IEC TR 63127

Edition 1.1 2024-04
CONSOLIDATED VERSION

TECHNICAL REPORT

colour inside

Guideline for the system design of HVDC converter stations with line-commutated converters

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240.01; 29.240.10

ISBN 978-2-8322-8767-5

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

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 6
INTRODUCTION 8
1 Scope 9
2 Normative references 9
3 Terms and definitions 9
4 Symbols 10
4.1 Letter symbols for variables 10
4.2 Subscripts 11
5 Overview of HVDC system design 11
5.1 General 11
5.2 Formulation of system design 13
5.2.1 HVDC system ratings 13
5.2.2 HVDC system configuration 13
5.2.3 Reactive power compensation and control 13
5.2.4 AC/DC interaction and control 13
5.2.5 Insulation coordination 14
5.2.6 AC/DC harmonic filtering 14
5.2.7 Environmental considerations 14
5.3 System studies and simulations 14
6 Determination of design conditions and requirements 16
6.1 Environmental conditions and requirements 16
6.2 DC transmission line (cable) and earth electrode 17
6.2.1 Parameters of DC overhead transmission line 17
6.2.2 Parameters of DC cable 18
6.2.3 Parameters of electrode line and ground electrode 18
6.3 AC system conditions 18
6.3.1 Operating scenarios of AC/DC system 18
6.3.2 AC system modelling 18
6.3.3 Relevant AC system protection 19
6.3.4 Reactive power supply and absorption 19
6.3.5 Short-circuit current or capacity 20
6.3.6 AC bus voltage 21
6.3.7 AC system frequency 21
6.3.8 Pre-existing harmonic and negative sequence voltage 22
6.4 Requirements for HVDC systems arising from AC/DC interaction 22
6.5 AC system equivalents 23
6.5.1 General 23
6.5.2 Equivalent for AC/DC system dynamic or transient simulation 23
6.5.3 Impedance equivalent for AC filter design 24
6.5.4 System equivalent for low order harmonic resonance study 26
7 Main circuit design 26
7.1 Ratings 26
7.1.1 Rated power 26
7.1.2 Rated voltage 27
7.1.3 Rated current 28
7.2 Configurations 28

7.2.1 Pole and return path 28
7.2.2 Converter topology 29
7.2.3 DC switchyard configuration 30
7.2.4 Reactive power equipment 38
7.3 Determination of main circuit parameters 38
7.3.1 General 38
7.3.2 Control strategy 39
7.3.3 Tolerances and errors 40
7.3.4 Determination of converter transformer impedance 40
7.3.5 Relative inductive voltage drop (d_{xN}) and relative resistive voltage drop (d_{rN}) 40
7.3.6 Ideal no-load DC voltage 41
7.3.7 DC voltage and DC current 41
7.3.8 Rated capacity of converter transformer 42
7.3.9 Converter transformer taps 43
7.3.10 Inductance of smoothing reactor 44
8 Insulation coordination 44
9 Filter design 45
9.1 General 45
9.2 AC filter design 45
9.3 DC filter design 45
9.4 Power line carrier (PLC) filters 46
9.5 Radio frequency interference (RFI) 46
10 Reactive power compensation and control 47
10.1 General 47
10.2 Reactive power consumption 47
10.2.1 Reactive power consumption calculation 47
10.2.2 Maximum reactive power consumption 48
10.2.3 Minimum reactive power consumption 48
10.3 Determination of reactive power equipment capacity 48
10.3.1 General 48
10.3.2 Capacity of reactive power supply equipment 48
10.3.3 Capacity of reactive power absorption equipment 48
10.3.4 Sizing of reactive power sub-bank 49
10.3.5 Sizing of reactive power bank 49
10.4 Reactive power control 49
10.4.1 General 49
10.4.2 Reactive power exchange control/voltage control 50
10.4.3 Voltage limitation 50
10.5 Temporary overvoltage control 51
11 Basic parameters of main equipment 51
11.1 General 51
11.2 Converter valves 51
11.2.1 General 51
11.2.2 Valve hall environment 51
11.2.3 Current rating 52
11.2.4 Voltage rating 52
11.2.5 Losses of converter valves 53
11.2.6 Testing requirements 53

11.3 Converter transformers 53
11.3.1 General 53
11.3.2 Current rating 54
11.3.3 Voltage rating 54
11.3.4 Other rating 54
11.3.5 Rated loss 54
11.3.6 Test requirements 55
11.4 Smoothing reactor 55
11.4.1 General 55
11.4.2 Current ratings 55
11.4.3 Voltage rating 56
11.4.4 Other ratings 56
11.4.5 Losses 56
11.4.6 Test requirements 56
11.5 Wall bushings 56
11.5.1 General 56
11.5.2 Current rating 56
11.5.3 Voltage rating 56
11.5.4 Testing requirement 56
11.6 AC and DC filter equipment 57
11.7 PLC filter equipment 57
11.8 Other equipment in DC yard 57
Annex A (informative) Typical control, measurement and equipment manufacturing tolerance in HVDC systems 58
Annex B (informative) Technical parameters for equipment specification 59
B.1 Converter valve 59
B.2 Converter transformer 61
B.3 Smoothing reactor 62
Bibliography 63

Figure 1 – System design in an HVDC project 12
Figure 2 – Example of schematic diagram of AC system frequency variation range 22
Figure 3 – Sector diagram of system harmonic impedance 25
Figure 4 – Circle diagram of system harmonic impedance 25
Figure 5 – Structure of equivalent network for low order harmonic resonance study 26
Figure 6 – Converter transformer connection topology 30
Figure 7 – Sketch maps of the DC yard switches of HVDC system 33
Figure 8 – Schematic diagram of converter parallel connection 33
Figure 9 – Schematic diagram of pole line parallel connection 34
Figure 10 – Procedure of NBS disconnecting DC fault 34
Figure 11 – Current transfer path of the MRTS 35
Figure 12 – Current transfer path of ERTS 35
Figure 13 – Connection and function of the NBES 36
Figure 14 – Commutating process of NBES in case of DMR 36
Figure 15 – High speed bypass switch 37
Figure 16 – Converter paralleling switches 37

Table 1 – Studies and simulations in HVDC system design 15
Table 2 – Preferred rated voltages for overhead line HVDC power transmission 27
Table 3 – Preferred rated voltages for submarine HVDC power transmission 28
Table A.1 – Tolerance for main circuit calculation 58
Table A.2 – Control parameters for main circuit calculation 58

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

GUIDELINE FOR THE SYSTEM DESIGN OF HVDC CONVERTER STATIONS 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC TR 63127 edition 1.1 contains the first edition (2019-06) [documents 115/195/DTR and 115/203/RVDTR] and its amendment 1 (2024-04) [documents 115/361/DTR and 115/364/RVDTR].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

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 63127, 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.

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

The committee has decided that the contents of this document and its amendment will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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.

INTRODUCTION

HVDC is an established technology that has been in commercial use for more than 60 years. With the changes in demands due to evolving environmental needs, installation of HVDC systems has increased dramatically in the last 30 years and ~~almost~~ more than half of HVDC projects were commissioned after the year 2000. HVDC has become a common tool in the design of future global transmission systems.

HVDC systems transmit more electrical power over longer distances than a similar alternating current (AC) transmission system, which means fewer transmission lines are needed, saving both money and land and simplifying permissions. In addition to significantly lowering electrical losses over long distances, HVDC transmission is also very stable and easily controlled, and can stabilize and interconnect AC power networks that are otherwise incompatible. Typically line-commutated converter (LCC) HVDC systems provide unique or superior capabilities in the following aspects:

- long distance bulk power transmission;
- asynchronous interconnections;
- long distance cable;
- controllability;
- lower losses;
- environmental concerns;
- limitation of short-circuit currents.

Simply due to these technical merits, the market demand for HVDC transmission technology is spreading widely over the world. There are many HVDC power transmission systems with a DC voltage from 50 kV up to ~~660~~ 1 100 kV in different countries. ~~In addition, there are several ±800 kV HVDC power transmission systems which have been built or operated or which are under construction in China, India and Brazil. In 2016, one ±1 100 kV HVDC power transmission system project was started in China.~~

The fast development of the HVDC power transmission and distribution industry has been accompanied by IEC standardization work. More than 40 IEC documents, from DC equipment to DC systems, have been published. Among these, the IEC TR 60919 series, IEC 60633, IEC 60071-5, the IEC TR 62001 series and the IEC 60700 series provide essential information for the design and operation of HVDC power transmission systems.

However, this document provides only a basic guide and refers to typical numbers and examples. Other points and values may also be valid in particular cases and should also be considered accordingly.

GUIDELINE FOR THE SYSTEM DESIGN OF HVDC CONVERTER STATIONS WITH LINE-COMMUTATED CONVERTERS

1 Scope

System design is the basis of construction and operation of HVDC systems. It defines the overall philosophy for the HVDC transmission system and enables the ratings and specifications for the equipment integrated in the project.

This document focuses on the system design of converter stations. It is applicable to point-to-point and back-to-back HVDC systems based on line-commutated converter (LCC) technology.

This document provides guidance and supporting information on the procedure for system design and the technical issues involved in the system design of HVDC transmission projects for both purchaser and potential suppliers. It can be used as the basis for drafting a procurement specification and as a guide during project implementation.

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*

CONTENTS

FOREWORD 6
INTRODUCTION 8
1 Scope 9
2 Normative references 9
3 Terms and definitions 9
4 Symbols 10
4.1 Letter symbols for variables 10
4.2 Subscripts 11
5 Overview of HVDC system design 11
5.1 General 11
5.2 Formulation of system design 13
5.2.1 HVDC system ratings 13
5.2.2 HVDC system configuration 13
5.2.3 Reactive power compensation and control 13
5.2.4 AC/DC interaction and control 13
5.2.5 Insulation coordination 14
5.2.6 AC/DC harmonic filtering 14
5.2.7 Environmental considerations 14
5.3 System studies and simulations 14
6 Determination of design conditions and requirements 16
6.1 Environmental conditions and requirements 16
6.2 DC transmission line (cable) and earth electrode 17
6.2.1 Parameters of DC overhead transmission line 17
6.2.2 Parameters of DC cable 18
6.2.3 Parameters of electrode line and ground electrode 18
6.3 AC system conditions 18
6.3.1 Operating scenarios of AC/DC system 18
6.3.2 AC system modelling 18
6.3.3 Relevant AC system protection 19
6.3.4 Reactive power supply and absorption 19
6.3.5 Short-circuit current or capacity 20
6.3.6 AC bus voltage 20
6.3.7 AC system frequency 21
6.3.8 Pre-existing harmonic and negative sequence voltage 22
6.4 Requirements for HVDC systems arising from AC/DC interaction 22
6.5 AC system equivalents 23
6.5.1 General 23
6.5.2 Equivalent for AC/DC system dynamic or transient simulation 23
6.5.3 Impedance equivalent for AC filter design 24
6.5.4 System equivalent for low order harmonic resonance study 26
7 Main circuit design 26
7.1 Ratings 26
7.1.1 Rated power 26
7.1.2 Rated voltage 27
7.1.3 Rated current 28
7.2 Configurations 28

7.2.1 Pole and return path 28
7.2.2 Converter topology 29
7.2.3 DC switchyard configuration 30
7.2.4 Reactive power equipment 38
7.3 Determination of main circuit parameters 38
7.3.1 General 38
7.3.2 Control strategy 39
7.3.3 Tolerances and errors 40
7.3.4 Determination of converter transformer impedance 40
7.3.5 Relative inductive voltage drop (d_{xN}) and relative resistive voltage drop (d_{rN}) 40
7.3.6 Ideal no-load DC voltage 41
7.3.7 DC voltage and DC current 41
7.3.8 Rated capacity of converter transformer 42
7.3.9 Converter transformer taps 43
7.3.10 Inductance of smoothing reactor 44
8 Insulation coordination 44
9 Filter design 45
9.1 General 45
9.2 AC filter design 45
9.3 DC filter design 45
9.4 Power line carrier (PLC) filters 46
9.5 Radio frequency interference (RFI) 46
10 Reactive power compensation and control 47
10.1 General 47
10.2 Reactive power consumption 47
10.2.1 Reactive power consumption calculation 47
10.2.2 Maximum reactive power consumption 48
10.2.3 Minimum reactive power consumption 48
10.3 Determination of reactive power equipment capacity 48
10.3.1 General 48
10.3.2 Capacity of reactive power supply equipment 48
10.3.3 Capacity of reactive power absorption equipment 48
10.3.4 Sizing of reactive power sub-bank 49
10.3.5 Sizing of reactive power bank 49
10.4 Reactive power control 49
10.4.1 General 49
10.4.2 Reactive power exchange control/voltage control 50
10.4.3 Voltage limitation 50
10.5 Temporary overvoltage control 51
11 Basic parameters of main equipment 51
11.1 General 51
11.2 Converter valves 51
11.2.1 General 51
11.2.2 Valve hall environment 51
11.2.3 Current rating 52
11.2.4 Voltage rating 52
11.2.5 Losses of converter valves 53
11.2.6 Testing requirements 53

11.3 Converter transformers 53
11.3.1 General 53
11.3.2 Current rating 54
11.3.3 Voltage rating 54
11.3.4 Other rating 54
11.3.5 Rated loss 54
11.3.6 Test requirements 55
11.4 Smoothing reactor 55
11.4.1 General 55
11.4.2 Current ratings 55
11.4.3 Voltage rating 56
11.4.4 Other ratings 56
11.4.5 Losses 56
11.4.6 Test requirements 56
11.5 Wall bushings 56
11.5.1 General 56
11.5.2 Current rating 56
11.5.3 Voltage rating 56
11.5.4 Testing requirement 56
11.6 AC and DC filter equipment 57
11.7 PLC filter equipment 57
11.8 Other equipment in DC yard 57
Annex A (informative) Typical control, measurement and equipment manufacturing tolerance in HVDC systems 58
Annex B (informative) Technical parameters for equipment specification 59
B.1 Converter valve 59
B.2 Converter transformer 61
B.3 Smoothing reactor 62
Bibliography 63

Figure 1 – System design in an HVDC project 12
Figure 2 – Example of schematic diagram of AC system frequency variation range 22
Figure 3 – Sector diagram of system harmonic impedance 25
Figure 4 – Circle diagram of system harmonic impedance 25
Figure 5 – Structure of equivalent network for low order harmonic resonance study 26
Figure 6 – Converter transformer connection topology 30
Figure 7 – Sketch maps of the DC yard switches of HVDC system 33
Figure 8 – Schematic diagram of converter parallel connection 33
Figure 9 – Schematic diagram of pole line parallel connection 34
Figure 10 – Procedure of NBS disconnecting DC fault 34
Figure 11 – Current transfer path of the MRTS 35
Figure 12 – Current transfer path of ERTS 35
Figure 13 – Connection and function of the NBES 36
Figure 14 – Commutating process of NBES in case of DMR 36
Figure 15 – High speed bypass switch 37
Figure 16 – Converter paralleling switches 37

Table 1 – Studies and simulations in HVDC system design 15
Table 2 – Preferred rated voltages for overhead line HVDC power transmission 27
Table 3 – Preferred rated voltages for submarine HVDC power transmission 28
Table A.1 – Tolerance for main circuit calculation 58
Table A.2 – Control parameters for main circuit calculation 58

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

GUIDELINE FOR THE SYSTEM DESIGN OF HVDC CONVERTER STATIONS 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC TR 63127 edition 1.1 contains the first edition (2019-06) [documents 115/195/DTR and 115/203/RVDTR] and its amendment 1 (2024-04) [documents 115/361/DTR and 115/364/RVDTR].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

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 63127, 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.

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

The committee has decided that the contents of this document and its amendment will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

HVDC is an established technology that has been in commercial use for more than 60 years. With the changes in demands due to evolving environmental needs, installation of HVDC systems has increased dramatically in the last 30 years and more than half of HVDC projects were commissioned after the year 2000. HVDC has become a common tool in the design of future global transmission systems.

HVDC systems transmit more electrical power over longer distances than a similar alternating current (AC) transmission system, which means fewer transmission lines are needed, saving both money and land and simplifying permissions. In addition to significantly lowering electrical losses over long distances, HVDC transmission is also very stable and easily controlled, and can stabilize and interconnect AC power networks that are otherwise incompatible. Typically line-commutated converter (LCC) HVDC systems provide unique or superior capabilities in the following aspects:

- long distance bulk power transmission;
- asynchronous interconnections;
- long distance cable;
- controllability;
- lower losses;
- environmental concerns;
- limitation of short-circuit currents.

Simply due to these technical merits, the market demand for HVDC transmission technology is spreading widely over the world. There are many HVDC power transmission systems with a DC voltage from 50 kV up to 1 100 kV in different countries.

The fast development of the HVDC power transmission and distribution industry has been accompanied by IEC standardization work. More than 40 IEC documents, from DC equipment to DC systems, have been published. Among these, the IEC TR 60919 series, IEC 60633, IEC 60071-5, the IEC TR 62001 series and the IEC 60700 series provide essential information for the design and operation of HVDC power transmission systems.

However, this document provides only a basic guide and refers to typical numbers and examples. Other points and values may also be valid in particular cases and should also be considered accordingly.

GUIDELINE FOR THE SYSTEM DESIGN OF HVDC CONVERTER STATIONS WITH LINE-COMMUTATED CONVERTERS

1 Scope

System design is the basis of construction and operation of HVDC systems. It defines the overall philosophy for the HVDC transmission system and enables the ratings and specifications for the equipment integrated in the project.

This document focuses on the system design of converter stations. It is applicable to point-to-point and back-to-back HVDC systems based on line-commutated converter (LCC) technology.

This document provides guidance and supporting information on the procedure for system design and the technical issues involved in the system design of HVDC transmission projects for both purchaser and potential suppliers. It can be used as the basis for drafting a procurement specification and as a guide during project implementation.

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*