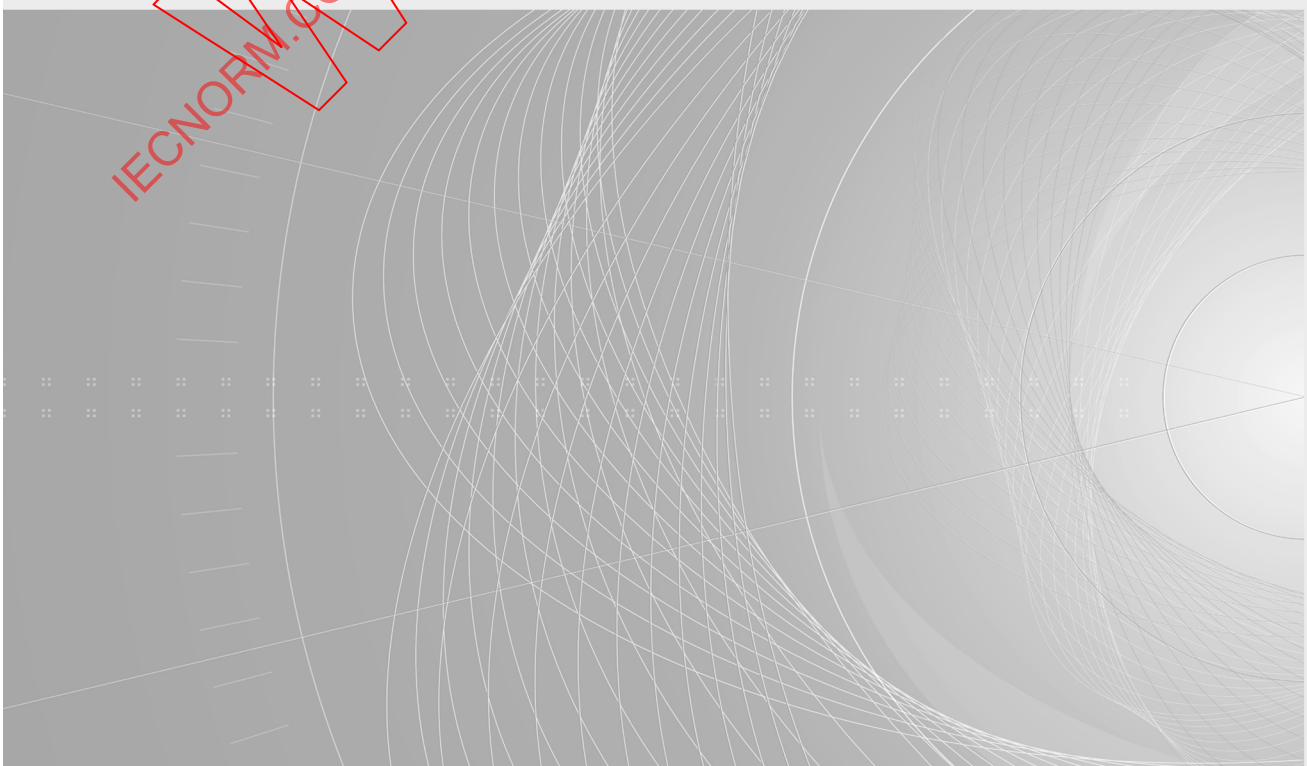
IEC/PAS 60092-510

Edition 1.0 2009-04

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

Electrical installations in ships –
Part 510: Special features – High-voltage shore connection systems



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Electrical installations in ships –
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL INSTALLATIONS IN SHIPS –

Part 510: Special features – High-voltage shore connection systems

FOREWORD

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A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 60092-510 has been processed by subcommittee IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This PAS has been prepared in cooperation with ISO technical committee 8: Ships and marine technology, Subcommittee 3: Piping and machinery.

It is published as a double logo PAS.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document
Draft PAS	**Report on voting**
18/1094/PAS	18/1103/RVD

In ISO, the PAS was approved by 7 P members of 8 having cast a vote.

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single 3-year period, following which it shall be revised to become another type of normative document, or shall be withdrawn.

INTRODUCTION

This PAS was ultimately developed jointly between IEC TC18 MT 26/PT 60092-510 and the technical committee of ISO TC8, Ships and Marine Technology Subcommittee SC 3, Piping and Machinery, WG11.

IEC 60092 forms a series of International Standards for electrical installations in sea-going ships, incorporating good practice and co-ordinating, as far as possible, existing rules.

These standards form a code of practical interpretation and amplification of the requirements of the International Convention for the Safety of Life at Sea, a guide for future regulations which may be prepared and a statement of practice for use by shipowners, shipbuilders and appropriate organizations.

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 intention of this PAS is to define requirements that support, with the application of suitable operating practices, compliant ships to connect quickly to compliant high-voltage shore power supplies through a compatible shore to ship connection.

With the support of sufficient planning and appropriate operating procedures and assessment, compliance with the requirements of this PAS is intended to allow different ships to connect to high-voltage shore connections 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 PAS may find it impossible to connect to compliant shore supplies.

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

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

Low-voltage shore connection is covered by IEC 60092-201, Clause 14 and IEC 60092-507.

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 510: Special features – High-voltage shore connection systems

1 Scope

This PAS describes high-voltage shore connection (HVSC)-Systems, on board the ship and on shore, to supply the ship with electrical power from shore during the port lay period.

This PAS is applicable to the specification, installation and testing of HVSC- Systems and plants and addresses:

- high-voltage shore distribution system,
- shore-to-ship connection,
- transformers/reactors,
- semiconductor convertors and rotating convertors,
- ship distribution system, and
- control, monitoring, interlocking and power management system.

This PAS does not apply to the electrical power supply during docking periods and shall not apply to HVSC-Systems that existed before the validity date of this PAS.

NOTE 1 Additional requirements and/or restrictions may be imposed by the National Administration or 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.

NOTE 2 It is expected that HVSC-Systems will have practicable applications for ships requiring 1 MW or more or ships with high voltage main supply.

2 Normative references

The following referenced documents are indispensable for the application 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 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, *Electrical installations in ships – Part 201: System design – General*

IEC 60092-301:1980, *Electrical installations in ships – Part 301: Equipment – Generators and motors*

IEC 60092-303, *Electrical installations in ships – Part 303: Equipment – Transformers for power and lighting*

IEC 60092-350:2008, *Electrical installations in ships – Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications*

IEC 60092-351:2004, *Electrical installations in ships – Part 351: Insulating materials for shipboard and offshore units, power, control, instrumentation, telecommunication and data cables*

IEC 60092-352:2005, *Electrical installations in ships – Part 352: Choice and installation of electrical cables*

IEC 60092-354:2003, *Electrical installations in ships – Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV (U_m = 7,2 kV) up to 30 kV (U_m = 36 kV)*

IEC 60092-376:2003, *Electrical installations in ships – Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)*

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, *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

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

IEC 60228:2004, *Conductors of insulated cables*

IEC 60309-1, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

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 60502-4:2005, *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 60529, *Degrees of protection provided by enclosures (IP-Code)*

IEC 60664-1 Ed. 2.0, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60721-3-6:1987, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities –Ship environment*

IEC/TR 60721-4-6:2001, *Classification of environmental conditions – Part 4-6: Guidance for the correlation and transformation of environmental condition classes of IEC 60721-3 to the environmental tests of IEC 60068 – Ship environment*
Amendment 1(2003)

IEC 60793-2:2007, *Optical fibres – Part 2: Product specifications – General*

IEC 60811 (all parts), *Common test methods for insulating and sheathing materials of electric cables and optical cables*

IEC 60811-1-4, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section four: Test at low temperature*

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

IEC 61241 (all parts), *Electrical apparatus for use in the presence of combustible dust*

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 61378-1:1997, *Convertor transformers – Part 1: Transformers for industrial applications*

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

IEC 62262:2002, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

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*

ISO 4649, *Rubber, vulcanized or thermoplastic – Determination of abrasion resistance using a rotating cylindrical drum device*

ISO 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

DIN VDE 0472 Part 512, *Widerstand zwischen Schutzleiter und Leitschicht*

MIL-DTL 38999K, *General Specification for connectors, electrical, circular, miniature, high density, quick disconnect (bayonet, threaded, and breech coupling), environmental 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*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the IEC 60092 series and the following apply.

3.1
HVSC-System
high-voltage shore connection system

3.2
High Voltage
HV
systems with nominal voltage in range above 1 000 V a.c. and up to and including 15 kV a.c.

NOTE This definition differs from the conventional definition.

3.3
Low Voltage
LV
systems with nominal voltage up to and including 1 000 V a.c.

3.4
electrical operating spaces
spaces which are intended solely for the installation of electrical equipment such as switchgear, transformers, etc.

3.5
cable management system
all equipment designed to control, monitor and handle the HV-flexible and control cables and their connection devices

3.6
dry operating spaces
spaces in which no moisture normally occurs, e.g. engine control rooms

3.7
locked electrical spaces
spaces which are provided with lockable doors

3.8
Person in Charge
PIC
individual responsible for the conduction of HVSC-Systems operations

3.9
power distribution system
electrical supply system

3.10
pilot contact
one contact of plug and socket-outlet which signals correct plug connection and is part of a safety loop

3.11
supply point
connection point of the flexible cable on shore

3.12
the fail safe principle
any failure shall result in a safe situation, e.g. by a single fault in a circuit the faulty circuit is disconnected to be voltage free or without power

SECTION ONE –
GENERAL REQUIREMENTS

4 System

4.1 System description

A typical HVSC-System described in this PAS consists of the following hardware components:

- main on-shore supply equipment,
- transformer,
- static/rotating convertor,
- cable management equipment,
- distribution switchgear and control gear assembly,
- interface equipment,
- plug and socket-outlet, and
- on board distribution switchgear.

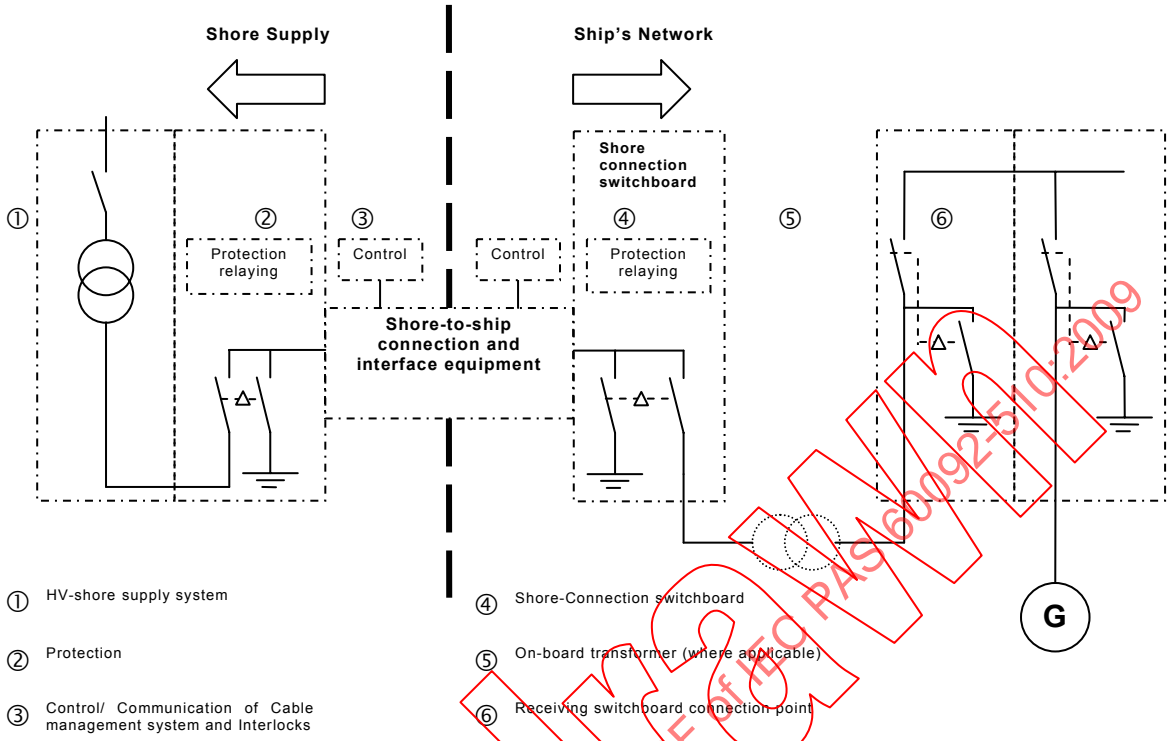

Figure 1 – Diagram of a typical described HVSC-System arrangement

4.2 Distribution system

4.2.1 General

Typical distribution systems used on shore are described in IEC 61936-1.

4.2.2 Equipotential bonding

An equipotential bonding between ship and shore shall be done, see 6.4.2

The verification of the equipotential bonding shall be a part of the safety circuit. Loss of equipotential bonding shall result in shut down of the HVSC, and the ship shall go into blackout recovery mode.

NOTE Sufficient protection for electrochemical corrosion shall be taken. Special arrangement shall be taken for aluminium ships.

4.2.3 Electrochemical corrosion

Measures shall be taken to detect corrosion current across the potential equalisation. Effective means shall be provided to avoid electrochemical corrosion.

4.3 Compatibility assessment before connection

Compatibility assessment shall be carried out to verify the possibility to connect the ship to shore supply HV.

NOTE Compatibility assessment will normally be performed at least prior to the first arrival at a terminal.

Assessment of compatibility shall be done to at least determine the following:

- compliance with the requirement of this PAS and any deviations from the recommendations,
- maximum prospective short-circuit current,
- nominal ratings of the shore supply, ship-to-shore connection and ship connection,
- acceptable voltage variations at ship switchboards between no-load and nominal rating,
- steady state and transient ship load demands when connected to a HV shore supply, HV shore supply response to step changes in load,
- system study and calculations see 4.8,
- verification of ship equipment impulse withstand capability, see 5.3,
- compatibility of shore and ship side control voltages,
- compatibility of communication link,
- grid configuration compatibility assessment (neutral point connection),
- sufficient cable length,
- compatibility of safety circuits, and
- where applicable, electrical equipment installed in areas where flammable gas or vapour and/or combustible dust may be encountered shall be in accordance with the IEC 60079 and/or IEC 61241 series.

4.4 System integration and management

4.4.1 During installation

There shall be one nominated body responsible for the integration of the complete HVSC-System during construction.

As HVSC-Systems are connected to various other systems, for example shore and ship alarm and control systems, system integration of shore and ship HVSC-System installations shall be managed by a single designated party and shall be carried out in accordance with a defined procedure identifying the roles, responsibilities and requirements of all parties involved.

During operation of HVSC-Systems, designated parties shall be identified at the shore facility and on board the ship for the purposes of communication.

These parties shall be provided with sufficient information, instructions, tools and other resources to allow activities to be conducted sufficiently in a safe and effective manner.

NOTE Ship and shore personnel responsible for the physical connection and operating the HVSC-system should not be required to conduct electrical system compatibility assessment. This assessment should be conducted and compatibility should be verified by designated responsible parties prior to connection.

4.5 Personnel safety

The safety of the personnel during establishing the connection supplying the ship, during all normal operations including in the event of a failure and during disconnecting of the shore connection and when not in use, shall be ensured by the construction of the HV-equipment and operating safety procedures.

4.6 Design requirements

4.6.1 General

Each failure shall be identified by alarm at a manned control station on board.

Functions shall be designed 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

HV 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 safe and efficient 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:

- 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,
- 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, or
- physical guards that may be required to prevent personnel falling from the shore or the ship because of HVSC-Systems operations or the presence of cable management equipment.

When determining the location of the HVSC system all tidal conditions shall be considered.

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

HV equipment shall be positioned outside the combined hazardous area envelope of the ship and shore facilities under normal operating conditions.

Other HVSC-System equipment shall be positioned outside the combined hazardous area envelope 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-System equipment that may fall within one of the hazardous zones of the terminal under emergency conditions (inadvertent movement of ship from berth) shall be:

- of a ‘safe-type’, suitable for the flammable gas or vapour and/or combustible dust encountered; or
- automatically isolated and discharged before entering the potentially hazardous area.

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

NOTE 1 HVSC-Systems shall 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.

NOTE 2 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 fall 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 HV-System components type and routine tests shall be carried out according to the relevant standards.

To allow standardisation of the HV shore supply and link nominal voltage in different ports, any equipment requiring conversion to nominal voltage shall be installed on board.

To be able to address the various grounding philosophies in accordance with IEC 60092-503 on high voltage ships, where an on board transformer is not feasible, the neutral point treatment on the shore supply must be able to adapt to various grounding philosophies.

The prospective short-circuit contribution levels shall be limited as defined in the ship specific Annexes.

Electrical system design, including short-circuit protective device rating, shall be suitable for the prospective maximum short-circuit fault current at the point of installation.

4.8 System study and calculations

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

- the required electrical load during shore connection;
- the short-circuit current calculations, see IEC 61363-1, shall be carried out 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:
  - for shore supply installations, a maximum permitted prospective fault level for visiting ships,
  - for ships, a maximum permitted prospective fault level for visited shore supply installations.
- The calculations may take into account any arrangements that:
  - prevent parallel connection of high voltage shore supplies with ship sources of electrical power and/or
  - restrict the number of ship generators operating during parallel connection to transfer load,
  - restrict load to be connected.
- These calculated currents shall be used to select suitably rated shore connection equipment and to allow the selection and setting of protective devices to ensure that successful discriminatory fault clearance is achieved.

NOTE 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 Shut-Down facilities shall be provided that, when activated, will instantaneously open all shore-connection circuit-breakers.

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:

- be automatically earthed so that they are safe to touch following the isolation from ship and shore electrical power supplies immediately (this option shall not be chosen where connection equipment may move into a potentially hazardous area, see below), or

- be 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, see below).

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

- control personnel access to relevant spaces and areas when the high voltage connection is live. Locking arrangements may be considered; and
- arrange for the safe discharge of high voltage conductors.

NOTE Where earthing of shore equipment by ship equipment would not be permitted by the responsible shore authorities, alternative proposals for personnel protection and connection cable discharge may be considered.

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 high voltage equipment then automatically discharged, so that it will not present an ignition hazard in the event of inadvertently leaving the berthed position.

The Emergency Shut-Down facilities shall be activated in the event of:

- loss of equipotential bonding, via the ground check relays,
- overtension on the flexible cable (mechanical stress) see 7.1.1.2,
- loss of safety circuit,
- activation of any emergency-stop buttons,
- activation of protection relays provided to detect faults on the HV connection cable or connectors and
- dis-engaging of power plugs from socket-outlets while HV connections are live (before the necessary degree of protection is no longer achieved or power connections are broken).

Emergency stops that will manually activate the Emergency Shut-Down facilities shall be provided at:

- a ship machinery control station that is attended when connected to an external electrical power supply;
- at active cable management system control locations; and
- at the shore side and ship circuit-breaker locations.

Additional manual activation facilities may also be provided at other locations where it is 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 Shut-Down shall be provided at a ship machinery control station that is attended when connected to an external electrical power supply. The alarm shall indicate the cause of the activation.

SECTION TWO –
SHORE REQUIREMENTS

5 HV-shore supply system

5.1 Current Inrush

Consideration shall be given to provide means to reduce transformer current in-rush and/or inhibiting the starting of large motors, or the connection of other large loads, when a HV supply system is connected.

5.2 Voltages and frequencies

The maximum nominal system voltage of shore-connection voltage to the ship is 15 kV, see IEC 60092-503.

To allow standardisation 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 and or 11 kV galvanically separated from the shore distribution system.

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

NOTE Other IEC standard nominal values, see IEC 60092-503, may be considered where ships undertake a regular, repeated itinerary in service where the visited ports HV shore supply provides the required nominal values.

5.3 Quality of HV-shore power supply

The HV shore power supply system shall have 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 and frequency characteristics given below. To ensure that this is complied with the compatibility assessment referred to in 4.3 shall include verification of the following:

- voltage and frequency tolerances (continuous):
  - i) the frequency shall not to exceed the continuous tolerances ±5 % between no-load and nominal rating,
  - ii) for no-load conditions, the voltage at the point of the shore-supply connection (on shore or on board depending on the ship-to-shore cable arrangement) shall not exceed 3,5 % of nominal voltage,
  - iii) for rated load conditions, the voltage at the point of the shore-supply connection (on-shore or on-board depending on the high voltage cable arrangement) shall not exceed a voltage drop of –3,5 % of nominal voltage,
- voltage and frequency transients:
  - i) 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,
  - ii) 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,

iii) comparison of i) and ii) shall be done to ensure that the voltage transients limits of voltage +20 % −15 % and the frequency transients limits of ±10 %, will not be exceeded.

The shore-side supply system shall consider protection against fast transients (e.g. spikes-caused by lightning strikes or atmospheric overvoltages) to protect connection and ship equipment from resultant damage.

NOTE 1 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 that the effect of the connected ship load is acceptable.

NOTE 2 Where the possible loading conditions of a particular ship when connected to a particular HV shore supply would result in a quality of the supply different from that specified in IEC 60092-101, 2.8, due regard should be paid to the effect this may have on the performance of equipment.

6 Installation

6.1 General

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

NOTE Local Authorities might have additional requirements.

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

Transformers shall be of the separate winding type for primary and secondary side. The secondary side shall be wye-configuration.

When more than one ship may be connected in one location, each ship shall be provided with a dedicated high voltage shore supply installation which is galvanically isolated from other connected ships and consumers.

NOTE This may not be required where a high voltage shore supply is dedicated to supply only ships which have galvanic isolation on board.

6.2 Components and system requirements

6.2.1 Combination circuit breaker, disconnector and earthing switch

In order to have the installation isolated before it is earthed, the following are required:

- circuit breaker and disconnector shall be interlocked in accordance with IEC 62271-200, and
- disconnector and earthing switch shall be interlocked in accordance with IEC 62271-200.

The rated making capacity of the earthing switch shall be above the prospected peak value of the short-circuit current (I_P).

A remote operated earthing switch shall be provided.

6.2.2 Transformer

Where adjustments are required to maintain the HV-supply voltage within tolerances, see 5.3, this adjustment shall be automatically controlled.

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 7.5.3. The alarm signal shall activate an alarm on board at a manned position to advise relevant duty personnel.

Short circuit protection for each supply transformers shall be provided by circuit-breakers or fuses in the primary circuit and in addition, overload protection shall be provided either in the primary or secondary circuit.

In the event of circuit breaker protection activation, see 6.3, an alarm signal shall be transmitted to the ship using the data-communication link. The alarm signal shall activate an alarm onboard to advise relevant duty personnel.

6.3 Protection system

HV circuit-breaker on the secondary side of the transformer shall be arranged to open all insulated poles in the event of the following conditions:

- all overcurrents up to and including short-circuit,
- over-voltage/under-voltage and
- reverse power.

To satisfy this requirement, at least the following protective devices, or equivalent protective measures, shall be provided:

- (27) undervoltage
- (32) reverse power
- (49) overload
- (50) instantaneous overcurrent
- (51) overcurrent
- (51G) earth fault
- (59) overvoltage
- (67) directional overcurrent

NOTE ANSI standard device designation numbers are shown in brackets.

Alarms shall be communicated to the ship, see 7.5.3.

The protection systems shall be provided with battery back-up adequate for at least 30 min.

6.4 High-voltage (HV) interlocking concept

Operating personnel protection shall be achieved by an interlocking concept while plugging and unplugging of HV plug and socket-outlet connections.

Operational procedures to ensure and verify that non-fixed high-voltage cables are discharged before disconnection shall be established.

6.4.1 Access

Access to HV plug/socket-outlets shall only be possible when the associated earthing switches on both ship and shore sides for that part are closed.

Access to the ship-side connector/inlets is only possible when the ship-side earthing switch is closed.

Access to the shore-side plug/socket-outlets is only possible when the shore-side earthing switch is closed.

6.4.2 Operating of the high-voltage (HV) circuit-breakers, disconnectors and earthing switches

Arrangements shall be provided to ensure that the HV circuit-breaker does not close to connect the HV-supply to the connection cable when:

- one of the earthing switches is closed (shore-side/ship-side),
- the pilot contact circuit, see 7.2.2, is not established,
- ship or shore control, alarm or safety system self-monitoring properties detect an error that would affect safe connection,
- the communication link between shore and ship is not operational,
- the permission from ship is not activated, 7.5.3 and
- the HV supply is not present.

It shall not be possible to close the disconnector, if:

- one of the earth switches is closed,
- the pilot circuit of the plugs and socket-outlets is not closed,
- communication line between shore and ship fails, and
- equipotential bonding is not established (via ground check relays).

The shore- and ship-side earthing switches shall only be opened when:

- the pilot contacts are closed,
- the communication between ship and shore is established,
- the ratings of the shore-ship system (voltage, frequency, short-circuit current, etc.) are co-ordinated, and
- no emergency stop switch is activated.

6.5 Shore-connection convertor equipment

Where provided, ship-converting equipment (transformers and/or semiconductor convertors) for connecting HV-shore supplies to a ship electrical distribution system shall be constructed in accordance with IEC 60092-303, IEC 60076-series for transformers and IEC 60146-1-series for semiconductor convertors, as applicable.

Rotating convertors shall be designed and tested in accordance with IEC 60034.

For transformers and reactors which are intended for integration within semiconductor convertors, see IEC 61378-1.

The effect of harmonic distortion and power factor shall be considered in the assignment of a required power rating.

Transformer-winding and semiconductor convertor temperatures shall be monitored and an alarm shall be given at a machinery control station that is attended when connected to HV-shore supplies if the temperature exceeds a predetermined safe value.

The use of frequency convertors shall not reduce the downstream selectivity in any conditions.

6.5.1 Degree of protection

Electrical equipment degree of protection shall be in accordance with IEC 60092-201 and IEC 60092-503 as applicable.

6.5.2 Cooling

When forced cooling is used, whether by air or with liquid, an alarm shall be initiated when the cooling medium exceeds preset limits.

There shall be arrangements so that transformer load may be reduced to a level compatible with the cooling available.

Semiconductor-convertor equipment shall be so arranged that it cannot remain loaded unless effective cooling is maintained. Alternatively, the load may be automatically reduced to a level compatible with the cooling available.

Where closed-circuit cooling is used, low-flow alarms shall be provided for primary and secondary coolant.

Liquid-cooled convertor equipment shall be provided with leakage alarms and a suitable means shall be provided to contain any liquid which may leak from the system in order to ensure that it does not cause an electrical failure of the equipment.

Where water-cooled-heat exchangers are used in transformer-cooling circuits, there shall be detection of water leakage and the system shall be arranged so that the entry of water into the transformer is prevented.

Where the semiconductors and other current carrying parts of semiconductor convertors are in direct contact with the cooling liquid, the liquid shall be monitored for satisfactory conductivity and an alarm shall be initiated if the conductivity is outside the manufacturer's limits.

The alarms shall be provided at a machinery control station that is attended when the ship is connected to HV-shore supplies.

6.5.3 Protection

In the event of overload, an alarm signal shall be activated at a machinery control station that is attended when the ship is connected to HV-shore supplies to warn relevant duty personnel. The alarm shall be activated at a lower overload level than the circuit-breaker protection.

Alarms from the onshore protection equipment shall be transmitted to the ship.

SECTION THREE –

SHIP-TO-SHORE CONNECTION AND INTERFACE EQUIPMENT

7 General

This section deals with standardized HVSC-Systems, cables and their accessories, including socket-outlets, shore-connection cables and communications between ship and shore and earthing.

For electrical ratings for different applications, see Annexes.

7.1 Ship-to-shore connection and interface equipment

The ship-to-shore connection cable installation and operation shall be arranged to provide adequate movement compensation, cable guidance and anchoring/positioning of the cable during normal planned ship-to-shore connection conditions.

The shore-side of the connection cable shall be fitted by a plug. The body shall be arranged to protect all contacts. Cable connections may be permanently connected on shore to suitable terminations.

The ship-side of the connection cable shall be fitted with a connector, if the arrangement of a connector - inlet will be used on-board. Cable connections may be permanently connected on-board to suitable terminations.

Cable extensions shall not be permitted.

NOTE If an alternative to the standard arrangement of cable and HV plug and socket-outlets is designed, it is likely that the installation will not be able to connect to a compliant shore supply/ship without significant additional equipment and modification.

7.1.1 Cable management system

7.1.1.1 General

The cable management system shall:

- be capable of moving the flexible cable, enabling the cable to reach between the points of shore and ship connection,
- be capable of maintaining an optimum length of cable which avoids slack cable as well as exceeding of tension limits,
- be equipped with a device (e.g. limit switches), independent of its control system, to monitor maximum cable tension and deployed cable length,
- address the risk of submersion by prevention or by the equipment design,
- be positioned to prevent interference with ship berthing and mooring systems, including the systems of ships that do not connect to shore power while berthed at the facility,
- ensure that the bending radius of cables is maintained above the minimum bending radius recommended by the manufacturer during deployment, in steady state operation and when stowed,
- be capable of supporting the cables over the entire range of ship drafts and tidal ranges, and
- be capable of retrieving and stowing the cables once operations are complete.

Where the cable management system employs cable reel(s), the HVSC system rated power shall be based on the operating condition with the maximum number of wraps of cable stowed

on the reel that is encountered during normal operations. Where applicable the cable sizing shall include appropriate de-rating factors.

7.1.1.2 Monitoring of cable tension

The cable management system shall ensure that the cable tension does not exceed the permitted design value.

Means to detect tension or, in the case of active cable management systems limiting the cable tension, a shortage of cable in the HVSC power supply connection cables shall be provided and threshold limits shall be arranged in two stages:

1) alarm
2) activation of emergency shutdown facilities, see 4.9.

7.1.1.3 Monitoring of the cable length

The cable management system shall ensure that the supply system can follow the ship movements.

Where the cable length may vary, the remaining cable length shall be monitored and threshold limits are to be arranged in two stages:

1) alarm
2) activation of emergency shutdown facilities, see 4.9.

Consideration may be given to equivalent alternative measures (automatic break-away release, connectors with shear bolts and pilot lines, connection with ship/shore Emergency Shut-Down system, etc.).

7.1.1.4 Connection conductor imbalance protection

The ship and shore HV circuit-breakers shall be arranged to open all insulated poles in the event of a damaging current imbalance between multiple phase conductors (separate, parallel power cables and connectors).

To satisfy this requirement, the following protective devices, or equivalent protective measures shall be provided:

- (46) phase balance current relay (between multiple plug systems),
- (67N) directional overcurrent (to detect current flow to earth fault from a parallel connection cable).

NOTE ANSI standard device designation numbers are shown in brackets.

Protective relays to satisfy this requirement may be installed on board and/or ashore provided the connection is isolated in the event of imbalance detection.

7.2 Plugs and socket-outlets

7.2.1 General

The plug and socket-outlet arrangement shall be fitted with a mechanical-securing device that locks the connection in engaged position.

The plugs and socket-outlets shall be designed so that an incorrect connection cannot be made.

Socket-outlets and inlets shall be interlocked with the earth switch so that plugs or connectors cannot be inserted or withdrawn without the earthing switch in closed position.

Access to plug and socket outlets shall be possible only when the associated earthing switch is closed.

The earthing contacts shall make contact before the live contact pins do when inserting a plug.

Plugs shall be designed so that no strain is transmitted to the terminals and contacts. The contacts shall only be subjected to the mechanical load which is necessary to ensure satisfactory contact pressure, also when connecting and disconnecting.

Each plug shall be fitted with two pilot contacts to ensure continuity verification of the safety loop.

Contact sequence shall be the following:

- connection:
  - earth contact,
  - power contacts, and
  - pilot contacts.
- disconnection:
  - pilot contacts,
  - power contacts, and
  - earth contact.

Each plug and socket-outlet shall have a permanent, durable and readable nameplate which at least shall give:

- manufacturer's name and trademark,
- type designation and serial number, and
- applicable rated values.

The nameplates shall be legible during normal service.

Minimum values for plugs and socket-outlets regarding electrical and mechanical ratings are given in Annex A.

Support arrangements are required to ensure that the weight of connected cable is not borne by any plug or socket termination or connection.

7.2.2 Pilot contacts

Pilot-contacts connections shall open before the necessary degree of protection is no longer achieved during the removal of a HV-plug or connector.

7.3 Interlocking of earthing switches

Arrangements shall be provided to ensure that the HV power contacts remain earthed until:

- all connections are made,
- the communication link is operational,
- ship or shore control, alarm or safety system self-monitoring properties detects that no failure would affect safe connections, and
- the permission from ship and shore is activated.

7.3.1 Earth contact

The current-carrying capacity of the earth contact shall be at least equal to the rated current of the other main contacts.

7.4 Ship-to-shore connection cable

Cables shall be at least of a flame-retardant type in accordance with the requirements given in IEC 60332-1-2. The outer sheath shall be oil-resistant and resistant to sea air, seawater, solar radiation (UV) and nonhygroscopic. The temperature class shall be at least 85 °C, insulation according to Annex B. Correction factor for various ambient air temperatures above 45 °C shall be taken into account, see IEC 60092-201 Table 7.

Acceptable HV connection cable electrical ratings are given in Annex B.

7.5 Control and monitoring cable

7.5.1 General

Control and monitoring cables shall be at least of a flame retardant type in accordance with the requirements of IEC 60332-1-2. The insulation shall be resistant to oil, sea air containing moisture, salt, seawater and they shall be nonhygroscopic. They shall also be able to withstand in the outer part certain UV-levels and the temperatures at the location.

The control and monitoring cables, if integrated with the power cable assembly, they shall be able to withstand internal and external short-circuits.

7.5.2 Control and monitoring plugs and socket-outlets

See Annex A.

7.5.3 Data communication

The data-communication link between ship and shore arrangements shall be used for communicating the following information:

- shore transformer high-temperature alarm, see 6.2.2,
- HV shore supply circuit-breaker protection activation, see 6.3,
- permission to operate HV circuit breakers for HV ship-to-shore connection, see 6.4, 6.4.2 and 8.6.4,
- if ship or shore control, alarm or safety system self-monitoring properties detect an error that would affect safe connection, see 6.4.2 and 8.6.4,
- emergency stop activation, see 8.6.4,
- where provided, shore control functions in accordance with 9.1, and
- emergency disconnection of the shore supply, see 4.9.

The communication protocol for communication link between ship and shore shall be defined.

Regard shall be given to the fact that this communication is safety related. The IEC 60092-504 shall be observed.

7.6 Storage

Arrangements shall be provided for stowage when not in use, such that:

- ship board equipment shall be stored in dry spaces;
- national standards shall apply for shore based equipment;

- equipment can be stowed, stored and removed without damage;
- equipment does not present a hazard during normal ship operation; and
- during storage the plugs, socket-outlets, inlets and connectors shall maintain their IP ratings.

Parts dismantled after use of the communication link shall be provided with stowage arrangements.

NOTE Temporary coverings are not considered to satisfy this requirement.

SECTION FOUR – SHIP REQUIREMENTS

8 Installation

8.1 General

IEC 60092-standards apply.

Additional requirements and/or restrictions may be imposed by the National Administration or 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.

8.2 Ship-electrical-distribution-system protection

The maximum prospective short-circuit current for which HV-shore supply or ship-electrical-system equipment is rated shall not be exceeded at any point in the installation by connecting to HV-shore supplies and this shall be addressed as part of the compatibility assessment, see 4.3.

Where it is necessary to connect high powers that would result in a higher prospective maximum short-circuit current, arrangements to connect to more than one independent and separate HV-shore supply and ship-to-shore interface in accordance with Sections Two and Three shall be done.

Where connection to more than one HV-shore supply is possible, measures shall be taken to ensure that HV-shore supplies cannot be connected in parallel if the maximum prospective short-circuit current is exceeded at any point in the installation.

8.3 Connection switchboard

A shore-connection switchboard shall be provided at a suitable location, in the vicinity of the supply point, for the reception and/or extension of the ship-to-shore connection.

The shore connection switchboard shall be in accordance with IEC 62271-200.

The switchboard shall include a circuit-breaker to protect fixed electrical cables installed from that point onwards. In no case shall the protection at the shore-connection switchboard be omitted.

8.3.1 Combination circuit breaker, disconnector and earthing switch

In order to have the installation isolated before it is earthed, the following are required:

- circuit breaker and disconnector shall be interlocked and

- disconnector and earthing switch shall be interlocked.

The rated making capacity of the earthing switch shall be above the prospected peak value of the short-circuit current (I_P).

Remote operated or manually operated earthing switch shall be provided.

The rated making capacity of the circuit breaker switch shall be above the prospected peak value of the short-circuit current (I_P).

The short-circuit breaking capacity of the circuit breaker shall be above the prospective short-circuit ($I_{AC0.5T}$) in accordance with IEC 61363-1.

Automatic operated circuit breaker shall be provided.

8.4 Connection-switchboard instrumentation and protection

The connection switchboard shall be equipped with:

- voltmeter, all three phases,
- short-circuit devices: tripping and alarm,
- overcurrent devices: tripping and alarm,
- earth-fault indicator: alarm, and
- unbalanced protection for systems with more than one inlet

The protection systems shall be provided with battery back-up adequate for at least 30 min., see IEC 60092-504, 9.6.2.5.

Alarms and indications shall be provided at an appropriate location for safe and effective operation.

8.5 On-board transformer

Galvanic separation between the on-shore and on-board systems shall be provided.

NOTE The on-board transformer may not be required if the ship's network is designed for 6.6/11 kV and the neutral point treatment is in line with the ship systems and the galvanic separation is done on shore.

When necessary means shall be provided to reduce transformer current in-rush and/or inhibiting the starting of large motors, or the connection of other large loads, when a HV-supply system is connected, see 4.8 and 5.3.

8.6 Receiving switchboard connection point

An additional panel shall be provided in the receiving switchboard.

Where parallel connection of the HV-shore supply and ship sources of electrical power for transferring of load is arranged, synchronising devices shall be provided.

NOTE Receiving switchboard connection point is normally a part of the main switchboard.

8.6.1 Shore-connection circuit breaker

The making capacity of the circuit breaker shall be above the calculated peak short circuit current (I_p). The short-circuit breaking capacity of the circuit breaker shall be above the maximum prospective short-circuit ($I_{AC0.5T}$) in accordance with IEC 61363-1.

The circuit breaker shall be suitable for a short time parallel operation.

Automatic circuit breaker shall be provided.

Earthing switch shall be installed if the main switchboard rated voltage is >1 000 V a.c.

8.6.2 Connection point instrumentation

If load transfer via parallel connection is chosen, the instrumentation shall be:

- two voltmeters;
- two frequency meters;
- one ammeter with an ammeter switch to enable the current in each phase to be read, or an ammeter in each phase;
- phase sequence indicator or lamps, and
- one synchronising device.

One voltmeter and one frequency meter shall be connected to the switchboard busbars, the other voltmeter and frequency meter shall be switched to enable the voltage and frequency of the connection to be measured.

If load transfer via black out is chosen, the instrumentation shall be:

- two voltmeters;
- two frequency meters;
- one ammeter with an ammeter switch to enable the current in each phase to be read, or an ammeter in each phase, and
- phase sequence indicator or lamps.

8.6.3 Connection point protection

Tripping and alarm criteria for the circuit-breaker shall be:

- short-circuit: tripping with alarm,
- overcurrent in two steps:
  - alarm, and
  - tripping with alarm,
- earth fault:
  - alarm,
  - tripping if required by the type of isolation system used
- over-/under-voltage in two steps:
  - 1: alarm, and
  - 2: tripping with alarm,
- over-/under-frequency in two steps:
  - 1: alarm, and
  - 2: tripping with alarm,
- reverse power: tripping with alarm,
- directional overcurrent: tripping with alarm, and
- phase sequence protection with alarm and interlock.

To satisfy this requirement, at least the following protective devices, or equivalent protective measures, shall be provided:

- (25) synchrocheck
- (27) undervoltage
- (32) directional power (reverse power)
- (47) phase sequence voltage
- (49) overload
- (50) instantaneous overcurrent
- (51) overcurrent
- (51G) earth fault
- (59) overvoltage
- (67) directional overcurrent
- (81) frequency (under and over)

NOTE 1 The phase sequence protection shall protect the ship's system against wrong phase connection.

NOTE 2 Tripping of unessential consumers and restoration of ship power should be considered where these measures could prevent complete power loss.

NOTE 3 ANSI standard device designation numbers are shown in brackets.

8.6.4 Operation of the shore-connection circuit-breaker

Arrangements shall be provided to ensure that the shore connection circuit-breakers can not be operated when:

- one of the earthing switches is closed (shore-side/ship-side),
- the pilot contact circuit is not established,
- emergency-stop facilities are activated,
- ship or shore control, alarm or safety system self-monitoring properties detect an error that would affect safe connection,
- the data-communication link between shore and ship is not operational,
- the high-voltage supply is not present, and
- earth fault is detected.

One PIC on the ship and one facility PIC are required. PICs shall have high-voltage training and HVSC-system specific training.

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

NOTE 1 For ships on a regular service trade, PIC may be responsible for both ship and shore HVSC operations.

NOTE 2 Where HVSC operations are conducted concurrently with cargo transfer operations the PIC responsible for cargo operations shall not also be responsible for HVSC operations.

8.7 Ship power restoration

When the ship main source of electrical power is shut-down and failure of the connected HVSC supply occurs, all shore-connection circuit-breakers shall automatically open followed by:

- starting of the emergency source of electrical power to supply emergency services equivalent to SOLAS Ch II-1/D, Reg. 42 for passenger ships or 43 for cargo ships; and
- automatic connection of the transitional source of electrical power to emergency services, equivalent to SOLAS Ch II-1/D, Reg. 42 for passenger ships or 43 for cargo ships; and

- automatic starting and connecting to the main switchboard of the main source of electrical power and automatic sequential restarting of essential services, in as short a time as is practicable.

Failures include loss of HV power, disconnection (including activation of emergency shutdown or electrical system protective device activation).

NOTE It may be necessary to consider necessary relaxations of the requirements for automatic starting and connection of ship sources of electrical power for existing ships constructed prior to the introduction of the relevant part of SOLAS Ch II-1/D, Reg. 42 or 43. In such cases, alternative measures for the restoration of ship power acceptable to the relevant authorities are to be provided.

An alarm shall be provided at a ship machinery control station that is attended when connected to HVSC to indicate activation of the automatic power supply failure response required by this subclause. The alarm shall indicate the failure that caused the activation.

9 HVSC-System control and monitoring

9.1 General requirements

Ship equipment shall be controlled by the ship's own control and protection systems.

If the shore supply fails for any reason, supply by the ship's own auxiliary engines is permitted.

Load transfer shall be provided via black out or synchronization.

9.2 Load transfer via black out

Interlocking means shall be provided to ensure that the shore supply can only be connected to a dead switchboard. The interlocking system shall be fault tolerant, i.e. a single fault shall not allow asynchronous connection.

The simultaneous connection of a HV-shore supply and a ship source of electrical power to the same dead section of the electrical system shall be prevented,

See 8.6.2 and 8.6.3.

9.3 Temporary parallel connection for load transfer

9.3.1 General

HV-shore supply and ship source(s) of electrical power in temporarily parallel shall be in accordance with the following:

- load shall be automatically transferred between the HV shore supply and ship source(s) of electrical power following their connection in parallel,
- the load transfer shall be completed in as short a time as practicable without causing machinery or equipment failure or operation of protective devices and this time shall be used as the basis for defining the transfer time limit, and
- any system or function, used for paralleling or controlling the shore connection, shall have no influence on the ship's electrical system, when there is no shore connection.

NOTE The transfer time limit should be defined and made available to responsible personnel. Where the transfer time limit is adjustable to match with the ability of an external source of electrical power to accept and shed load, then the procedure for setting this limit should be addressed in operating instructions.

Where operation of only designated or a restricted number of ship source(s) of electrical power is required to permit the safe transfer of load between a HV shore supply and ship

source(s) of electrical power, the arrangements shall ensure that this requirement is fulfilled before and during parallel connection.

9.3.2 Protection requirements

At the defined transfer time limit (see 9.3.1) for transferring of load between HV-shore supply and ship source(s) of electrical power, then, automatically one of the sources shall be disconnected and an alarm shall be provided at an attended machinery control station. Special care shall be taken to ensure the maximum permissible load steps of the generator sets are not exceeded (see IEC 60092-301).

Where load reductions are required to transfer load, this shall not result in loss of essential or emergency services.

SECTION FIVE –
VERIFICATION AND TESTING

10 Initial tests

10.1 General

All HV Systems components shall have passed type tests and routine tests according to the relevant standards.

The HVCS System including control equipment shall be tested according to a prescriptive test program.

Tests shall be carried out to demonstrate that the electrical system, control, monitoring and alarm systems have been correctly installed and are in good working order before being put into service. Tests shall be realistic and simulations avoided as far as is practicable.

NOTE Such tests are intended to indicate the general condition of the installation. However, satisfactory test results do not in themselves necessarily ensure that the installation is satisfactory in all respects.

10.2 Initial tests of shore side installation

10.2.1 General

These tests shall verify that the shore side installation complies with this PAS. The target is to achieve a certificate of conformity.

Tests shall be carried out after completion of the installation.

NOTE These tests may be required to be witnessed by the appropriate authorities.

10.2.2 Tests

The following tests shall be carried out:

- visual inspection,
- HV test*
- insulation resistance measurement*,

* The HV test shall be carried out only if one of the installations, shore side or ship side, was out of service for more than 3 months.

- measurement of the earthing resistance,
- function test including correct settings of the protection devices,
- function test of the interlocking system,
- function test of the control equipment,
- earth-fault-monitoring test,
- phase-sequence test,
- function test of the cable management system, where applicable,
- additional tests if requested by the national regulations.

10.3 Initial tests of ship side installation

10.3.1 General

These tests shall verify that the ship side installation complies with this PAS. The target is to achieve a test certificate.

Tests shall be carried out after completion of the installation.

These tests shall be conducted as witness test together with the appropriate authorities.

10.3.2 Tests

The following tests shall be carried out:

- visual inspection,
- HV test*,
- insulation resistance measurement,
- measurement of the earthing resistance,
- function test including correct settings of the protection devices,
- function test of the interlocking system,
- function test of the control equipment,
- earth-fault-monitoring test,
- phase-sequence test,
- function test of the cable management system, where applicable, and
- integration tests to demonstrate that the shipside installations like power management system, integrated alarm, monitoring and control system etc. work properly together with the new installation.

10.4 Tests at the first call at a shore supply point

10.4.1 General

A compatibility assessment study according to 4.3 shall be carried out.

Upon completion of the tests in 10.2.2 and 10.3.2, the tests of 10.4.2 shall be conducted.

10.4.2 Tests

The following tests shall be carried out as an integration test of the complete HVSC-System:

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* The HV test shall be carried out only if one of the installations, shore side or ship side, was out of service for more than 3 months.

- visual inspection,
- HV test,
- insulation resistance measurement,
- measurement of the earthing resistance,
- function test of the protection devices,
- function test of the interlocking system,
- function test of the control equipment,
- earth-fault-monitoring test,
- phase-sequence test,
- function test of the cable management system, and
- integration tests to demonstrate that the shore and shipside installations work properly together.

11 Periodic tests and maintenance

11.1 General

A record of annual maintenance, repair, equipment modifications and the test results shall be available for the shore and ship side HVSC-System.

11.2 Tests at repeated calls of a shore supply point

11.2.1 General

If the time between port calls does not exceed 12 months and if no modifications have been carried out either on the shore side or ship side, or both, the verification 11.2.2 shall be conducted.

NOTE The time between port calls means same ship at the same shore supply point.

11.2.2 Verification

The following shall be carried out:

- visual inspection,
- confirmation that no earth fault is present,
- statement of voltage and frequency, and
- an authorized switching and connection procedure or equivalent shall be provided.

NOTE Procedures should employ an approved “Lock-out, Tag-out” system that is jointly controlled by the ship and shore PIC.

12 Documentation

12.1 General

For the HVSC-System and each control apparatus, the manufacturer shall deliver documentation concerning principles of operation, technical specifications, mounting instructions, required starting-up or commissioning procedures, fault-finding procedures, maintenance and repair, as well as lists of the necessary test facilities and replaceable parts.

12.2 System description

A complete system description, including circuit diagrams, specifying set points and operation instructions, shall be prepared by the nominated body (see 4.4.1) responsible for the integration of the HVSC-System.

The nominated body, see 4.4.1, shall provide a testing and verification program for the whole installation that will demonstrate compliance with the specification.

Annex A
(normative)

Plugs and socket-outlets

A.1 Test specimen

Three-phase plug and socket-outlets electrical ratings are given in Table A.1.

Table A.1 – Electrical ratings

Characteristic	Column A	Column B
Nominal voltage	11 kV	6,6 kV
Rated voltage	12 kV	7,2 kV
AC withstand voltage	25 kV	20 kV
Impulse a.c. withstand voltage	75 kV	60 kV
Partial discharge test	10 pC at 10 kV (IEC 60502-4)	10 pC at 6,0 kV (IEC 60502-4)
Rated current	500 A	320 A
Cable cross-section, max.		240 mm²
Rated short time short-circuit withstand capacity	See ship specific Annexes	See ship-specific Annexes

Three-phase plugs and socket-outlets mechanical ratings are given in Table A.2.

Table A.2 – Mechanical ratings

Characteristic	Limits
Degree of protection	The plugs shall meet two degrees of protection, IP66 and IP67. The sealing has to prove self-actuating. Establishment of system after proper contact and satisfied protection. Plug and socket-outlet shall be locked in unplugged position and shall meet the protection.
Material	UV-proof, seawater-proof
Ambient temperature	(-25 to +45) °C
Mechanical strength	+ Socket-outlet tested according IEC 60309-1 24.2 with impact energy 6 J + Plug tested according IEC 60309-1 24.3. In case plugs are provided with protection cover, the test shall be carried out with the cover closed. Test of 5000 plug-in cycles. Replace after 4000 plug-in cycles.
Max. plug-in strength	25 kg (240Nm)

Creepage and clearance distances shall be designed in accordance with IEC 60664–1, overvoltage category III and pollution degree 3, or equivalent.

Where mechanical ratings other than those recommended are proposed, plugs and socket-outlet are, in any event, shall be suitable for handling and operation in the locations installed,

operated and stored in accordance with IEC 60092-101, Annex B, for climatic and biological conditions and exposure to chemically and mechanically active substances and mechanical conditions.

A.2 Type testing of plugs and socket-outlets

HV plugs and socket-outlets shall have type tests carried out in the following order:

Electrical tests:

- partial discharge test: 10 pC at 10kV in accordance with IEC 60502-4,
- A.C. voltage test: 28 kV for 5 minutes in accordance with IEC 60502-4,
- short time and peak withstand current test in accordance with IEC 62271-200,
- lightning impulse withstand test 75 kV 10 impulse in accordance with IEC 60502-4, and
- temperature rise test in accordance with IEC 60309-1 Clause 22.

Mechanical tests:

- mechanical strength test IK10 in accordance with IEC 62262,
- normal operation test in accordance with IEC 60309-1 Clause 21 (5000 cycles; for main contacts only off-load, for pilot contacts on-load),
- degree of protection in accordance with IEC 60529,
- ageing of gasket and insulator in accordance with IEC 60309-1 Clause 13,
- corrosion and resistance to rusting in accordance with IEC 60309-1 Clause 28,
- environmental tests to demonstrate compliance with IEC 60092-101, Annex B and IEC 60721-3-6 for the ship environment following IEC/TR 60721-4-6, and
- pilot contact shall be tested according to IEC 60947-5-1. The degree of protection shall be at least IP20 when not plugged.

After conducting the tests above, the temperature rise test, lightning impulse withstand test and a.c. voltage and insulation resistance test shall be repeated and functional tests of pilot contacts and communication line.

An additional arc test shall be conducted in accordance to IEC 62271-200, followed by functional tests of the main, pilot contacts and data communication line connections to verify continued operation.

A.3 Coding and specification of plugs and socket-outlets

1 notch – 11kV/50 or 60Hz/16kA /-30 degree/colour red (plug and socket-outlet).

Socket-outlets should be constructed to be compatible with this recommended plug specification. Where an alternative to this recommended specification is proposed, it is likely that the installation will not be able to connect to a compliant shore supply/ship without significant additional equipment and modification.

A.4 Fibre optical plug/socket

Fibre optical cable, for communication purpose, shall be integrated in the power cable.

The fibre optical connection shall be integrated on the ship plug. A fibre optical receptacle while on the socket shall be installed a fibre optical plug with a lead cable to permit the connection to the receptacles before the power plug/socket mating.

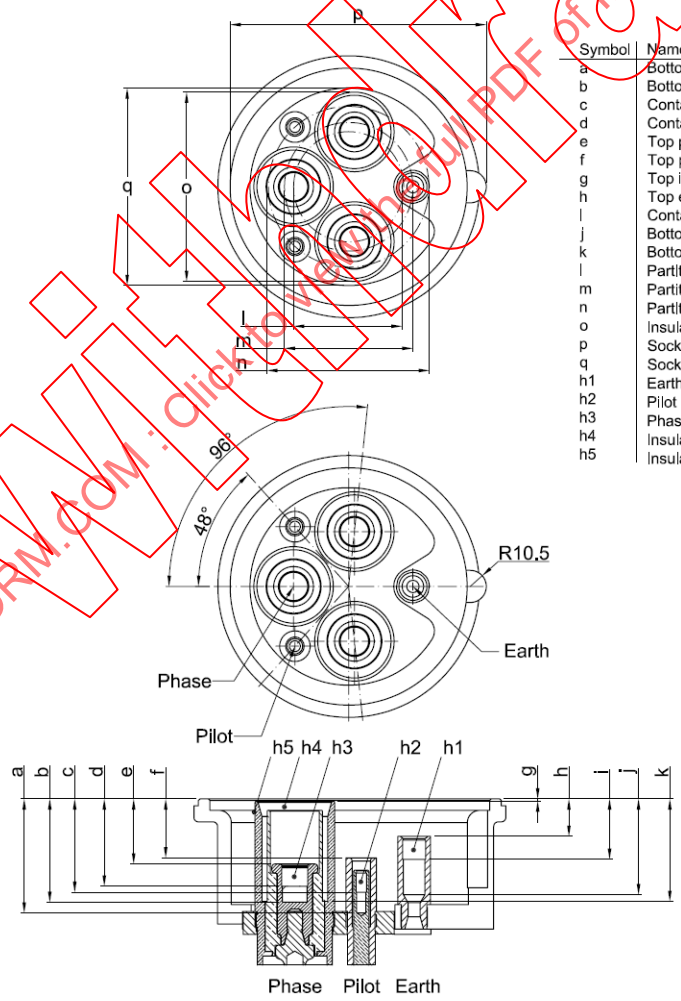
Fibre optical receptacle and plug shall be:

Receptacle Type box mounting according to MIL-DTL_38999K Serie III, class H, size 15, polarization N Insert type 15-5 according to MIL-STD-1560A (5 contacts) F.O. termini according MIL-PRF-29504/5C (socket type) Plug.

Type plug straight without spring finger according to MIL-DTL_38999K Serie III, class H, size 15, polarization N.

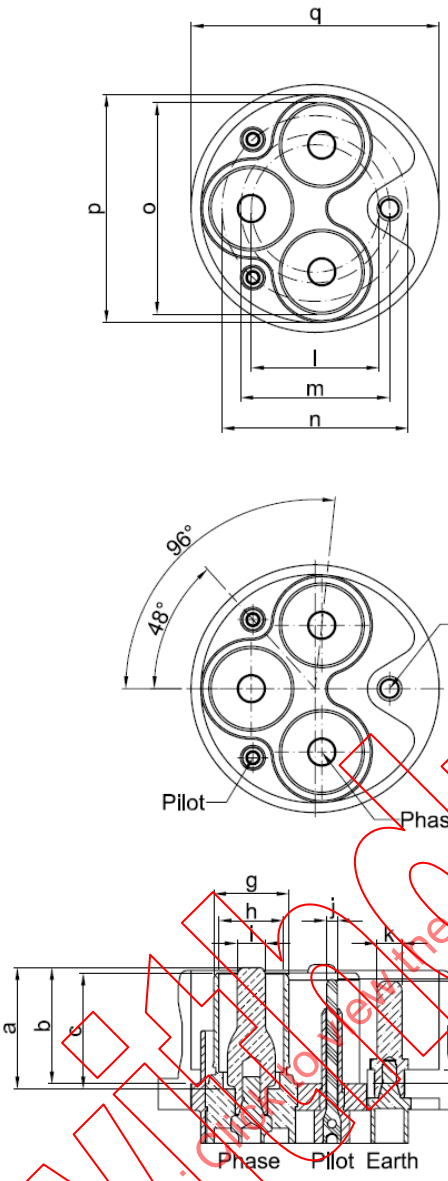
Insert type 15-5 according to MIL-STD-1560A (5 contacts).

F.O.termini according MIL-PRF-29504/4C (plug type).



Symbol	Name	Dimension
a	Bottom pilot	74,5
b	Botton phase	67,5
c	Contact pilot	61
d	Contact phase	57
e	Top phase	42,5
f	Top pilot	38,5
g	Top insulator	1,5
h	Top earth	24,5
i	Contact earth	39,5
j	Bottom earth	62,5
k	Bottom insulator	67
l	Partition phases Ø	70,95
m	Partition earth Ø	84
n	Partition pilots Ø	106
o	Insulator Ø	123,6
p	Socket + guide	167,5
q	Socket Ø	129
h1	Earth Ø	14
h2	Pilot Ø	6
h3	Phase Ø	16
h4	Insulator inside Ø	43
h5	Insulator outside Ø	52

Figure A.1 – Socket Outlet



Symbol	Name	Dimension
a	Phase height	68,6
b	Insulator depth	65,7
c	Phase outside height	65,5
d	Earth height	50
e	Pilot height	59
f	Tounge depth	56
g	Insulator outside Ø	42,5
h	Insulator inside Ø	36,5
i	Phase Ø	16
j	Pilot Ø	6
k	Earth Ø	14
l	Partition phases Ø	72
m	Partition pilots Ø	84
n	Partition earth Ø	105
o	Insulator Ø	119,6
p	Plug inside Ø	129
q	Plug outside Ø	140

Figure A.2 – Plug

Annex B
(normative)

Ship-to-shore connection cable

B.1 Rated voltage

The standard rated voltages U_o/U (U_m) of the cables considered are as follows:

$$U_o/U\ (U_m) = 6/10\ (12)\ \text{kV r.m.s}$$

The voltage designation of cables given above $U_0/U/U_m$ shall be as defined in IEC 60092-352.

For alternative nominal voltages, see 5.2.

B.2 General design requirements

The cables shall be constituted as follows: power cores with copper conductors, conductor screen, insulation, insulation screen. The power cores shall be laid up with earth cores with copper conductor and semi conducting layer, with pilots element and with fibre-optics element in the interstices of the power cores.

NOTE Where an alternative to the requirements of Annex B is proposed, it is possible that the installation will not be suitable for connection to a compliant shore supply/ship. Application of an alternative should be documented and made available to responsible personnel for the compatibility assessment.

B.2.1 Conductors

The power-core conductors shall be flexible class 5 of IEC 60228. The conductor shall be plain or metal-coated copper conductors.

B.2.2 Material

The insulating compounds shall be extruded cross-linked solid dielectric designated as EPR, HF EPR, HEPR and HF HEPR in IEC 60092-351.

Electrical and non-electrical characteristics of the insulation system as specified in IEC 60092-351 for the type of insulating compound used.

Insulation thickness shall be in accordance with IEC 60092-354 for the standard rated voltages.

B.2.3 Screening

Screening of individual power cores shall consist of a conductor screen and an insulation screen.

The conductor screen shall be non-metallic and shall consist of an extruded semi-conducting compound. The conductor screen shall be firmly bonded to the insulation.

The insulation screen shall consist of an extruded semi-conducting, non-metallic layer. The insulation screen shall be strippable.

The metallic screen, if any, shall consist of a braid or a concentric layer of copper wires with a single-wire diameter less than 0,3 mm and with a minimum coverage density of 70 %.

B.2.4 Earth conductors

Earth conductors shall be flexible copper conductors according to class 5 of IEC 60228 forming together at least 50 % of the power core cross section.

B.2.4.1 Conductor screen of earth conductors

The insulation screen shall be non-metallic and shall consist of an extruded semi-conducting compound.

B.2.5 Pilot element with rated voltage U_o/U (U_m) = 150/250 (300) V

B.2.5.1 Conductors

Pilot conductors shall be flexible stranded, plain or metal-coated copper conductors according to IEC 60228 class 5; with a cross section minimum 1,5 mm^2.

B.2.5.2 Insulation

The pilot conductors insulation shall be extruded cross-linked solid dielectric of one of the types indicated in B.2.2.

Electrical and non-electrical characteristics of the insulation system shall be as specified in IEC 60092-351 for the relevant type of insulating compound used.

Thickness of insulation shall be in accordance with IEC 60092-376 for the relevant insulation type.

3 pilot cores shall be laid up. Over the laid up cores a wrapped covering with tapes or an extruded covering is permitted. Screening is optional.

B.2.6 Optical fibres

Mechanical and thermal stress resistant of optical fibre element shall be of at least 6 gradient fibres 62.5/125 according to IEC 60793-2 A1b.

B.2.7 Cabling

The 3 power cores, the earth core(s), the pilot element and the optical fibres element shall be laid up.

B.2.8 Separator tape

In case separator tape is used it shall be wrapped around the assembled cores and shall consist of a suitable, non-hygroscopic material.

B.2.9 Non-metallic outer sheath

B.2.9.1 Material

The non-metallic sheath shall be chlorinated rubber (CR) or polyurethane (PUR).

B.2.9.2 Electrical and non-electrical characteristics of the sheathing material

As specified in EN 50363 for the relevant compound. (TMPU: EN 50363-10-2, EM7: EN 50363-2-1)

B.2.9.3 Thickness of sheath

The minimum thickness at any point of the extruded outer sheath shall be 6 mm.

B.2.10 Markings

B.2.10.1 Indication of origin

Cables shall be provided with a continuous indication of origin (manufacturer's name or trademark), rated voltage (U_0/U), construction (number of cores and cross sectional area of power conductors, earth conductors, pilots and fibre type of fibre optics) and the relevant standard to be printed or embossed on the sheath.

EXAMPLE: "name or trademark" 3x185/95 + Pilot + FO 6/10 kV IEC 60092-201.

B.2.10.2 Continuity

Continuity shall be in accordance with IEC 60092-354.

B.2.10.3 Durability

Durability shall be in accordance with IEC 60092-354.

B.2.10.3.1 Legibility

Legibility shall be in accordance with IEC 60092-354.

B.3 Tests on complete cables

For these tests, reference is made to the relevant clauses of IEC 60092-350.

For test methods for insulation and sheaths reference should be made to the appropriate part of IEC 60811.

The routine tests, the special tests and the type tests shall be conducted in accordance with IEC 60092-354 with the following exceptions:

- Bending test:

The test shall be carried out 5,000 times in a single direction.

The diameter of the cylinder shall be 10 $D \pm 5$ %;

where:

D is the actual external diameter of the cable sample, in millimetres.

Tensile force to be defined (15 N/mm^2 of power cores).

Maximum % of broken wires to be defined (20 %).

On completion of this test, the sample shall be subjected to a partial discharge measurement. The magnitude of discharges at 1,73 U_0 shall not be higher than 10 pC.

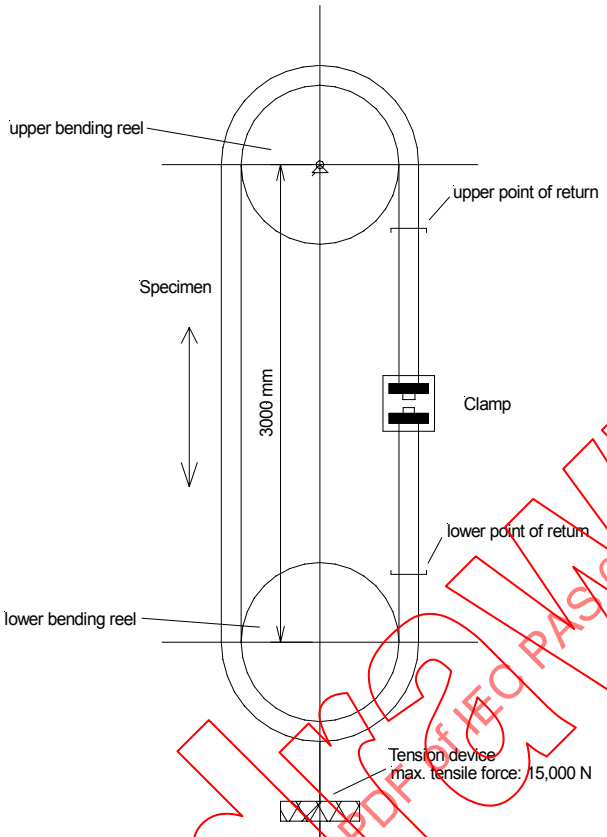


Figure B.1 – Bending test arrangement

- Sunlight-resistant test on outer sheath (duration of test 720 h):

  The test shall be carried out in accordance with ISO 4892-2, test method A, cycle 2.

  Maximum permissible change: tensile strength ± 40 %, and elongation at break ± 40 %.

- Abrasion test on outer sheath:

  The test shall be carried out in accordance with ISO 4649 test method A.

  Relative volume loss, ΔV_{rel}: max 300 mm^2.

- Flame propagation test:

  The test shall be carried out in accordance with IEC 60332-1-2.

- Behaviour at low temperatures:

  The test shall be carried out in accordance with IEC 60811.

  Elongation at break test at low temperature in accordance with IEC 60811-1-4, 8.4.4, 8.4.5; minimum 30 % elongation at break at -40 ± 2 °C.

- Resistance between protective conductor and semi-conductive layer

  The resistance between protective conductor and semi-conductive layer shall be maximum 500 ohm, see DIN VDE 0472 Part 512.

Annex C
(normative)

Additional requirements for ships with low voltage distribution systems

C.1 Scope

This annex describes the additional requirements for high-voltage shore connection systems of ships with only low voltage sources of electrical power.

NOTE For example, Clause C.4 makes reference to Clause 4.

C.2 Normative references

No additional references.

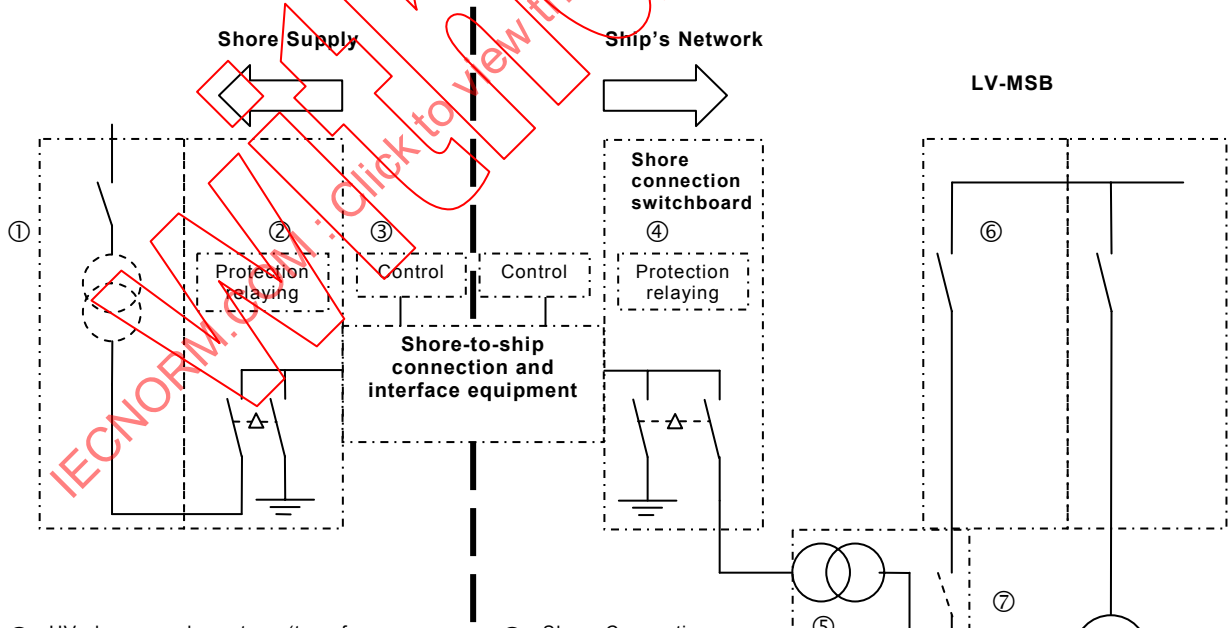
C.3 Terms and definitions

No additional terms and definitions.

SECTION ONE – GENERAL REQUIREMENTS

C.4 System

C.4.1 System description



① HV-shore supply system, (transformer only where applicable)

② Protection

③ Control/Communication of Cable management system and Interlocks

④ Shore-Connection switchboard

⑤ On-board transformer

⑥ Receiving switchboard connection point

⑦ Secondary cable protection (where applicable)

Figure C.1 – General overview shore supply system of ships with LV-distribution system

C.4.2 Distribution system

No additional requirements.

C.4.3 Compatibility assessment before connection

In addition to the requirement set forth in section one, the following item shall be observed:

- Compatibility of shore connection to energise the transformer used.

C.4.4 System integration and management

No additional requirements.

C.4.5 Personnel safety

No additional requirements.

C.4.6 Design requirements

No additional requirements.

C.4.7 Electrical requirements

The prospective short-circuit contribution level from the HV shore distribution system shall be limited by the shore-sided system to 16 $kA_{r.m.s.}$ but not less than the minimum required short circuit current to maintain full down stream selectivity.

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 $kA_{r.m.s.}$ for 1 s.

NOTE 1 Special requirements apply to the distribution systems of tankers, see IEC 60092-502.

NOTE 2 If no dedicated shore transformer is installed, local authorities may require higher ratings than 16 kA.

C.4.8 System study and calculations

The connection between LV-side of the transformer and main switch board shall be evaluated and, if necessary, overload protection shall be provided between transformer and the receiving switchboard.

SECTION TWO – SHORE REQUIREMENTS

C.5 HV-shore supply system

C.5.1 Current Inrush

No additional requirements.

C.5.2 Voltages and frequencies

The nominal voltage for roro-passenger ferries shall be 11 kV.

NOTE For roro passenger ferries 11 kV allows the use of one connection cable and permits easier handling.

C.5.3 Quality of HV-shore power supply

No additional requirements.

C.6 Installation

C.6.1 General

No additional requirements.

C.6.2 Components and system requirements

No additional requirements.

C.6.3 Protection system

No additional requirements.

C.6.4 High-voltage interlocking concept

No additional requirements.

C.6.5 Shore-connection convertor equipment

No additional requirements.

SECTION THREE –

SHORE-TO-SHIP CONNECTION AND INTERFACE EQUIPMENT

C.7 General

Plugs, socket-outlets and shore connection cables shall be capable to withstand the mechanical and thermal effects of the maximum short-circuit current of 16 kA/1s and a maximum rated peak withstand current of 35 kA, see IEC 60502-4.

C.7.1 Shore-to-ship connection and interface equipment

C.7.1.1 Cable management system

C.7.1.1.1 General

The cable management system shall be fitted at:

- the shore side facility for roro passenger ships and ships carrying hazardous cargo in bulk and
- the ship side for (roro) cargo ships.

C.7.2 Plugs and socket-outlets

C.7.2.1 General

Each plug shall be fitted with three pilot contacts (see Figure C.3).

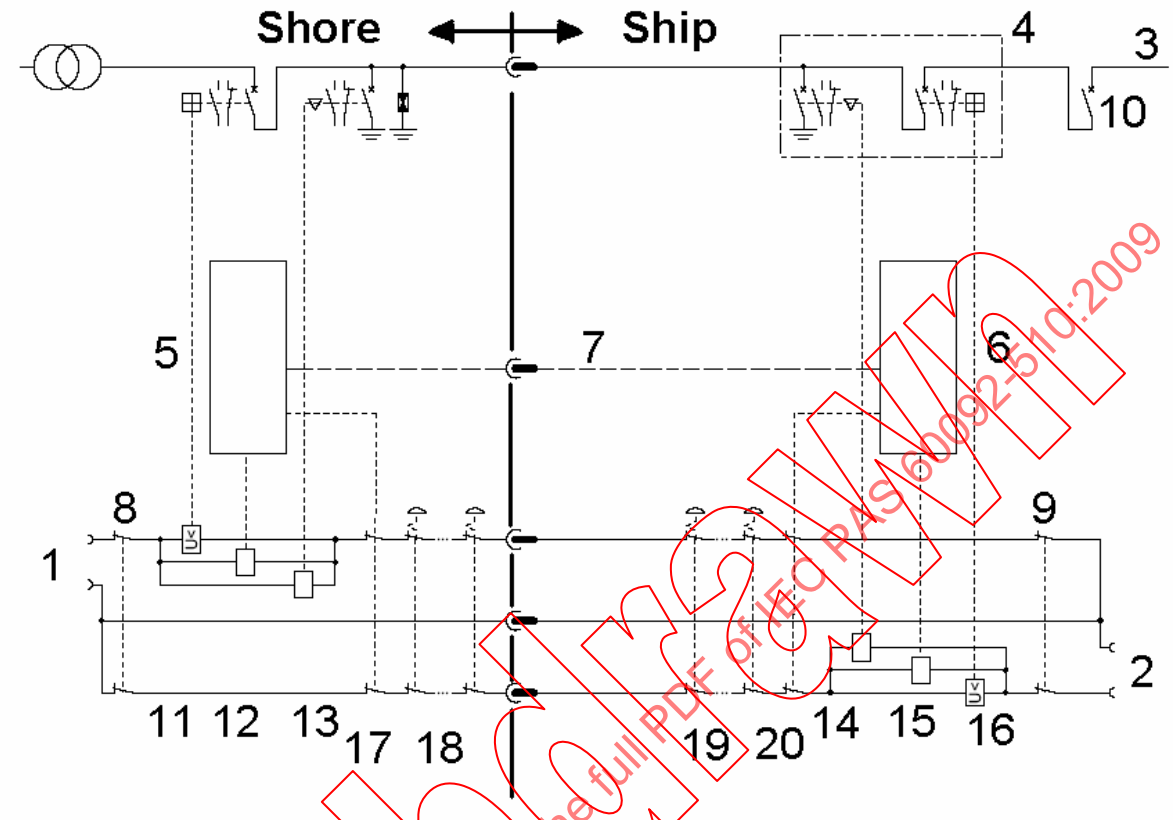
C.7.2.2 Pilot Contacts

All parts and equipment of safety circuits shall be suitable for operation voltage of 230 V.

For the purposes of this Annex pilot contacts are parts of the safety circuit. An example for a safety circuit is shown in Figure C.2.

C.7.3 Interlocking of earthing switchs

No additional requirements.



Key:

1 Control power shore side
2 Control power ship side
3 Ship mains
4 Connection switchboard
5 Control and monitoring system shore side
6 Control and monitoring system ship side
7 Fibreoptic
8 Protection shore
9 Protection ship
10 Synchronizing switch
11 Circuit breaker trip shore
12 Safety circuit on shore
13 Earthing switch permission shore side
14 Earthing switch permission ship side
15 Safety circuit on ship
16 Circuit breaker trip ship
17 Control ES shore
18 Manual ES shore
19 Manual ES ship
20 Control ES ship

Figure C.2 – Example of safety circuit

C.7.4 Ship-to-shore connection cable

No additional requirements.

C.7.5 Control and monitoring cable

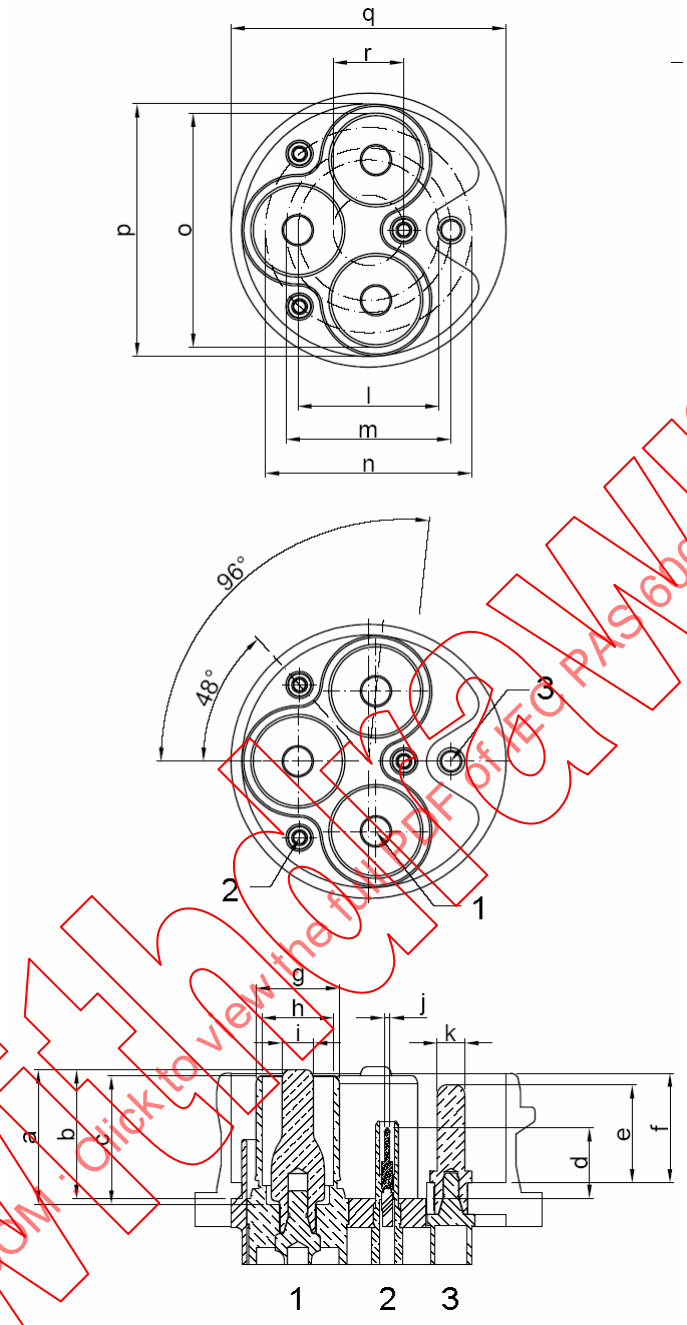
C.7.5.1 General

No additional requirements.

C.7.5.2 Control and monitoring plugs and socket-outlets

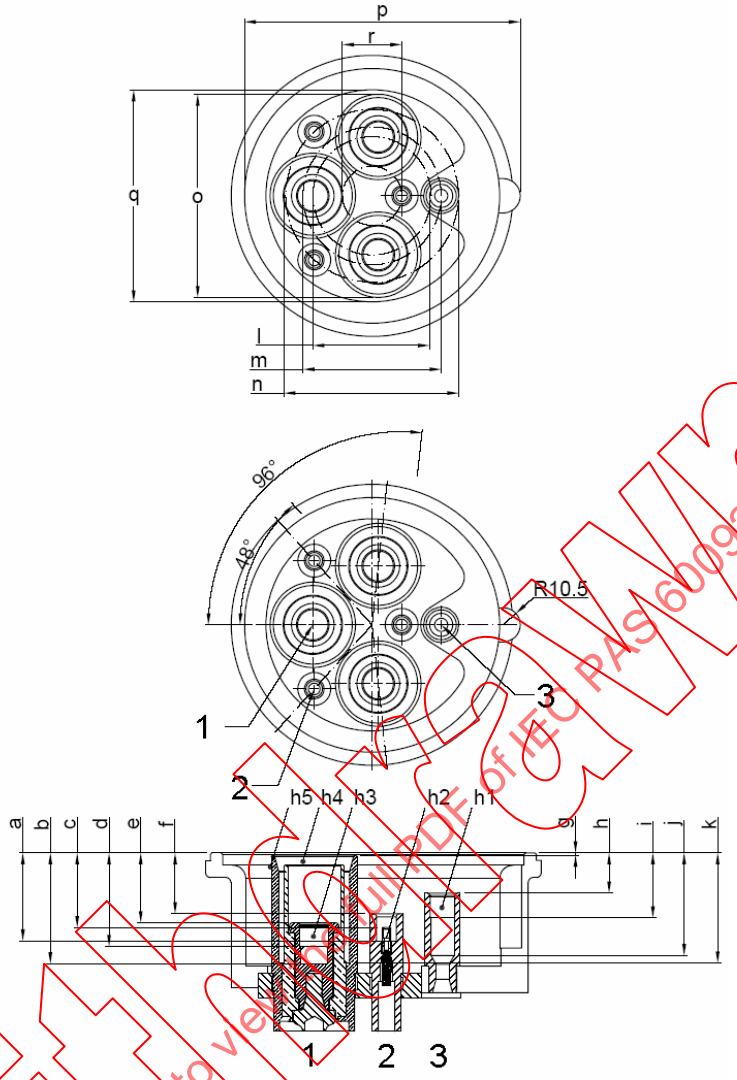
Three pilot contacts are required for each power plug and socket.

Design of a power plug is shown in Figure C.3 and of a power socket-outlet in Figure C.4.



Key:
1 Phase
2 Pilot
3 Earth

Figure C.3 – Power plug, touch proof



Key:
See Figure C.3

Figure C.4 – Power socket-outlet, touch proof

C.7.5.3 Data communication

The data communication shall be carried out with fibre optic. The emergency shut down functions shall be carried out with pilot conductors (see Annexes A and B).

C.7.6 Storage

No additional requirements

SECTION FOUR – SHIP REQUIREMENTS

C.8 Installation

C.8.1 General

NOTE It is highlighted that on ships without high voltage generation that additional efforts may be required to ensure responsible ship personnel are sufficiently aware of high voltage safe operating practices and of the operation of the ship high voltage shore connection system.

C.8.2 Ship-electrical-distribution-system protection

No additional requirements.

C.8.3 Connection switchboard

The HV ship connection switchboard shall be rated at least for 16 kA/1s.

C.8.4 Connection-switchboard instrumentation and protection

No additional requirements.

C.8.5 On-board transformer

Transformers shall be of the separate winding type for primary and secondary side. The secondary side shall be wye-configuration

The neutral point of the transformer shall be connected to the mains switchboard according to the grounding philosophy used for the LV-distribution system

If no dedicated shore transformer is installed:

- Adjustments to maintain the LV supply within tolerances shall be automatically controlled, see 5.3.

Use of onboard static convertors shall not reduce the downstream selectivity in any condition.

NOTE The ship may be able to use existing non-essential onboard convertors.

C.8.6 Receiving switchboard connection point

C.8.6.1 Shore-connection circuit breaker

The HV shore connection circuit breaker shall be rated at least for 16 kA/1s.

C.8.7 Emergency-stop switches and shutdown conditions

No additional requirements.

C.8.8 On board short-circuit current limits

No additional requirements.

C.9 HVSC-System control and monitoring

C.9.1 General requirements

No additional requirements.

C.9.2 Dead-transfer

No additional requirements.

C.9.3 Temporary parallel connection for load transfer

No additional requirements.

SECTION FIVE – VERIFICATION AND TESTING

C.10 Tests of completed installation

No additional requirements.

C.11 Tests after commissioning

No additional requirements.

C.12 Documentation

No additional requirements.

Annex D
(normative)

Additional requirements for cruise ships

D.1 Scope

This annex describes the additional requirements for high-voltage shore connection systems of cruise ships.

NOTE For example, Clause D.4 makes reference to Clause 4.

D.2 Normative references

No additional references.

D.3 Terms and definitions.

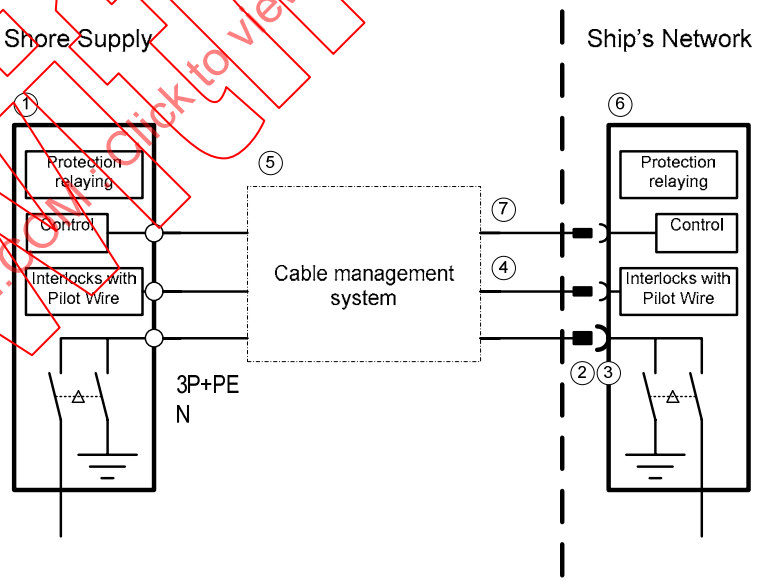
No additional terms and definitions.

SECTION ONE – GENERAL REQUIREMENTS

D.4 System

D.4.1 System description

Cruise ship HVSC-System shall be arranged in accordance with Figure D.1.



① HV-Shore supply system
② HV-Plug
③ Ship's HV-socket
④ Pilot wires (integrated in Plug and socket)
⑤ Cable management system
⑥ Shore connection switchboard
⑦ Communication for control and monitoring

Figure D.1 – General overview of cruise ship HVSC-System

To supplement general overview data provided in Figure D.1, Figure D.2 is provided to show a detailed representation of an example of a cruise ship HVSC-System.

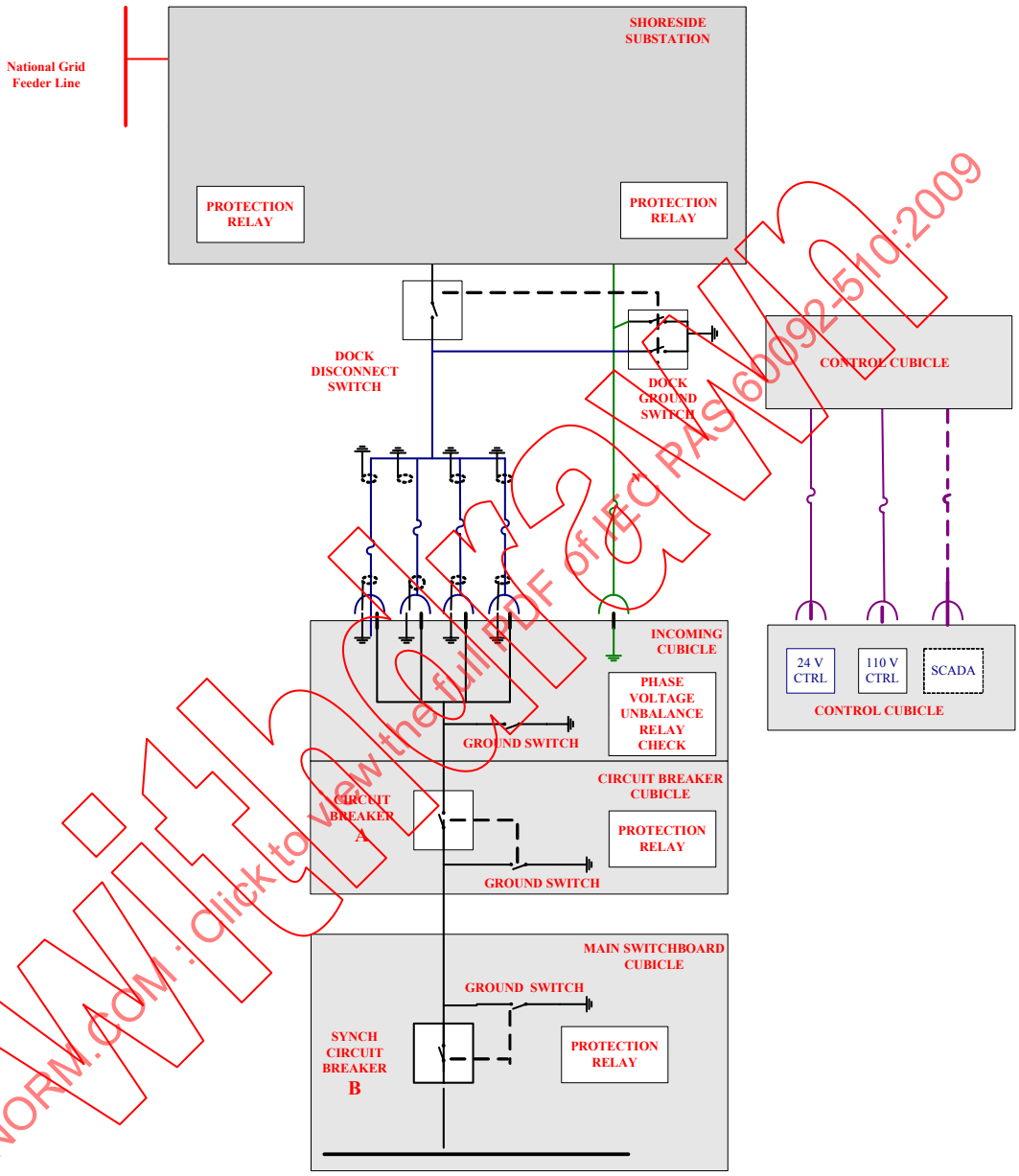


Figure D.2 – Example cruise ship HVSC-System single line diagram

D.4.2 Distribution system

No additional requirements.

D.4.3 Compatibility assessment before connection

No additional requirements.

D.4.4 System integration and management

No additional requirements.

D.4.5 Personnel safety

No additional requirements.

D.4.6 Design requirements

No additional requirements.

D.4.7 Electrical requirements

Present typical cruise ship HV distribution systems are earthed via a high resistance grounding resistors that are installed on each of the ship's generators star point to earth connection.

By using this grounding system on each of the generators, the ground fault current can be limited according to the size of the resistor, while on the shore high voltage earth fault current may range from a minimum value that exceeds the rating of the ship high voltage installation.

Consequently, the shore side transformer star point should be earthed through a neutral grounding resistor that matched the ship arrangement and is bonded only to the shipside.

D.4.8 System study and calculations

The HV shore connection system shall be rated for at least 16 MVA (but 20 MVA is recommended where practicable) at a nominal ship system voltages of 11 kV and/or 6,6 kV.

Consideration may be given to a HVSC-System with a lower rating where only ships with lower power demands will be required to connect. In such cases, measures are to be implemented to ensure that ships with power demands higher than the HVSC-System rating will not attempt to connect.

NOTE 1 Analysis of the existing cruise ship fleet suggests that a minimum shore supply rating of 20 MVA at the nominal system voltages described will be required for ports visited regularly by a variety of cruise ships in the near to medium term. Analysis shows that the majority of cruise ship electrical systems have a nominal operating frequency of 60 Hz.

NOTE 2 Designers may give consideration to rating connection equipment for 6.6 kV HVSC-systems for 11 kV characteristics where inadvertent connection of the ship socket-outlet and connection switchboard to an 11 kV shore supply is considered to be reasonably foreseeable.

SECTION TWO – SHORE REQUIREMENTS

D.5 HV-shore supply system

No additional requirements.

D.6 Installation

No additional requirements.

SECTION THREE – SHIP-TO-SHORE CONNECTION AND INTERFACE EQUIPMENT

D.7 General

D.7.1 Ship-to-shore connection and interface equipment

No additional requirements.

D.7.2 Plugs and socket-outlets

D.7.2.1 General

Plugs and socket-outlets of the type described in Annex A, Table A.1, Column A shall be tested in accordance with Annex A.

Size, quantity and rating of cables shall be sufficient to meet the maximum power rating and voltage that the terminal can supply to the vessel. 16 MVA will be the minimum rating.

NOTE Typically, cruise ships utilize four (4) power 3-phase couplers, each rated 500 A and for ships with earthed distribution system one neutral single phase connector rated 8kV, 250A, see Figure 7.

Rated peak short time short-circuit withstand capacity shall be at least 40 kA.

Each 3-phase HV plug or socket-outlet has:

- 3 phase current carrying connectors, (L1, L2, L3);
- one earth-ground connector (see Figure below); and
- one pilot for ground-check monitoring.

In addition, the power plugs as well as the neutral plug are fitted with limit switches that are activated only when the plug and socket-outlet are properly mated.

These contact switches are part of the main safety system and shall activate the emergency shutdown arrangements if the plug is moved from the mated position while live.

The power and neutral plugs and socket-outlets, where installed, shall conform with Figures D.3 to D.6

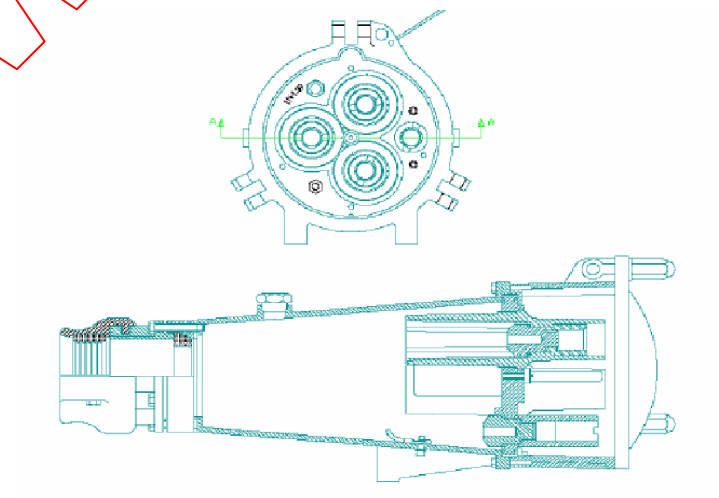


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Figure D.3 – Cruise ship plug

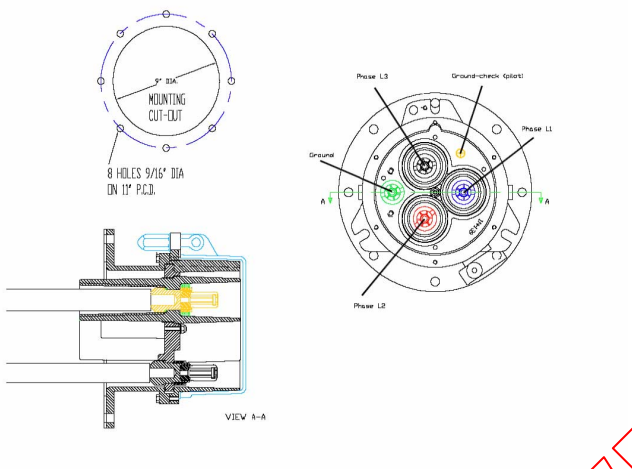


Figure D.4 – Cruise ship socket-outlet

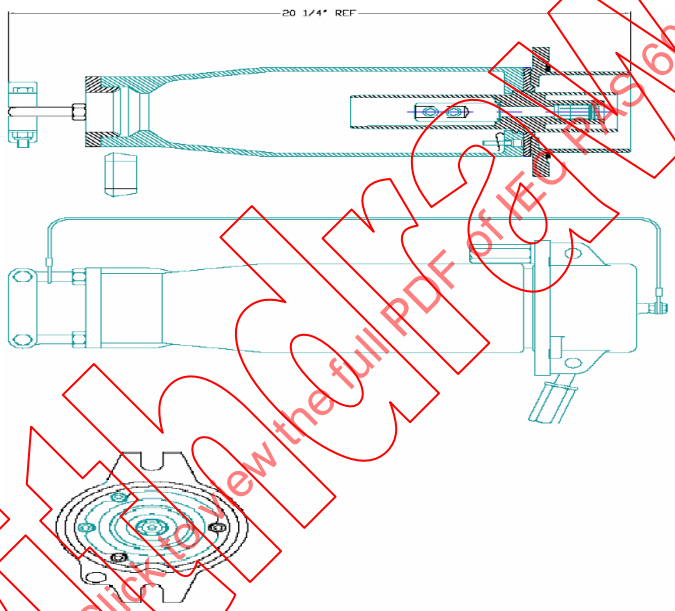


Figure D.5 – Cruise ship neutral plug

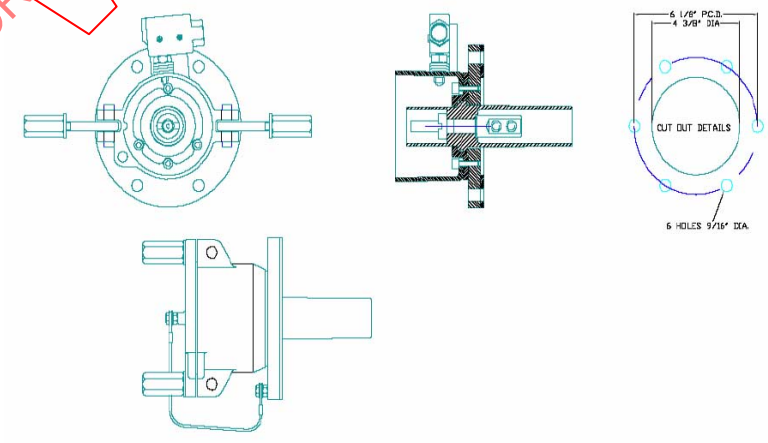


Figure D.6 – Cruise ship neutral socket-outlet

D.7.2.2 Pilot contacts

No additional requirements.

D.7.3 Interlocking of earthing switches

No additional requirements.

D.7.4 Ship-to-shore connection cable

Due to the requirements of cruise ships, the cable described in Annex B is not used in cruise ship applications.

Cables shall be assigned appropriate rated electrical values for the characteristics described in Annex B the HVSC specification in this Annex. The cables are to undergo equivalent electrical testing (albeit with different appropriate test criteria) as described in Annex B. Mechanical testing shall be in accordance with Annex B or equivalent.

D.7.5 Control and monitoring cable

D.7.5.1 General

No additional requirements.

D.7.5.2 Control and monitoring plugs and socket-outlets

No additional requirements.

D.7.5.3 Data communication

A general ship to shore data communication interface shall be developed that identifies and includes all parameters which are to be exchanged between ship and shore. The interlocks/interface between ship and shore does not necessarily need to be the ship's automation system, but a combination of defined conditions consolidated through various interfaces, either automation system I/O's (inputs/outputs) or hardwired connections.

D.7.6 Storage

No additional requirements.

SECTION FOUR – SHIP REQUIREMENTS

D.8 Installation

No additional requirements.

D.9 HVSC-System control and monitoring

No additional requirements.

SECTION FIVE – VERIFICATION AND TESTING

D.10 Tests of completed installation

No additional requirements.

D.11 Tests after commissioning

D.11.1 General

Due to current cruise ships itineraries there may be significant periods of the year when a HVSC-System is not regularly used. Under such circumstances, consideration should be given to the necessary commissioning testing that is necessary prior to the connection of the first cruise ship following an extended period of non-use. Under such circumstances, testing procedures should include visual inspection, insulation resistance testing, operation of control and safety equipment and mechanical operation of the cable management system and mating of connectors.

For this period re-commissioning tests the following values are recommended:

- Insulation resistance shall be measured between each circuit listed below and the constructional frame connected to earth in accordance with the following values:

  > 1000 M Ω for Main HV circuit phase at 2500 V d.c. test voltage,

  > 1000 M Ω for low voltage auxiliary circuits at 500 V d.c. test voltage

D.11.2 Operational tests

No additional requirements.

D.12 Documentation

D.12.1 General

Operating procedures (including Work Permits and Checklist) to assist responsible ship and shore responsible operating personnel with safe and effective operation shall be produced.

D.12.2 Circuit diagrams

No additional requirements.

Annex E
(normative)

Additional requirements of container vessels

E.1 Scope

This Annex describes the additional requirements on HVSC-Systems of container vessels.

NOTE For example, Clause E.4 makes reference to Clause 4.

E.2 Normative references

No additional references.

E.3 Terms and definitions

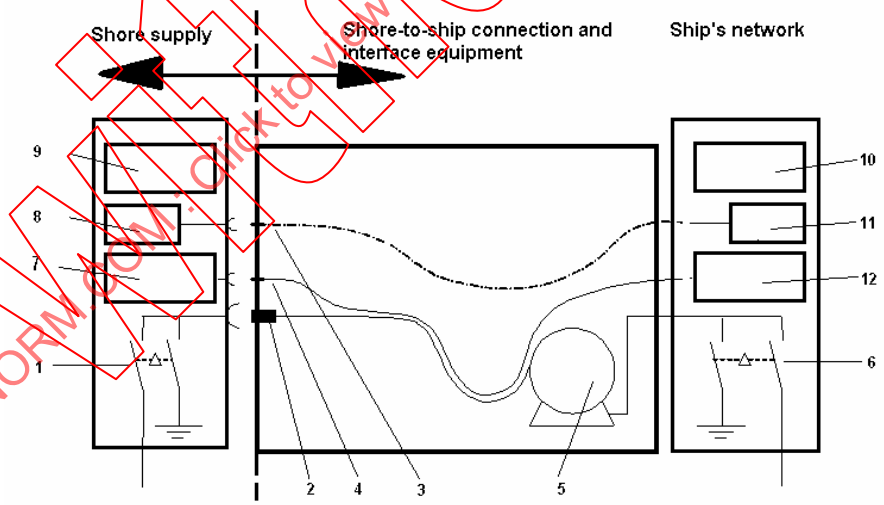
No additional terms and definitions.

SECTION ONE – GENERAL REQUIREMENTS

E.4 System

E.4.1 System description

The general system layout is shown in Figure E.1.



Key
1 HV-shore supply system with socket-outlets
2 HV-plug
3 Fibre optic communication for control and monitoring (possibly integrated in power cable)
4 Pilot wires (integrated in plug and socket)
5 Cable handling system, here shown as cable reel
6 Shore connection switchboard
7 Interlocks with pilot wire shore side
8 Control shore side
9 Protection relaying shore side
10 Protection relaying ship side
11 Control ship side
12 Interlocks with pilot wire ship side

Figure E.1 – Example for general system layout