



BSI Standards Publication

Guideline for planning of HVDC systems

Part 1: HVDC systems with line-commutated converters

National foreword

This Published Document is the UK implementation of IEC TR 63179-1:2020.

The UK participation in its preparation was entrusted to Technical Committee PEL/22/-/2, High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2020
Published by BSI Standards Limited 2020

ISBN 978 0 580 99657 3

ICS 29.200; 29.240.01

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 May 2020.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------



TECHNICAL REPORT



Guideline for planning of HVDC systems – Part 1: HVDC systems with line-commutated converters

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.200; 29.240.01

ISBN 978-2-8322-8208-3

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

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 General	6
5 Comparison between HVDC and AC alternatives	8
5.1 Consideration of overall network planning	8
5.1.1 Overall network planning	8
5.1.2 Connection topologies for HVDC systems	8
5.2 Comparison of transmission capacity	9
5.3 Comparison of operation requirements.....	9
5.3.1 Comparison of system fault and stability	9
5.3.2 Comparison of voltage regulation and reactive power compensation.....	9
5.4 Comparison of cost.....	10
5.5 Comparison of other aspects	11
6 HVDC solutions	11
6.1 Main circuit topologies	11
6.1.1 General	11
6.1.2 Monopolar HVDC transmission system	12
6.1.3 Bipolar HVDC transmission system.....	12
6.1.4 Rigid bipolar HVDC system.....	12
6.2 Main equipment	13
6.2.1 General	13
6.2.2 Converter	13
6.2.3 AC filtering equipment	14
6.3 Key DC rating parameters.....	14
6.3.1 Rated DC power	14
6.3.2 Rated DC voltage	15
6.3.3 Rated DC current.....	16
6.4 Line conductor	16
6.5 Station sites and transmission line routes	17
6.5.1 Converter station sites.....	17
6.5.2 Electrode station sites	18
6.5.3 Overhead line route	18
6.5.4 Submarine cable route.....	18
6.5.5 Land cable route.....	19
6.6 Interface requirements between AC network and HVDC.....	19
6.7 Requirements of HVDC control system	20
6.7.1 Requirements for basic control and protection	20
6.7.2 Supplementary control.....	20
7 Analysis of security of supply and stability for DC alternatives	21
7.1 Requirements for power network connection criteria	21
7.1.1 General requirements for AC/DC power network.....	21
7.1.2 Short-circuit ratio (SCR) of the AC system connected with single DC system.....	21
7.1.3 Short-circuit ratio of the AC system connected with multi-infeed DC system.....	22

7.1.4	Effective inertia constant of AC/DC power network	23
7.2	Stability of AC power system due to HVDC alternatives	24
7.2.1	Stability analysis for AC power system	24
7.2.2	Analysis of sub-synchronous torsional interactions (SSTI) between HVDC and nearby turbine-generator	24
7.2.3	Analysis for multi-infeed HVDC links	25
8	Economic comparison among the alternatives	25
8.1	General.....	25
8.2	Main factors to be considered	25
8.3	Indexes to be considered	26
8.4	Sensitivity analysis	26
8.5	Economic conclusion for recommended solution	26
9	Study conclusions and recommended solution	26
	Bibliography.....	28
	Figure 1 – Phases during integration of a new HVDC system into the power network.....	7
	Figure 2 – Procedure for planning an HVDC system	8
	Figure 3 – Cost versus distance.....	11
	Table 1 – Typical overhead bipolar HVDC project for power transmission	15

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDELINE FOR PLANNING OF HVDC SYSTEMS –**Part 1: HVDC systems with line-commutated converters**

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 nearly 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, access to 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 63179-1, 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:

Draft TR	Report on voting
115/216/DTR	115/230/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.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

GUIDELINE FOR PLANNING OF HVDC SYSTEMS –

Part 1: HVDC systems with line-commutated converters

1 Scope

This document provides guidelines for the selection of a high-voltage directive current (HVDC) system with line-commutated converters (LCC), hereafter referred to as HVDC system, for the purposes of HVDC system planning. It covers the guidelines on the requirements for integrating HVDC systems in AC power networks, selection of rated voltage and power, overloads, circuit configuration, expandability, comparison of technical, economic, regulatory, political, social and environmental factors, etc. This document is applicable for planning an HVDC system.

This guideline is not exhaustive and it is possible that there will be other specific aspects, particular to a specific HVDC project, which will also need to be considered.

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, *High-voltage direct current (HVDC) transmission – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60633 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>

4 General

The HVDC system development and integration cycle may be described in terms of six phases, as shown in Figure 1.

The main task of HVDC system planning is to develop and select an HVDC scheme based on the conclusions of power network development planning where the network requirements are defined. HVDC system planning uses as a minimum the total transmission capacity and range of connection points previously determined by power network development planning, taking into account current and future conditions of the power system, environment, and other contributing factors.

There is a certain degree of repetition and iteration between HVDC system planning and system design (refer to Figure 1). For the purpose of project feasibility study and scheme comparison, some investigation would be carried out during the system planning phase, the detailed studies and final design would be accomplished during the system design phase.