IEC TR 60919-3

Edition 2.0 2016-03

TECHNICAL REPORT

AMENDMENT 1

Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 3: Dynamic conditions

IEC TR 60919-3:2009-10/AMD1:2016-03(en)

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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:

DTR	Report on voting
22F/376/DTR	22F/382A/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- withdrawn,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.

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

2 Normative references

Replace the existing reference to "IEC/TR 60919-1:2005" *by the following new reference:*

IEC TR 60919-1:2010, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 1: Steady-state conditions*
IEC TR 60919-1:2010/AMD1:2013

Replace the existing reference to "IEC/TR 60919-2:2008" *by the following new reference:*

IEC TR 60919-2:2008, *Performance of high-voltage direct current (HVDC) systems with line-commutated converters – Part 2: Faults and switching*
IEC TR 60919-2:2008/AMD1:2015

5.2.5 Voltage characteristics of static var compensator (SVC)

Delete the third sentence of the first paragraph.

Add, after 5.2.6, the following new subclause:

5.2.7 Voltage characteristics of static synchronous compensator (STATCOM)

The fundamental of STATCOM is utilizing Voltage Sourced Converter (VSC) technology, using turn-off power semiconductor devices, such as IGBTs and GTO thyristors, comprising self-commutated bridge circuit, in parallel with power grid by means of reactors. The dynamic reactive power compensation is achieved by regulating properly the amplitude and phase of output voltage on the a.c. side of the bridge circuit or controlling directly the current on the a.c. side, so as to absorb or release the reactive current of meeting the demand. For reactive power compensation at low voltage limit, STATCOM has better performance than SVC, because the output reactive power of STATCOM decreases linearly with system voltage, while the output of SVC decreases with the square of voltage.

STATCOM with these characteristics provides robust and effective control on voltage support and stability improvements of the system.

5.4.2 HVDC converters, switchable reactive power sources, SVC

Delete the last paragraph

Add, after 5.4.3, the following new subclause:

5.4.4 HVDC converters, switchable reactive power sources, STATCOM

Similar to SVC, STATCOM may be installed, if an HVDC is connected to a weak a.c. system. Typical SVC is representatively TCR (Thyristor Controlled Reactor) type, which requires harmonic filters, such as 5th, 7th, 11th, 13th and high pass filters. On the other hand, latest STATCOM needs only small blocking filters or even no filters.

This feature brings the advantage of smaller installation space for STATCOM than SVC. In addition, the resonance problem which often arises from filters will hardly occur for the system with STATCOM.

Some STATCOM are designed as scalable and re-locatable, and it is easy to meet users demand. STATCOM also has capability of balancing the voltage, decreasing negative sequence component.

For the application where receiving end system has small or even no synchronous generators (nor synchronous compensator: SC), STATCOM could provide voltage and frequency control for commutation of HVDC, if adequate active power to the STATCOM were supplied, such as diesel generators. This function is so called "black start" capability, in which blackout system is restored by feeding from other source system through the HVDC.

Recent application of STATCOM to the HVDC includes replacement of synchronous compensator (SC). Since STATCOM has no mechanical rotating parts, maintenance work is easier than that of SC. One of the great advantages of using STATCOM instead of SC is that maintenance time for STATCOM is very much shorter than for SC.

NOTE A case study displaying $0,05 < UIF < 0,1$ and a little risk under the nominal d.c voltage conditions, was reported [11] as a case leading to significant risk under the reduced d.c voltage and power operating conditions (e.g. 70 % of the nominal voltage and power).

The size of the STATCOM should be designed according to the required regulation range, which should be larger than the largest switchable reactive power element.

8.3 Screening criteria for identifying generator units susceptible to torsional interactions

Replace the existing formula and key by the following new formula and key:

$$UIF_i = \frac{P_{dN}}{S_i}\left(1 - \frac{SC_i}{SC_{tot}}\right)^2$$

where

UIF_i is the unit interaction factor of *i*-th generating unit;

P_{dN} is the MW rating of the HVDC system;

SC_i is the short-circuit capability at HVDC commutating bus excluding *i*-th unit (excluding a.c. filters);

SC_{tot} is the short-circuit capability at HVDC commutating bus including *i*-th unit (excluding a.c. filters).

8.4 Performance considerations for utilizing subsynchronous damping controls

Replace the existing subclause title by the following new title:

8.4 Performance considerations for utilizing subsynchronous damping controllers (SSDCs)

Replace, in the fifth and sixth paragraphs, the words "SSDC controller" *by* "SSDC".

8.6 Turbine generator protection

Replace, in the first paragraph, the words "SSDC controllers" *by* "SSDCs".

Replace, in the first paragraph, the words "SSR relay protections" *by* "torsional protective relays".

9.2.4 Overvoltage effects

Replace, in the second paragraph, the words "4.3 of IEC 60919-2" by "5.3 of IEC 60919-2:2008/AMD 1:2015".

Bibliography

Add the following new reference

[11] YANG YU, QIU WEI, ZHAO XIAO-BIN, DENG JING, WANG XI-TIAN, "Evaluation of Subsynchronous Oscillation of Xiluodu Right Station – Guangdong Double line ±500 kV DC Transmission Project", IEEE International Conference on Power System Technology (POWERCON), 2012

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