IEC/ISO/IEEE 80005-1

Edition 1.0 2012-07

INTERNATIONAL STANDARD

Utility connections in port –
Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements

IEC/ISO/IEEE 80005-1:2012(E)

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2012 IEC/ISO/IEEE

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 IEC, ISO or IEEE at the respective address given below.

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

ISO copyright office
Case postale 56
CH-1211 Geneva 20
Switzerland
Tel.: +41 22 749 01 11
Fax: +41 22 749 09 47
copyright@iso.org
www.iso.org

Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue
New York, NY 10016-5997
United States of America
stds.info@ieee.org
www.ieee.org

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.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you 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It also gives information on projects, replaced and withdrawn publications.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 on-line 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 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

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.

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

IEC/ISO/IEEE 80005-1

Edition 1.0 2012-07

INTERNATIONAL STANDARD

Utility connections in port –
Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE XB

ICS 47.020.60

ISBN 978-2-83220-111-4

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

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms and definitions 10
4 General requirements 11
4.1 System description 11
4.2 Distribution system 12
4.2.1 General 12
4.2.2 Equipotential bonding 12
4.3 Compatibility assessment before connection 12
4.4 HVSC system design and operation 13
4.4.1 System design 13
4.4.2 System operation 13
4.5 Personnel safety 13
4.6 Design requirements 13
4.6.1 General 13
4.6.2 Protection against moisture and condensation 13
4.6.3 Location and construction 13
4.6.4 Electrical equipment in areas where flammable gas or vapour and/or combustible dust may be present 14
4.7 Electrical requirements 14
4.8 System study and calculations 15
4.9 Emergency shutdown including emergency stop facilities 15
5 HV shore supply system requirements 17
5.1 Voltages and frequencies 17
5.2 Quality of HV shore supply 18
6 Shore side installation 19
6.1 General 19
6.2 System component requirements 19
6.2.1 Circuit-breaker, disconnector and earthing switch 19
6.2.2 Transformer 19
6.2.3 Neutral earthing resistor 20
6.2.4 Equipment earthing conductor bonding 20
6.3 Shore to ship electrical protection system 20
6.4 HV interlocking 21
6.4.1 General 21
6.4.2 Handling of HV plug/socket-outlets 21
6.4.3 Operating of the high-voltage (HV) circuit-breakers, disconnectors and earthing switches 21
6.5 Shore connection convertor equipment 22
6.5.1 General 22
6.5.2 Degree of protection 22
6.5.3 Cooling 22
6.5.4 Protection 23
7 Ship to shore connection and interface equipment 23

AVA Documents
Document Sharing Hub
Full document details: ISO_IEC_IEEE 80005-1_2012

7.1 General ... 23
7.2 Cable management system ... 23
7.2.1 General ... 23
7.2.2 Monitoring of cable tension ... 24
7.2.3 Monitoring of the cable length ... 24
7.2.4 Connection conductor current unbalance protection ... 24
7.2.5 Equipotential bond monitoring ... 25
7.2.6 Slip ring units ... 25
7.3 Plugs and socket-outlets ... 25
7.3.1 General ... 25
7.3.2 Pilot contacts ... 26
7.3.3 Earth contact ... 26
7.3.4 Fibre optical plug/socket ... 26
7.4 Interlocking of earthing switches ... 26
7.5 Ship to shore connection cable ... 27
7.6 Independent control and monitoring cable ... 27
7.7 Storage ... 27
7.8 Data communication ... 27
8 Ship requirements ... 28
8.1 General ... 28
8.2 Ship electrical distribution system protection ... 28
8.2.1 Short-circuit protection ... 28
8.2.2 Earth fault protection, monitoring and alarm ... 28
8.3 Shore connection switchboard ... 28
8.3.1 General ... 28
8.3.2 Circuit-breaker, disconnector and earthing switch ... 29
8.3.3 Instrumentation and protection ... 29
8.4 On board transformer ... 29
8.5 On board receiving switchboard connection point ... 30
8.5.1 General ... 30
8.5.2 Circuit-breaker and earthing switch ... 30
8.5.3 Instrumentation ... 30
8.5.4 Protection ... 30
8.5.5 Operation of the circuit-breaker ... 31
8.6 Ship power restoration ... 32
9 HVSC system control and monitoring ... 32
9.1 General requirements ... 32
9.2 Load transfer via blackout ... 33
9.3 Load transfer via automatic synchronization ... 33
9.3.1 General ... 33
9.3.2 Protection requirements ... 33
10 Verification and testing ... 33
10.1 General ... 33
10.2 Initial tests of shore side installation ... 34
10.2.1 General ... 34
10.2.2 Tests ... 34
10.3 Initial tests of ship side installation ... 34
10.3.1 General ... 34
10.3.2 Tests ... 34

Documents
Document Sharing Hub
Full document details: ISO_IEC_IEEE 80005-1_2012

10.4 Tests at the first call at a shore supply point 35
10.4.1 General 35
10.4.2 Tests 35
11 Periodic tests and maintenance 35
11.1 General 35
11.2 Tests at repeated calls of a shore supply point 36
11.2.1 General 36
11.2.2 Verification 36
12 Documentation 36
12.1 General 36
12.2 System description 36
Annex A (informative) Ship to shore connection cable 37
Annex B (normative) Additional requirements for Roll-on Roll-off (Ro-Ro) cargo ships and Ro-Ro passenger ships 42
Annex C (normative) Additional requirements for cruise ships 45
Annex D (normative) Additional requirements of container ships 51
Annex E (normative) Additional requirements of liquefied natural gas carriers (LNGC) 55
Annex F (normative) Additional requirements for tankers 60
Bibliography 63

Figure 1 – Block diagram of a typical described HVSC system arrangement 11
Figure 2 – Phase sequence rotation – Positive direction 17
Figure 3 – Balanced three-phase variables in time domain 18
Figure A.1 – Bending test arrangement 41
Figure B.1 – Example for general system layout 42
Figure B.2 – Example of a safety circuit 43
Figure B.3 – Power plug and socket pin assignment 44
Figure C.1 – General system layout 45
Figure C.2 – Cruise ship HVSC system single line diagram 46
Figure C.3 – Example of safety and control circuit 47
Figure C.4 – Shore power connector pin assignment 49
Figure C.5 – The power inlet fitted with fail-safe limit switch 50
Figure D.1 – General system layout 51
Figure D.2 – Safety circuits 53
Figure D.3 – Power plug and socket pin assignment 54
Figure E.1 – General system layout 55
Figure E.2 – Power plug and socket pin assignment 58
Figure F.1 – General system layout 60
Figure F.2 – Power plug and socket pin assignment 61

Table E.1 – LNGC 140 000 – 225 000 m^3 56
Table E.2 – LNGC > 225 000 m^3 57

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

UTILITY CONNECTIONS IN PORT –

Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements

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.

   ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

   IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. IEEE documents are made available for use subject to important notices and legal disclaimers (see http://standards.ieee.org/IPR/disclaimers.html for more information).

   IEC collaborates closely with ISO and IEEE in accordance with conditions determined by agreement between the organizations. This Triple Logo International Standard was jointly developed by the IEC, ISO and IEEE under the terms of that agreement.

2) The formal decisions 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.. In the ISO, Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE Standard document is given by the IEEE Standards Association (IEEE-SA) Standards Board.

3) IEC/ISO/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/ISO member bodies /IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/ISO/IEEE Publications is accurate, IEC, ISO or IEEE 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 (including IEC/ISO/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/ISO/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC, ISO and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC, ISO and IEEE are 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, ISO or IEEE or their directors, employees, servants or agents including individual experts and members of technical committees and IEC National Committees and ISO member bodies, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board, 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/ISO/IEEE Publication or any other IEC, ISO or IEEE 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 implementation of this IEC/ISO/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC, ISO or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the

AVA Documents
Document Sharing Hub

legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from ISO or the IEEE Standards Association.

International Standard IEC/ISO/IEEE 80005-1 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units, in cooperation with IEC subcommittee 23H: Industrial plugs and socket-outlets, of IEC technical committee 23: Electrical accessories; ISO technical committee 8: Ships and marine technology, subcommittee 3: Piping and machinery; and IEEE IAS Petroleum and Chemical Industry Committee (PCIC) of the Industry Applications Society of the IEEE[1].

This publication is published as an IEC/ISO/IEEE triple logo and prefix standard.

This document cancels and replaces IEC/PAS 60092-510 published in 2009.

A list of all the parts in the IEC 80005 series, published under the general title *Utility connections in port*, can be found on the IEC website.

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

FDIS	Report on voting
18/1254/FDIS	18/1268/RVD

Full information on the voting for the approvals of this standard can be found in the report on voting indicated in the above table. In ISO, the standard has been approved by 9 members out of 9 having a cast vote.

International standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The IEC Technical Committee, the ISO Technical Committee and IEEE Technical Committee have decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC, ISO and IEEE web site in the data related to the specific publication. At this date, the publication will be

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

[1] A list of IEEE participants can be found at the following URL: http://standards.ieee.org/downloads/80005-1/80005-1-2012/80005-1-2012_wg-participants.pdf

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

INTRODUCTION

The following standard was developed jointly between IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units, ISO technical committee 8: Ships and marine technology, subcommittee 3: Piping and machinery, and IEEE IAS PCIC Marine industry subcommittee.

For a variety of reasons, including environmental considerations, it is becoming an increasingly common requirement for ships to shut down ship generators and to connect to shore power for as long as practicable during stays in port. The scenario of receiving electrical power and other utilities from shore is historically known as “cold ironing”.

The intention of this standard is to define requirements that support, with the application of suitable operating practices, efficiency and safety of connections by compliant ships to compliant high-voltage shore power supplies through a compatible shore to ship connection.

With the support of sufficient planning, cooperation between ship and terminal facilities, and appropriate operating procedures and assessment, compliance with the requirements of this standard is intended to allow different ships to connect to high-voltage shore connections (HVSC) at different berths. This provides the benefits of standard, straightforward connection without the need for adaptation and adjustment at different locations that can satisfy the requirement to connect for as long as practicable during stays in port.

Ships that do not apply this standard may find it impossible to connect to compliant shore supplies.

Where deviations from the requirements and recommendations in this standard may be considered for certain designs, the potential effects on compatibility are highlighted.

Where the requirements and recommendations of this standard are complied with, high-voltage shore supplies arrangements are likely to be compatible for visiting ships for connection.

Clauses 1 to 12 are intended for application to all HVSC systems. They intend to address mainly the safety and effectiveness of HVSC systems with a minimum level of requirements that would standardise on one solution. This standard includes the requirement to complete a detailed compatibility assessment for each combination of ship and shore supply prior to a given ship arriving to connect to a given shore supply for the first time

Annex A includes cabling recommendations that should be used in HVSC systems.

The other annexes in this standard are ship specific annexes that include additional requirements related to agreed standardisation of solutions to achieve compatibility for compliant ships at different compliant berths and to address safety issues that are considered to be particular to that ship type. These annexes use the same numbering as Clauses 1 to 12 with an annex letter prefix. Hence, the numbering is not necessarily continuous. Where no additional requirements are identified, the clause is not shown.

It should be noted that Annex A is considered informative for the purposes of this document. This annex contains performance-based requirements for shore connection cable, and was developed by technical experts from a number of countries. IEC technical committee 18, subcommittee 18A and IEC technical committee 20 were consulted regarding cable requirements. It was determined that existing standards for cable can be used at this time and there is presently no need to develop a separate standard for shore connection cables.

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

UTILITY CONNECTIONS IN PORT –

Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements

1 Scope

This part of IEC 80005 describes high voltage shore connection (HVSC) systems, on board the ship and on shore, to supply the ship with electrical power from shore.

This standard is applicable to the design, installation and testing of HVSC systems and addresses:

- HV shore distribution systems;
- shore-to-ship connection and interface equipment;
- transformers/reactors;
- semiconductor/rotating convertors;
- ship distribution systems; and
- control, monitoring, interlocking and power management systems.

It does not apply to the electrical power supply during docking periods, e.g. dry docking and other out of service maintenance and repair.

Additional and/or alternative requirements may be imposed by national administrations or the authorities within whose jurisdiction the ship is intended to operate and/or by the owners or authorities responsible for a shore supply or distribution system.

It is expected that HVSC systems will have practicable applications for ships requiring 1 MW or more or ships with HV main supply.

Low-voltage shore connection systems are not covered by this standard.

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 60034 (all parts), *Rotating electrical machines*

IEC 60076 (all parts), *Power transformers*

IEC 60079 (all parts), *Electrical apparatus for explosive gas atmospheres*

IEC 60092-101:2002, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60092-201:1994, *Electrical installations in ships – Part 201: System design – General*

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

IEC 60092-301:1995, *Electrical installations in ships – Part 301: Equipment – Generators and motors*

IEC 60092-502:1999, *Electrical installations in ships – Part 502: Tankers – Special features*

IEC 60092-503:2007, *Electrical installations in ships – Part 503: Special features – AC supply systems with voltages in the range of above 1 kV up to and including 15 kV*

IEC 60092-504:2001, *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

IEC 60146-1 (all parts), *Semiconductor convertors – General requirements and line commutated convertors*

IEC 60204-11:2000, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60332-1-2:2004, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60502-2:2005, *Power cables with extruded insulation and their accessories for rated voltages from 1kV(U_m=7,2 kV) up to 30 kV(U_m=36 kV) – Part 2: Cables for rated voltages from 6 kV(U_m=7,2 kV) up to 30 kV(U_m=36 kV)*

IEC 60502-4:2005, *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) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)*

IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 61363-1, *Electrical installations of ships and mobile and fixed offshore units – Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*

IEC 61936-1:2002, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*

IEC 62271-200:2003, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 62613-1:2011, *Plugs, socket-outlets and ship couplers for high-voltage shore connection systems (HVSC systems) – Part 1: General Requirements*

IEC 62613-2:2011, *Plugs, socket-outlets and ship couplers for high-voltage shore connection systems (HVSC-systems) – Part 2: Dimensional compatibility and interchangeability requirements for accessories to be used by various types of ships*

SOLAS 2009, Chapter II-1/D, Regulations 42, 43 and 45

MIL-DTL-38999K, *General specification for connectors, electrical, circular, miniature, high density, quick disconnect (bayonet, threaded, and breech coupling), environment resistant, removable crimp and hermetic solder contacts*

MIL-STD-1560A, *Interface standard: Insert arrangements for MIL-C-38999 and MIL-C-27599 electrical, circular connectors*

AVA Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

MIL-PRF-29504/5C, *Performance specification sheet. Termini, fiber optic, connector, removable, environment resisting, socket terminus, size 16, rear release, MIL-DTL-38999, SERIES III*

3 Terms and definitions

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

3.1
cable management system
all equipment designed to control, monitor and handle the HV-flexible and control cables and their connection devices

3.2
equipotential bonding
provision of electric connections between conductive parts, intended to achieve equipotentiality

[SOURCE: IEC 60050-195:1998, 195-01-10]

3.3
emergency shutdown-1
ESD-1
shutdown initiated when the ship moves past the warning range of allowable motion forward, aft or outward from the dock, and which initiates an LNG-ESD signal from shore to ship

3.4
emergency shutdown-2
ESD-2
shutdown initiated when the ship moves past the maximum range of allowable motion forward, aft or outward from the dock, and which initiates loading arm disconnection on shore

3.5
high voltage
HV
nominal voltage in range above 1 000 V a.c. and up to and including 15 kV a.c.

3.6
liquefied natural gas-emergency shutdown
LNG-ESD
type of emergency shutdown defined at LNG terminals

3.7
low voltage
LV
nominal voltage up to and including 1 000 V a.c.

3.8
person in charge
PIC
individual responsible for HVSC systems operations

3.9
pilot contact
contact of the plug and socket-outlet which signals correct plug connection and is a safety-related component

Documents
Document Sharing Hub
Full document details: ISO_IEC_IEEE 80005-1_2012

3.10
receiving point
connection point of the flexible cable on the ship

3.11
safe
condition in which safety risks are minimized to an acceptable level

3.12
supply point
connection point of the flexible cable on shore

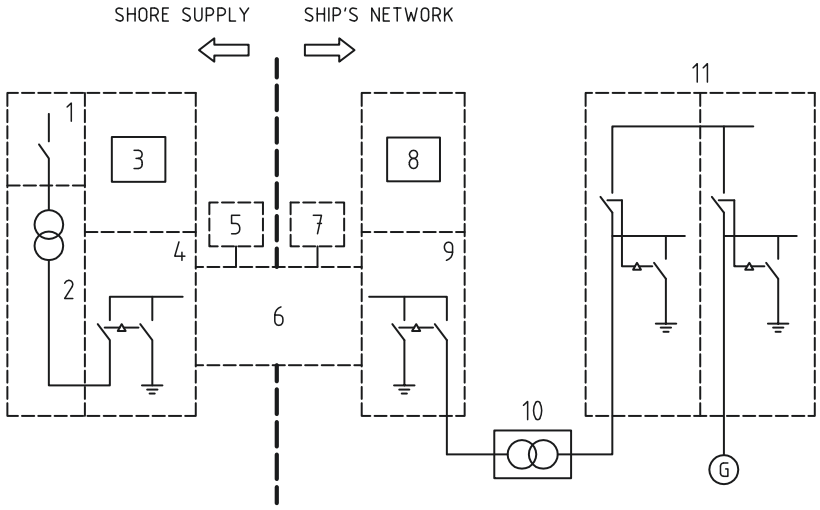
3.13
fail safe
design property of an item which prevents its failures from resulting in critical faults

[SOURCE: IEC 60050-195:1998, 191-15-04]

4 General requirements

4.1 System description

A typical HVSC system described in this standard consists of hardware components as shown in Figure 1.



KEY

1. HV-SHORE SUPPLY SYSTEM
2. SHORE SIDE TRANSFORMER
3. SHORE SIDE PROTECTION RELAYING
4. SHORE SIDE CIRCUIT BREAKER AND EARTH SWITCH
5. CONTROL
6. SHORE-TO-SHIP CONNECTION AND INTERFACE EQUIPMENT
7. CONTROL
8. SHIP PROTECTION RELAYING
9. SHORE CONNECTION SWITCHBOARD
10. ON-BOARD TRANSFORMER (WHERE APPLICABLE)
11. ON-BOARD RECEIVING SWITCHBOARD

Figure 1 – Block diagram of a typical described HVSC system arrangement

Documents
Document Sharing Hub
Full document details: ISO_IEC_IEEE 80005-1_2012

4.2 Distribution system

4.2.1 General

Typical distribution systems used on shore are given in IEC 61936-1. Typical ship distribution systems are given in IEC 60092-503.

NOTE IEEE Std 45™ provides additional information on typical ship distribution systems.

4.2.2 Equipotential bonding

An equipotential bonding between the ship's hull and shore earthing electrode shall be established.

Verification of the equipotential bonding shall be a part of the safety circuit (see 7.2.5). Loss of equipotential bonding shall result in the shutdown of the HVSC system, and the ship shall go into ship power restoration mode (see 8.6).

NOTE The terms earth(ing) and ground(ing) are used interchangeably throughout this standard and have the same meaning (see IEC 60050-195:1998,195-01-08).

4.3 Compatibility assessment before connection

Compatibility assessment shall be performed to verify the possibility to connect the ship to shore HV supply. Compatibility assessment shall be performed prior to the first arrival at a terminal.

Assessment of compatibility shall be performed to determine the following:

a) compliance with the requirements of this standard and any deviations from the recommendations;

b) minimum and maximum prospective short-circuit current (see 4.7 and 4.8);

c) nominal ratings of the shore supply, ship to shore connection and ship connection (see 5.1);

d) any de-rating for cable coiling or other factors (see 7.2.1);

e) acceptable voltage variations at ship switchboards between no-load and nominal rating (see 5.2);

f) steady state and transient ship load demands when connected to a HV shore supply, HV shore supply response to step changes in load (see 5.2);

g) system study and calculations (see 4.8);

h) verification of ship equipment impulse withstand voltage;

i) compatibility of shore and ship side control voltages, where applicable;

j) compatibility of communication link;

k) distribution system compatibility assessment (shore power transformer neutral earthing);

l) functioning of ship earth fault protection, monitoring and alarms when connected to a HVSC supply (see 8.2.2);

m) sufficient cable length;

n) compatibility of safety circuits, in accordance with 9.1;

o) total harmonic distortion (THD) (see 5.2);

p) consideration of hazardous areas, where applicable (see 4.6.4);

q) when a HV supply system is connected, consideration shall be given to provide means to reduce current in-rush and/or inhibit the starting of large loads that would result in failure, overloading or activation of automatic load reduction measures;

r) consideration of electrochemical corrosion due to equipotential bonding;

Documents
Document Sharing Hub

s) utility interconnection requirements for load transfer parallel connection; and

t) equipotential bond monitoring.

4.4 HVSC system design and operation

4.4.1 System design

The design and construction shall be integrated and coordinated among the parties responsible for shore and ship HVSC systems.

System integration of shore and ship HVSC systems shall be managed by a single designated party and shall be performed in accordance with a defined procedure identifying the roles, responsibilities and requirements of all parties involved.

4.4.2 System operation

During the operation of HVSC systems, PIC(s) shall be identified at the shore facility and on board the ship for the purposes of communication.

The PIC(s) shall be provided with sufficient information, instructions, tools and other resources for safety and efficiency of these activities.

4.5 Personnel safety

Construction of the HV equipment and operating safety procedures shall provide for the safety of personnel during the establishment of the connection of the ship supply, during all normal operations, in the event of a failure, during disconnection and when not in use.

The use of the term “safe” is not intended to suggest or guarantee that absolute safety can be achieved in any situation and/or by compliance with the recommended practices set forth herein. The use of terms such as “safe,” “intrinsically safe,” “electrically safe work practices,” “safe work condition,” “safe work environment,” “safe design,” “safe distance,” “safe work method,” “safe work area,” “safe use,” etc. describe practices, conditions, etc. in which safety risks are minimized but not eliminated absolutely, such that safety is not guaranteed.

4.6 Design requirements

4.6.1 General

Protection and safety systems shall be designed based on the fail safe principle.

Suitable warning notices shall be provided at locations along connection equipment routes including connection locations.

4.6.2 Protection against moisture and condensation

Effective means shall be provided to prevent accumulation of moisture and condensation, even if equipment is idle for appreciable periods.

4.6.3 Location and construction

HVSC equipment shall be installed in access controlled spaces.

Equipment shall be suitable for the environment conditions in the space(s) where it is expected to operate. Ship equipment shall comply with the applicable requirements of IEC 60092-101 and IEC 60092-503.

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

Equipment location is critical to the safety and efficiency of operation of the ship's cargo and mooring systems. When determining the location of the HVSC system, the full range of cargo, bunkering and other utility operations shall be considered, including:

a) the cargo handling and mooring equipment in use on the ship and shore, and the areas that must be clear for their operation, along with any movement of the ship along the pier required to accommodate these operations;

b) traffic management considerations such that the use of an HVSC system does not interfere with other ships' operations (including mooring) or prevent necessary traffic flow on the pier and to maintain open fire lanes where required; and

c) personnel safety measures, such as physical barriers to prevent unauthorized personnel access to HVSC equipment or the cable management equipment.

When determining the connection point of the HVSC system, all tidal conditions and ship operations affecting ship's free board shall be considered.

4.6.4 Electrical equipment in areas where flammable gas or vapour and/or combustible dust may be present

HVSC equipment shall be located outside the hazardous areas of the ship and shore facilities under normal operating conditions, except where it is shown to be necessarily located in these areas for safety reasons.

HVSC equipment that may fall within one of the hazardous areas of the terminal under emergency conditions (inadvertent movement of ship from berth) shall be:

a) certified in accordance with IEC 60079 as suitable for the flammable gas or vapour and/or combustible dust encountered; or

b) automatically isolated and discharged before entering the potentially hazardous area.

Control equipment located within hazardous areas shall not present an ignition hazard.

HVSC systems should as far as possible not be installed in areas which may become hazardous areas upon failure of required air changes per hours during loading and offloading cargo or during normal operation.

When a tanker is at a berth, it is possible that an area in the tanker that is regarded as safe according to IEC 60092-502 may falls within one of the hazardous zones of the terminal. If such a situation should arise and, if the area in question contains electrical equipment that is not of a safe-type, certified or approved by a competent authority for the gases encountered, then such equipment may have to be isolated whilst the tanker is at the berth. IEC 60079 should be considered during the compatibility assessment.

4.7 Electrical requirements

For all HVSC system components type and routine tests shall be performed according to relevant standards.

NOTE See IEEE Std C37.100.1™ for additional recommendations.

To allow standardisation of the HV shore supply and link nominal voltage (6,6 kV a.c. or 11 kV a.c.) in different ports, any equipment requiring conversion to nominal voltage shall be installed on board.

The prospective short-circuit contribution level from the HV shore distribution system shall be limited by the shore side system to 16 kA rms, unless otherwise specified in the ship specific annexes.

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

The prospective short-circuit contribution level from the on board running induction motors and the generators in operation shall be limited to a short circuit current of 16 kA rms, unless otherwise specified in the ship type's specific annexes.

Electrical system/equipment, including short-circuit protective device rating, shall be suitable for the prospective maximum short-circuit fault current. Equipment shall be rated for minimum of 16 kA rms for 1 s, and 40 kA peak, unless otherwise specified in the ship specific annexes.

4.8 System study and calculations

The shore-connected electrical system shall be evaluated. The system study and calculations shall determine:

a) the electrical load during shore connection;

b) the short-circuit current calculations (see IEC 61363-1) shall be performed that take into account the prospective contribution of the shore supply and the ship installations. The following ratings shall be defined and used in these calculations:

   1) for shore supply installations, a maximum and minimum prospective short circuit current for visiting ships;

   2) for ships, a maximum and minimum prospective short circuit current for visited shore supply installations.

c) the calculations may take into account any arrangements that:

   1) prevent parallel connection of HV shore supplies with ship sources of electrical power; and/or

   2) restrict the number of ship generators operating during parallel connection to transfer load;

   3) restrict load to be connected.

d) system charging (capacitive) current for shore and ship;

e) this system charging current calculation shall consider the shore power system and the expected ship power including the on line generator(s);

f) shore power transformer neutral earthing resistor analysis (see 6.2.3); and

g) transient overvoltage protection analysis (see 5.2).

These calculated values shall be used to select suitably rated shore connection equipment and to allow the selection and setting of protective devices so that successful discriminatory fault clearance is achieved for the largest on-board load while connected.

The system study shall be made available to all involved parties.

For ships with low voltage main distribution the connection between LV-side of the on-board transformer and main switchboard shall be evaluated and overload protection shall be provided between the on-board transformer and the receiving switchboard.

Documented alternative proposals that take into account measures to limit the parallel connection to short times may be considered where permitted by the relevant authorities. Documentation should be made available to relevant ship and shore personnel.

4.9 Emergency shutdown including emergency stop facilities

Emergency shutdown facilities shall be provided. When activated, they will instantaneously open shore connection circuit-breakers on shore and on board ship.

Fail-safe, hard-wired circuits shall be used for emergency shut-down. This does not preclude emergency shut-down activation commands from programmable electronic equipment, e.g. programmable protection relays.

AVA Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

The relay contacts of the safety circuit shall be designed according to IEC 60947-5-1 and for a rated insulation voltage of U_i = 300 V, a.c. 5 A, d.c.1 A.

To address the potential hazard to personnel of access to high-voltage connection cables that have not been discharged, the high-voltage power connections shall either:

a) be automatically earthed so that they are safe to touch immediately following the isolation from ship and shore electrical power supplies (this option shall be chosen where connection equipment may move into a potentially hazardous area); or

b) be arranged for manual earthing and routed and located such that personnel are prevented from access to live connection cables and live connection points by barriers and/or adequate distance(s) under normal operational conditions (this option shall not be chosen where connection equipment may move into a potentially hazardous area).

Barriers and/or adequate distance(s) shall be supported with operational procedures established to:

c) restrict un-authorized access to HVSC spaces;

d) control personnel access to HVSC spaces and areas when the HV connection is live. Locking arrangements may be considered; and

e) arrange for the safe discharge of HV conductors.

Where connection equipment may move into a potentially hazardous area (where flammable gas, vapour and/or combustible dust may accumulate) associated with the terminal or port berth area as a result of the ship inadvertently leaving the berthed position (slipping/breaking of moorings, etc.) all electrical powered HVSC equipment that is not intrinsically safe shall be automatically isolated, and HV equipment then automatically discharged, so that it will not present an ignition hazard.

The emergency shutdown facilities shall be activated in the event of:

f) loss of equipotential bonding, via the equipotential bond monitoring relays;

g) overtension on the flexible cable (mechanical stress) (see 7.2.2);

h) loss of any safety circuit;

i) activation of any manual emergency-stop;

j) activation of protection relays provided to detect faults on the HV connection cable or connectors; and

k) disengaging of power plugs from socket-outlets while HV connections are live (before the necessary degree of protection is no longer achieved).

Emergency stop push buttons, activating emergency shutdown facilities, shall be provided at:

l) an attended onboard ship control station during HVSC;

m) in the vicinity of the socket outlet;

n) at active cable management system control locations; and

o) at the shore side and ship circuit-breaker locations.

Additional emergency push buttons may also be provided at other locations, where considered necessary.

The means of activation shall be visible and prominent, prevent inadvertent operation and require a manual action to reset.

An alarm to indicate activation of the emergency shutdown shall be provided to advise relevant duty personnel when connected to HV shore supply.

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

For reliable operation of safety circuits the pilot cable length shall be considered.

5 HV shore supply system requirements

5.1 Voltages and frequencies

To allow standardization of the HV shore supply and link nominal voltage in different ports, HV shore connections shall be provided with a nominal voltage of 6,6 kV a.c. and/or 11 kV a.c. galvanically separated from the shore distribution system.

Galvanic separation on shore may be omitted if it is provided on board.

The operating frequencies (Hz) of the ship and shore electrical systems shall match; otherwise, a frequency convertor may be utilized on shore.

Where ships undertake a, repeated itinerary at the same ports and their dedicated berths, other IEC voltage nominal values may be considered (see IEC 60092-503).

At the connection point, looking at the socket/connector face, the phase sequence shall be L1-L2-L3 or A-B-C or R-S-T. A phase sequence indicator must indicate correct sequence prior to energizing or paralleling HVSC (see Figure 2). Figure 3 illustrates the balanced three-phase voltages in time domain.

If an observer looking at phase sequence rotation diagram is fixed at its location, phasors must rotate counter clockwise in reference to fixed observer to produce a clockwise indication on the phase sequence indicator (see Figure 2).

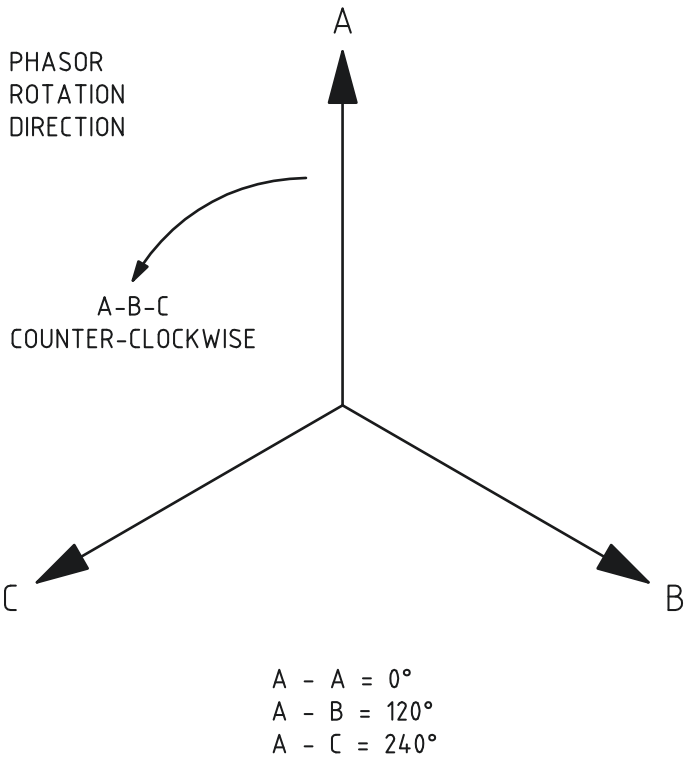


Figure 2 – Phase sequence rotation – Positive direction

Documents
Document Sharing Hub
Full document details: ISO_IEC_IEEE 80005-1_2012

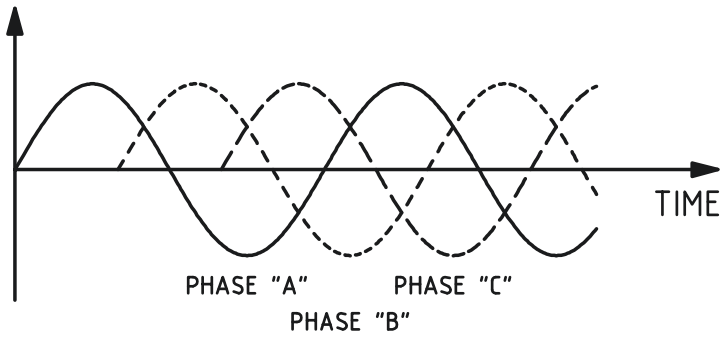


Figure 3 – Balanced three-phase variables in time domain

5.2 Quality of HV shore supply

The HV shore supply system shall have a documented voltage supply quality specification.

Ship electrical equipment shall only be connected to shore supplies that will be able to maintain the distribution system voltage, frequency and total harmonic distortion characteristics given below. For compliance, the compatibility assessment referred to in 4.3 shall include verification of the following:

a) voltage and frequency tolerances (continuous):
   1) the frequency shall not exceed the continuous tolerances ±5 % between no-load and nominal rating;
   2) for no-load conditions, the voltage at the point of the shore supply connection shall not exceed a voltage increase of 6 % of nominal voltage;
   3) for rated load conditions, the voltage at the point of the shore supply connection shall not exceed a voltage drop of -3,5 % of nominal voltage.

b) voltage and frequency transients:
   1) the response of the voltage and frequency at the shore connection when subjected to an appropriate range of step changes in load shall be defined and documented for each HV shore supply installation;
   2) the maximum step change in load expected when connected to a HV shore supply shall be defined and documented for each ship. The part of the system subjected to the largest voltage dip or peak in the event of the maximum step load being connected or disconnected shall be identified;
   3) comparison of 1) and 2) shall be done to verify that the voltage transients limits of voltage +20 % and −15 % and the frequency transients limits of ±10 %, will not be exceeded.

c) harmonic distortion:
   – for no-load conditions, voltage harmonic distortion limits shall not exceed 3 % for individual harmonic and 5 % for total harmonic distortion.

NOTE Additional recommendations are provided in IEEE Std 519™ and MIL STD 1399-680.

The above parameters shall be measured at the supply point (see 3.12).

The HV shore supply shall include appropriate rated surge arrestors to protect against fast transient overvoltage surges (e.g. spikes caused by lightning strikes or switching surges).

Different voltage and frequency tolerances may be imposed by the owners or authorities responsible for the shore supply system and these should be considered as part of the compatibility assessment to verify the effect on the connected ship load is acceptable.

AVA Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012

Where the possible loading conditions of a ship when connected to a HV shore supply would result in a quality of the supply different from that specified in IEC 60092-101:2002, 2.8, due regard should be given to the effect this may have on the performance of equipment.

6 Shore side installation

6.1 General

Shore connection equipment and installations shall be in accordance with IEC 61936-1.

NOTE Local Authorities may have additional requirements.

The rating of the HVSC system shall be adequate for the required electrical load as calculated by 4.8.

Each ship shall be provided with a dedicated HV shore supply installation which is galvanically isolated from other connected ships and consumers. This may not be required where a HV shore supply is dedicated to supply only ships which have galvanic isolation on board. A risk assessment should be performed.

6.2 System component requirements

6.2.1 Circuit-breaker, disconnector and earthing switch

In order to have the installation isolated before it is earthed, the circuit-breaker, disconnector and earthing switch shall be interlocked in accordance with the requirements of IEC 62271-200.

The rated making capacity of the circuit breaker and the earthing switch shall not be less than the prospective peak value of the short-circuit current (I_P) calculated in accordance with IEC 61363-1.

The rated short-circuit breaking capacity of the circuit-breaker shall not be less than the maximum prospective symmetrical short-circuit current ($I_{AC(0,5T)}$) calculated in accordance with IEC 61363-1.

An automatic operated circuit-breaker shall be provided.

6.2.2 Transformer

In the event adjustments are required to maintain the HV supply voltage within tolerances under load, then these adjustments shall be automatically controlled (see 5.2).

Transformers shall be of the separate winding type for primary and secondary side. The secondary side shall be star-configuration with neutral bushings (Dyn).

NOTE Dyn = Delta connected HV winding, star connected LV winding, with provision to connect to the neutral point.

The temperature of supply-transformer windings shall be monitored.

In the event of over temperature, an alarm signal shall be transmitted to the ship using the data-communication link (see 7.8). The alarm signal shall activate an alarm on board to warn relevant duty personnel.

Short circuit protection for each supply transformer shall be provided by circuit-breakers or fuses in the primary circuit and by a circuit breaker in the secondary. In addition, overload protection shall be provided for the primary and secondary circuit.

Documents
Document Sharing Hub

Full document details: ISO_IEC_IEEE 80005-1_2012