



BSI Standards Publication

Guidelines for operation and maintenance of line commutated converter (LCC) HVDC converter station

National foreword

This Published Document is the UK implementation of IEC TR 63065:2017+A1:2022. It supersedes PD IEC/TR 63065:2017, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee GEL/8/4.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided "as is", and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication is not to be regarded as a British Standard.

© The British Standards Institution 2023
Published by BSI Standards Limited 2023

ISBN 978 0 539 14714 8

ICS 29.200; 29.240.01

Compliance with a Published Document cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 October 2017.

Amendments/corrigenda issued since publication

Date	Text affected
30 November 2023	Implementation of IEC amendment 1:2022



TECHNICAL REPORT

AMENDMENT 1

Guidelines for operation and maintenance of line commutated converter (LCC) HVDC converter station

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.200; 29.240.01

ISBN 978-2-8322-2077-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	4
1 Scope	6
2 Normative references	6
3 Terms, definitions, and abbreviated terms	6
3.1 Terms and definitions	6
3.2 Abbreviated terms	7
4 Operation	8
4.1 Operation policy	8
4.1.1 Target reliability and availability	8
4.1.2 Operation cost	9
4.1.3 Manned or unmanned	9
4.2 Operation condition and limits	9
4.3 Operations of an HVDC system	10
4.3.1 General	10
4.3.2 Typical operation configuration	10
4.3.3 Set up the control mode	12
4.3.4 Operation procedure	13
4.4 Operations of HVDC equipment	16
4.4.1 Converter valves	16
4.4.2 Converter transformers and oil immersed smoothing reactors	19
4.4.3 AC/DC breakers and switchgear	22
4.4.4 AC/DC filters	24
4.4.5 Control and protections	27
4.4.6 DC measurement instruments	29
4.4.7 Valve cooling system	30
4.4.8 Auxiliary power system	33
4.4.9 Fire protection system	34
5 Maintenance	35
5.1 Maintenance policy	35
5.1.1 General	35
5.1.2 Corrective maintenance	36
5.1.3 Time-based maintenance (TBM)	36
5.1.4 Condition-based maintenance (CBM)	36
5.1.5 Reliability-centred maintenance (RCM)	37
5.1.6 Maintenance programme	37
5.2 Maintenance during operation	37
5.2.1 Routine maintenance for converter transformers	37
5.2.2 Maintenance for control and protections	38
5.2.3 Maintenance for DC measurements	38
5.2.4 Routine maintenance for valve cooling system	38
5.2.5 Routine maintenance for Fire protection system	39
5.3 Maintenance under outage	39
5.3.1 Converter valves	39
5.3.2 Converter transformers	39
5.3.3 AC/DC breakers and switchgear	41
5.3.4 AC/DC filters	41

5.3.5	DC measurements	42
5.3.6	Valve cooling system	42
5.3.7	AC/DC arresters	43
A1	5.3.8 Fire protection system	43 A1
6	Fault analysis and troubleshooting.....	44
6.1	General.....	44
6.2	System disturbances.....	44
6.3	Station faults.....	44
6.4	General information for fault analysis	45
6.4.1	General	45
6.4.2	Interpreting events and the TFR	5
6.4.3	Checking plant circuit diagram and application software logics	45
6.4.4	Analyzing the equipment status	45
6.4.5	Simulation	45
6.4.6	Site test.....	46
6.4.7	Involving the HVDC supplier	46
7	Training.....	46
7.1	General.....	46
7.2	Operator training program	46
7.2.1	General	46
7.2.2	Training courses.....	46
7.2.3	Participation during installation and commissioning	46
7.3	Maintenance training program.....	47
7.3.1	General	47
7.3.2	Training courses.....	47
7.3.3	Training during equipment installation and testing	47
7.3.4	Continuous transfer of knowledge.....	48
8	Spare parts.....	48
9	Tools	49
10	Documentation	50
10.1	General.....	50
10.2	Documents to be provided by the supplier.....	50
10.3	Documents to be prepared by the operators.....	50
10.4	Statistics and analysis	50
	Bibliography.....	52

Table 1 – Basic tools needed for operation and maintenance of an HVDC converter station	49
---	----

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**GUIDELINES FOR OPERATION AND MAINTENANCE
OF LINE COMMUTATED CONVERTER (LCC)
HVDC CONVERTER STATION**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as far as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, accept IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 63065, which is a technical report, has been prepared by IEC technical committee 115: High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
115/153/DTR	115/163/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.

IEC TR 63065:2017+A1:2022
© IEC 2022

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

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.

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

Currently in preview, click buy full version

GUIDELINES FOR OPERATION AND MAINTENANCE OF LINE COMMUTATED CONVERTER (LCC) HVDC CONVERTER STATION

1 Scope

This Technical Report provides general guidance on basic principles and general proposals for the safe and economic operation and maintenance of an LCC converter station.

These guidelines are based on the operation and maintenance practices that have been used successfully during the last decades at HVDC converter stations all over the world and can be referred to by new HVDC users to optimize operation and maintenance policy and assist in performing the operation and maintenance work.

This document focuses only on the operation and maintenance of the equipment inside an LCC converter station, including back-to-back HVDC systems. The operation and maintenance of HVDC overhead transmission lines, HVDC cables and voltage sourced converter (VSC) are not covered by this document.

NOTE Usually the agreement between the purchaser and the suppliers of an HVDC converter station includes specific requirements regarding contractual requirements of particular systems. Such specific requirements will supersede the general/typical description mentioned in this document and all functions mentioned in this document are not necessarily applicable for all systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60633, *Terminology for high-voltage direct current (HVDC) transmission*

IEC 60919 (all parts), *Performance of high-voltage direct current (HVDC) systems with line-commutated converters*

IEC 61975, *System tests for High-voltage direct current (HVDC) installations*

IEC TS 62671-1, *Reliability and availability evaluation of HVDC systems – Part 1: HVDC systems with line-commutated converters*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60633 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>