IEC 62751-1

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 2
AMENDEMENT 2

Power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems – Part 1: General requirements

Pertes de puissance dans les valves à convertisseur de source de tension (VSC) des systèmes en courant continu à haute tension (CCHT) – Partie 1: Exigences générales

IEC 62751-1:2014-08/AMD2:2022-03(en-fr)

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Pertes de puissance dans les valves à convertisseur de source de tension (VSC) des systèmes en courant continu à haute tension (CCHT) – Partie 1: Exigences générales

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POWER LOSSES IN VOLTAGE SOURCED CONVERTER (VSC) VALVES FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS –

Part 1: General requirements

AMENDMENT 2

FOREWORD

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Amendment 2 to IEC 62751-1:2014 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:

Draft	Report on voting
22F/648/CDV	22F/679/RVC

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/.

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1 Scope

Add, to the last sentence of the first existing paragraph, the words "or unified power flow controller (UPFC)".

3.4.2
IGBT turn-on energy

Replace, in the existing definition, the words "turn-on of" *with* "turn-on process for".

3.4.3
IGBT turn-off energy

Replace, in the existing definition, the words "turn-off procedure of" *with* "turn-off process for".

3.4.5
diode reverse recovery energy

Replace, in the existing definition, the word "procedure" *with* "process".

4.1 General

Replace the existing last paragraph with the following new paragraph:

This standard standardizes a method of calculating the HVDC converter station losses by summing the losses calculated for each item of equipment. The standardized calculation method will help the purchaser to meaningfully compare the competing bids. It will also allow an easy generation of performance curves for the wide range of operating conditions in which the performance has to be known. In the absence of an inexpensive and accurate experimental method which could be employed for an objective verification of losses during type tests, the calculation method is the next best alternative as it uses, wherever possible, experimental data obtained from measurements on individual equipment and components under conditions equivalent to those encountered in real operation.

4.4.1 General

Replace the existing paragraph with the following new paragraphs:

When power losses are being calculated for the purposes of determining the worst-case ratings of individual components or equipment (for example, the cooling plant), the worst possible

combination of a.c. network conditions, ambient conditions and real/reactive power (including overload) shall be considered.

When power losses are being calculated for the purpose of contractual loss guarantees, it is important that a standard set of assumptions with regard to a.c. network conditions, ambient conditions and real/reactive power are made so that bids from different manufacturers can be compared on an equal basis. Purchasers of HVDC systems may specify their own standard reference conditions for atmospheric pressure, ambient temperature, humidity, coolant temperature, power transmission level, etc., at which the power losses are to be determined. Where the purchaser does not specify such reference conditions, losses shall be determined under the following default conditions.

4.4.5 Treatment of redundancy

Add, in the existing note, the word "generally" *before* "occur"*.*

4.5.3.2 Characterisation testing of other components

Add, to the existing first bulleted list item, the words "on DC capacitor"*.*

Add, after the existing last bulleted list item, the following new item:

- power consumption of valve electronics.

8.2 IGBT switching losses

Delete, in the paragraph preceding immediately Formula (11), the words "which is recommended to be one second".

Add, at the end of 8.2, modified by IEC 62751-1:2014/AMD1:2018, the following new text:

The sampling period t_s should be chosen to represent a period of time in which the converter is operating in normal, steady-state conditions with no transient phenomena such as power order changes, network faults, etc.

A typical value of sampling period is one second; however, the choice of sampling period shall take into account the specific type of modulation strategy employed and how predictable the resulting switching pattern is. For example, if a pulse width modulation (PWM) control strategy is used, the switching pattern may be relatively predictable, and a sampling time shorter than 1 s may be acceptable, but certain control strategies may require a sampling period longer than 1 s.

Table 1 – Matrix indicating the relationship of data needed for calculation of losses and the type of valve losses

Add, in the "Characterisation testing" *column, the crosses corresponding to* "Snubber turn-on energy E_{sn_on}" *and* "Snubber turn-off energy E_{sn_off}".

Delete, in the "Specified by VSC manufacturer" *column, the crosses corresponding to* "Snubber turn-on energy E_{sn_on}" *and* "Snubber turn-off energy E_{sn_off}".

A.1 General

Add, at the beginning of the existing first paragraph, the following new text:

CIGRE WG B4-75 has published Technical Brochure 844 which discusses several possible experimental methods for determining valve losses. In some special circumstances, it may be

possible, for example, to arrange a temporary test connection in which two converters are operated from the same a.c. source and also connected together via their d.c. terminals. In this connection, the power drawn from the a.c. source equals the losses in the circuit. However, this method requires additional instrument transformers and switchgear and is only possible where there are two identical converters connected to the same AC system at the same site. Once again, there are practical measurement difficulties. It is also possible to arrange for a direct thermal measurement of the valve losses on site by measuring the temperature rise of the valve coolant fluid; however, this method does not capture all sources of power loss in the valve and the achievable accuracy, with the flow and temperature sensors typically installed on site, is relatively poor. Another alternative is to perform a thermal or electrical measurement of the losses in the valve during type testing, but this method is also challenging to perform with sufficient accuracy because the voltage and current waveforms experienced by the test object are not identical to those experienced during real service conditions.

A.2.3 Line side harmonic filter

Replace, in the first sentence of the existing paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999 and IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.4 Line side high frequency filter

Replace, in the existing paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999 and IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.5 Interface transformer

Replace, in the existing second paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999, IEC 61803:1999/AMD1:2010 and IEC 61803:1999/AMD2:2016" *with* "IEC 61803:2020".

A.2.8 Phase reactor

Replace, in the existing first paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999, IEC 61803:1999/AMD1:2010 and IEC 61803:1999/AMD2:2016" *with* "IEC 61803:2020".

Replace, in the existing second paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999 and IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.9 VSC unit

Replace, in the existing paragraph, the reference "IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.10 VSC d.c. capacitor

Replace, in the existing paragraph, the reference "IEC 61803:1999" *with* "IEC 61803:2020".

A.2.11 D.C. harmonic filter

Replace, in the existing paragraph, the reference "IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.13 Neutral point grounding branch

Replace, in the existing paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999 and IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.14 D.C. reactor

Replace, in the existing first paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999 and IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

A.2.16 D.C. side high frequency filter

Replace, in the existing paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999, IEC 61803:1999/AMD1:2010 and IEC 61803:1999/AMD2:2016" *with* "IEC 61803:2020".

A.3 Auxiliaries and station service losses

Replace, in the existing paragraph, modified by IEC 62751-1:2014/AMD1:2018, the reference "IEC 61803:1999 and IEC 61803:1999/AMD1:2010" *with* "IEC 61803:2020".

Bibliography

Replace the existing reference to IEC 61803, modified by IEC 62751-1:2014/AMD1:2018, with the following new reference:

IEC 61803:2020, *Determination of power losses in high-voltage direct current (HVDC) converter stations with line-commutated converters*

Add the following new reference:

CIGRE Technical Brochure 844, Feasibility Study for assessment of lab losses measurement of VSC valves, 2021

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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PERTES DE PUISSANCE DANS LES VALVES À CONVERTISSEUR DE SOURCE DE TENSION (VSC) DES SYSTÈMES EN COURANT CONTINU À HAUTE TENSION (CCHT) –

Partie 1: Exigences générales

AMENDEMENT 2

AVANT-PROPOS

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