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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 20989-2017

Replacing GB/T 20989-2007

**Determination of power losses in high-voltage direct current
(HVDC) converter stations
(English Translation)**

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Foreword

This standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This standard replaces GB/T 20989-2007 "HVDC converter station loss determination," compared with the GB/T 20989-2007 main technology the changes are as follows.

- Removed "GB/T 10229-1988 (IEC 60289), reactor" (2007 edition of Chapter 2);
- Added "IEC 60076-6 Power Transformer Part 6. Reactors" (see Chapter 2);
- Added terms and definitions "station auxiliary load" (see 3.1.7);
- The symbol U_{v0} meaning "converter transformer valve side no-load line voltage root

mean square value (V)" to "converter transformer valve side does not contain harmonics (V) of the no-load line voltage "(see 3.2, 2007 version 3.2);

--- Added comment (see 4.2.1);

--- The formula $PV4 = U2V0 \cdot 2\pi RDC [\cos(2\alpha) \cos(2\alpha \cdot 2\mu)] \cdot 6m2-12m-7 [\sin(2\alpha) - \sin(2\alpha \cdot 2\mu) \cdot 2\mu]$ Change to $PV4 = UV02 \cdot 2\pi RDC \cdot 3\pi [\cos(2\alpha) \cos(2\alpha \cdot 2\mu)] \cdot 6m2-12m-7 [\sin(2\alpha) - \sin(2\alpha \cdot 2\mu) \cdot 2\mu]$ (See 5.1.4, 2007 edition) 5.1.4);

--- Note added in 5.2.3 (see 5.2.3);

--- Removed "can also be measured at the converter station auxiliary equipment loss measurement" (2007 version 5.2.4);

--- Added "in the calculation, it should be assumed that the AC system is operating at the rated frequency, the filter bank at rated conditions." (See 5.3.1);

--- Added "Low-voltage capacitors (filters for 2 or more tuning frequencies) have a small, negligible loss" (see 5.3.2);

--- Removed "can also be measured at the converter station auxiliary equipment loss measurement" (2007 version 5.6);

--- Modify the description of auxiliary equipment and station loss (see 5.8);

--- The symbol "RPLC --- reactor DC resistance (ohm)" to "R --- reactor DC resistance (ohm)" (see 5.9, 2007 Version 5.9);

--- The formula $P = I2d \times RPLC \sum n = 48 n = 12 I2n \times Xn Qn$ Change to $P = I2d \times R \sum n = 48 n = 12 I2n \times Xn Qn$ (See 5.9, version 5.9 of 2007);

--- Added "In addition, the series filter is also used to prevent harmonic interference between interconnected AC systems or for other purposes" (see 5.9);

--- The formula $F2 = k23 \cdot k24-2k3 \times k4 \times \cos(2\alpha \cdot \mu) \cdot 1$ Change to $F2 = k23 \cdot k24-2k3 \times k4 \times \cos(2\alpha \cdot \mu) \cdot 1$ (See Appendix A.3, Appendix A.3 of the 2007 edition);

--- Change all "Converters" to "Converters" and "Tap" for all description transformers to "Tap Changer".

This standard uses the translation method identical with IEC 61803:2011 "The use of high-voltage DC commutation converter commutator losses indeed set".

The documents of our country that are consistent with the corresponding international documents that are normative references in this standard are as follows.

--- GB 1094.1 Power Transformer Part 1. General (GB 1094.1-2013, IEC 60076-1:2011, MOD);

--- GB 1094.6-2011 power transformers Part 6. Reactors (GB/T 1094.6-2011, IEC

60076-6:2007, MOD);

--- GB/T 20990.1 HVDC thyristor valve Part 1. Electrical test (GB/T 20990.1-2007, IEC 60700-1:1998, IDT);

--- GB/T 15291 Semiconductor devices Part 6. Thyristors (GB/T 15291-2015, IEC 60747-6:2000, IDT);

--- GB/T 11024.1 Shunt capacitors for AC power systems with nominal voltages above 1000 V - Part 1. General (GB/T 11024.1-2010, IEC 60871-1:2005, MOD).

This standard made the following editorial changes or errata.

--- 3.1.1, for ease of understanding, an increase of "Note";

--- 3.2, according to our habits, "(trigger) delay angle" to "trigger angle", "overlap angle" to "commutation angle";

--- 5.1.7, delete the "on the thyristor and damping resistance," because a single valve turn-off loss refers not only to "in the thyristor and damping on "loss, but the loss of all the valves.

This standard proposed by the China Electrical Equipment Industry Association.

This standard by the National Standardization Technical Committee power electronic systems and equipment (SAC/TC60) centralized.

This standard was drafted unit. China Electric Power Research Institute, Xi'an High Voltage Apparatus Research Institute Co., Ltd., Xi'an West Power System Limited, CLP Power Engineering Co., Ltd., Beijing State Economic and Technological Research Institute, China Southern Power Grid Institute of Science and Technology Co., Ltd., the country NARI Technology Co., Ltd., Xi'an Xixian Power Capacitor Co., Ltd., China Southern Power Grid EHV Transmission and Maintenance Test center.

1 Scope

This standard applies to all power conversion phase-type high-voltage DC converter station in the power system. This standard assumes the use of 12 Pulsating thyristor converter, 6-pulse thyristor converter can also refer to the use.

In some projects, synchronous compensators or static var compensators may be connected to the AC bus of a HVDC converter station. This standard the method of determining the loss of these devices is not included.

This standard proposes a set of standard methods to determine the total loss of HVDC converter stations. A typical high-voltage DC equipment shown in Figure 1.

These methods involve all but the equipment referred to in the preceding paragraph, define the no-load loss and the operational loss, and propose to use as much as possible the

quantity parameter determines how these losses are calculated.

If the design of the converter station is compared with the typical design assumed in this standard, a new component or new circuit structure is used or a possible shadow Losses special additional circuits, then the loss should be determined, as the case may be.

2 Normative references

The following documents for the application of this document is essential. For dated references, only the dated version applies to this article Pieces. For undated references, the latest edition (including all amendments) applies to this document.

IEC 60076-1 Power Transformer Part 1. General (Powertransformers-Part 1: General) IEC 60076-6 Power Transformer Part 6. Reactors (Powertransformers-Part 1: Reactors) IEC 60700-1 HVDC thyristor valves - Part 1. Electrical tests (Thyristorvalvesforhighvoltage di-rectcurrent power transmission-Part 1: Electrical testing) IEC 60747-6 Semiconductor Devices Part 6. Thyristors (Semiconductor devices-Part 6: Thyristors) Shuntcapacitors - Shuntcapacitors - Shuntcapacitors - Shuntcapacitors - Shuntcapacitors - Part 1. Shuntcapacitors for a.c. power system having a rated voltage above 1000V-Part 1: General)

3.1 Terms and definitions

The following terms and definitions apply to this document.

3.1.1

Additional loss auxiliary losses Attached to the converter station system power required. The additional loss is related to whether the converter is in the no-load condition or the load condition it also depends on the load power level.

Note: Additional systems include auxiliary equipment and station equipment.

3.1.2

No-load loss loss no-load opel os losses Converter station equipment in the following state loss. Converter station has been charged, but the converter is in a locked state, immediately with the required load Auxiliary equipment and station equipment has been put into operation.