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TECHNICAL REPORT

colour inside

Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 1: Steady-state conditions

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PERFORMANCE OF HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS WITH LINE-COMMUTATED CONVERTERS –

Part 1: Steady-state conditions

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IEC TR 60919-1, which is a technical report, has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

This fourth edition cancels and replaces the third edition, published in 2010, Amendment 1:2013 and Amendment 2:2017. This edition constitutes a technical revision.

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

a) Figure 8 and Figure 20 have been updated, a new Figure 18 "LCC/VSC hybrid bipolar system" has been added;

b) the HVDC system control objectives have been supplemented;

c) additional explanations regarding the HVDC system control structure have been given;

d) a new subclause 13.6 on HVDC system protection has been added.

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

Draft TR	Report on voting
22F/535/DTR	22F/549A/RVDTR

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

A list of all parts of the IEC 60919 series, published under the general title *Performance of high-voltage direct current (HVDC) systems with line-commutated converters*, 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- withdrawn,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.

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 document using a colour printer.

INTRODUCTION

The difference between system performance specifications and equipment design specifications for individual components of a system is realized. Frequently, performance specifications are prepared as a single package for the two HVDC substations in a particular system. Alternatively, some parts of the HVDC system can be separately specified and purchased. In such cases, due consideration is given to coordination of each part with the overall HVDC system performance objectives and to ensuring that the interface of each with the system is clearly defined. Typical of such parts, listed in the appropriate order of relative ease for separate treatment and interface definition, are:

a) DC line, electrode line and earth electrode;
b) telecommunication system;
c) converter building, foundations and other civil engineering work;
d) reactive power supply including AC shunt capacitor banks, shunt reactors, synchronous and static reactive power (var) compensators;
e) AC switchgear;
f) DC switchgear;
g) auxiliary systems;
h) AC filters;
i) DC filters;
j) DC reactors;
k) converter transformers;
l) surge arresters;
m) series commutation capacitors;
n) valves and their ancillaries;
o) control and protection systems.

NOTE The last four items are the most difficult to separate, and, in fact, separation of these four can be inadvisable.

Clause 4 to Clause 22 of this document set out a complete steady-state performance specification for an HVDC system.

Since the equipment items are usually separately specified and purchased, the HVDC transmission line, earth electrode line and earth electrode (see Clause 11) are included only because of their influence on the HVDC system performance.

For the purpose of this document, an HVDC substation is assumed to consist of one or more converter units installed in a single location together with buildings, reactors, filters, reactive power supply, control, monitoring, protective, measuring and auxiliary equipment. While there is no discussion of AC switching substations in this document, AC filters and reactive power sources are included, although they can be connected to an AC bus separate from the HVDC substation, as discussed in Clause 17.