

ICS 29.180  
CCS K 41

**DL**

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

**DL/T 2003-2019**

---

**Application guide of on-load tap-changer for HVDC converter  
transformers**

**(English Translation)**

**Issued on: June 4, 2019**

**Implemented on: October 1, 2019**

---

**Issued by: National Energy Administration**

## Table of Contents

|                                                                                       |   |
|---------------------------------------------------------------------------------------|---|
| Preface .....                                                                         | 1 |
| 1 Scope .....                                                                         | 1 |
| 2 Normative references .....                                                          | 1 |
| 3 Terms and definitions .....                                                         | 1 |
| 4 Structure and classification .....                                                  | 3 |
| 4.1 Structure .....                                                                   | 3 |
| 4.2 Classification .....                                                              | 3 |
| 5 Selection principle .....                                                           | 3 |
| 5.1 Basic selection principles .....                                                  | 3 |
| 5.2 Principles for determining insulation level .....                                 | 3 |
| 5.3 Tap Range .....                                                                   | 4 |
| 5.4 Winding arrangement .....                                                         | 4 |
| 5.5 Type selection .....                                                              | 4 |
| 5.6 Current rate of change .....                                                      | 4 |
| 5.7 Harmonics .....                                                                   | 4 |
| 5.8 Potential Resistance and Potential Resistance Switch .....                        | 4 |
| 6 Technical requirements .....                                                        | 4 |
| 6.1 Overview .....                                                                    | 4 |
| 6.2 Normal operating conditions .....                                                 | 4 |
| 6.3 Overload .....                                                                    | 5 |
| 6.4 Mechanical life and electrical life .....                                         | 5 |
| 6.5 Oil Conservator and Oil Chamber .....                                             | 5 |
| 6.6 Insulating oil, oil filtering device and heat sink .....                          | 5 |
| 6.7 Oil temperature requirements in the oil chamber during continuous operation ..... | 5 |
| 6.8 Protection .....                                                                  | 6 |
| 7 Test .....                                                                          | 6 |
| 7.1 Type test and routine test .....                                                  | 6 |
| 7.2 Routine test with converter transformer .....                                     | 6 |
| 8 Installation .....                                                                  | 6 |
| 8.1 Installation of on-load tap-changer body .....                                    | 6 |
| 8.2 Installation of electric operating mechanism .....                                | 7 |
| 8.3 Installation of oil filter device .....                                           | 7 |

|                                                                                                                                                   |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 9 Operation, maintenance and overhaul .....                                                                                                       | 7  |
| 9.1 Operation and maintenance .....                                                                                                               | 7  |
| 9.2 Maintenance .....                                                                                                                             | 8  |
| 10 Marking, packaging, transportation and storage .....                                                                                           | 11 |
| 10.1 Logo .....                                                                                                                                   | 11 |
| 10.2 Packaging .....                                                                                                                              | 11 |
| 10.3 Transportation and storage .....                                                                                                             | 11 |
| Appendix A (informative appendix) Current rate of change .....                                                                                    | 13 |
| Appendix B (informative appendix) Gas generation characteristics of on-load<br>tap-changer change-over selector for commutation transformer ..... | 14 |
| Appendix C (informative appendix) Layout of external embedded on-load tap-changer<br>without partition .....                                      | 16 |

## Foreword

This standard is compiled in accordance with the rules of GB/T 1.1-2009 "Guidelines for Standardization Part 1: Standard Structure and Compilation".

This standard was proposed by the China Electricity Council.

This standard is under the jurisdiction of the Power Transformer Standardization Technical Committee (DL/T C 02) of the power industry.

Drafting organizations of this standard. China Southern Power Grid Research Institute Co., Ltd., State Grid Jiangsu Electric Power Co., Ltd., China Southern Power Grid Limited liability company, China Electric Power Research Institute Co., Ltd., State Grid Hubei Electric Power Co., Ltd. Electric Power Research Institute, Electric Power Industry Equipment Quality Inspection and Testing Center, State Grid Zhejiang Electric Power Research Institute, Guangxi Power Grid Co., Ltd. Electric Power Research Institute, China Southern Power Grid EHV Transmission Company, Shanghai Huaming Power Equipment Manufacturing Co., Ltd., Hefei ABB Transformer Co., Ltd., Guizhou Changzheng Electric Co., Ltd., MR Kaide Trading (Shanghai) Co., Ltd., Baoding Tianwei Baobian Electric Co., Ltd., Xi'an Xidian Transformer Co., Ltd.

Ren company, TBEA Hengyang Transformer Co., Ltd.

## 1 Scope

This standard specifies the structure, classification and selection principles of on-load tap changers of oil-immersed converter transformers (hereinafter referred to as converter transformers) Technical requirements, testing, installation, operation and maintenance, packaging, transportation and storage.

This standard applies to resistance type on-load tap changers for converter transformers.

## 2 Normative references

The following documents are indispensable for the application of this standard. For dated reference documents, only the dated version applies to this standard.

For undated reference documents, the latest version (including all amendments) is applicable to this standard.

GB/T 507 Insulating oil breakdown voltage test method GB 1094.1 Power Transformer Part 1: General Rules GB 1094.3 Power Transformer Part 3: Insulation level, insulation test and external insulation air gap GB 1094.5 Power Transformer Part 5: Ability to withstand short circuit GB 1094.7 Power Transformer Part 7: Load Guidelines for Oil-immersed Power Transformers GB 2536 Unused mineral insulating oil for electrical fluid transformers and switches GB 10230.1 On-load tap changer Part 1: Performance requirements and test methods GB/T 10230.2 On-load tap changer Part 2: Application guidelines GB 18494.2-2007 Converter transformer Part 2: Converter transformer for HVDC transmission GB 20838-2007 Technical parameters and requirements for oil-immersed converter transformers for HVDC transmission GB 50776-2012 Code for site construction and acceptance of converter transformers in converter stations of  $\pm 800\text{kV}$  and below GB 50150 Electrical equipment installation engineering electrical equipment handover test standard DL/T \*\*\*\* Guidelines for the selection of on-load tap-changers for power transformers (write clauses in the quoted part) DL/T 572 Power Transformer Operation Regulations DL/T 573 Power Transformer Maintenance Guide DL/T 574 Operation and maintenance guidelines for on-load tap changers of transformers DL/T 596 Preventive test procedures for electrical equipment JB/T 7065 Pressure relief valve for transformer JB/T 8314 Test Guide for On-load Tap Changers JB/T 9647 gas relay JB/T 10372 hydraulic pressure relay

## 3 Terms and definitions

The following terms and definitions established by GB 10230.1 and GB/T 10230.2 apply to this standard. For ease of use, the following Some terms and definitions in GB 10230.1 and GB/T 10230.2 are listed repeatedly.

**Change-over selector** A device that can be used in conjunction with a tap selector or selector switch and can carry current but cannot make and break the passing current. When from one when one terminal position is transferred to another terminal position, the contact of the tap selector or selector switch and the tap connected to it can be connected more than once.

Is being used.

**Note:** Rewrite GB 10230.1-2007, definition 3.6 3.2 Reversing change-over selector A change-over selector that connects one end or the other end of the tap winding to the main winding. There may

be common between it and the tap selector the number of contacts and the polarity selection position is 2, which are respectively connected to the 2 terminals of the tap winding.

**Note:** Rewrite GB 10230.1-2007, definition 3.8 3.3 Coarse change-over selector A change-over selector that connects the tap winding to the coarse winding or to the main winding or its part of the winding.

[GB 10230.1-2007, definition 3.7] 3.4 Switched current when tapping is changed, the expected breaking current on each main make-break contact group or transition contact group of the diverter switch, or when the change-over selector moves During operation, due to the capacitive coupling effect of the tap winding on the adjacent windings, the fuel tank and the iron core and the connection potential resistance, the expected opening on the moving and fixed contacts Broken current.

**Note:** Rewrite GB 2900.95-2015, definition 2.2.1.

#### Recovery voltage

Each main on-off contact group or transition contact group of the diverter switch of the combined on-load tap-changer appears after the breaking current is cut off.

The power frequency voltage of the fracture. Or when the change-over selector acts, due to the capacitive coupling effect of the tap winding on the adjacent windings, the fuel tank and the iron core, the power frequency voltage generated between the switch selector contact groups after the breaking current is cut off.

**Note:** Rewrite GB 10230.1-2007, definition 3.22.

#### Tie-in resistor

#### Binding resistance

In order to limit the recovery voltage generated between the contacts when the contacts of the change-over selector are moved, the tap winding is connected to the current output terminal the resistance connected between.

Switch for tie-in resistor Bonded resistance switch A device used to connect and disconnect potential resistance. One end of the device is connected with the potential resistance, and the other end is connected with the switch current output the terminal connection shall be closed before the switching selector action, and reopen when the switching selector action is completed, and the insulation distance shall be ensured.

#### Current change rate

The rate of change when the load current of the grid-side winding of the converter transformer crosses zero. Its magnitude is related to the trigger angle and the cut-off angle, and is generally recorded as  $di/dt$ .