IEC 60183

Edition 3.0 2015-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Guidance for the selection of high-voltage A.C. cable systems

Lignes directrices pour le choix de systèmes de câbles à haute tension en courant alternatif

IEC 60183:2015-01(en-fr)

Documents
Document Sharing Hub

Full document details: IEC 60183 2015

THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2015 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 Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
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 also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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: csc@iec.ch.

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.

Catalogue IEC - webstore.iec.ch/catalogue
Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

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 aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
Plus de 60 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

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

Documents
Document Sharing Hub

Full document details: IEC 60183 2015

IEC 60183

Edition 3.0 2015-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Guidance for the selection of high-voltage A.C. cable systems

Lignes directrices pour le choix de systèmes de câbles à haute tension en courant alternatif

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.060.20

ISBN 978-2-8322-2181-5

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.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

AVA Documents
Document Sharing Hub

Full document details: IEC 60183 2015

CONTENTS

FOREWORD 3
1 Scope 5
2 Normative references 5
3 Terms and definitions 6
3.1 Voltages pertaining to the cable and its accessories 6
3.2 Voltages pertaining to the system on which cables and accessories are to be used 6
4 Service conditions 7
4.1 General 7
4.2 Operating conditions 7
4.3 Installation data 8
4.3.1 General 8
4.3.2 Underground cables 8
4.3.3 Cables in air 9
4.3.4 Cables in water 9
5 Cable insulation levels 9
5.1 Introductory remark 9
5.2 System categories 9
5.3 Selection of U_m 10
5.4 Selection of U_p 10
6 Selection of the conductor size 10
7 Accessories 10
7.1 General 10
7.2 Terminations 11
7.2.1 General 11
7.2.2 Atmospheric pollution 11
7.2.3 Altitude 11
7.3 Joints 11
8 Environmental aspects 11
Annex A (informative) System monitoring 14
Bibliography 15

Table 1 – Relationship between U_0/U and (U_m) and impulse voltages 13

Documents
Document Sharing Hub
Full document details: IEC 60183 2015

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDANCE FOR THE SELECTION OF HIGH-VOLTAGE A.C. CABLE SYSTEMS

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.

International Standard IEC 60183 has been prepared by IEC technical committee 20: Electric cables.

This third edition cancels and replaces the second edition, published in 1984, and its Amendment 1 (1990) and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– the scope has been changed to a.c. high-voltage cables and cable systems;
– guidance relates to cables with extruded insulation;
– submarine cables are not covered but cables laid in water are covered;
– operation of systems with special bonding of the screen is covered;
– there is guidance on accessories;
– environmental aspects are addressed.

AVA Documents
Document Sharing Hub

Full document details: IEC 60183 2015

The text of this standard is based on the following documents:

FDIS	Report on voting
20/1530/FDIS	20/1558/RVD

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

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

Documents
Document Sharing Hub

Full document details: IEC 60183 2015

GUIDANCE FOR THE SELECTION OF HIGH-VOLTAGE A.C. CABLE SYSTEMS

1 Scope

This International Standard is intended to give guidance in the selection of a.c. high-voltage cables and cable systems with extruded insulation and mainly to be used on three-phase alternating systems operating at voltages exceeding U = 1 kV (in this standard the term 'high voltage' is used to cover any cable above 1 kV). Submarine cables are not included in the scope.

Guidance is given in the selection of the conductor size, insulation level and constructional requirements of cable to be used. In addition, information necessary to enable the appropriate selection to be made is summarized.

Paper insulated power cables are not considered in this standard for their selection into cable systems. However, when selecting cables with extruded insulation to be connected together with existing paper insulated cables, particular consideration for their proper compatibility, accessories and operational characteristics should be made.

Environmental aspects are mentioned at the level at which they may influence the selection of high-voltage cables and their application.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60071-1:2006, *Insulation co-ordination – Part 1: Definitions, principles and rules* Amendment 1:2010

IEC 60228*, Conductors of insulated cables*

IEC 60287 (all parts), *Electric cables – Calculation of the current rating*

IEC 60287-1-1:2006, *Electric cables – Calculation of the current rating – Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General*

IEC 60287-3-1, *Electric cables – Calculation of the current rating – Part 3-1: Sections on operating conditions – Reference operating conditions and selection of cable type*

IEC 60287-3-2, *Electric cables – Calculation of the current rating – Part 3-2: Sections on operating conditions – Economic optimization of power cable size*

IEC 60502, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (U_m = 1,2 kV) up to 30 kV (U_m = 36 kV)*

IEC 60840, *Power cables with extruded insulation and their accessories for rated voltages above 30 kV (U_m = 36 kV) up to 150 kV (U_m = 170 kV) – Test methods and requirements*

Documents
Document Sharing Hub

Full document details: IEC 60183 2015

IEC 62067, *Power cables with extruded insulation and their accessories for rated voltages above 150 kV (U_m = 170 kV) up to 500 kV (U_m = 550 kV) – Test methods and requirements*

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

IEC 62271-209, *High-voltage switchgear and controlgear – Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV – Fluid-filled and extruded insulation cables – Fluid-filled and dry-type cable terminations*

ISO 14000, *Environmental management*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Voltages pertaining to the cable and its accessories

NOTE Cables will henceforth be designated by U_0/U (U_m) to provide guidance on compatibility with switchgear and transformers. Table 1 gives this information.

3.1.1
rated voltage
U_0
rated r.m.s. power-frequency voltage between each conductor and screen or sheath for which cables and accessories are designed

3.1.2
rated voltage between conductors
U
rated r.m.s. power-frequency voltage between any two conductors for which cables and accessories are designed

Note 1 to entry: This quantity only affects the design of non-radial field cables and accessories.

3.1.3
highest system voltage
U_m
maximum r.m.s. power-frequency voltage between any two conductors for which cables and accessories are designed

Note 1 to entry: It is the highest voltage that can be sustained under normal operating conditions at any time and at any point in a system and excludes temporary voltage variations due to fault conditions and the sudden disconnection of large loads.

3.1.4
peak impulse voltage
U_p
peak value of the lightning impulse withstand voltage (and switching, where applicable) between each conductor and screen or sheath for which cables and accessories are designed

3.2 Voltages pertaining to the system on which cables and accessories are to be used

3.2.1
nominal voltage of system
r.m.s. phase-to-phase voltage by which the system is designated and to which certain operating characteristics of the system are related

AVA Documents Document Sharing Hub

Full document details: IEC 60183 2015

3.2.2
highest voltage of three-phase system
highest r.m.s. phase-to-phase voltage which occurs under normal operating conditions at any time and at any point in the system

Note 1 to entry: It excludes voltage transients (such as those due to system switching) and temporary voltage variation due to abnormal system conditions (such as those due to fault conditions or sudden disconnection of large loads).

3.2.3
lightning overvoltage
phase-to-earth or phase-to-phase overvoltage at a given location in a system due to a lightning discharge or other cause, the wave-shape of which can be regarded, for insulation co-ordination purposes, as similar to the standard impulse

Note 1 to entry: See 3.18.3 of IEC 60071-1:2006 and IEC 60071-1:2006/AMD1:2010 used for lightning impulse withstand tests.

Note 2 to entry: Such overvoltages are usually unidirectional and of very short duration.

3.2.4
switching overvoltage
phase-to-earth or phase-to-phase overvoltage at a given location in a system due to a switching operation in a system, the wave-shape of which can be regarded, for insulation co-ordination purpose, as similar to the standard impulse

Note 1 to entry: See 3.18.2 of IEC 60071-1:2006 and IEC 60071-1:2006/AMD1:2010 used for switching impulse withstand tests.

4 Service conditions

4.1 General

To determine the appropriate design of cable system for a particular project, the following information with regard to service conditions is required. Reference should be made to the relevant IEC publications which deal with many of the following service conditions.

4.2 Operating conditions

The following operation conditions apply:

a) Nominal voltage of the system.

b) Highest voltage of the three-phase system.

c) Lightning overvoltage and switching overvoltage for higher (U_m ≥300 kV) voltage systems (see Table 1).

d) System frequency.

e) Type of earthing and, where the neutral is not effectively earthed, the maximum permitted duration of earth fault conditions on any one occasion and the total duration per year.

f) Screen bonding.

For single-core cables, the current-carrying capability depends largely on the screen bonding technique.

Special bonding (single point bonding or cross-bonding) is generally used where bulk transmission has to be achieved, since the amount of losses in metal screens is significantly reduced, compared to solid bonding (see 2.3 of IEC 60287-1-1:2006). However they require special equipments such as surge voltage limiters (to protect cable sheaths and accessories from transient overvoltages) or earth continuity conductor to be laid along the cable route.

g) Where terminals are specified, the environmental conditions shall be given, for example:

AVA Documents Document Sharing Hub

Full document details: IEC 60183 2015

- the altitude above sea level, if above 1 000 m;
- indoor or outdoor installation;
- whether excessive atmospheric pollution is expected; according to IEC TS 60815-1;
- termination in SF_6 switchgear; transformer or metal-clad system, with orientation; following IEC 62271-209;
- design clearance and insulation used in the method for connecting cable to equipment, for example transformers, switchgear, motors, etc. For example, clearance and surrounding insulation should be specified.

h) Maximum rated current:

- for continuous operation;
- for cyclic operation;
- for emergency or overload operation, if any, without exceeding maximum allowed cable temperature.

A load curve is essential if cyclic loading or emergency or overload operation is considered when determining conductor size.

i) The expected symmetrical and asymmetrical short-circuit currents which may flow in case of short-circuits, both between phases and to earth.

j) Maximum time for which short-circuit currents may flow.

k) Possible operation with forced cooling.

4.3 Installation data

4.3.1 General

The following details apply:

a) Length and profile of route.

b) Details of laying arrangements (e.g. flat or trefoil arrangement) and how the metallic coverings are connected to each other and to earth.

c) Special laying conditions, for example cables in water. Individual installations require special consideration.

4.3.2 Underground cables

The following details apply:

a) Typical ambient temperatures over the year (see IEC 60287-3-1).

b) Details of installation conditions (e.g. direct burial, in ducts, mechanical laying, etc.) to enable decisions to be taken on composition of metallic screen or sheath, type of armour (if required) and type of serving, for example anti-corrosion or anti-termite.

c) Depth of laying.

d) Thermal resistivities and kinds of soil along the route (e.g. sand, clay, made-up ground, special backfill), and whether this information is based on measurement and inspection or only assumed. Meteorological data to evaluate risk of soil drying (see IEC 60287 series).

e) Minimum, maximum and average ground temperature at the depth of burial.

f) Proximity of other load-carrying cables (especially where the link involves several parallel circuits) or of other heat sources, with details.

g) Lengths of troughs, ducts or pipe lines, with spacing of manholes, if any.

h) Details of ductbanks, if any: number of ducts or pipes. Internal diameter of ducts and pipes. Spacing between individual ducts and pipes, if more than one. Material of ducts or pipes.

i) Risk for water ingress and corrosion (the right cable design shall be chosen).

Documents
Document Sharing Hub
Full document details: IEC 60183 2015

4.3.3 Cables in air

The following details apply:

a) Minimum, maximum and average ambient air temperature to be assumed.

b) Type of installation (e.g. direct laying on walls, racks, on poles, boxes, possibly water filled, etc. grouping of cables, dimensions of the tunnels, ducts, vertical shafts etc.).

c) Details of ventilation (for cables indoors, in tunnels or ducts).

d) Whether exposed to direct sunlight or having sun shield.

e) Special conditions, for example fire risk or flame spread, harmful gases and smoke.

4.3.4 Cables in water

The following details apply:

a) Water depth and currents.

b) Installation and laying technique.

c) Risk for mechanical damage during service from fishing equipment, ice, abrasion etc. (need for armouring, fastening and trenching).

d) How to fasten, protect and install the cable where it comes ashore (clamping, trenching, tubing, need for armouring etc.).

e) Risk for water ingress and corrosion (the right cable design must be chosen).

5 Cable insulation levels

5.1 Introductory remark

The rated voltage of the cable for a given application shall be suitable for the operating conditions in the system in which the cable is used. To facilitate the selection of the cable, systems are divided into three categories according to the duration of time the system can be operated under earth fault conditions.

5.2 System categories

The following details apply:

– Category A

  This category comprises those systems in which any phase conductor that comes in contact with earth or an earth conductor is disconnected from the system within 1 min.

– Category B

  This category comprises those systems, which, under fault conditions, are operated for a short time only with one phase earthed. This period should, in general, not exceed 1 h, but a longer period can be tolerated as specified in the relevant cable standard.

– Category C

  This category comprises all systems which do not fall into category A or B.

Reference should be made to the relevant cable standards choosing, for example, between those listed in Clause 2.

In a system where an earth fault is not automatically and promptly isolated, the extra stresses on the insulation of cables during the earth fault reduce the life of the cables to a certain degree. If the system is expected to be operated fairly often with a permanent earth fault, it is advisable to classify the system in category C.

Documents
Document Sharing Hub
Full document details: IEC 60183 2015