

STN	Koordinácia izolácie Časť 11: Definície, zásady a pravidlá systému jednosmerného prúdu vysokého napätia (HVDC)	STN EN IEC 60071-11 33 0400
------------	---	---

Insulation co-ordination - Part 11:Definitions, principles and rules for HVDC system

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 02/23

Táto STN čiastočne nahrádza STN EN 60071-5 z júna 2015.

Obsahuje: EN IEC 60071-11:2022, IEC 60071-11:2022

136453

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 60071-11

December 2022

ICS 29.080.30

Supersedes EN 60071-5:2015 (partially)

English Version

**Insulation co-ordination - Part 11: Definitions, principles and rules
for HVDC system
(IEC 60071-11:2022)**

Coordination de l'isolement - Partie 11: Définitions,
principes et règles relatifs au réseau CCHT
(IEC 60071-11:2022)

Isolationskoordination - Teil 11: Begriffe, Grundsätze und
Anforderungen für HVDC Systeme
(IEC 60071-11:2022)

This European Standard was approved by CENELEC on 2022-12-13. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 60071-11:2022 (E)

European foreword

The text of document 99/374/FDIS, future edition 1 of IEC 60071-11, prepared by IEC/TC 99 "Insulation co-ordination and system engineering of high voltage electrical power installations above 1,0 kV AC and 1,5 kV DC" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60071-11:2022.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2023-09-13 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2025-12-13 document have to be withdrawn

This document, in conjunction with EN IEC 60071-12:2022, supersedes (partially) EN 60071-5:2015 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 60071-11:2022 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standard indicated:

IEC 60071-5:2014	NOTE	Harmonized as EN 60071-5:2015 (not modified)
IEC 60700-1:2015	NOTE	Harmonized as EN 60700-1:2015 (not modified)
IEC 60633	NOTE	Harmonized as EN IEC 60633
IEC 60099-5:2018	NOTE	Harmonized as EN IEC 60099-5:2018 (not modified)
IEC 60505:2011	NOTE	Harmonized as EN 60505:2011 (not modified)
IEC 60721-3-0:2020	NOTE	Harmonized as EN IEC 60721-3-0:2020 (not modified)
IEC/TR 60919-2:2008	NOTE	Harmonized as CLC/TR 60919-2:2010 (not modified)

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60060-1	-	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	-
IEC 60071-1	2019	Insulation co-ordination - Part 1: Definitions, principles and rules	EN IEC 60071-1	2019
IEC 60071-2	2018	Insulation co-ordination - Part 2: Application guidelines	EN IEC 60071-2	2018
IEC 60099-4	2014	Surge arresters - Part 4: Metal-oxide surge arresters without gaps for a.c. systems	EN 60099-4	2014
IEC/TS 60815-1	2008	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles	-	-
IEC/TS 60815-2	2008	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems	-	-
IEC/TS 60815-3	2008	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 3: Polymer insulators for a.c. systems	-	-



IEC 60071-11

Edition 1.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Insulation co-ordination –
Part 11: Definitions, principles and rules for HVDC system**

**Coordination de l'isolement –
Partie 11: Définitions, principes et règles relatifs au réseau CCHT**





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 60071-11

Edition 1.0 2022-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Insulation co-ordination –
Part 11: Definitions, principles and rules for HVDC system**

**Coordination de l'isolement –
Partie 11: Définitions, principes et règles relatifs au réseau CCHT**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.080.30

ISBN 978-2-8322-6026-5

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Symbols and abbreviations.....	13
4.1 General.....	13
4.2 Subscripts.....	14
4.3 Letter symbols	14
4.4 Abbreviations.....	15
5 Principles of insulation co-ordination	15
5.1 General.....	15
5.2 Essential differences between AC and DC systems.....	15
5.3 Insulation co-ordination procedure	16
5.4 Differences of withstand voltage selection in AC and DC systems.....	16
6 Design procedure of insulation co-ordination	18
6.1 General.....	18
6.2 Arrester characteristics	18
6.3 Insulation characteristics	18
6.4 Determination of the representative overvoltages (U_{rp}).....	18
6.5 Determination of the co-ordination withstand voltages (U_{cw}).....	19
6.6 Determination of the required withstand voltages (U_{rw})	19
6.7 Determination of the specified withstand voltage (U_w)	21
7 Requirements for withstand voltage tests.....	21
8 Creepage distances.....	21
8.1 General.....	21
8.2 Base voltage for creepage distance	22
8.3 Creepage distance for outdoor insulation under DC voltage	22
8.4 Creepage distance for indoor insulation under DC or mixed voltage.....	22
8.5 Creepage distance of AC insulators	22
9 Clearances in air	23
Annex A (informative) Typical HVDC converter station schemes	24
Annex B (informative) Example of air clearances calculation.....	28
B.1 Introductory remarks	28
B.2 Calculated minimum air clearance for switching impulse stress.....	28
B.2.1 General	28
B.2.2 Example calculation.....	29
B.3 Calculated minimum air clearance for lightning impulse stress	29
B.3.1 General	29
B.3.2 Example calculation.....	30
Annex C (normative) Example of typical DC voltages with possible insulation levels and corresponding air clearances	31
C.1 Introductory remarks	31
C.2 List of typical DC voltages and possible insulation levels	31

C.3	Example of presumed switching impulse insulation levels and minimum air clearances	31
C.4	Example of presumed lightning impulse insulation levels and minimum air clearances	33
C.5	Possible/Presumed specified DC withstand voltages	33
C.5.1	General	33
C.5.2	Specified DC withstand voltages	34
C.5.3	List of specified power frequency withstand voltages	34
Annex D (informative)	Typical arrester characteristics	35
Annex E (informative)	The Correlation of clauses between IEC 60071-11 and IEC 60071-5:2014	36
Bibliography	37
Figure 1	– Comparison of the selection between withstand voltages for AC equipment and for HVDC converter station equipment	17
Figure A.1	– Possible arrester locations in one pole of bipole LCC converter station with 12-pulse converters in series	25
Figure A.2	– Possible arrester locations in one pole of bipolar of VSC converter stations	26
Figure A.3	– Possible arrester locations in symmetrical monopole VSC converter stations	26
Figure D.1	– Typical arrester V-I characteristics	35
Table 1	– Classes and shapes of overvoltages, standard voltage shapes and standard withstand voltage tests	9
Table 2	– Comparison of the insulation co-ordination procedure of AC and DC systems	16
Table 3	– Indicative values of ratios of required impulse withstand voltage to impulse protective level	20
Table A.1	– Symbol description	27
Table C.1	– Typical DC voltages and switching/lightning impulse withstand voltage	32
Table C.2	– Correlation between presumed rated switching impulse withstand voltages and minimum phase-to-earth air clearances	33
Table C.3	– Correlation between presumed rated lightning impulse withstand voltages and minimum phase-to-earth air clearances	34

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSULATION CO-ORDINATION –

Part 11: Definitions, principles and rules for HVDC system

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.

IEC 60071-11 has been prepared by IEC technical committee 99: Insulation co-ordination and system engineering of high voltage electrical power installations above 1,0 kV AC and 1,5 kV DC. It is an International Standard.

This international standard replaces, in conjunction with IEC 60071-12, IEC 60071-5 published in 2014.

This edition includes the following significant technical changes with respect to IEC 60071-5:2014:

- a) This standard applies to both LCC and VSC HVDC systems whereas IEC 60071-5 only dealt with LCC HVDC system;
- b) Annex C (normative) gives the recommended specified withstand voltage (LI and SI);
- c) Annex C (normative) gives the minimum air clearances;
- d) Annex E shows the correlation of clauses between this standard and IEC 60071-5:2014.

The text of this International Standard is based on the following documents:

Draft	Report on voting
99/374/FDIS	99/394/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 60071 series, published under the general title *Insulation co-ordination*, can be found on the IEC website.

The committee has decided that the contents of this document 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,
- replaced by a revised edition, or
- amended.

INTRODUCTION

As the demand for electrical energy is growing, more and more HVDC projects have appeared, and the voltage up to ± 1 100 kV so far. However, the nominal voltage, nominal current and insulation levels for HVDC system are not yet as standardized as the AC system.

In October 2016, IEC Technical Committee 28 (Insulation co-ordination) established AHG 8 (Ad hoc group 8) to make the roadmap for HVDC system insulation co-ordination standards.

After IEC TC 28 was merged into IEC TC 99 in 2017, JWG 13 (Joint working group 13) was built by IEC TC 99 and TC 115 and was responsible for making the series standards for HVDC system according to the approved roadmap, as follows:

- a) Part 11: Definitions, principles and rules for HVDC system;
- b) Part 12: Application guidelines for LCC HVDC converter stations;
- c) Part 13: Application guidelines for VSC HVDC converter stations;
- d) Part 14: Insulation co-ordination for AC/DC filters;
- e) Part 15: Insulation co-ordination for DC transmission lines.

INSULATION CO-ORDINATION –

Part 11: Definitions, principles and rules for HVDC system

1 Scope

This part of IEC 60071 applies to high-voltage direct current (HVDC) systems. It specifies the principles on the procedures for the determination of the specified withstand voltages, creepage distance and air clearances for the equipment and the installations of these systems.

This document gives the insulation co-ordination principles related to line commutated converter (LCC) and voltage sourced converters (VSC) HVDC systems. The main principles of this document also apply to other special converter configurations of LCC, such as the capacitor commutated converter (CCC) as well as the controlled series compensated converter (CSCC), etc.

This document applies to insulation co-ordination of equipment connected between the converter AC bus (including the AC harmonic filters, the converter transformer, the circuit breakers) and the DC line side. The line and cable terminations in so far as they influence the insulation co-ordination of converter station equipment are also covered.

This document applies only for HVDC applications in power systems and not for industrial conversion equipment. Principles and guidance given are for insulation co-ordination purposes only. The requirements for human safety are not covered by this document.

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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60071-1:2019, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60071-2:2018, *Insulation co-ordination – Part 2: Application guidelines*

IEC 60099-4:2014, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC TS 60815-1:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles*

IEC TS 60815-2:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for a.c. systems*

IEC TS 60815-3:2008, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 3: Polymer insulators for a.c. systems*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN