



BSI Standards Publication

Utility connections in port

Part 1: High voltage shore connection (HVSC) systems — General requirements

National foreword

This British Standard is the UK implementation of EN IEC/IEEE 80005-1:2025. It is identical to IEC/IEEE 80005-1:2019, incorporating amendment 1:2022 and amendment 2:2023.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC/IEEE text carry the number of the IEC/IEEE amendment. For example, text altered by IEC/IEEE amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee JPEL/18, Electrical installations of ships and of mobile and fixed offshore units.

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

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Amendments/corrigenda issued since publication

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English Version

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(HVSC) systems - General requirements
(IEC/IEEE 80005-1:2019 + AMD1:2022 + AMD2:2023)

Alimentation des navires à quai - Partie 1 : Systèmes de
connexion à quai à haute tension - Exigences générales
(IEC/IEEE 80005-1:2019 + AMD1:2022 + AMD2:2023)

Stromversorgungsanschlüsse im Hafen - Teil 1:
Hochspannungs-Landanschlusssysteme (HVSC-Systeme) -
Allgemeine Anforderungen
(IEC/IEEE 80005-1:2019 + AMD1:2022 + AMD2:2023)

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European foreword

This document (EN IEC/IEEE 80005-1:2025) consists of the text of IEC/IEEE 80005-1:2019 + IEC/IEEE 80005-1:2019/AMD1:2022 + IEC/IEEE 80005-1:2019/AMD2:2023 prepared by IEC/TC 18 "Electrical installations of ships and of mobile and fixed offshore units".

The following dates are fixed:

- latest date by which this document has to be (dop) 2026-11-30 implemented at national level by publication of an identical national standard or by endorsement
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In the official version, for Bibliography, the following notes have to be added for the standard indicated:

IEC 60228	NOTE Approved as EN IEC 60228
IEC 60793-2	NOTE Approved as EN IEC 60793-2
IEC 60793-2-10	NOTE Approved as EN IEC 60793-2-10
IEC 60811 (series)	NOTE Approved as EN 60811 (series)
IEC 61140	NOTE Approved as EN 61140

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.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034	series	Rotating electrical machines	EN IEC 60034	series
IEC 60050-151	2001	International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices	-	-
IEC 60076	series	Power transformers	EN IEC 60076	series
IEC 60079	series	Explosive atmospheres	EN IEC 60079	series
IEC 60092-101	-	Electrical installations in ships – Part 101: Definitions and general requirements	-	-
IEC 60092-201	1994	Electrical installations in ships – Part 201: System design – General	-	-
IEC 60092-301	-	Electrical installations in ships – Part 301: Equipment – Generators and motors	-	-
IEC 60092-503	-	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	2016	Electrical installations in ships – Part 504: Automation, control and instrumentation	-	-
IEC 60146-1	series	Semiconductor convertors – General requirements and line commutated convertors	EN IEC 60146-1	series
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	EN 60204-11	2000
IEC 60332-1-2	-	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 premixed flame	EN 60332-1-2	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60364-4-41	-	Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock	HD 60364-4-41	-
IEC 60502-2	-	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)	-	-
IEC 60947-5-1	-	Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices	EN IEC 60947-5-1	-
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	-	Power installations exceeding 1 kV a.c. – Part 1: Common rules	EN IEC 61936-1	-
IEC 62271-200	-	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	EN IEC 62271-200	-
IEC 62613-1	-	Plugs, socket-outlets and ship couplers for high-voltage shore connection systems (HVSC-Systems) – Part 1: General requirements	-	-
IEC 62613-2	2016	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	EN IEC 62613-2	2018
IEC/IEEE 80005-2	-	Utility connections in port – Part 2: High and low voltage shore connection systems – Data communication for monitoring and control	-	-
IEEE C37.20.2	-	Standard for Metal-Clad Switchgear	-	-
IMO	2014	International Convention for the Safety of Life at Sea (SOLAS):1974, Consolidated edition 2014	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

UTILITY CONNECTIONS IN PORT –

Part 1: High voltage shore connection (HVSC) systems – General requirements

FOREWORD

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International Standard IEC/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: Plugs, socket-outlets and couplers for industrial and similar applications, and for Electric Vehicles, 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.

This document is published as a triple logo (IEC, ISO and IEEE) standard.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

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

- a) modification of 4.1, Figure 1:
 - transformer on ship is optional, earthing switches on ship removed;
- b) modification of 4.2.2 and new item 11.3:
 - alternative procedure of periodic testing added;
- c) modification of 4.9:
 - minimum current value in the safety circuits shall be 50 mA;
 - opening of safety loop shall cause the automatic opening of ship and shore HVSC circuit breakers in a maximum time of 200 ms;
- d) modification of 5.2:
 - added Figure on harmonic contents;
- e) modification of 6.2.3:
 - earthing transformer with resistor can be used also on the secondary side;
 - neutral earthing resistor rating in amperes shall be minimum 25 A, 5 s;
- f) modification of all annexes:
 - the safety circuits shall be mandatory;
- g) modification of A.2.1:
 - a metallic shield shall be installed at least on the power cores or common on pilot wires;
- h) modification of B.7.2.1:
 - new safety circuit introduced: single line diagram and description;
- i) modification of C.4.1:

- SLD for cruise ships was updated, also the safety circuits to be coherent with main body, IEC symbols and introduced more details about the control socket-outlets and plugs manufacturer type;
- j) modification of C.7.3.1:
 - shore power connector pin assignment is updated;
 - all cruise ships shall use 4 cables in all cases;
- k) added D.6.1:
 - the supply point on shore can be fixed or movable;
- l) modification of D.7.3.2:
 - the voltage used in the pilot circuit for container ships shall be less than 60 V DC or 25 V AC.
- m) added D.8.6 and D.9.3.1:
 - automatic restart and synchronization alternatives;
- n) Annex E set to informative;
- o) Annex F set to informative.

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.

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

FDIS	Report on voting
18/1643/FDIS	18/1657/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.

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

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 IEC 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 website 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.

A bilingual version of this publication may be issued at a later date.

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

INTRODUCTION

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 part of IEC/IEEE 80005 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 document 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 document can find it impossible to connect to compliant shore supplies.

Where deviations from this document are considered, it is useful to note the effects of such deviations in the compatibility study.

Where the requirements and recommendations of this document 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 document 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. This does not preclude the use of this document e.g. for safety purposes, such as for proprietary connection systems where a ship operates on dedicated routes.

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

The other annexes in this document 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.

Annex A is considered informative for the purposes of this document. Annex A contains performance-based requirements for shore connection cables 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.

UTILITY CONNECTIONS IN PORT –

Part 1: High voltage shore connection (HVSC) systems – General requirements

1 Scope

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

This document 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 frequency convertors,
- ship distribution systems, and
- control, monitoring, interlocking and power management systems.

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

Additional and/or alternative requirements can 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 MVA or more or ships with HV main supply.

Low-voltage shore connection systems 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 60034 (all parts), *Rotating electrical machines*

IEC 60050-151:2001, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices*

IEC 60076 (all parts), *Power transformers*

IEC 60079 (all parts), *Explosive atmospheres*

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

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

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

IEC 60092-503, *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 60092-504:2016, *Electrical installations in ships – Part 504: Automation, 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, *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 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60502-2, *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 2: Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)*

IEC 60947-5-1, *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, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*

IEC 62271-200, *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, *Plugs, socket-outlets and ship couplers for high-voltage shore connection systems (HVSC-Systems) – Part 1: General requirements*

IEC 62613-2:2016, *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*

IEC/IEEE 80005-2, *Utility connections in port – Part 2: High and low voltage shore connection systems – Data communication for monitoring and control*

IEEE Std C37.20.2™, *Standard for Metal-Clad Switchgear*

IMO, *International Convention for the Safety of Life at Sea (SOLAS):1974, Consolidated edition 2014*

3 Terms and definitions

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

ISO, IEC and IEEE maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEEE Standards Dictionary Online: available at <http://dictionary.ieee.org>

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

equipotential bond monitoring device

device that monitors the equipotential bonding between two points

3.4

ESD-1

emergency shutdown-1

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

3.5

ESD-2

emergency shutdown-2

shutdown initiated when the ship moves past the maximum range of allowable motion forward, aft or outward from the berth, and which initiates loading arm disconnection on shore

3.6

high voltage

HV

nominal voltage in range above 1 000 V AC and up to and including 15 kV AC

3.7

LNG-ESD

liquefied natural gas-emergency shutdown

type of emergency shutdown defined at LNG terminals

3.8

low voltage

LV

nominal voltage up to and including 1 000 V AC

3.9

PIC

person in charge

individual responsible for HVSC systems operations

3.10

pilot contact

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

3.11

receiving point

connection point of the flexible cable on the ship

3.12

safe

condition in which safety risks are minimized to an acceptable level

3.13

supply point

connection point of the flexible cable on shore

3.14

fail-safe

able to enter or remain in a safe state in the event of a failure

[SOURCE: IEC 60050-821:2017, 821-01-10]

3.15

safety circuit

normally closed interlocking circuit with pilot contacts and safety devices that shuts down the HVSC system in response to specific initiating events

3.16

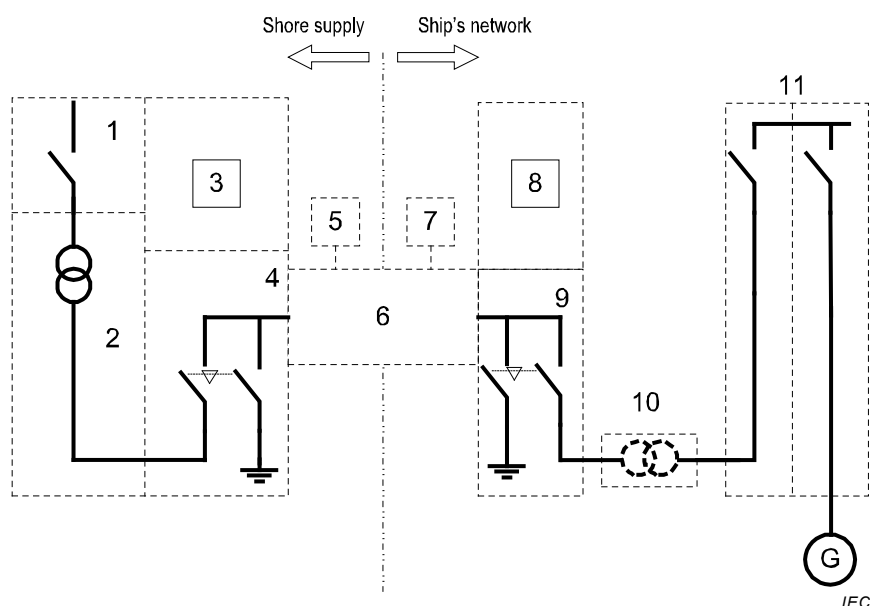
connector

coupling device employed to connect conductors of one circuit element with those of another circuit element

4 General requirements

4.1 System description

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



Key

- | | | | |
|---|--|----|---|
| 1 | Shore supply system | 7 | Control ship |
| 2 | Shore-side transformer | 8 | On-board protection relaying |
| 3 | Shore-side protection relaying | 9 | On-board shore connection switchboard |
| 4 | Shore-side circuit-breaker and earth switch | 10 | On-board transformer (where applicable) |
| 5 | Control shore | 11 | On-board receiving switchboard |
| 6 | Shore-to-ship connection and interface equipment | | |

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

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 45.1™ and IEEE Std 45.3™ provide additional information on typical ship distribution systems.

4.2.2 Equipotential bonding

An equipotential bonding between the ship's hull and shore earthing system shall be provided, (see 6.2.4).

In order to assure the integrity of the bonding in the shore connection, two alternative procedures are allowed:

- Continuous monitoring of the bonding. Verification of the equipotential bonding shall be a part of the safety circuit. 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).
- Periodic testing and maintenance of the bonding connections. Where continuous monitoring of the equipotential bonding is not in place, periodic testing and maintenance of the bonding connections shall be performed and documented (see Clause 11).

NOTE The **terms** earth(ing) and ground(ing) are used interchangeably throughout this document and have the same meaning (see IEC 60050-195:1998, 195-01-08). Equipotential bonding as protection against electric shock is described in IEC 61140.

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 document 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 method and means;
- k) distribution system compatibility assessment (shore power transformer neutral earthing);
- l) functioning of ship earth fault protection, monitoring and alarms when connected to an HVSC supply (see 8.2.2);
- m) sufficient cable length;
- n) compatibility of safety circuits;
- 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;
- s) utility interconnection requirements for load transfer parallel connection;
- t) equipotential bond monitoring (see 4.2.2).

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, the person in charge [PIC(s)] shall be identified at the shore facility and onboard 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.

An independent means of voice communication should be provided between the ship and the facility's PIC (e.g. two-way radios).

4.5 Personnel safety

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

NOTE 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", and "safe use" 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, hard wired.

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.

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 shall be clear for their operation, along with any movement of the ship along the pier required to accommodate these operations;
- b) interferences with terminal operations or to allow necessary traffic flow on the pier and maintain open fire lanes where required; and
- c) personnel safety measures, such as physical barriers to prevent unauthorized personnel from accessing the HVSC equipment or the cable management equipment.

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

4.6.4 Electrical equipment in areas where flammable gas or vapour and/or combustible dust can 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 (all parts) 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.

4.7 Electrical requirements

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

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

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.

The prospective short-circuit contribution level from the onboard 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 short-circuit withstand current 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 the following:

- a) the electrical load during shore connection;
- b) the short-circuit current calculations (see IEC 61363-1) shall be performed in order to take into account the prospective contribution of the shore supply and the ship's 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, and
 - 3) restrict load to be connected.

 NOTE Provisional load restrictions can be necessary during load transfer. 

- d) system-charging (capacitive) current for shore and ship; this system-charging current calculation shall consider the shore power system and the expected ship power system including the on-line generator(s);
- e) shore power transformer neutral earthing resistor analysis, where neutral resistor is required by annexes (see 6.2.3);
- f) transient overvoltage protection analysis (see 5.2);
- g) fail-safe principle for cables/connectors operation (see 4.6.1).

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 onboard transformer and main switchboard shall be evaluated, and overload protection shall be provided between the onboard 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 shall 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 onshore and onboard ship.

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

The relay contacts of the safety circuit shall be designed in accordance with IEC 60947-5-1 and for a rated insulation voltage of $U_i = 300 \text{ V}$, AC 5 A, DC 1 A.

Minimum current value in the safety circuits shall be 50 mA.

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 be either

- a) automatically earthed so that they are safe to touch immediately following the isolation from ship and shore electrical power supplies, or
- b) 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.

Barriers and/or adequate distance(s) shall be satisfied 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 can move into a potentially hazardous area (where flammable gas, vapour and/or combustible dust can accumulate) associated with the terminal or port berth area as a result of the ship inadvertently leaving the berthed position (slipping/leaving

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 devices (where utilized),
- g) overtension on the flexible cable (mechanical stress) (see 7.2.2),
- h) remaining cable length is too low (see 7.2.3),
- i) loss of any safety circuit,
- j) activation of any manual emergency-stop,
- k) activation of protection relays provided to detect faults on the HV connection cable or connectors, and
- l) 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 each of the following locations:

- m) an attended onboard ship control station during HVSC;
- n) in the vicinity of the socket-outlet;
- o) at active cable management system control locations; and
- p) 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.

Opening of safety loop shall cause the automatic opening of ship and shore HVSC circuit breakers in a maximum time of 200 ms.

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

For reliable operation of safety circuits, the pilot cable length and cross section shall be considered.

A₂ 4.10 Ship specific annexes

Annex B to Annex G are ship specific annexes that include additional requirements to safety and compatibility for compliant ships at different compliant berths. **A₂**

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 AC and/or 11 kV AC galvanically separated from the shore distribution system.

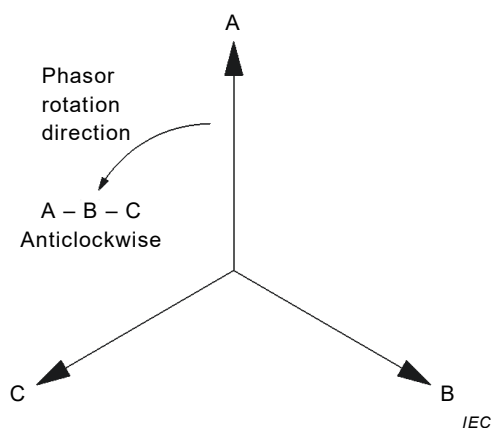
The operating frequencies (Hz) of the ship and shore electrical systems shall match; otherwise, a frequency convertor shall be utilized ashore.

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).

A1) The phase sequence shall be L1-L2-L3 or A-B-C or R-S-T, anticlockwise. A phase sequence indicator shall indicate correct sequence prior to energizing or paralleling HVSC – see Figure 2a). Figure 2b) illustrates the balanced three-phase voltages in the time domain. **A1)**

If an observer looking at the phase sequence rotation diagram is fixed at its location, phasors shall rotate anticlockwise in relation to the fixed observer to produce a clockwise indication on the phase sequence indicator [see Figure 2b)].

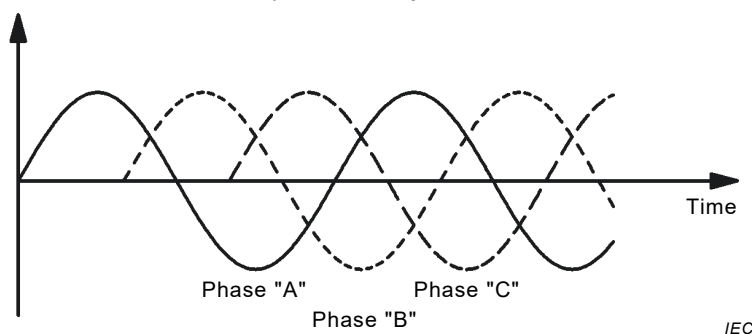
A1) NOTE See ship specific annexes for phase assignment of the pins in the connector. **A1)**



Key

A – A = 0°
A – B = 120°
A – C = 240°

a) Phase sequence rotation – Positive direction



b) Balanced three-phase variables in the time domain

Figure 2 – Phase sequences

5.2 Quality of HV shore supply

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

Electrical equipment of ships 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 $\pm 5\%$ between no-load and nominal rating;
- 2) for no-load conditions, the voltage at the supply point shall not exceed a voltage increase of 6% of nominal voltage;