IRCLASS
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GUIDELINES ON SHORE CONNECTION SYSTEMS ON SHIPS

REVISION 1

JULY 2025

Guidelines

Shore Connection Systems on Ships

(Earlier titled: Guidelines on High Voltage Shore Connection Systems for Ships)

Revision 1, July 2025

TABLE 1 – AMENDMENTS INCORPORATED IN THIS EDITION

These amendments are effective from 1 July 2025

Section	Subject/ Amendments
Introduction	
	Amended to clarify that these Sections are applicable to both Part 1 (HVSCS) and Part 2 (LVSCS), unless otherwise indicated as specific to either part.
Part 1: High Voltage Shore Connection Systems on Ships	
1, 2, 3, 4	Amendments are made to better clarify requirements for High Voltage Shore Connection Systems (HVSCS) onboard ships.
Part 2: Low Voltage Shore Connection Systems on Ships (new)	
1, 2, 3, 4 (all new)	New Sections are added to specify requirements for Low Voltage Shore Connection Systems (LVSCS) onboard ships.

Guidelines

Shore Connection Systems on Ships

Revision 1, July 2025

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Part 1 – High Voltage Shore Connection Systems on Ships

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Sections

Introduction

1. Scope and Applicability

1.1 It is becoming an increasingly common feature for ships to shut down generators and to connect to shore power for as long as practicable during stays in port, for a number of reasons including environmental considerations. This scenario of the application of onshore power supply is also known as alternative maritime power (AMP), cold ironing, shore-side electricity and shore power connection.

1.2 These Guidelines are applicable to vessels equipped with a High Voltage Shore Connection System (HVSCS) or a Low Voltage Shore Connection System (LVSCS) designed to power the vessel with shore power, enabling the shipboard generators to be shut down while in port/ at berth.

1.3 Vessels with a high voltage shore connection installation in compliance with the requirements in Part 1 of these Guidelines will be assigned additional notation **HVSCS.** Vessels with a low voltage shore connection installation in compliance with the requirements in Part 2 of these Guidelines will be assigned additional notation **LVSCS**. The Guidelines require that the installations on-board the vessel have been verified and tested. Shore-side installations are not within the purview of these Guidelines.

1.4 These requirements in these Guidelines are additional to those given in the various parts of the relevant IRS Rules.

1.5 These Guidelines do not apply to the electrical power supply during docking periods, e.g. dry docking and other out-of-service maintenance and repair.

1.6 Additional requirements and/or restrictions may be imposed by the flag Administration, statutory and port authorities within whose jurisdiction the ship is intended to operate, and the same are to be complied with as relevant and applicable.

2 General

2.1 Connection to an external electric power supply is not to adversely affect the availability of main, auxiliary or emergency machinery, including ship sources of electrical power to allow ship power to be restored.

2.2 The shore connection system is to be located in areas where it cannot be damaged by in-port activities or vessel activities under normal operational circumstances.

2.3 The shore connection system is to be compatible with the forces, moments and deflections resulting from the movement of the moored ship under normal operational circumstances.

3 Definitions

The following definitions apply to both Part 1 (HVSCS) and Part 2 (LVSCS), unless otherwise indicated as specific to either part.

3.1 *Cable Management System*: the cable management system comprises all equipment designed to control, monitor and handle the HV or LV flexible power and control cables and their connection devices, allowing transmission of power and electrical signals and compensating for vessel's movement caused by tidal range and/or cargo operation. It serves as an interface on the ship with the shore power system.

3.2 *Earthing*: The manner in which the electrical power supply system is grounded. Grounding may be achieved by means of methods such as neutral earthing, low or high resistance earthing, etc. The protection of circuits is designed around the method of system grounding selected.

3.3 *Emergency shutdown:* is manual and/or automatic shutdown in critical situations.

3.4 *Equipotential bonding*: provision of electric connections between conductive parts, intended to achieve equi-potentiality.

3.5 *High Voltage (HV)*: The system nominal voltage in the range above 1kV AC and upto and including 15 kV AC is considered as high voltage for the purpose of these Guidelines.

3.6 *High Voltage Shore Connection System (HVSCS)*: The system on-board a vessel that is designed to receive high voltage shore power. Typically, the system would consist of incoming power receptacles and plugs, high voltage switchgears and protections, step-down (or isolation) transformers, high voltage flexible cables, automation, shore connection switchboard, cable management system and associated instrumentation.

3.7 *Low Voltage (LV)*: is nominal voltage upto and including 1kV AC.

3.8 *Low Voltage Shore Connection System (LVSCS)*: The system on-board a vessel that is designed to receive low voltage shore power. Typically, the system would consist of incoming power receptacles and plugs, low voltage switchgears and protections, step-down (or isolation) transformers (as applicable), low voltage flexible cables, automation, shore connection switchboard, cable management system and associated instrumentation.

3.9 *Receiving Point*: Receiving point for the high or Low voltage flexible cable on the ship side.

3.10 *Shore Connection Switchboard*: Consists of shore connection circuit breakers and is a switchboard installed close to the receiving point. HV/LV shore power is connected to the shore connection switchboard by means of HV/LV plug and socket arrangement.

3.11 *Ship receiving switchboard*: Normally, a part of the ship's main switchboard to which the shore power is fed from the shore connection switchboard.

3.12 *Supply Point*: Supply point for the HV/LV flexible cable on the shore side.

4 Documentation

Documentation requirements applicable to both Part 1 (HVSCS) and Part 2 (LVSCS) are listed below; part-specific requirements are indicated where relevant.

4.1 The following documents/ details/ drawings are required to be submitted to IRS:

(a) for approval

- Single line diagram of the HVSCS/ LVSCS (ship side features/ elements)
- System earthing/ grounding details
- Details of instrumentation, safety interlocks, monitoring and alarms
- Load analysis and details of services supplied
- Cable specifications
- Details of cable management system, if installed
- Description of automatic synchronization system for the temporary generator parallel running of the ship's generator and shore power, if fitted.
- Details of supplementary arrangements required to protect equipment from exposure to moisture, condensation or temperatures outside their rating
- Tests and trial program, at manufacturer's works and on ship

(b) for information

- Overall description of HVSCS/ LVSCS and operating philosophy
- Environmental conditions having consequences on shore connection (weather, tides, mooring arrangements, etc.)

- General arrangement showing location of connection equipment, cabinets, cable routing, etc.
- Type testing of plugs, sockets, cables, etc.
- Operation manual describing methods of connection, operating and monitoring instructions, etc.
- maximum design short-circuit level from all sources (generators, motors and shore facility)

4.2 When the approved arrangements are intended to be modified, details are to be forwarded to IRS for review.

Part 1

High Voltage Shore Connection Systems on Ships

Section 1

General

1.1 General

1.1.1 This Part of the Guidelines specifies requirements for High Voltage Shore Connection Systems (HVSCS) onboard ships.

1.1.2 For scope, applicability, general requirements, definitions, and documentation, refer to the Introduction to these Guidelines.

Section 2

System Design Requirements

2.1 General

2.1.1 A typical HVSCS described in these Guidelines would consist of the following hardware components (Refer fig. 2.1.1):

- HV shore supply equipment
- Transformer
- Convertors, where applicable (for e.g. when the shore and vessel have different frequencies)
- Cables, plugs and sockets
- Cable management system, where fitted
- Shore connection switchboard
- Ship receiving switchboard (in general, a section of the main switchboard)

2.1.2 Functions are to be designed on the fail-safe principle

2.1.3. Each failure is to be identified by an alarm at a manned control station on-board.

2.1.4 Suitable warning notices are to be provided at locations along the connection equipment routes, including at connection locations.

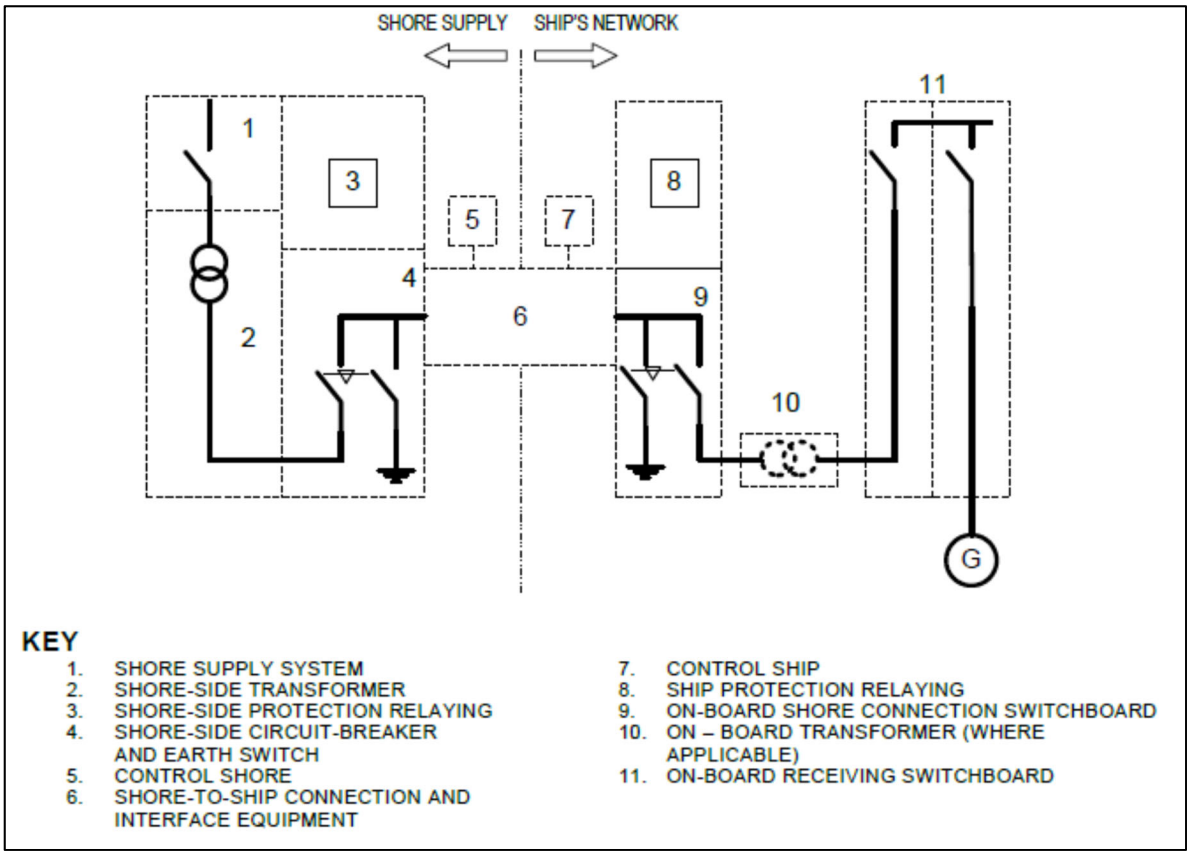

Fig. 2.1.1: Block diagram of a typical HVSCS arrangement

2.2 System Design

2.2.1 Arrangement

2.2.1.1 Shore connection system is to be installed in access-controlled spaces.

2.2.1.2 Shore connection system is not to be installed in hazardous spaces

2.2.1.3 The shore connection switchboard is to be installed in a space protected from exposure. Shore connection cables are to enter this compartment through a temporary opening with weathertight arrangement.

2.2.1.4 The shore connection switchboard is to be installed as close as possible to the receiving point. The distance between the supply point and the receiving point is to be as short as possible.

2.2.1.5 Adequate space is to be provided around the shore connection switchboard to enable the operator to perform connection and disconnection operations.

2.2.1.6 When determining the location of the shore connection system, the full range of cargo, bunkering and other utility operations are to be considered, including:

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

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

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

2.2.1.7 When determining the connection point of the shore connection system, all tidal conditions and ship operations affecting ship's free board are to be considered.

2.2.2 Compatibility with shore power

2.2.2.1 The locations for controlling HV shore circuit breaker (for e.g. engine room) are to be provided with means to confirm status of shore power (for e.g. voltage, frequency, phase sequence, etc.).

2.2.3 Capacity

2.2.3.1 HVSC equipment is to be sufficiently rated to supply the following

- Normal loads required at berth
- Emergency loads
- Loads required to support ship operations at berth

2.2.4 Earthing

2.2.4.1 *Equipotential bonding*: Equipotential bonding between the ship and the shore is to be provided. An interlock is to be provided such that the shore connection cannot be established until the equipotential bonding has been established. The equipotential bonding cable may be integrated into the shore power cable. When the equipotential bonding cable is intended to carry the shipboard earth fault current, the cable size is to be sufficient to carry the design maximum earth fault current.

Note:The adoption of special arrangements (e.g. detection of corrosion currents across the equipotential bonding circuit) against electrochemical corrosion should be considered, especially in the case of aluminium ships.

2.2.4.2 *Safe interlock for equipotential bonding*: Means for interlocking are to be provided such that connection with shore supply is automatically cut-off when equipotential bonding is lost and the ship system is to perform a standard restart after blackout.

2.2.4.3 Integrity of the equipotential bonding should be continuously checked as a part of the ship shore safety circuit.

2.2.4.4 *Compatibility with system earthing*: Arrangements are to be provided so that when the shore connection is established, the resulting system earthing onboard is to be compatible with the vessel's original electrical system earthing philosophy. Functions for earth fault detection and earthing protection are to remain available after the shore connection has been established.

2.2.4.5 The vessel is not to be permitted to establish shore power connection with an earth fault present in the HV system on either side.

2.2.5 Rated Voltage

2.2.5.1 The rated voltage of electrical equipment is to be appropriate for the earthing system.

2.2.6 Circuit Protection

2.2.6.1 The HV shore connection switchboard is to be provided with a circuit breaker to protect fixed HV electrical cables installed from that point onward.

2.2.7 Short circuit level protection

2.2.7.1 In general, relevant requirements for short-circuit calculations indicated in the IRS Rules are to be complied with.

2.2.7.2 The calculations may take into account any arrangements that:

.1 prevent permanent parallel connection of shore supply with ship sources of electrical power and/or,

.2 restrict the number of ship generators operating during parallel connection to transfer load,

.3 restrict load to be connected.

2.2.7.3 The maximum number of generators or transformers may be evaluated without taking into consideration short-term parallel operation for load transfer, provided that suitable interlocks are foreseen.

2.2.7.4 After a shore connection has been established, the prospective short-circuit current level at any point in the ship's power distribution system is not to exceed the short-circuit breaking and making capacities of circuit breakers installed onboard. Operational procedures are to be established for assessment of the shore side impedance, which determines the prospective short-circuit current level after the shore connection has been established. Such procedures are to be included in the operation manual.

2.2.8 Overvoltage Protection

2.2.8.1 Where a step-down transformer is installed onboard, the ship's low voltage system is to be protected against accidental overvoltage. This may be achieved by:

- Direct earthing of the lower voltage system while the shore power is connected; or
- Earthed screen between the primary and the secondary windings of the transformer

2.2.9 Coordination of protective devices

2.2.9.1 Shore connection circuit breakers are to be coordinated with circuit breakers for generators as far as possible so that a blackout does not occur even when a short circuit occurs in the shore connection system during parallel running of shore power and generators.

2.2.9.2 The circuit breaker in the on-board distribution system is to be coordinated as far as possible with the shore connection circuit breaker, so that shore power is supplied continuously to other circuits in the distribution system, even if short circuit occurs in the distribution system.

2.2.10 Transformer Protection

2.2.10.1 Transformer, (where provided), is to be protected against short-circuit and overload protection in accordance with the requirements of the IRS *Rules and Regulations for the Construction and Classification of Steel Ships*. The overload protection device is to have time-current protection characteristics consistent with the transformer's thermal damage characteristics.

2.2.11 Load Transfer

2.2.11.1 Load transfer between operation using ship sources of electrical power and an external electrical power supply is to be provided via short time parallel operation/ synchronization between the two sources or blackout.

.1 *Load transfer by short time parallel operation/ synchronization*: In ships where the load transfer can take place without blackout i.e. a short time parallel connection of the onboard generators and the shore power supply, the following requirements are to be complied with:

- The shore power voltage is to be within the regulation range of the automatic voltage regulator of the on-board generator
- Automatic means of synchronization are to be provided
- Automatic means of load transfer are to be provided
- The load transfer is to be completed in a time as short as practicable without causing failure of machinery or equipment or operation of protective devices. This time is to be used as the basis to define the transfer time limit (TTL). The TTL may be adjustable to match with the ability of the external source of power to accept and shed load. If the load transfer exceeds the TTL, arrangements are to be such that :
    - Transfer is aborted
    - The connection circuit breaker is opened
    - Load is removed from the ship's generators or shore power supply
    - An alarm is provided at the attended machinery control station, which is active when TTL is exceeded and is to indicate return to previous operating conditions.

.2 *Load transfer via blackout*: In such cases, the interlocking means are to be provided such that the shore power circuit breaker activates only in the no voltage condition. Interlocking means are to be provided so that shore power and on-board power are not switched on simultaneously onto a dead switchboard.

2.2.12 Restoration after disruption/ failure

2.2.12.1 When shore power is lost, on-board power required for safety operations are to be automatically restored. The detailed procedures for failure recovery are to be included in the Operation Manual (see Sec.3.10).

2.2.13 Distortion Control

2.2.13.1 When convertors are provided in the shore connection equipment to acquire the required voltage or frequency, the total harmonic distortion is to be within 5% in all the operating load ranges, whereas a single harmonic distortion is not to exceed 3%.

2.2.14 Emergency Shutdown

2.2.14.1 Emergency shutdown facilities are to be provided such that they are automatically activated under the following conditions:

- Loss of equipotential bonding
- Failure of shore connection safety circuits
- High tension level (over extension) in the cable
- Activation of emergency stop button

2.2.14.2 Activation of the emergency shut down is to instantaneously:

- Open all shore connection circuit breakers
- Connect to earth the HV power connections

2.2.14.3 The emergency stop buttons are to be installed at the following locations:

- Remote control location for controlling circuit breakers (if fitted)
- Ship's manned station during shore connection system operations
- Shore connection switchboard
- Control location for automatic tension device in the cable management system
- Other locations, as deemed necessary.

2.2.14.4 The emergency stop buttons are to be clearly marked so that their operation method is clearly visible, prevent inadvertent operation and easily followed. The emergency stop button is to be reset manually, once activated.

2.2.14.5 Activation of the emergency stop button is to result in a visual warning and easily distinguishable audible alarm at a manned station.

2.2.14.6 Consequences of emergency shutdown activation on ship installations are to be evaluated.

2.2.15 Control, Monitoring and Alarms

2.2.15.1 Arrangements are to be provided to ensure that the shore connection circuit-breakers cannot be operated when:

.1 One of the earthing switches is closed (shore-side/ship-side)
.2 The pilot contact circuit is not established
.3 Emergency-stop facilities are activated
.4 Ship or shore control, alarm or safety system self-monitoring properties detect an error that would affect safe connection
.5 The data-communication link between shore and ship is not operational
.6 The voltage supply is not present
.7 Earth fault is detected.

2.2.15.2 The measuring point for all instrumentation related to the shore power is to be on the upstream side of the incoming circuit breaker that isolates the shore power from the vessels power system.

2.2.15.3 An independent means of voice communication is to be provided between the ship and the shore control locations. A reliable data communication link is recommended to be provided between the ship and shore control locations in accordance with a recognized standard such as IEC 80005-2:2016.

2.2.15.4 The following monitoring and alarms are to be provided at the location from which the shore connection system circuit breakers are controlled, and at other strategic locations that are normally manned if deemed necessary:

.1 Over tension alarm on shore connection cables, or cable management system over deployment (low remaining cable length) alarm, prior to the emergency shutdown
.2 The loss of shore power
.3 Emergency shutdown
.4 Manual emergency-stop
.5 Safety device activation alarms (e.g., overcurrent, earth fault)

2.3 Fire Protection of HVSCS

2.3.1 At-least the fire protection and extinguishing requirements required for "Other Machinery Spaces", as stipulated in the IRS *Rules and Regulations for the Construction and Classification of Steel Ships* are to be complied with in the spaces where HVSCS are installed (excluding spaces where ship receiving switchboards are installed). Machinery and equipment installed in directly exposed parts/ spaces would be specially considered.

Section 3

Equipment Requirements

3.1 General

3.1.1 Electrical equipment are to be constructed of durable, flame-retardant, moisture-resistant material, which are not subject to deterioration in the marine environment and at the temperatures to which they are likely to be exposed.

3.1.2 The determination of equipment protection class (IP rating) is to be in accordance with Part 4, Chapter 8, Table 1.13.1 of the IRS *Rules and Regulations for the Construction and Classification of Steel Ships.*

3.1.3 Effective means are to be provided to prevent moisture accumulation and condensation, even if equipment is idle for long periods of time. Appropriate arrangements are to be provided for storage of removable shore connection equipment when not in use. Such arrangements should also take into account issues such as dust, moisture, physical damage of sockets, plugs, cables etc.

3.2 Shore Connection Switchboard

3.2.1 The HV shore connection switchboard is to be designed, manufactured and tested in accordance with a recognized standard such as IEC 62271-200:2021.

3.2.2 The circuit breakers in the shore connection switchboard are to be as follows:

.1 HV circuit breaker is to be equipped with low voltage protection (LVP)
.2 The rated short-circuit making capacity of the circuit breaker is to be greater than the prospective peak value of the short-circuit current
.3 The rated short-circuit breaking capacity of the circuit breaker is to be greater than the maximum prospective short-circuit current (rms value).
.4 HV shore connection circuit breaker is to be remotely operated

3.2.3 Backup power supply for operation of at least 30 minutes is to be provided for the instrumentation devices. In the event of a breakdown of this backup power supply, alarm is to be given in the machinery control room. The following instrumentation is to be provided in the shore connection switchboard:

.1 Voltmeter (all phases)
.2 Short circuit protection device (open circuit and alarm)
.3 Overload protection device (open circuit and alarm)
.4 Earth fault detector
.5 Unbalance protection device (for multiple connections)

3.2.4 The shore connection switchboard is to be located onboard the vessel in a dry space close to the connection point.

3.3 Ship Receiving Switchboard

3.3.1 The ship receiving switchboard is to be designed, manufactured and tested in accordance with a recognized standard such as IEC 62271-200:2021.

3.3.2 The circuit breakers in the ship receiving switchboard are to be as follows:

.1 The rated short-circuit making capacity of the circuit breaker is to be greater than the prospective peak value of the short-circuit current
.2 The rated short-circuit breaking capacity of the circuit breaker is to be greater than the maximum prospective short-circuit current (rms value).
.3 HV connection circuit breaker is to be remotely operated

3.3.3 The following instrumentation is to be provided in the ship receiving switchboard:

a) If load transfer by synchronization

- Two voltmeters
- Two frequency meters
- One phase sequence indicator
- Synchronizing device (if designed for short term parallel operation)
- Ammeter for each phase
- Short circuit protection device (open circuit and alarm)
- Overload protection device (open circuit and alarm)
- Earth fault detector

One voltmeter and one frequency meter are to be connected to the switchboard bus bars; the other voltmeter and frequency meter are to enable the voltage and frequency of the shore connection to be measured.

b) If load transfer by blackout

- One Voltmeter
- Phase sequence indicator
- One Frequency meter
- Ammeter for each phase
- Short circuit protection device (open circuit and alarm)
- Overload protection device (open circuit and alarm)
- Earth fault detector

3.4 Cable Management System

3.4.1 A cable management system (cable reels, crane, etc) enabling the connection of cables between the shore connection switchboard and the ship receiving switchboard and suitable for the different places where the vessel intends to connect is to be provided.

3.4.2 Cable management system, cables are to be equipped with warning notices to highlight the presence of voltage level, moving parts, obstacles, risks of fall, etc.

3.4.3 The cable management system is to be arranged to provide an adequate movement compensation (due to ship movement, tidal changes, etc.) and to maintain an optimum length of cable which avoids slack cable or exceeding of tension limits.

3.4.4 The cable management system is to ensure that the cable tension does not exceed the permitted design value.

3.4.5 The cable management system is to be equipped with a device (e.g. limit switches), independent of its control system, to monitor maximum cable tension and deployed cable length.

3.4.6 The detection of tension in the cable is to activate an alarm at the first stage and an emergency shutdown at the second stage.

3.4.7 The cable management system, cables are to be physically protected against heavy seas and mechanical damage.

3.4.8 Power connections with external electrical power supply arrangements may be made with either suitable connections or by using socket-outlets and plugs in accordance with 3.6.

3.4.9 Power, control and monitoring cables are to be at least of a flame-retardant type in accordance with the requirements given in IEC 60332-1-2. The outer sheath is to be oil-resistant and resistant to sea air, seawater, solar radiation (UV) and not hygroscopic.

3.4.10 Power, control and monitoring may be based on a single cable or cables in bunch.

3.4.11 Arrangements are to be provided to stow the cable management system and associated cable when not in operation.

3.4.12 The breakaway capability of the vessel is to be demonstrated. The time necessary to disconnect the shore connection system is to be recorded.

3.4.13 Consequences of mooring breaks on the shore connection are to be considered. It is not to lead to critical damage to the installation.

3.5 Transformer

3.5.1 Where provided, the transformer is to be in compliance with the requirements of Part 4, Chapter 8 of the *IRS Rules and Regulations for the Construction and Classification of Steel Ships*. The level of harmonics current is to be taken into account, whilst deciding the rated capacity of the transformer.

3.5.2 The transformer is to be protected from short circuit and overloads.

3.6 HV Voltage Plugs and Sockets

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

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

3.6.3 Socket-outlets and inlets are to be interlocked with the earth switch so that plugs or connectors cannot be inserted or withdrawn without the earthing switch in closed position. The earthing contacts are to make contact before the power contacts do when inserting a plug.

3.6.4 Plugs are to be designed so that no strain is transmitted to the terminals, contacts and cables.

3.6.5 Connection plug and socket-outlets are to be designed according to international or national standards such as IEC 62613-1:2019. Type test reports are to be submitted.

3.7 HV Cables

3.7.1 Permanently fixed cables are to be connected between the shore connection switchboard and the ship receiving switchboard connection point.

3.7.2 Ship to shore connection cable extensions are not to be permitted.

3.7.3 Fixed HV cables installed on-board are to comply with the provisions of IEC 60092-353 and IEC 60092-354. The cables are to be at least of a flame retardant type in accordance with IEC 60332-1-2. The outer sheath is to be oil-resistant and resistant to sea air, seawater, solar radiation (UV) and not hygroscopic. HV flexible cables would be specially considered.

3.7.4 HV cables are not to be laid in the same cable tray as low voltage cables (below 1kV).

3.7.5 HV cables are not to be laid through accommodation spaces, as far as is practicable. If it is unavoidable to pass HV cable through accommodation spaces, fully closed cable runs are to be used.

3.7.6 When HV cables are installed in a cable tray or equivalent, the cables are to have continuous metal sheathing or armour, which is earthed effectively. If this is not feasible, the entire length of HV cable is to be covered effectively by earthed metallic case.

3.7.7 HV cables are to be appropriately marked for easy identification.

3.8 Compatibility Assessment

3.8.1 It is recommended that a compatibility assessment to confirm the consistency with shore power systems be carried out prior to receiving shore power. These may include, but not be limited to, the following:

- Rated capacity of shore power, ship-shore connections, ship side connections
- Maximum and minimum prospective short circuit current
- Acceptable voltage variations in the range of loads from no-load to maximum loads of on-board distribution switchboard
- System study and calculations
- Compatibility with ship control voltage
- Compatibility with communication link
- Compatibility with distribution system
- Compatibility with safety circuits
- Shipside earth fault protection, monitoring and alarm functions during shore power connections
- Cable length adequacy
- Total harmonic distortion
- Consideration of hazardous areas, where applicable
- Equipotential bond monitoring

3.9 Maintenance Plan

3.9.1 A maintenance plan indicating the periodic tests and maintenance procedures for the HVSCS is to be prepared and included in the Operation Manual.

3.10 Operation Manual

3.10.1 A manual depicting the operational procedures for the shore connection systems is to be stored at an easily accessible location to the crew, preferably at the operating stations. The operation manual is to include, but not be limited to, the following

- Operator qualification requirements
- Compatibility assessment procedures (also refer 3.8)
- Actions to be taken when the shore power supply is incompatible with on-board equipment
- Step-by-step instruction for shore power connection and disconnection, including equipotential bonding and load transfer
- Procedure for transmitting “permission to close” shore side shore connection circuit breaker

- Emergency shutdown procedure and restoration of power (in at least the following conditions: loss of equipotential bonding, high cable tension or shortage of remaining cable length, "safety circuit pilot loop" failure, manual activation of the emergency stop system and disconnection of plugs while energized)
- Procedure for recovery from fault conditions
- Storage requirements for shore connection equipment
- Maintenance plan

Note: Relevant requirements from MSC.1/Circ. 1675 and IACS Rec. 182 may be referred for guidance in preparation of the operation manual.

Section 4

Test and Trials

4.1 General

4.1.1 All HV Systems components are to clear the applicable type tests and routine tests according to the relevant IEC standards, in particular IEC 62271-200:2021.

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

4.1.3 Electrical and control engineering equipment is to be surveyed at manufacturer's works and undergo survey and operational trials on board in accordance with the approved test schedules and applicable testing requirements in Part 4 of the *IRS Rules and Regulations for the Construction and Classification of Steel Ships* .

4.1.4 All tests/ trials indicated in this Section are to be carried out in the presence of the Surveyor, unless specified otherwise.

4.2 Tests at Manufacturing Works

4.2 1 HV Switchboard

4.2.1.1 HV switchboards are to be subjected to an AC withstand voltage test in accordance with relevant national or international standards.

4.2.2 HV cable reel and slip rings

4.2.2.1 The slip rings are to be subjected to an AC withstand voltage test in accordance with relevant national or international standards such as IEC 62271-200:2021. The following tests are to be carried out:

- HV withstand test
- Impulse voltage withstand test
- Insulation resistance measurement
- Heat run test with nominal current
- Short circuit withstand test
- Arc test (if accessible in energized condition)
- IP test (IP rating)

4.2.3 Transformers

4.2.3.1 Transformer tests are to be carried out in accordance with the requirements specified in Part 4, Chapter 8 of the *IRS Rules and Regulations for the Construction and Classification of Steel Ships*.

4.3 On-board Tests and Trials

4.3.1 The tests / trials are to be carried out as per the approved trial protocols. In general, the following tests/ trials are to be carried out after installation onboard:

.1 General visual examination of shore connection system
.2 Insulation resistance test of the shore connection and ship receiving switchboards
.3 Voltage withstand test
.4 Measurement of the earthing resistance
.5 Function test including correct setting of the protection devices

.6 Function test of the interlocking system
.7 Function test of the control equipment and alarms
.8 Load transfer (blackout/ synchronization, as relevant)
.9 Earth fault monitoring test
.10 Phase sequence test
.11 Function test of the cable management system, where fitted
.12 Function tests of the emergency shutdown arrangements

4.3.2 Any additional tests, as required by the statutory authorities are also to be carried out, as applicable.

4.4 Annual Surveys

4.4.1 A record of maintenance, repairs, equipment modifications (if any) and test results are to be available on-board for review by the Surveyor.

4.4.2 A general examination of the shore connection system is to be carried out by the Surveyor.

4.4.3 Insulation resistance measurement and voltage withstand test of the cable are to be carried out in the presence of the Surveyor.

4.4.4 If the shore connection equipment has been used and no modifications have been carried out or the insulation resistance measurement or the voltage withstand test has been carried out in the previous 30 months, then the above tests may be omitted. Records of the testing are to be made available to the Surveyor.

4.4.5 If it is noted that the shore connection equipment has not been used in the previous 30 months, the tests as indicated in 4.3.1 are to be repeated.

Section 5

Additional Specific Ship Type Requirements

5.1 General

5.1.1 The requirements in this Section are additional to those in the previous Sections, based on specific ship types and are to be read in conjunction with those requirements.

5.1.2 IEC 80005-1 may also be referred for detailed requirements.

5.2 Ro-Ro Cargo Ships and Ro-Ro Passenger Ships

5.2.1 HVSC systems are not to be installed in areas which may become hazardous areas, such as car decks, upon failure of required air changes per hour during loading and offloading cargo or during normal operations.

5.2.2 The nominal voltage is to be 11 kV AC. Nominal voltage of 6.6 kV AC may be used in coastal vessels.

5.2.3 Galvanic isolation may not be required where a HV shore supply is dedicated to supply only ships which have galvanic isolation on board.

5.2.4 One cable is to be used for HVSC system up to a power demand of 6.5 MVA.

5.2.5 The shore side facility may be equipped with cable management systems in the case of these ships.

5.2.6 If data-communication link is installed, data communication shall be performed utilizing fibre optic systems. Emergency shutdown functions are to be performed with pilot conductors (as per IEC 62613-1, IEC 62613-2 and Annex A of IEC 80005-1).

5.3 Cruise Ships

5.3.1 Periodic verification of the ship's earthing system is recommended.

5.3.2 The HVSC system is to be rated for at least 16 MVA (but 20 MVA is recommended where practical) at nominal ship system voltages of 11 kV A.C. and/or 6.6 kV A.C.

5.3.3 Measures are to be taken so that ships with power demands higher than the HVSC system rating will reduce their power demand prior to connecting.

5.3.4 Some ships may require on-board isolation transformer.

5.3.5 The prospective short-circuit contribution level from the HV shore distribution system is to be limited by the shore-sided system to 25 kA r.m.s.

5.3.6 The prospective short-circuit contribution level from the on-board running induction motors and the generators in operation is to be limited to a short circuit current of 25 kA r.m.s. for 1s.

5.4 Container Ships

5.4.1 The nominal voltage of the HVSC is to be 6.6 kV.

5.4.2 Two parallel cables with three pilot conductors each is to be used for HVSC systems up to a maximum power demand of 7.5 MVA.

5.4.3 The cable management system is to be located on the ship.

5.4.4 If data-communication link is installed, data communication shall be performed utilizing fibre optic systems. Emergency shutdown functions are to be performed with pilot conductors (as per IEC 62613-1, IEC 62613-2 and Annex A of IEC 80005-1).

5.5 LNG Carriers

5.5.1 In addition to the compatibility assessment in 3.10, the following are also required to be observed:

- Compatibility of shutdown system and disconnection equipment
- Availability of shore power supply for cargo operations

5.5.2 The prospective short-circuit contribution level from the HV shore distribution system should be limited by the shore-sided system to 16 kA r.m.s.

5.5.3 The prospective short-circuit contribution level from the on board running induction motors and the generators in operation should be limited to a short circuit current of 16 kA r.m.s.

5.5.4 Special requirements for the distribution systems in LNG carriers are also to be complied with in accordance with IEC 60092-502.

5.5.5 Connections should be made at a nominal voltage of 6.6 kV A.C. and a frequency of 60 Hz.

5.5.6 Emergency Shutdown

5.5.6.1 Emergency shutdown is to be initiated in two steps: ESD-1, when the ship moves past the warning range, and ESD-2, when the ship moves past the maximum range of movement of the ship.

5.5.6.2 Means should be provided to facilitate emergency physical disconnection of the HVSC cables in the event of ESD-2 (movement of the ship away from the dock) being detected.

5.5.6.3 Disconnection may be triggered by an "active" system employing an external mechanical force or by a “passive” system employing a weak link in the design. Suitable "passive" systems may be fitted at the ship or shore side or as part of a coupler in the HVSC power cable.

5.5.6.4 LNG-ESD may be initiated manually, by fusible links, by process deviation or by excessive movement of the loading arms. The LNG-ESD signal is to be passed between ship and shore (or vice versa) and is to cause cargo pumps and compressors to be stopped and cargo valves to be closed on ship and shore.

5.5.7 HVSC Point location

5.5.7.1 It is recommended that the physical location of the HVSC point may be in accordance with Table 5.5.7.1 (a) and 5.5.7.1 (b)

Table 5.5.7.1 (a) LNGC 140000 – 225000 cu.m		
HVSC Point	Dimensions (m)	
	Minimum	Maximum
From cargo manifold centre-line	112	130
Above design waterline	5.35	8.85
From berthing line	0	11.5

Table 5.5.7.1 (b) LNGC > 225000 cu.m		
HVSC Point	Dimensions (m)	
	Minimum	Maximum
From cargo manifold centre-line	120	149
Above design waterline	5.55	9.05
From berthing line	0	11.5

5.5.8 The cable management system should be located on shore.

5.5.9 The maximum short-circuit current of 16 kA / 1 s and a maximum peak short-circuit current of 40 kA are recommended.

5.5.10 Certified intrinsically safe or fibre optic systems may be a suitable means of communication.

5.5.11 It is recommended that hardline telephones are provided as the means of voice communication required between ship and shore control locations.

5.5.12 If data-communication link is installed, data communication is to be performed utilizing fibre optic systems. Emergency shutdown functions are to be performed with pilot conductors (as per IEC 62613-1, IEC 62613-2 and Annex A of IEC 80005-1).

5.5.13 ESD Philosophy

5.5.13.1 An emergency shutdown philosophy is to be agreed between terminal and ship during compatibility assessment of the HVSC system. It is to at least cover actions in the event of the following situations:

- manual shutdown of cargo operations
- loss of electrical power (initiates LNG-ESD)
- LNG-ESD
- ESD-1
- ESD-2
- Simultaneous release of mooring hooks.

5.5.13.2 The HVSC shutdown system is to be self-contained and the emergency shutdown philosophy should not require additional signals to be transmitted from ship to shore (or vice versa) by the existing LNG terminal shutdown system. However, the LNG terminal shutdown system is to provide ESD-1 & ESD-2 signals to the HVSC shutdown system.

5.5.13.3 The LNG-ESD should not be required to have an automatic effect on the HVSC system.

5.5.13.4 The ESD-1 is to be communicated from shore to ship via the fibre-optic system and is to initiate automatic starting, synchronization and connection of the ship main source of power followed by isolation and earthing of the shore power connection(s) both onshore and on-board.

5.5.13.5 The ESD-2 is to be communicated from shore to ship via the fibre-optic system and should trigger an emergency-stop as described in 3.10 (i.e. the immediate opening of all the shore supply circuit-breakers etc.) and earthing of the shore power connection(s) both onshore and on-board.

5.5.13.6 Additional emergency-stop switches would be required on shore in the terminal control room where the HVSC controls are located and at the cable management system operating location.

5.6 Tankers

5.6.1 It is possible that an area in the tanker that is regarded as safe in accordance with 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. Requirements of IEC 60079 are to be considered during the compatibility assessment.

5.6.2 The prospective short-circuit contribution level from the HV shore distribution system is to be limited by the shore-sided system to 16 kA r.m.s.

5.6.3 The prospective short-circuit contribution level from the on board running induction motors and the generators in operation is to be limited to a short circuit current of 16 kA r.m.s.

5.6.4 Special requirements applicable to the distribution systems of tankers are to be complied with in accordance with IEC 60092-502.

5.6.5 Connections for tanker ships are to be made at a nominal voltage of 6,6 kV A.C.

5.6.6 The cable management system is to be located on shore.

5.6.7 Certified intrinsically safe or fibre optic systems may be a suitable means of communication.

5.6.8 It is recommended that hardline telephones are provided as the means of voice communication required between ship and shore control locations.

Part 2

Low Voltage Shore Connection Systems on Ships

Section 1

General

1.1 General

1.1.1 This Part specifies requirements for Low Voltage Shore Connection Systems (LVSCS).

1.1.2 For scope, applicability, general requirements, definitions, and documentation, refer to the Introduction to these Guidelines.

1.1.3 Certain requirements in Part 2 (LVSCS) of these Guidelines cross-refer to those in Part 1 (HVSCS), as these are also equally applicable to LVSCS.

Section 2

System Design Requirements

2.1 General

2.1.1 A typical LVSCS described in these Guidelines would consist of the following hardware components (Refer fig. 2.1.1):

- LV shore supply equipment
- Transformer
- Convertors, where applicable (for e.g. when the shore and vessel have different frequencies)
- Cables, plugs and sockets
- Cable management system, where fitted
- Shore connection switchboard
- Ship receiving switchboard (in general, a section of the main switchboard)

2.1.2 Functions are to be designed on the fail-safe principle

2.1.3. Each failure is to be identified by an alarm at a manned control station on-board.

2.1.4 Suitable warning notices are to be provided at locations along the connection equipment routes, including at connection locations.

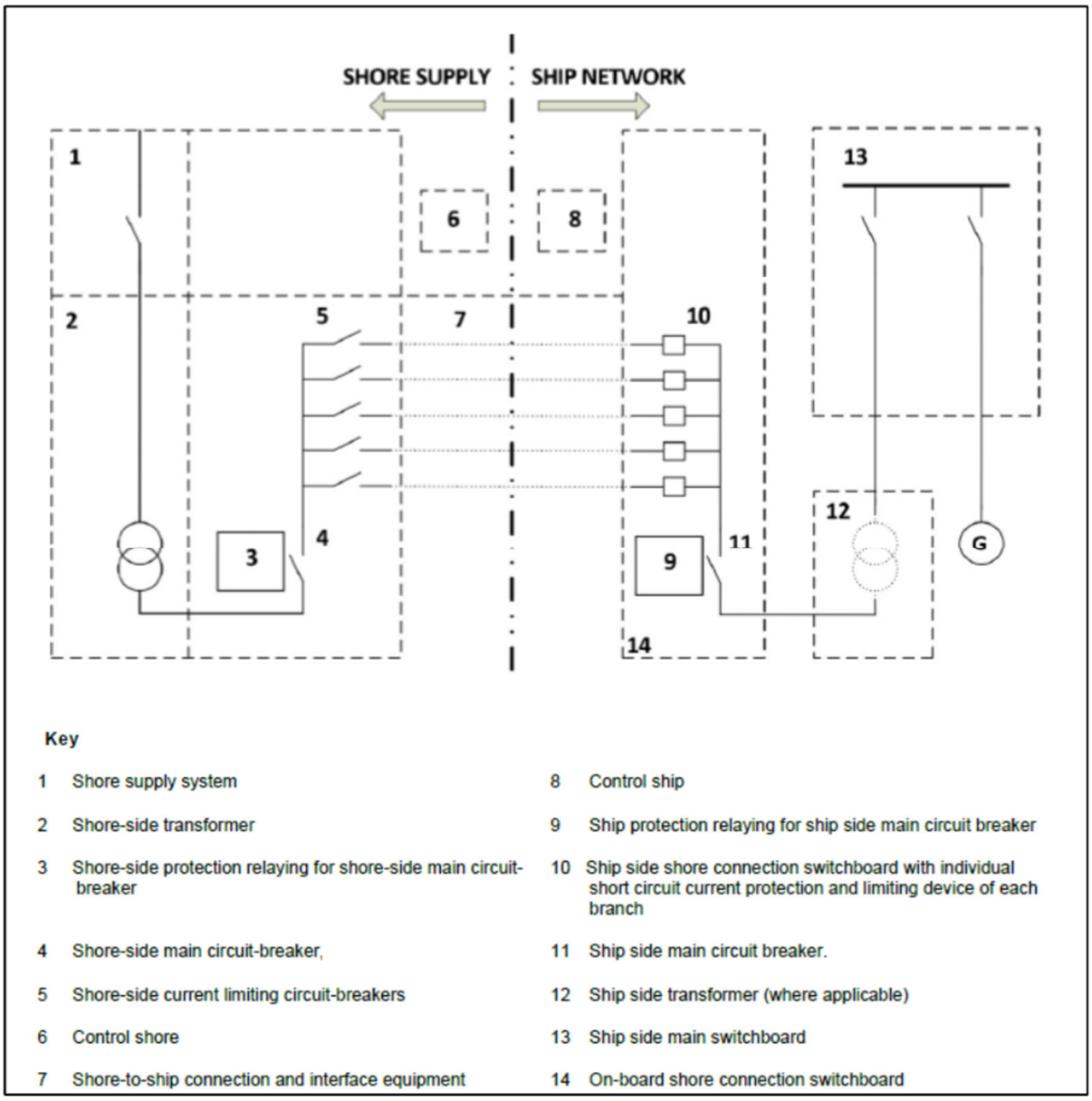

Fig. 2.1.1: Block diagram of a typical LVSCS arrangement

2.2 System Design

2.2.1 Arrangement

2.2.1.1 Arrangement of LVSCS is to be in accordance with Part 1, Section 2, 2.2.1.

2.2.2 Compatibility with shore power

2.2.2.1 The locations for controlling LV shore circuit breakers are to be provided with means to confirm the status of shore power (for e.g. voltage, frequency, phase sequence, etc.).

2.2.3 Capacity

2.2.3.1 LVSC equipment is to be sufficiently rated to supply the following

- Normal loads required at berth
- Emergency loads
- Loads required to support ship operations at berth

2.2.4 Earthing

2.2.4.1 Equipotential bonding and Safe interlock for equipotential bonding are to be in accordance with Part 1, Section 2, 2.2.4.1 to 2.2.4.3

2.2.4.2 Compatibility with system earthing: Arrangements are to be provided so that when the shore connection is established, the resulting system earthing onboard is to be compatible with the vessel's original electrical system earthing philosophy. Functions for earth fault detection and earthing protection are to remain available after the shore connection has been established.

Note: In LVSCS, ships with an IT power system are to be connected only to an equivalent IT shore power system. Ships with a directly earthing power system are to be connected via an onboard transformer (see key 12 in Figure 2.1.1) that creates the required grounding conditions.

2.2.4.3 The vessel is not to be permitted to establish shore power connection with an earth fault present in the LV system on either side.

2.2.5 Rated Voltage

2.2.5.1 The rated voltage of electrical equipment is to be appropriate for the earthing system.

2.2.6 Circuit Protection

2.2.6.1 The LV shore connection switchboard is to be provided with a circuit breaker to protect fixed LV electrical cables installed from that point onward.

2.2.7 Short circuit level protection

2.2.7.1 Short circuit level protection is to be in accordance with Part 1, Section 2, 2.2.7.

2.2.8 Overvoltage Protection

2.2.8.1 Overvoltage protection is to be in accordance with Part 1, Section 2, 2.2.8.

2.2.9 Coordination of protective devices

2.2.9.1 Coordination of protective devices is to be ensured in accordance with Part 1, Section 2, 2.2.9.

2.2.10 Transformer Protection

2.2.10.1 Transformer, (where provided), is to be protected against short-circuit and overload protection in accordance with the requirements of the applicable IRS Rules. The overload protection device is to have time-current protection characteristics consistent with the transformer's thermal damage characteristics.

2.2.11 Load Transfer

2.2.11.1 The requirements for load transfer between shipboard and shore power sources are to be in accordance with Part 1, Section 2, 2.2.11.

2.2.12 Restoration after disruption/ failure

2.2.12.1 When shore power is lost, on-board power required for safety operations is to be automatically restored. The detailed procedures for failure recovery are to be included in the Operation Manual (see Sec.3.10).

2.2.13 Distortion Control

2.2.13.1 When convertors are provided in the shore connection equipment to acquire the required voltage or frequency, the total harmonic distortion is to be within 5% in all the operating load ranges, whereas a single harmonic distortion is not to exceed 3%.

2.2.14 Emergency Shutdown

2.2.14.1 Emergency shutdown facilities are to be provided such that they are automatically activated under the conditions specified in Part 1, Section 2, 2.2.14.1.

2.2.14.2 Activation of the emergency shutdown is to instantaneously open all shore connection circuit breakers.

2.2.14.3 The emergency stop buttons are to be installed at the locations specified in Part 1, Section 2, 2.2.14.3 and are also to be in accordance with Part 1, Section 2, 2.2.14.4 to 2.2.14.6.

2.2.15 Control, Monitoring and Alarms

2.2.15.1 Arrangements are to be provided to ensure that the LV shore connection circuit-breakers cannot be operated under the conditions specified in Part 1, Section 2, 2.2.15.1.2 to 2.2.15.1.7.

2.2.15.2 The requirements related to the LVSCS for measuring points for all instrumentation, voice and data communication between ship and shore, monitoring and alarms are to be in accordance with Part 1, Section 2, 2.2.15.2 to 2.2.15.4.

2.3 Fire Protection of LVSCS

2.3.1 At-least the fire protection and extinguishing requirements required for “Other Machinery Spaces”, as stipulated in the applicable IRS Rules are to be complied with in the spaces where LVSCS are installed (excluding spaces where ship receiving switchboards are installed). Machinery and equipment installed in directly exposed parts/ spaces on the ship would be specially considered.

Section 3

Equipment Requirements

3.1 General

3.1.1 For requirements related to the construction, IP rating, and storage of electrical equipment, refer Part 1, Section 3, 3.1.

3.2 Shore Connection Switchboard

3.2.1 The LV shore connection switchboard is to be designed, manufactured and tested in accordance with requirements specified in the relevant IRS Rules.

3.2.2 In addition to the requirements specified in Part 1, Section 3, 3.2.2.2 and 3.2.2.3, the circuit breakers in the LV shore connection switchboard are to be electrically operated.

3.2.3 The instrumentation to be provided in the shore connection switchboard and its backup power supply requirements are to be in accordance with Part 1, Section 3, 3.2.3.

3.2.4 The shore connection switchboard is to be located onboard the vessel in a dry space close to the connection point.

3.3 Ship Receiving Switchboard

3.3.1 The ship receiving switchboard is to be designed, manufactured and tested in accordance with the requirements specified in the relevant IRS Rules.

3.3.2 In addition to the requirements specified in Part 1, Section 3, 3.3.2.1 and 3.3.2.2, the circuit breakers in the ship receiving switchboard are to be electrically operated.

3.3.3 The instrumentation to be provided in the ship receiving switchboard is to be in accordance with Part 1, Section 3, 3.3.3

3.4 Cable Management System

3.4.1 Cable management system is to be in compliance with the requirements specified in Part 1, Section 3, 3.4.

3.5 Transformer

3.5.1 Where provided, the transformer is to be in compliance with the requirements specified in IRS Rules. The level of harmonics current is to be taken into account, whilst deciding the rated capacity of the transformer.

3.5.2 The transformer is to be protected from short circuit and overloads.

3.6 LV Voltage Plugs and Sockets

3.6.1 The plug, socket-outlet, ship connector and ship inlet are to be in accordance with IEC 60309-5:2017.

3.7 LV Cables

3.7.1 Permanently fixed onboard LV cables are to be in compliance with the requirements specified in the relevant IRS Rules.

3.8 Compatibility Assessment

3.8.1 Compatibility assessment is to be carried out in accordance with Part 1, Section 3, 3.8.1.

3.9 Maintenance Plan

3.9.1 A maintenance plan indicating the periodic tests and maintenance procedures for the LVSCS is to be prepared and included in the Operation Manual.

3.10 Operation Manual

3.10.1 Operational manual is to be stored at an easily accessible location to the crew and is to be in accordance with Part 1, Section 3, 3.10.

Section 4

Test and Trials

4.1 General

4.1.1 All LV Systems components are to be subjected to the applicable type tests and routine tests according to the relevant IEC standards, in particular IEC 60947.

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

4.1.3 Electrical and control engineering equipment is to be surveyed at manufacturer's works and undergo survey and operational trials on board in accordance with the approved test schedules and applicable testing requirements in relevant IRS Rules.

4.1.4 All tests/ trials indicated in this Section are to be carried out in the presence of the Surveyor, unless specified otherwise.

4.2 Tests at Manufacturing Works

4.2.1 LV Switchboard

4.2.1.1 LV switchboards are to be subjected to an AC withstand voltage test in accordance with the applicable IRS Rules.

4.2.2 Transformers

4.2.2.1 Transformer tests are to be carried out in accordance with the requirements specified in the relevant IRS Rules.

4.3 On-board Tests and Trials

4.3.1 The tests / trials are to be carried out as per the approved trial protocols. In general, the tests/ trials specified in Part 1, Section 4, 4.3.1 are to be carried out for LVSCS after installation onboard.

4.3.2 Any additional tests, as required by the statutory authorities for LVSCS are also to be carried out, as applicable.

4.4 Annual Surveys

4.4.1 Annual surveys are to be carried out in accordance with Part 1, Section 4, 4.4.

References

1. IEC/ IEEE 80005-1:2019 (+AMD 1:2022+AMD2:2023): Utility connections in port - Part 1: High voltage shore connection (HVSC) systems - General requirements
2. IEC/ IEEE 80005-2:2016): Utility connections in port - Part 2: High and low voltage shore connection systems - Data communication for monitoring and control
3. IEC 62271-200:2021: High-voltage switchgear and control gear - Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
4. IEC 62613-1:2019: Plugs, socket-outlets and ship couplers for high-voltage shore connection (HVSC) systems - Part 1: General requirements
5. IEC DIS 80005-3.2:2024: Utility connections in port - Part 3: Low voltage shore connection (LVSC) systems - General requirements
6. IACS Rec. 182, December 2024: Onshore Power Supply
7. MSC.1/Circ.1675: Interim Guidelines on Safe Operation of Onshore Power Supply (OPS) Service in Port for Ships Engaged on International Voyages

End of Guidelines