\cos\alpha - \cos(\alpha + \mu)\right)} \qquad (32)$$

Replace, the existing Equation (34) $u = \arccos\left(\cos\alpha - 2d_{\text{x}} \cdot \frac{I_{\text{d}}}{I_{\text{dN}}} \cdot \frac{U_{\text{dioN}}}{U_{\text{dio}}}\right) - \alpha$