RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF INLAND WATERWAYS VESSELS

PART VII
ELECTRICAL EQUIPMENT AND AUTOMATION

July
2019

GDAŃSK

RULES FOR CLASSIFICATION AND CONSTRUCTION OF INLAND WATERWAYS VESSELS developed and published by Polish Register of Shipping PLC, hereinafter referred to as PRS, consist of the following Parts:

Part I – Classification Regulations
Part II – Hull
Part III – Hull Equipment
Part IV – Stability and Freeboard
Part V – Fire Protection
Part VI – Machinery and Piping Systems
Part VII – Electrical Equipment and Automation,

whereas for the materials and welding the requirements specified in *Part IX – Materials and Welding,* of the *Rules for Classification and Construction of Sea-going Ships* shall be fulfilled.

Part VII – Electrical Equipment and Automation – July 2019, was approved by the PRS Board on 14 June 2019 and enters into force on 1 July 2019.

From the entry into force, the requirements of *Part VII – Electrical Equipment and Automation* apply, in full, to new ships.

For existing ships, the requirements of *Part VII – Electrical Equipment and Automation* are applicable within the scope specified in *Part I – Classification Regulations.*

The requirements of *Part VII – Electrical Equipment and Automation* are extended by the below-listed Publications:

Publication No. 11/P – Environmental Tests on Marine Equipment,
Publication No. 15/P – Current Rating Tables for Cables, Wires and Busbars in Marine Installations,
Publication No. 42/P – Testing of Electric Rotating Machines,
Publication No. 92/P Specific Requirements for Inland Waterways High-Speed Vessels,
Publication No. 106/P – ECO Class Rules.
Publication No. 121/P – Use of LNG as a fuel on inland waterways vessels,
Publication No. 92/P – Specific Requirements for Inland Waterways High-Speed Vessels.

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1 GENERAL PROVISIONS

1.1 Application

1.1.1 The present Part of the *Rules* applies to electrical installations in inland waterways vessels mentioned in 1.1.1, *Part I – Classification Regulations* as well as to individual types of electrical equipment in accordance with provisions of 1.3.

For electrical installations on ashore units, pontoons and vessels supplied with electrical power from the shore only, requirements of the present Part of the Rules apply only in scope to safety and environmental preservation, each time determined by PRS.

1.1.2 The relevant requirements of present *Part VII* of the Rules are recommended to be also extended to cover electrical equipment not specified in 1.3.2 and 1.3.3 but installed in vessels.

1.1.3 In justified cases PRS may grant exemptions from the requirements specified in *Part VII*, e.g. in respect of navigation on their national waterways for limited journeys of local interest or PRS may extend these requirements e.g. in the case of novelty solutions applied on board the vessel.

1.1.4 Apart from the requirements of the present, the electrical equipment is to fulfil the requirements of the national or international standards indicated by PRS.

1.2 Definitions

Definitions and explanations relating to general terminology of the *Rules for the Classification and Construction of Inland Waterways Vessels* (hereafter referred to as the *Rules*) are specified in *Part I – Classification Regulation*.

For the purpose of *Part VII* the following definitions and explanations have been adopted.

Certified safe type electrical apparatus – an electrical apparatus which has been tested and approved by competent authority regarding its safety of operation in an explosive atmosphere, e.g.:
- intrinsic safety: EEx (ia) and EEX (ib)(see PN-EN 60079-11);
- flameproof enclosure: EEx (d) (see PN-EN 60079-1);
- pressurized apparatus: EEx (p) (see PN-EN 60079-2);
- powder filling: EEx (q) (see PN-EN 60079-5);
- encapsulation: EEx (m) (see PN-EN 60079-18);
- increased safety: EEx (e) (see PN-EN 60079-7).

Emergency source of electrical power – a source of electrical power intended to supply the essential vessel's consumers in of failure of electrical supply from the main switchboard busbars.

Component of automatic system – the simplest and functionally self-dependent structural item used in automatic systems (e.g. relay, resistor, logic element, sensor, final control element).

Explosion group – (see IEC publication 60079-10 and PN-EN 60079-0) means a grouping of flammable gases and vapours according to their maximum experimental safe gaps and minimum ignition currents, and of electrical apparatus which may be used in the corresponding potentially explosive atmosphere.

Temperature class – (see IEC publication 60079–10 and PN-EN 60079-0) means a grouping of flammable gases and vapours of flammable liquids according to their ignition temperature; and of the electrical apparatus intended to be used in the corresponding potentially explosive atmosphere according to their maximum surface temperature.

Nonflamable material – see *Part V – Fire Protection*.

Flame-retardant material – a material is flame-retardant when it does not transmit flame and does not continue burning longer than specified during the test defined in 2.28.2 of IEC publication 60092-101.

Safe voltage – any voltage not causing potential danger of electric shock or burn in normal conditions. This condition is considered to be satisfied if the windings of transformers, converters and other devices stepping down voltage are isolated electrically, and if the value of the stepped-down voltage across these devices or sources of electric power does not exceed:
- 50 V between conductors for direct current,
- 50 V between conductors or between the hull and the phase for alternating current.

Emergency lighting – lighting of the ship's compartments and spaces by means of lighting fixtures fed from the emergency source of power or from the transitional source of emergency electric power.

Special electrical spaces – spaces or locations intended exclusively for electrical equipment and accessible only for authorized personnel.

Shaft generators – generators driven by the ship main propulsion plant supplying the ship power network or individual consumers on board the ship.

Lightning conductor – conductor which ensures connection of spike with earthing.

Rate-of-turn regulator – equipment which automatically produces and maintains a given rate of turn of the vessel in accordance with preselected values;

Zone 0 – areas in which dangerous explosive atmospheres of gases, vapours or sprays exist permanently or during long periods (see EN 600079-10).

Zone 1 – areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur occasionally (see EN 600079-10).

Zone 2 – areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur rarely and if so for short periods only (see EN 600079-10).

Protected area – the hold (see *zone 1*) and the area above the deck (see *zone 2*), restricted to:
- athwartships, by vertical planes corresponding to the side plating;
- fore and aft, by vertical planes corresponding to the end bulkheads of the hold and;
- upwards, by a horizontal plane 2.00 m above the upper level of the load, but at least by a horizontal plane 3.00 m above the deck.

Lightning protection zone – zone protected against direct lightning stroke.

Alarm system – the system intended to give warnings of conditions when deviations from the preset limits on the selected parameters or changes in normal working conditions occur.

Automatic system – a defined number of components, units and their connections forming structural and functional integrity, intended to perform control and monitoring functions.

Safety system – the system intended to intervene in a specific way upon the machinery controlled in order to prevent the failure of machinery or enlargement of its consequences.

Automatic control system – the system intended to control the machinery without human interference according to the specified control function.

Remote control system – the system intended to affect remotely the machinery in order to achieve control function given by the operator.

Indicating system – the system intended to indicate values of given physical quantities or significant states.

Monitoring systems – general term for alarm, safety and indicating systems.

Limited explosion risk electrical apparatus – an electrical apparatus which, during normal operation, does not cause sparks or exhibits surface temperatures which are above the required temperature class, including e.g.:
- three-phase squirrel cage rotor motors;
- brushless generators with contactless excitation;
- fuses with an enclosed fuse element;
- contactless electronic apparatus;
- means an electrical apparatus with an enclosure protected against water jets (degree of protection IP55).

Automated machinery – an engine, machinery, installation or other devices equipped with automatic or remote control systems.

Earthing – metallic connection of equipment terminal with the ship's metal hull.

Essential equipment – equipment which, under normal operation, ensures safe navigation, safety of cargo and safety of human life on board the ship.

Unit of automatic system – part of the automatic system consisting of a certain number of components forming structural and functional integrity.

Spike – the upper part of the lightning conductor designed for the direct receiving of lightning strokes.

1.3 Scope of Supervision

1.3.1 General Provisions

The general provisions relating to the classification procedure, supervision during ship construction, manufacture of equipment and to surveys, are specified in *Part I – Classification Regulations.*

1.3.2 Supervision of Electrical Installation in Ship

1.3.2.1 The following types of equipment and systems are subject to PRS supervision during installation on shipboard:

.1 main and emergency sources of electric power;

.2 power and lighting transformers and electric power converters used in equipment listed in 1.3.2.1;

.3 distribution gear and control and monitoring panels;

.4 electric drives for:

- **.1** machinery essential for the operation of propulsion engines,
- **.2** steering gear,
- **.3** controllable pitch propellers,
- **.4** windlasses, mooring and towing winches,
- **.5** starting air compressors and air compressors for sound signals,
- **.6** bilge and ballast pumps as well as cargo pumps on tankers;
- **.7** watertight doors and fire doors,
- **.8** pumps and compressors of the smothering system,
- **.9** ventilating fans in machinery spaces, cofferdams, cargo holds and hazardous rooms and spaces;

.5 main and emergency lighting of spaces and locations of essential machinery and means of escape;

.6 navigation lights;
.7 electric engine-room telegraphs;
.8 internal service communication;
.9 general alarm system;
.10 fire detection signaling and warning system indicating the release of the fire extinguishing medium;
.11 electrical equipment in hazardous rooms and spaces;
.12 cabling;
.13 earthing devices on oil tankers;
.14 lightning conductors;
.15 electrical heaters of fuel and lubricating oil;
.16 equipment, systems and electrical installations related to propulsion, control and signalisation of navigation:
- remote control of main engine;
- generating sets automatic control system;
- main propulsion safety system and engines driving generating sets;
- automatic system of pumps and machinery;
- machinery alarm system;

.17 other machinery and facilities as required by PRS.

1.3.2.2 Electrical equipment intended for domestic, living and technological application is to be supervised by PRS within the following scope:
.1 influence of this equipment operation on the ship's electric network parameters;
.2 choice of cable types, cable sections and the ways of running the cables;
.3 means of protection, insulation and earthing.

1.3.3 Supervision of Manufacture of Electrical Equipment

1.3.3.1 The following items of electrical equipment intended for systems and devices specified in 1.3.2.1 are subject to PRS supervision during manufacture:
.1 generating sets;
.2 generators and electric motors of rating 50 kW (kVA) and above;
.3 transformers above 3 kVA rating;
.4 switchboards;
.5 control and monitoring panels;
.6 electric couplings and brakes;
.7 switchgear, protection and control devices;
.8 rotary converters and power-electronic equipment;
.9 fuel and oil heaters;
.10 accumulators;
.11 cables and wires;
.12 sensors and controllers;
.13 power operated valves;
.14 servo-motors;
.15 amplifiers
.16 electric, hydraulic and pneumatic relays;
.17 logic components;
.18 other items of electrical equipment, as required by PRS. other machinery and facilities as required by PRS.

The use of equipment produced without PRS supervision is to be each time considered by PRS. It especially refers to heating, galleys and refrigerating appliances.

1.3.3.2 Each explosion-proof electrical equipment is to be supervised (with respect to its explosion proofness) by a special body recognised by PRS for this purpose, irrespective of whether or not this equipment is subject to supervision according to the requirements specified in 1.3.3.1.

1.4 Technical Documentation of a Ship

1.4.1 Classification Documentation of a Ship under Construction

1.4.1.1 Prior to the commencement of the ship construction, documentation is to be submitted to the PRS Head Office for consideration and approval:

- **.1** principle diagrams of power generation and distribution circuits of the main and emergency electric power sources: (power circuits, lighting circuits and navigation light circuits);
- **.2** specification of data on the circuits with indication of current values, the applied protective devices, as well as the types and cross-sectional areas of cables;
- **.3** principle diagrams and a general view of the main and emergency switchboards, ship's navigation control and monitoring console and other devices of non-standard design;
- **.4** choice of a number and output of generators necessary to provide operation of the ship in conditions specified in 3.1, 9.1.3 and 16.1.3.1;
- **.5** diagrams of internal communication and signaling;
- **.6** principle diagrams of essential electric drives according to 1.3.2.1.4;
- **.7** diagrams of remote switching-off ventilation, fuel pumps and lubricating pumps;
- **.8** diagrams of protective earthing, drawings and if necessary, calculation of lightning conductors for tankers carrying dangerous goods;
- **.9** principle diagram of cable passages with indication of compartments through which they pass;
- **.10** data on electrical equipment in spaces where explosion hazard exists with equipment specification in each space;
- **.11** calculation results of short-circuit currents on the main switchboard busbars and in the other points of electric network together with the selection of protective devices, for vessels where the current rating of generators exceeds 1000 A;
- **.12** arrangement plans of generators, switchboards, accumulator batteries and equipment of explosion-proof execution;
- **.13** diagram of emergency lighting with arrangement plans;
- **.14** classification documentation of shipboard automated machinery:
  - technical description including: specification of parameters covered by alarm, safety and automatic control systems;
  - functional diagrams of particular automatic systems with regard to the respective equipment, machinery and installations, giving information concerning: method of supply, functional features, structure, connections with other systems as well as the kind and limit values of parameters covered by these systems;
  - drawings of particular units of automatic systems such as desks, consoles, showing their arrangement of external and internal components, as well as their location on board the ship;
  - list of applied individual set of elements and devices with specification, purpose, type, producer and range of adjustment.

1.4.2 Workshop Documentation of a Ship under Construction

In the case of approval of the classification documentation mentioned in 1.4.1.1, the following workshop documentation is to be submitted to the relevant PRS Branch Office or Survey Station for agreement:

.1 test programme for ship's electrical equipment and automated machinery carried out alongside the quay and at sea trial;
.2 drawings of cabling and cable fastening.

1.4.3 Classification Documentation of a Ship under Conversion or Reconstruction

1.4.3.1 Prior to the commencement of conversion or reconstruction of a ship, documentation relating to installations, systems and equipment subject to conversion or reconstruction is to be submitted to the PRS Head Office for consideration and approval.

1.4.3.2 Where new machinery or arrangements, covered by the requirements of the *Rules*, are installed, or machinery installed differs substantially from those initially fitted, additional documentation, within the scope required for a new ship, is to be submitted to the PRS Head Office (see 1.4.1.1).

1.5 Technical Documentation of Equipment

1.5.1 Prior to the commencement of supervising the manufacture of electrical equipment, the following documentation is to be submitted to PRS for consideration:

.1 description of the principle of operation and the main characteristics;
.2 material specification which is to contain elements, instruments and materials used and their technical characteristics;
.3 assembly drawing with sections;
.4 circuit diagram;
.5 technical specifications and the test programme;
.6 the rotor shaft mechanical strength calculations, drawings of poles and commutator fastenings for machines of rating 50 kW (kVA) and above;
.7 for distribution switchboards – calculation of thermal and electrodynamic strength of busbars under short-circuit conditions and the choice of apparatus to fit these conditions where the current rating of a generator or generators running in parallel exceeds 1000 A;
.8 for generating sets – selection of output of internal combustion engine for generator, list of sensors and their limit values, as well as calculation of torsional vibrations;
.9 data on static or dynamic interference resistance, or the means of testing the electro-magnetic compatibility;
.10 definite means of interference damping.

Where necessary, PRS may require that additional documentation and data on reliability should be submitted.

1.6 Documentation Obligatory on Existing Vessel

1.6.1 The following documents should be on board:

- description of electrical installation and a set of manuals for electrical devices,
- principle diagrams of electrical installation approved by PRS, including:
  - type of machines and electrical equipment, their power,
  - type and cross-section of cables,
  - set-points of protective devices and rating currents,
- in addition, for vessels with ADN sign, documents listed in 16.2.1.1.

2 GENERAL REQUIREMENTS

2.1 Operating Conditions

When designing, selecting and arranging electrical equipment, the operating conditions specified in 2.1.1 ÷ 2.1.4 are to be taken into account.

2.1.1 Climatic Hazards

2.1.1.1 The temperature values specified in Table 2.1.1.1 are to be taken as the rated ambient air temperature for electrical equipment.

Table 2.1.1.1

No.	Location in the ship	Ambient air temperature, [°C]
1	Machinery spaces, special electrical spaces, galleys	from 0 to +40*
2	Open decks and spaces	from –20 to +40*
3	Other spaces	from 0 to +30

* For tropic zone ambient temperature equal to 45ºC is to be accepted.

2.1.1.2 Electrical equipment is to be capable of correct operation at a relative air humidity 80 ± 3% and a temperature of +40 ± 2°C or at a relative air humidity of 95 ± 3% and a temperature of + 25 ± 2°C.

2.1.2 Mechanical Hazards

2.1.2.1 Electrical equipment is to be capable of correct operation at vibrations with a frequency of 2 Hz to 100 Hz, as follows:
– at a frequency from 2 Hz to 13.2 Hz with displacement amplitude ±1.0 mm;
– at a frequency from 13.2 Hz to 100 Hz with acceleration amplitude ±7 m/s^2.

Electrical equipment intended to be installed in locations in which specific severe vibration conditions prevail (e.g. internal combustion engines, compressors) or to be installed in the steering gear compartment is to be capable of correct operation at vibrations with a frequency of 2 Hz to 100 Hz, as follows:
– at a frequency from 2 Hz to 25 Hz with displacement amplitude ±1.6 mm;
– at a frequency from 25 Hz to 100 Hz with acceleration amplitude ±40 m/s^2.

2.1.2.2 Electrical equipment is to be capable of reliable operation in the conditions as that ship can be, as follows:
– long-term incline up to 15°,
– long-term trimming up to 5°.

Emergency equipment is also to be capable with the ship continuously inclined up to 22.5° transversely or up to 10° of trimming.

2.1.2.3 Electrical equipment is to have adequate mechanical strength and is to be so located that it is not exposed to a risk of mechanical damage.

2.1.3 Power Supply Parameters

2.1.3.1 Electrical equipment is to be so designed that it remains operative under steady conditions in all cases, at all deviations from the rated supply voltage and frequency specified in Table 2.1.3.1.

Table 2.1.3.1

Parameter	Deviations from rated values		
	Prolonged, [%]	Transient	
		Value, [%]	Time, [s]
Voltage	+6 to –10	± 20	1.5
Frequency	± 5	± 10	5

Note: Where the source of power supply is an accumulator battery, the following prolonged deviations of voltage are to be taken:
- from +30% to –20% for equipment connected to the battery during charging;
- from +20% to – 0% for equipment not connected to the battery during charging.

2.1.4 Electromagnetic Compatibility (EMC)

2.1.4.1 Where PRS required, electrical installations and equipment should be tested in accordance with *Publication No. 11/P – Environmental Tests on Marine Equipment*.

2.2 Materials

2.2.1 Construction Materials

2.2.1.1 The structural parts of electrical equipment are to be made of metal or at least of hardly combustible insulating materials, resistant to humidity and oil vapour effects, or they are to be reliably protected against such effects.

2.2.1.2 Screws, nuts, hinges and similar items designed to fasten enclosures of the electrical equipment to be installed on weather decks or in spaces with higher than normal humidity are to be made of corrosion-resistant materials or are to have effective corrosion-resistant covering.

2.2.2 Insulating Materials

2.2.2.1 Insulating materials of live parts are to have adequate dielectric and mechanical strength, resistance to creepage currents, moisture and oil vapour or else they are to be suitably protected.

At the rated load, the temperature of the parts carrying current and the points of their connections is not to be greater than the permissible temperature of the applied insulating material.

2.2.2.2 Uninsulated parts of electrical equipment are to be cooled by incombustible liquids only.

2.2.2.3 For winding insulation in machines, apparatus and other equipment insulating materials of at least Class E are recommendable.

2.2.2.4 Conductors used in electrical devices for internal connections are to have insulation made of materials rated at least as hardly combustible. For apparatus with increased heating, as well as those specified in Chapter 13 – of incombustible materials.

2.2.2.5 Insulating materials used for manufacturing cables are to comply with the requirements specified in 14.3.

2.3 Design Requirements and Degrees of Enclosures Protection

2.3.1 General Requirements

2.3.1.1 Parts which may require replacement while in service are to be easily dismountable.

2.3.1.2 Where screw fastenings are employed, measures are to be taken to exclude self-loosening of screws and nuts or, where dismantling and opening are at frequent occurrence, loss of some.

2.3.1.3 Gaskets used in conjunction with electrical equipment components (such as doors, covers, sight holes, packing glands, etc.) are to be appropriate to the degree of enclosure protection of the equipment in question.

Gaskets are to be secured to the covers or casings.

2.3.1.4 Enclosures, shields and covers of electrical equipment installed in places accessible to unauthorised persons, protecting against access to live parts, are to be opened only with the use of tools.

2.3.1.5 Water drainage arrangements are to be provided in electrical equipment where condensation is likely to occur. Channels are to be fitted inside the equipment to ensure condensate drainage from all equipment components. Windings and live parts are to be so arranged or protected that they are not exposed to the effect of condensate which may accumulate inside the equipment.

2.3.2 Insulation Clearances

2.3.2.1 Clearances between live parts of different potentials, or between live parts and earthed metal parts or an outer enclosure, both in the air and across the insulated surface, are to be in accordance with the operating voltage and operating conditions of the installation, the properties of the insulating materials used being taken into account.

2.3.3 Internal Connections

2.3.3.1 Stranded conductors are to be used for all the internal wiring in electrical equipment. The use of single-wire conductors will be specially considered by PRS in each particular case.

2.3.3.2 The conductors to be used for the internal wiring switchboards, control and monitoring desks and other distribution and switching gear are to have the cross-sectional area of not less than 1 mm^2. For control, protection, measurement of parameters, signaling and internal communication circuits, conductors with cross-sectional area of not less than 0.5 mm^2 may be used.

For electric and electronic circuits transforming and transmitting low-current signals, conductors with cross-sectional area of less than 0.5 mm^2 may be used, which will be specially considered by PRS in each particular case.

2.3.3.3 Current-carrying parts are to be so attached as not to transmit any additional mechanical stresses; such parts are not to be attached by means of screws fitted directly into insulating materials.

2.3.3.4 Stranded cores, cables and conductors are to have their ends fitted out to suit the type of terminal used, or are to be provided with lugs.

2.3.3.5 Insulated conductors are to be laid out and secured in such a manner that the method used for their attachment and arrangement does not lead to reduced insulation resistance and that they are not exposed to damage due to dynamic loads caused by vibrations or shocks.

2.3.3.6 The connection of insulated conductors to terminals and busbars is to be so effected that, under rated operating conditions, the insulation of conductors is not exposed to overheating.

2.3.3.7 Terminals for more than 50 V are to be separated from terminals for less than 50 V and clearly marked.

2.3.4 Degrees of Enclosures Protection

2.3.4.1 Electrical equipment is to be provided with appropriate protective enclosures depending on their location or other suitable measures are to be taken to protect the equipment from a harmful effect of the environment and to protect the personnel from electric shock hazards.

2.3.4.2 The minimum degree of protection of electrical equipment installed in rooms and spaces of the ship is to be chosen in accordance with Table 2.3.4.2.

Table 2.3.4.2

No.	Place of electrical equipment location	Conditions in equipment location	Ingress protection according to EN 60529
1 2	Dry accommodation spaces Dry control rooms	Danger of touching live parts only	IP20
3 4 5	Rooms on the bridge Engine and boiler rooms above floor Steering gear rooms	Danger of dripping liquid and/or moderate mechanical damage	IP22
6	Bathrooms and showers	Increased danger of liquid occurrence and/or mechanical damage	IP34
7 8	Engine and boiler rooms below floor Galleys and laundries	Increased danger of liquid occurrence and mechanical damage	IP44
9	Holds	Danger of liquid spraying and serious mechanical damage	IP55
10	Open decks	Danger of occurrence of liquid in massive quantities	IP56

Note: Where the protection is not achieved by the equipment enclosure itself, other means or the location where it is installed, shall ensure the degree of protection required in the Table.

2.4 Earthing of Non-current-carrying Metal Parts

2.4.1 Parts Subject to Earthing

2.4.1.1 Metal enclosures of electrical equipment designed for higher than the safety voltage, having no double or reinforced insulation, are to be fitted with an earth terminal marked with the symbol:

Depending on the purpose of the electrical equipment, provision is to be made for its earthing from inside or from outside.

2.4.1.2 The metal parts of electrical equipment which are likely to be touched under service conditions and which may become live in the event of damage to the insulation (except those mentioned in 2.4.1.3), are to have a reliable electric contact with a component fitted with an earth terminal (see also 2.4.3).

2.4.1.3 Protective earthing against electric shock hazard is not required for:

.1 electrical equipment supplied with current at safety voltage;

.2 electrical equipment provided with double or reinforced insulation;

.3 metal parts, which are fully covered by insulation material, or in the case of not such a covering, they are isolated in such a manner that under normal operating conditions these parts cannot happen to be live or get in contact with the earthed parts;

.4 cages of specially insulated bearings;
.5 lamp bases, lamp holders and fasteners for luminescent lamps, lamp shades and reflectors, covers fastened to lamp holders or to lighting fixtures made of an insulating material or screwed into such a material;
.6 cable hangers and brackets;
.7 single sets of 250 V supplied by a separating transformer.

2.4.1.4 The screens and metal sheaths of cables are to be earthed.

2.4.1.5 The secondary windings of all measuring current and voltage transformers are to be earthed.

2.4.1.6 Fuel oil tanks which do not form an integral part of hull shall be earthed.

2.4.2 Earthing of Aluminium Superstructures in Steel Ships

Superstructures of aluminium alloys fastened to the ship's steel hull, but insulated from it, are to be earthed with a special conductor having a cross-section not less than 16 mm^2 which is to be corrosion-resistant and such that will not start electrolytic corrosion at the point of contact of the superstructure with the hull.

Such earthing connections are to be effected with at least two conductors provided at different locations situated opposite each other, accessible for inspection and suitably protected from damage.

2.4.3 Earthing Terminals and Earthing Wires

2.4.3.1 Bolts for fastening the earthing wire to the ship's structure are to have a diameter not less than 6 mm; only for fastening wires with a cross-section of up to 2.5 mm^2 and wires with cross-section of up to 4 mm^2, bolts of 4 mm and 5 mm in diameter, respectively, may be used. These bolts are not to be used for other purposes than fastening the earthing wires. Bolts which are screwed to a material (without nuts), are to be made of brass or other corrosion-resistant material.

The surface of ship's structure to which the earthing wire is connected is to be metallically clean and adequately protected against corrosion.

2.4.3.2 Fixed electrical equipment is to be earthed by means of external earthing wires or an earthing conductor in the feeding cable.

If earthing is made by means of one of the cores of the feeding cable, the core is to be connected to the earthed part of the equipment inside its enclosure.

Special earthing need not be provided if the fastening of equipment ensures reliable electrical contact between the equipment enclosure and the ship's hull under all operating conditions.

For the purpose of earthing effected with an external earthing wire, copper wire is to be used. Wire of any other corrosion-resistant metal may also be used, provided the resistance of this wire does not exceed that of the required copper wire.

The cross-section of copper earthing wire is not to be less than that specified in Table 2.4.3.2.

Table 2.4.3.2

Cross-section of cable connected to appliance, [mm^2]	Minimal cross-section of earthing conductor, [mm^2]	
	Earthing conductor the feeding cable	External earthing wire
up to 4	cross-section of the conductor	4
over 4 to 16	cross-section of the conductor	cross-section of the conductor
over 16 to 35	16	16
over 35 to 120	half the cross-section of a cable conductor	half the cross-section of a cable conductor
over 120	70	70

2.4.3.3 Earthing of the movable and portable appliances is to be effected through the earthed jack of a socket outlet or other earthed connecting elements and through the earthed copper core of the feeding cable.

Cross-section of the earthing core is not to be less than the nominal cross-section of the core in the flexible feeding cable for cables up to 16 mm^2 and at least half the cross-section of the core in the flexible feeding cable, but not less than 16 mm^2 for cables over 16 mm^2.

2.4.3.4 Earthing wires or earthing conductors of cables in fixed equipment are not to be disconnected without necessary tools.

2.4.3.5 Earthing of screens and metal sheaths of cables is to be effected by one of the following methods:

.1 by a copper earthing wire having a cross-section not less than 1.5 mm^2 for cables with a cross-section up to 25 mm^2 and not less than 4 mm^2 for cables with a cross-section over 25 mm^2;

.2 by a suitable fastening of the metal sheath or armour of cables to the metal hull of the ship;

.3 by means of rings in the cable glands, provided they are corrosion-resistant, well conducting and resilient.

The earthing is to be effected at both ends of a cable, except cables in final sub-circuits which are permitted to be earthed on the supply end only. Where the methods specified above cause failures in the equipment operation, the screens, metal sheaths and armour of cables may be earthed by other approved or arranged by PRS means.

2.4.3.6 The external earthing wires are to be accessible for inspection and are to be protected against getting loose and against mechanical damage.

2.5 Lightning Protection

2.5.1 General Requirements

2.5.1.1 The ship is to be fitted with a lightning protection, the protection zone of which should comprise all arrangements that require protection against lightning.

When a ship is exposed to the risk of fire or explosion due to after-effects of lightning, the earthing installation which would preclude secondary sparking is to be provided.

2.5.1.2 The lightning installation is to consist of a spike, lightning conductors and earthing. On metal masts, the lightning conductors need not be fitted if provision is made for a reliable electrical connection of the mast to the metal hull or to the earthing point.

2.5.2 Spike

2.5.2.1 In metal ships, such vertical structures as masts, superstructures, etc. are to be used as spikes if provision is made for their electrical connection to the ship's hull. Additional spikes may be used only in such cases in which the structural elements do not form the required protection zone.

2.5.2.2 If electrical equipment is installed on top of a metal mast, a lightning spike having a reliable connection with the mast is to be provided.

2.5.2.3 On each mast or topmast made of non-conducting material, a proper lightning installation is to be fitted.

2.5.2.4 Spikes are to be made of a rod of at least 12 mm in diameter. The rod may be of copper, copper alloys or steel suitably protected against corrosion; for aluminium masts, the spike may be made of an aluminium rod.

2.5.2.5 The spike is to be fitted to the mast in such a way as to project at least 300 mm above the top of the mast and any equipment fitted on its top.

2.5.3 Lightning Conductor

2.5.3.1 The lightning conductor is to be made of a rod, flat bar or metal rope having a cross-section not less than 70 mm^2 for copper or its alloys and not less than 100 mm^2 for steel, the steel lightning conductors being suitably protected against corrosion.

2.5.3.2 Lightning conductors are to be run on the outer side of the mast and superstructures and as straight as possible with a minimum number of bends which should be smooth and have the largest possible radii.

2.5.3.3 Lightning conductors are not to pass through explosion-hazardous spaces.

2.5.4 Earthing

2.5.4.1 In composite ships, the metal stem or other metal structures immersed in water under all conditions of sailing may be used as earthing.

2.5.4.2 Provision is to be made for earthing the ship's steel hull when the ship is in a dry dock or on a slipway.

2.5.5 Connections in the Lightning Installation

2.5.5.1 Connections in the lightning installation are to be welded, clamped, riveted or bolted with clamps.

2.5.5.2 The contact area of connections is to be at least 1000 mm^2.

Clamps and bolts are to be made of copper, copper alloys or steel suitably protected against corrosion.

2.5.5.3 Connections in the lightning installation should be accessible for inspection and protected against mechanical damage.

2.6 Arrangement of Equipment

2.6.1 Electrical and automation equipment is to be installed in such a manner as to provide convenient access to control elements and to all parts that require maintenance, inspection and replacement.

2.6.2 The air-cooled electrical equipment is to be so located that cooling air is not drawn in from bilges or other spaces in which the air may be contaminated with substances having a harmful effect on insulation.

2.6.3 The electrical equipment placed in locations subject to vibrations and shocks (heavier than those specified in 2.1.2.1) which are impossible to eliminate is to be so designed as to be capable of normal operation under such conditions or is to be mounted on shock absorbers.

2.6.4 The electrical equipment is to be fixed in position in such a manner that the fastening method does not reduce the strength or tightness of hull plating, deck or bulkhead.

2.6.5 Open live parts of electrical equipment are not to be situated closer than 300 mm horizontally and 1200 mm vertically to non-protected combustible materials.

2.6.6 When installing electrical equipment having enclosures made of material other than that used for the ship's structures, suitable means to prevent electrolytic corrosion are to be provided, where necessary.

2.7 Special Electrical Spaces

2.7.1 The doors of special electrical spaces are to be locked with a key. These doors are to open outwards. Doors leading to corridors and passageways may open inwards, provided that suitable stops are fitted. A warning plate is to be placed on the doors. From the inside, the doors are to open without the use of a key.

2.7.2 Special electrical spaces are not to be adjacent to the tanks filled with flammable liquids.

If this requirement is impracticable from the structural point of view, no fittings or pipeline connectors are to be fixed on the tanks within these spaces.

2.7.3 No exits, opening side-scuttles or other outlets are permissible from special electrical spaces into rooms and spaces subject to explosion hazard.

2.7.4 Handrails made of insulation material are to be installed in special electrical spaces, in passageways and servicing areas of open-type electrical equipment.

2.8 Electrical Equipment in Hazardous Rooms

2.8.1 The requirements of the present section apply to electrical equipment installed on all ships where in enclosed and semi-enclosed rooms and spaces explosive mixtures of vapour, gases and dust with air may accumulate.

The following areas may be classified as hazardous rooms: accumulator battery rooms, lamp rooms, paint rooms, holds classified as explosion-hazardous and tunnels for pipes containing oil with a flash-point of 60 ºC or below.

Additional requirements for the installation of electrical equipment installed on ships with ADN class mark are specified in 16.2 and 16.3.

2.8.2 In hazardous spaces and rooms, only electrical equipment of explosion- proof construction according to space category, temperature class and the ignition group of mixture, may be installed.

2.8.3 Each explosion-proof electrical equipment is to be supervised (with respect to its explosion proofness) by a special body recognised by PRS for this purpose, irrespective of whether or not this equipment is subject to supervision according to the requirements specified in 1.3.3.1.

2.8.4 In rooms where dust with air may produce explosive mixtures, electrical equipment is allowed to be installed, provided it has an enclosure protection of at least IP65.

In spaces where dust with air may temporarily produce explosive mixtures only as a result of damage to an enclosure or untightness of technological equipment under operation, as well as in the case of interruptions in operation of a ventilation system, electrical equipment having an enclosure protection of IP55 may be installed.

Electrical equipment installed in those rooms is to be so designed that the temperature of its upper horizontal surfaces or of those inclined at an angle not exceeding 60° to the horizontal is at least 75 °C below the smouldering point of the dust existing in these rooms under conditions of continuous operation (the smouldering point is to be determined for a layer of dust 5 mm thick).

2.8.5 Lighting fixtures of explosion-proof construction are to be installed in such a manner that, except the fastening points, a free space of at least 100 mm is left around.

2.8.6 All devices, except fire detection devices, installed in hazardous rooms and spaces, are to be fitted with switches, protection devices or starters capable of switching off all poles or phases located outside hazardous rooms and spaces.

2.8.7 Fastening of electrical equipment to the walls of tanks intended for flammable liquids is not permitted. The distance between electrical equipment and the tank walls is to be at least 75 mm.

2.8.8 In enclosed and semi-enclosed rooms which do not contain vapours or gases that could cause an explosion, but which have openings into hazardous rooms and spaces, as a rule, electrical equipment of explosion-proof construction is to be installed.

Electrical equipment of non-explosion-proof construction is allowed to be installed if the following conditions are met:

.1 interruption in operation of a ventilation system gives an alarm signal (audible and visual) and switches off the power supply to electrical equipment (with a time delay, if necessary);
.2 interlocking device is provided to ensure that electrical equipment cannot be switched on until the room is ventilated enough (air in the room is to be changed at least 10 times).

2.8.9 In cargo holds for the carriage of cargoes in containers, subject to explosion hazard, electrical equipment and cables are not to be installed. If the installation of electrical equipment is necessary, it is to be of explosion-proof construction, i.e. of intrinsically safe type (Exi), ventilated type or with pressurized enclosures (Exp), with flameproof enclosures (Exd) or of increased safety type (Exe).

In cargo holds intended for the occasional carriage of the above-mentioned cargoes, electrical equipment of non-explosion-proof construction may be installed, provided it is possible to disconnect completely the equipment by removal of special links, other than fuses, for the duration of the carriage of cargoes subject to explosion hazard.

2.8.10 In hazardous spaces and rooms, only cables intended for electrical equipment located in these spaces and rooms are to be installed.

Cables passing through the above-mentioned rooms and spaces may be installed, provided the requirements specified in 2.8.11 to 2.8.15.

2.8.11 Cables installed in hazardous rooms and spaces are to be sheathed with one of the following:

.1 metal armour or braid with non-metallic covering; or
.2 lead sheath plus further mechanical protection; or
.3 copper or stainless steel sheath (for mineral insulated cables only).

2.8.12 Cables passing through hazardous rooms and spaces are to be protected against mechanical damage.

2.8.13 All metal sheaths and armour of the power supply cables of electric motors and lighting circuits passing through hazardous rooms and spaces, or supplying electrical equipment located in these rooms and spaces, are to be earthed at least at both ends.

2.8.14 Cables associated with intrinsically safe circuits are to be used for one device only and are to be separated from other cables.

2.8.15 No cables of portable electrical equipment are to pass through hazardous rooms and spaces, except cables associated with intrinsically safe circuits.

3 MAIN SOURCE OF ELECTRIC POWER

3.1 Components and Main Source of Electric Power

3.1.1 Each ship is to be provided with main source of electric power of sufficient capacity to supply all essential services of the ship in conditions specified in 3.1.3. The source of electric power can be:

– generators with an independent prime mover;
– shaft generators;
– accumulator battery.

3.1.2 The number and the capacity of the generating sets and power converters composing the main source of electric power are to fulfil the following conditions:

.1 supply the essential services, mentioned in 3.1.3;
.2 start the electric motor with maximum starting current under the most severe starting conditions, with no such drop in voltage or frequency that might cause a fall out of synchronism or a stop of the generator prime mover, or switching off the running machines and apparatus;

3.1.3 The number and the capacity of the main source of electric power are to be determined with regard to the following operating conditions of the ship:

.1 running conditions;
.2 manoeuvring;
.3 other – according to the ship's assignment;
.4 and a time of day, simultaneity factors and type of service electrical devices.

3.1.4 If the main source of electric power are accumulator batteries, their capacity is to be sufficient to satisfy the requirements specified in 3.1.2.1 for 3 hours without recharging.

3.1.5 Shaft generator may be used as main source of electric power, if the following conditions are met:

.1 the shaft generator is driven by a main engine running with a constant rotary speed;

.2 there is a possibility of starting the ship's main engine in the event of failure of a generating set with independent prime mover;

.3 additional source of power, required by 3.1.11, is independent of running main engine.

3.1.6 Generators are to be provided with voltage regulation within limits specified in 10.2 and 10.3.

3.1.7 The regulator characteristics of prime movers used to drive alternating-current generators intended to operate in parallel are to be such that within 20 to 100 per cent of rated load the active loads of the generators do not differ from the proportional outputs of the individual generators by more than 15 per cent of the active output of the largest generator operated in parallel or 25 per cent of the active output of the given generator, whichever is the smaller.

Alternating-current generating sets intended to operate in parallel are to be provided with a device for precise regulation of the load change within the range not exceeding 5 per cent of the rated power at the rated frequency.

3.1.8 Alternating-current generating sets intended to be run in parallel are to be provided with such a reactance drop compensating system that when the sets are run in parallel, the reactive load sharing between the generators does not differ from a value proportional to their output by more than 10 per cent of the rated reactive load of the largest generator, or 25 per cent of the smallest generator, whichever is the smaller.

3.1.9 Where alternating-current generators are intended to operate in parallel, a synchronizer is to be installed in the main switchboard. Where synchronizing is arranged to operate automatically, a stand-by manual synchronizer is to be provided.

Lamps for manual synchronizing are to be provided irrespective of whether or not synchronoscopes have been fitted.

3.1.10 Where a generator and accumulator battery run parallel, the generator is to be fitted with a voltage regulator that can not allow to run down the accumulator battery.

3.1.11 Each vessel is to be provided with additional source of power of such capacity, that in a case of failure one of them, the additional one is to be efficient to supply equipment necessary to ensure the safety of the ship and manoeuvrability at least for 30 minutes.

3.1.12 The use of other source of electric power will be specially considered by PRS in each particular case.

3.2 Power Supply from an External Source of Electric Power

3.2.1 If provision is made for the ship's network to be supplied from an external source, a terminal for power supply from an external source of electric power is to be installed in the vessel.

The external supply terminal is to be connected to the main switchboard by permanently fixed cables.

It is allowed, subject to PRS' agreement, to connect the cable supplying the ship's network from an external source of electric power directly to the main switchboard.

3.2.2 The terminal for power supply from an external source of electric power is to be provided with:

.1 suitable clamps to connect flexible cables;

.2 switchgear and protective devices; where length of the cable between the main switchboard and the terminal is less than 10 m, the terminal need not be provided with protection;

.3 a voltmeter or signal lamps to show the presence of voltage on terminals;

.4 a device or a possibility of connecting a device for checking the polarity and the phase sequence;

.5 clamps for earthing the neutral run from the external source;

.6 a plate indicating voltage level, kind of current and frequency;

.7 at the external supply terminal or nearby, a device for mechanical fastening of the flexible cable led to the terminal and cable hangers are to be provided.

3.2.3 If provision has not been made for parallel operation between the shore electric power sources and those fitted on board, except the required time the connection system is to be provided with interlocking to prevent the connection of these sources for parallel operation.

3.2.4 Instead of the shore connection a plug-in socket may be used if the current does not exceed 63 A and the following requirements are fulfil:

.1 the flexible wire used as a shore connection is to be ended with a plug on the shore side and a socket on the ship side, for safe voltage plugs may be used on both sides, but the enclosure is to prevent short circuit, when touch a metal deck.

.2 a connector is to be installed near the plug-in socket that is possible to connect in current less conditions;

.3 the plug-in sockets fulfil requirements specified in section 12.2.4 and cross-sectional earth cable or natural cable in 2.4.3.3;

The above requirements are not to be applicable to cargo ships intended to carry explosive materials.

3.2.5 When other ships are to supply the electric power (generated on board or taken from external source), the plug-in sockets may be used. For voltages exceeding the safe voltage, power cables are to have a plug (at the source side) and a socket (at the end side).

3.2.6 In the case of power supplying other vessels a junction box for power cables is to be fitted with a connector or short-circuit and overload protection. For voltage exceeding the safe voltage and/or current more than 16 A, a connector that is able to connect in current less conditions is to be installed.

3.2.7 For supplying vessels in pushing sets the plug-in socket may be used.

Means to prevent closing voltage are to be used in supply circuits of pushing sets for voltage exceeding the safe voltage, in the case of a lack of connection or incorrect plug the plug-in sockets as well as in the case of disconnection pushing sets.

3.2.8 For external supply only flexible, fire-resisting and cables that withstand the action of water and oil are to be used.

4 DISTRIBUTION OF ELECTRIC POWER

4.1 Distribution Systems

4.1.1 The following systems of electric power distribution may be used in shipboard installations:

.1 for direct current and single-phase alternating current:

.1.1 two-wire insulated system;

.1.2 two-wire system with one pole earthed;

.1.3 single-wire system with hull return restricted to local installations (e.g. to start up internal combustion engines, for the hull cathode protection);

.2 for alternating current:

.2.1 four-wire system with neutral earthed but without hull return;

.2.2 three-phase insulated system;

.2.3 three-phase with hull return, except final sub-circuits.

4.1.2 The use of other systems is subject to consideration by PRS in each particular case.

4.1.3 Heating appliances and lighting are to be insulated from the hull in the system with hull return. Earthing connection between a pole or phase to the hull are to be done in the main or group switchboard in such a manner that disconnection the earthing wire is easy and insulation measurement is to be performed. The earthing wire cross-section is to be not less than the cross-section of supplying wire.

4.1.4 The systems with hull return and the system when the neutral cable is earthed are not to be used on vessels assigned to carry dangerous goods and vessels subject to ADN Rules.

4.1.5 The systems with hull return are not to be applied to vessels with aluminium hulls.

4.1.6 All phases or poles are to be isolated for supplying pushing sets.

4.1.7 In three-phase alternating current systems group of consumers are to be connected in such a manner that currents in individual phases are not to vary more than 15% for each phase.

4.1.8 Two-wire insulated systems are to be used in internal communication and signals, described in Chapter 7.

4.2 Permissible Voltages

4.2.1 Rated voltage of generator may be 5% higher that rated voltage of consumers.

4.2.2 The permissible rated voltages across the terminals of alternating current-consuming appliances are not to exceed the values specified in Table 4.2.2.

Table 4.2.2

Type of consumers	Permissible Voltage		
	Direct current	Alternating current single-phase	Alternating current three-phase
A. Power consumers, heating appliances permanently installed.	250 V	250 V	500 V
B. Lighting, signaling, and internal communication devices fitted permanently.	250 V	250 V	–
C. Sockets intended to supply portable devices used on open decks or within narrow or damp metal lockers, apart from boilers and tanks.			
.1 with or without a circuit-separation transformer,	50 V	50 V	–
.2 with a circuit-separation transformer only supplies one appliance (both conductors are to be isolated from earth),	–	250 V	–
.3 where protective-insulation (double insulation) appliances are used.	250 V	250 V	–
D. Sockets intended to supply containers, mobile pumps and blowers earthed by means of a protective conductor that is incorporated into connecting cable.	250 V	250 V	500 V
E. Sockets intended to supply portable appliance used inside boilers and tanks.	50 V	50 V	–

4.2.3 The plug-in sockets for voltage higher than safe voltage and installed in damp spaces are to be labelled with information that consumers with double or strengthen insulation or supply by separation from the voltage higher than the safe voltage may be used.

4.2.4 The use of higher voltages is subject to consideration by PRS in each particular case.

4.3 Power Supply to Essential Services

4.3.1 The following consumers are to be supplied with electric power by separate feeders from the main switchboard busbars:

- **.1** steering gear electric drives;
- **.2** windlass electric drives;
- **.3** fire pump electric drives;
- **.4** bilge pump electric drives;
- **.5** navigation lantern switchboard;
- **.6** section switchboard of the main lighting;
- **.7** section switchboards of other essential services concentrated in accordance with similar functions performed;
- **.8** switchboard of the ship's control and monitoring desk;
- **.9** control system of controllable pitch propellers;
- **.10** electric drives of active means of steering the ship (e.g. bowthrusters, propellers, stabilizers, etc.);
- **.11** chargers of starting batteries and of batteries supplying essential services;
- **.12** other consumers which will be specially considered by PRS in each particular case.

4.3.2 The consumers specified in .5, .6, .7 and .9 may be supplied from switchboard of the ship's control and monitoring desk by separate circuits equipped with switchgear and protective devices.

4.3.3 Final sub-circuits having a current rating in excess of 16 A are to supply no more than one consumer.

4.3.4 Drivers of essential services are to be supply by separete final circuits.

4.3.5 Power supply to automation systems is to comply with the requirements specified in 15.3.

4.4 Power Supply to Ship's Navigation Control and Monitoring Consoles

4.4.1 When locating the electrical equipment, navigational equipment, radio equipment, automatic and remote control equipment for the main and auxiliary machinery in the console, such equipment is to be supplied by separate feeders.

It is permitted to supply the equipment specified in 4.3.1 from the switchboards built into ship's navigation control and monitoring console, provided requirements of paragraphs from 4.4.2 to 4.4.5 are met.

4.4.2 The switchboards of control and monitoring console are to be supplied by two separate feeders from the main switchboard directly or through a transformer or by one feeder from the main switchboard and by one feeder from the emergency switchboard if the generating set is the emergency source of energy.

4.4.3 The switchboard is to be provided with a change-over switch for feeders specified in 4.4.2. If an automatic change-over switch is used, manual switching of feeders is also to be ensured. In this case, provision is to be made for appropriate interlocking.

4.4.4 Each consumer specified in 4.3.1, supplied from the switchboard of control and monitoring console, is to be supplied by a separate feeder.

4.4.5 In the control and monitoring console, a visual signaling device indicating the presence of voltage is to be fitted.

4.4.6 Signaling lamps for essential services shall be provided with the means for checking their correct operation, e.g. "lamp test" button.

4.4.7 Monitoring instruments shall be easily legible. Provision shall be made for possibility of the indicators illumination intensity adjustment without the possibility of their switching off. Light sources shall be neither intrusive nor impair the legibility of the monitoring instruments.

4.5 Distribution Switchboards

4.5.1 Switchboard Constructions

4.5.1.1 The frames, front panels and casings of switchboards are to be made of metal or some other incombustible material.

4.5.1.2 Switchboards are to be of rigid construction capable of withstanding the mechanical stresses liable to occur under service conditions or as a result of short-circuits.

4.5.1.3 Switchboards are to be at least protected from drip. This protection is not required if the switchboards are to be located in spaces where the conditions are such that no vertically falling drops of liquid can get into the switchboard.

4.5.1.4 Switchboards intended to be installed in places accessible to unauthorized persons are to be provided with doors to be opened with the use of a special key, the same for all the switchboards in the ship.

4.5.1.5 The design of the switchboard doors is to be such that with the doors opened access is assured to all parts which require maintenance; live parts installed on the doors are to be protected against accidental touch.

Opening panels and doors, on which electrical control devices and measuring instruments are located, are to be securely earthed with at least one flexible connection.

4.5.1.6 The generator panels of main switchboards are to be provided with lighting fittings supplied on the side of the generator, but before its main circuit-breaker.

4.5.1.7 The lighting fittings on the front side of switchboard panels are to be so arranged as not to interfere with instrument observation or produce a blinding effect.

4.5.1.8 The design of wall switchboards is to be such as to provide access to parts which require attendance.

4.5.2 Busbars and Bare Conductors

4.5.2.1 The permissible values of temperature rise due to rated loads and short-circuits for switchboard busbars and bare conductors, or of one-second short-circuit load for copper busbars, are to be taken in accordance with the relevant norms.

4.5.2.2 Equalizer busbars are to be designed for at least half the rated current of the largest-size generator connected to the main switchboard.

4.5.2.3 Where the busbar is in contact with or close to insulated parts, its heat effects under operating or short-circuit conditions are not to cause a temperature rise in excess of that allowable for a given insulating material.

4.5.2.4 Busbars and bare conductors of different polarity are to be marked with the following distinguishing colours:

.1 red for the positive pole;
.2 blue for the negative pole;
.3 black or yellow and green stripes for earth connections;

The equalizer connection is to be marked the appropriate colour as given above and in addition with white stripes.

4.5.2.5 Busbars and bare conductors of different phases are to be marked with the following distinguishing colours:

.1 yellow for phase 1;
.2 green for phase 2;
.3 violet for phase 3;
.4 light-blue for neutral wire;
.5 yellow and green stripes for earth connections.

4.5.2.6 Busbar connections are to be made in such a way as to preclude corrosion in places of connection.

4.5.3 Selection of Apparatus and Short-circuit Currents Calculation

4.5.3.1 Electrical apparatus are to be so selected that under normal service conditions their rated voltages, load and temperature rise limits are not exceeded. The apparatus are also to be capable of withstanding, without damage or reaching dangerous temperature, the prospective overloads and currents in transient conditions.

Short-circuit protective equipment is to conform to specific conditions of the ship's electrical network and in particular:
– power factor at short-circuit in alternating current networks,
– sub-transient and transient components of short-circuit current.

The following cases of the short-circuits are to be taken into consideration:
– on the generator side,
– on the busbars of the main switchboard,
– on the busbars of the emergency switchboard,
– on the consumers and switchboards supplied directly from the main switchboard.

Calculation of the minimal short-circuit current is to be carried out only if it is necessary for estimation of the system.

4.5.3.2 The rated breaking capacity of an electrical apparatus designed to break short-circuit currents is not to be less than the prospective short-circuit current at the point of its installation.

4.5.3.3 The rated making capacity of electrical apparatus designed to break short-circuit currents is not to be less than the prospective peak value of short-circuit current at the point of its installation.

4.5.3.4 Automatic circuit-breakers are to be used as overload protection in circuits with load currents exceeding 320 A. In circuits with load currents in excess of 200 A, the use of automatic circuit-breakers is recommended.

4.5.3.5 Switches in the circuit of compound generators designed for parallel operation are to have a pole in the equalizer connection so interlocked mechanically with the other circuit-breaker poles that it closes and opens after the other poles are connected to or disconnected from the busbars.

4.5.3.6 Calculation of short-circuit currents is to be carried out on the basis of standards or according to the calculation method approved by PRS.

4.5.3.7 When calculating the anticipated short-circuit current, the equivalent impedance of the arrangement on the damage side is to be taken into account. The source of current is to include all the generators which may be connected in parallel and all the motors running simultaneously. Currents induced by generators and motors are to be calculated according to their characteristics.

When the characteristics of the alternating-current motors are not exactly known the following values are to be taken:
- short-circuit – $6.25I_n$;
- at time T when the short-ciruit occur – $2.5I_n$;
- at time $2T$ when the short-ciruit occur – I_n;
- maximum value – $8I_n$;

where: T – period of alternating current

I_n – total value of rated currents of the electric motors

In the case of direct current, in order to determine the maximum value of the short-circuit current induced by electric motors, the current equal to six times the total value of rated currents of the electric motors running in parallel is to be taken.

Calculation is to be carried out for all cases of short-circuit necessary for obtaining the system characteristics.

4.5.4 Arrangement of Apparatus and Measuring Instruments

4.5.4.1 Each circuit in a switchboard is to be provided with a non-manoeuvring switch capable of switching off all poles or phases.

Switches may be not installed in each circuit in switchboards provided with central switches and supplying the final lighting circuits, as well as in the circuits of instruments, interlocking devices, alarms and local lighting of switchboards protected by fuses.

4.5.4.2 Apparatus, measuring and indicating instruments used in conjunction with generators and essential services are to be fitted on the switchboard panels associated with the respective generator or services.

4.5.4.3 One ammeter and one voltmeter are to be provided for each direct-current generator on the main and emergency switchboards.

4.5.4.4 The following instruments are to be installed on the main and emergency switchboard for each a.c. generator:

.1 an ammeter with a selector switch for current measurements in each phase;
.2 a voltmeter with a selector switch for measuring phase and line voltages;
.3 a frequency indicator (as regards generators operating in parallel, a twin frequency indicator with a selector switch for each generator may be used);
.4 a wattmeter (for outputs in excess of 50 kVA).

4.5.4.5 In ships with a low-power electric installation, where provision has not been made for the parallel operation of generators, only one set of the measuring instruments specified in 4.5.4.3 and 4.5.4.4 may be installed on the main and emergency switchboards, provided the possibility of measurements on each installed generator is ensured.

4.5.4.6 Ammeters are to be installed in the circuit of essential consumer services with rated current of 20 A and more. These ammeters may be installed on the main switchboard or at the control stations.

It is permitted to install ammeters with switches but not more than one ammeter for six consumers.

4.5.4.7 On the main switchboard in the circuit supplied by an external electric power source, the following is to be provided:

.1 a switchgear and a protective device;
.2 a voltmeter or indicating lamps.

4.5.4.8 A change-over arrangement or a separate device for each network of isolated systems is to be installed on the main and emergency switchboards for measuring insulation resistance.

Power systems with a voltage exceeding 50 V shall be provided with visual and audible alarms giving warning on the reduction of the resistance of power system insulation from the hull below 100 Ω/V.

4.5.4.9 Measuring instruments are to have scales with a margin exceeding the rated values of quantities to be measured.

The upper scale limits of the instruments used are to be not less than:

.1 for voltmeters – 120 per cent of the rated voltage;
.2 for ammeters associated with generators not operated in parallel and with current consumers – 130 per cent of the rated current;
.3 for ammeters associated with parallel-operated generators – 130 per cent of the rated current for load-current scale and 15 per cent of the rated current for reverse-current scale; (the last requirement applies to d.c. generators only);
.4 for wattmeters associated with generators not operated in parallel – 130 per cent of the rated output;
.5 for wattmeters associated with generators operated in parallel – 130 per cent for power scale and 15 per cent for reverse power scale;
.6 for frequency indicators – ± 10 per cent of the rated frequency.

4.5.4.10 The voltage, current and power ratings of electric propulsion plant and generator circuits are to be clearly indicated on the instrument scales.

4.5.4.11 Where possible, switchgear is to be installed and connected to busbars in such a way that none of the movable elements and the protection or control devices associated with the switchgear are energized in the open position.

4.5.4.12 Where switchboard outgoing circuits are provided with switches and fuses, the fuses are to be fitted between busbars and switches. Other pattern of fuse and switch installation will be specially considered by PRS in each particular case.

4.5.4.13 Fuses provided in switchboards installed on a foundation at the floor level are to be located not lower than 150 mm and not higher than 1800 mm from the floor level.

Open live parts of switchboards are to be located not lower than 150 mm from the floor level.

4.5.4.14 Fuses are to be so installed in switchboards as to be readily accessible and not to cause danger to the attending personnel when renewing the fuse elements.

4.5.4.15 Screwed-in fuses are to be so installed that the supply leads are connected to the lower terminal.

4.5.4.16 Fuses protecting the poles or phases of the same circuit are to be installed in a row, horizontally or vertically, depending on the fuse design.

The fuses in an a.c. circuit are to be positioned to follow the sequence of phases from left to right or from top to bottom. In a d.c. circuit, the positive-pole fuse is to be on the left side, on the top, or closer to be reached.

4.5.4.17 The manual actuators of voltage regulators installed in the main or emergency switchboards are to be positioned close to the measuring instruments associated with the respective generators.

4.5.4.18 The ammeters of compound-wound generators designed for operation in parallel are to be installed in the pole circuit which is not connected to the equalizer.

4.5.4.19 Flexible stranded conductors are to be used for connection of instruments located on movable or drawn-out parts.

4.5.4.20 Electrical apparatus and measuring instruments installed on the doors of a switchboard that are supply by voltage higher than 50 V, are to be protected against accidental touch when they are open.

4.5.4.21 Apparatus, instruments, panels and outgoing circuits are to have their designations marked on the switchboards.

The position of switchgear is also to be indicated. Besides, markings are to be provided to indicate the rated current of the fuses, as well as the setting of the circuits-breakers, thermal relays and other switches.

4.5.5 Visual Signals

4.5.5.1 For visual signals, colours specified in Table 4.5.5.1 are to be used.

Table 4.5.5.1

No.	Colour	Meaning	Type of signal	Equipment usage
1	Red	Danger	Blinking	Alarm in dangerous situations calling for immediate intervention.
			Permanent	General alarm in dangerous situations, as well as in dangerous situations detected but not yet eliminated.
2	Yellow	Attention	Blinking	Abnormal situations, but not requiring immediate intervention.
			Permanent	Situations intermediate between abnormal and safe. Abnormal situations detected, but not yet eliminated.
3	Green	Safety	Blinking	Indication that a stand-by unit is put into service.
			Permanent	Normal operating conditions, normal functioning.
4	Blue	Instructions and information	Permanent	Units and devices ready to be started. Circuit energized. ll in order.
5	White	General information	Permanent	Signals used when required. Notations relating to automatic action. Other additional signals.

4.5.5.2 Other type of visual signals than mentioned in 4.5.5.1 (e.g. letters) will be each time considered by PRS.

4.5.6 Arrangement of Switchboards

4.5.6.1 The switchboards are to be placed in locations where concentration of gases, steam, dust and acid evaporations is not possible.

4.5.6.2 If a switchboard with the degree of protection IP10 and lower is located in a special space, cabinet or recess, such spaces are to be made of incombustible material or are to have a lining of such material.

4.5.6.3 The arrangement of pipelines and tanks near the electrical equipment is to conform to the requirements of *Part VI – Machinery and Pipeline Installations*.

4.5.6.4 The navigation lantern switchboard is to be located on the navigation bridge where it is readily accessible and visible for the personnel on watch.

4.5.7 Access to Switchboards

4.5.7.1 In front of the switchboard, a passageway is to be provided not less than 600 mm wide.

4.5.7.2 Behind the free standing switchboards, it is necessary to provide a passageway not less than 600 mm wide for switchboards up to 3 m in length and not less than 800 mm wide – for longer switchboards.

The width of passageways between the free standing switchboards with open live parts, located in special electrical spaces is not to be less than 1000 mm.

4.5.7.3 The space behind the free standing switchboards with open live parts is to be enclosed and fitted with doors. Suitable stops are to be provided to keep the doors open.

4.5.7.4 The space behind the free standing switchboards of more than 3 m in length, is to have at least two exits located at the opposite ends of the switchboards and leading to the space where the switchboard is installed. One of the doors may lead to the adjacent space provided with at least one more exit.

4.5.7.5 The passageways specified in 4.5.7.1 and 4.5.7.2 are to be measured from the most protruding parts of the switchgear and the switchboard construction to the protruding parts of equipment or hull structures.

4.5.7.6 For the switchboard supplied by voltage higher than 50 V, floors are to be covered by a dielectric mat, in spaces available for service staff during maintaining the equipment installed in the switchboard.

5 ELECTRIC DRIVES FOR MACHINERY AND EQUIPMENT

5.1 General Requirements

5.1.1 The control stations and automatic features of the drives are to comply with the relevant requirements given in 15.2, while the power supply of electrical automation systems is to meet the requirements given in 15.3.

5.1.2 Electrically driven machinery is to be provided with visual signal indicating that the device is in ”on” position.

5.1.3 The equipment provided with automatic remote and manual control is to be designed in such a manner that the automatic or remote control is switched off when changing over to the manual control. Manual control is to be independent of automatic or remote control.

5.1.4 The machinery provided with electric and manual drives is to be fitted with interlocking devices that will prevent the possible simultaneous operation of the drives.

5.1.5 When mutual dependence of machinery operation or machinery operation in a certain sequence is required, the appropriate interlocking device is to be used.

5.1.6 A device may be installed that will switch off the interlocking on condition that this device is protected from accidental switching off the interlocking. An informative inscription is to be placed in close proximity to this device indicating its application and forbidding using it by unauthorized personnel. Such device is not to be used for machinery specified in 5.1.4.

5.1.7 Starting of the machinery whose electric motors or switchgear require additional ventilation in normal operating conditions is to be possible only with ventilation in action.

5.1.8 Control systems for the drive of e.g. winch, rope tightening device, whose operation may – in certain circumstances – put the vessel safety of human's safety at risk shall be provided with safety couplers to ensure the electric drive power supply cut-off.

The safety switches are to be painted red. An inscription indicating their purpose is to be placed near the switch.

These safety switches are to be protected from accidental, unintended use.

5.1.9 Safety switches are to be located in the control stations or in other places to ensure safe operation conditions.

5.1.10 Electric drives of the machinery and devices for which, in order to avoid damage or break-down, movement limits are required, are to be provided with limit switches that would ensure effective disconnecting of the electric motor.

5.1.11 The machine control gear employed is to enable starting an electric motor only from the stop position.

5.1.12 Machine control gear is to be provided with an appropriate discharge protection device that would permit the disconnection of the shunt-field windings.

5.1.13 Only such alternating-current electric motors that meet the requirements of 3.1.2.2 and 15.6.3.3 may be directly connected to the network.

5.1.14 For each electric motor rated at 0.5 kW and more and its control gear, a non-manoeuvring switch to disconnect the power supply is to be provided. If the control gear is mounted on the main switchboard or on any other switchboard in the same compartment and can be seen from the place of installation of the electric motor, then for this purpose it is permitted to use a non-manoeuvring switches mounted on the switchboard.

If the requirements concerning the location of machine control gear stated above are not met, the following is to be provided:

.1 a device interlocking the switch on the switchboard in the "off" position; or
.2 an additional disconnecting switch near the electric motor; or
.3 fuses in each pole or phase arranged in such a manner that they can be readily removed or replaced by the personnel.

5.2 Electric Drives for Steering Gear

5.2.1 In addition to the requirements given in *Part VI – Machinery and Pipeline Installation* and in *Part III – Hull Equipment*, steering gear is to meet the requirements of the present section.

5.2.2 Electric drives for steering gear are to be supply according to section 4.3.

5.2.3 Each electric or electrohydraulic drive of the main steering gear comprising one or more power units is to be supplied directly from the main switchboard by two separate circuits laid as much as possible on separate routes.

5.2.4 It is recommended that one of the circuits is to be supplied through the emergency switchboard.

5.2.5 The rudder angle indicator is to be supplied irrespective of steering gear.

5.2.6 The electric and electrohydraulic drive for the steering gear is to ensure:

.1 putting the rudder over from one side to the other side within the time and angle stated in *Part VI – Machinery and Pipeline Installation*;

.2 continuous putting the rudder over from one side to the other side during 30 minutes for each set with the rudder fully immersed and at maximum ahead speed corresponding to such draught;

.3 continuous operation during one hour at the maximum service speed ahead with putting the rudder over through an angle so as to ensure 350 puttings over per hour;

.4 possible stalling of the electric motor in ”on” position at the rated supply for one minute from hot state (only for rudders fitted with the direct electric drive);

.5 sufficient strength of electric drive in the presence of mechanical forces arsing at maximum speed astern; it is recommended to provide a possibility of putting the rudder over at the average speed astern.

5.2.7 Starting and stopping of the steering gear electric motors are to be effected from the steering gear room.

5.2.8 The starting devices are to ensure automatic restarting of electric motor as soon as the voltage is restored after interruption in power supply.

5.2.9 Remote controlled devices (also outside the wheelhouse) are to be fitted permanently and equipped with on/off indicators.

5.2.10 The supply and controlling circuits are to be independent when steering gears, the main and auxiliary, are driven by an electric motor.

Each steering gear is to be driven by an individual electric motor.

5.2.11 If the auxiliary steering gear is supplied from a generating set, which is not in service during the voyage and to start the engine up takes more than 5 seconds, a device to supply the auxiliary steering gear need to be provided during start it up.

5.2.12 Electrical motors of steering gear are to be conformed to continuous service.

5.2.13 If a change-over arrangement is provided to supply any electric motor from various feeders, the cross-sectional area of the cables is to be chosen for operation under the most severe loads. The change-over arrangement is to be installed in the wheelhouse.

5.2.14 At the control position visual and audible alarms shall be provided to give warning of:

.1 power failure and phase failure in the power supply of each power unit,
.2 power failure in the circuit supplying the control system,
.3 oil level drop in the hydraulic oil tank below the minimum filling level permitted for the steering gear safe operation and the oil working pressure drop in the hydraulic system,
.4 turning manoeuvre speed controller failure,
.5 failure of the required buffer devices.

5.2.15 A phase detector is not required when the electric drive of steering gear is supplied via the circuit-breaker.

5.2.16 It is permitted to use a steering wheel, a handle or push-buttons as manual controlling means on the control desk. The direction of rotation of the rudder wheel or the direction of the movement of the control gear handle is to agree with the direction of putting the rudder over. In the push-button control system, the push-buttons are to be arranged in such a manner that the push-button located on the right side causes the rudder blade to move rightward, while the button on the left side – leftward.

5.2.17 If such system types as rudder-propeller or cycloidal propeller are applied, then the lever position shall clearly indicate the direction of thrust. Derogation from this exception is subject to the Administration approval.

5.2.18 It is permitted to install in ships automatic pilots controlling the ship's steering gear. The automatic pilot is to be fitted with a visual signal that is in service operation as well as visual and audible signals of phase absence and fault of gyrocompass.

5.2.19 If double systems such as rudder-propeller, water-jet propeller, cycloidal propeller or other arrangement changing the direction of thrust have been applied as main manoeuvring arrangements, then independent systems shall be provided to control these thrusters.

5.2.20 The proper functioning of the rate-of-turn regulator (if installed) shall be displayed at the steering position by means of a green indicating light. Any lack of or unacceptable variations in the supply voltage and an unacceptable decrease in the speed of rotation of the gyroscope shall be monitored.

5.2.21 Where, in addition to the rate-of-turn regulator, there are other steering systems, it shall be possible to clearly distinguish at the steering position which of these systems has been activated. It shall be possible to shift from one system to another immediately. The rate-of-turn regulator shall not have any influence on the steering systems.

5.2.22 The power supply to the rate-of-turn regulator shall be independent of other power consumers.

5.3 Electric Drives for Anchor and Mooring Machinery

5.3.1 In addition to the requirements given in *Part VI – Machinery and Pipeline Installation*, the drives of windlasses, anchor and mooring capstans and mooring winches are to meet the requirements of the present section.

5.3.2 The power supply of windlass electric drives is to meet the requirements of 4.3.1.

In cargo ships the windlass may be supplied from the cargo winch switchboard, or any other switchboard, provided its power supply is taken directly from the main switchboard.

5.3.3 The alternating-current squirrel-cage electric motors for driving the wind- lasses and mooring winches are to withstand, after 30-minute operation at the rated load, the stalling in "on" position at the rated voltage for at least 30 seconds for windlasses and at least 15 seconds for mooring winches. For motors with a change-over of the number of poles, this requirement is to be complied with for operating with winding developing the largest starting torque.

The direct-current electric motors and the alternating-current wound-rotor electric motors are to withstand the above stalling conditions but at the torque twice that of the rated value; the voltage, in this case, may be reduced below the rated value.

After stalling conditions, the temperature rise is not to be over 130 per cent of the permissible value for the insulation used.

5.3.4 In anchor and mooring winch at the speed steps intended for mooring operations, not intended for anchor lifting, provision is to be made for appropriate overload protection of electric motor.

5.4 Electric Drives for Pumps and Fans

5.4.1 The power supply of electric drives for pumps and fans is to meet the requirements of 4.3.1.

5.4.2 The electric motors for oil and fuel pumps, oil separators and ventilation fans serving machinery room are to be provided with remote switching devices fitted at locations readily accessible from the main deck, but outside the machinery rooms.

These devices are to be fitted at visible places covered by a glass protection and labelled with notices.

5.4.3 The local starting of fire and bilge pumps is to be possible even in case of failure in their remote control circuits.

5.4.4 Electric motors of general shipboard ventilation, holds and kitchen are to be fitted with connectors in a place easily accessible from the main deck

5.4.5 Electric motors of exhaust fans from the space above galley ranges are to be provided with additional switching devices located inside the galley room.

6 LIGHTING

6.1 General Requirements

6.1.1 In all rooms, spaces and locations of the ship where lighting is necessary to ensure the safety of navigation, operating of machinery and equipment, as well as accommodation and evacuation of passengers and crew, stationary fixtures of the lighting are to be installed.

6.1.2 Lighting fixtures installed in rooms, locations and spaces where mechanical damage is possible to the hoods are to be provided with protection gratings or hoods made of material resistant to mechanical shocks.

6.1.3 Lighting fixtures are to be installed in such a manner as to prevent heating of cables and adjacent materials up to a temperature exceeding the permissible level.

6.1.4 In rooms and places illuminated with luminescent lamps where visible rotating parts of machinery are located, all measures are to be taken to prevent stroboscopic effect.

6.1.5 External lighting fixtures are to be installed in such a manner as not to dazzle the person running the ship and do not affect the recognition of navigation lights.

6.1.6 In rooms, locations and spaces lighted with discharge lamps which do not ensure the continuity of lighting at the voltage variations specified in 2.1.3.1, lighting fixtures with incandescent lamps are to be provided.

6.1.7 Battery compartments and other explosion-hazardous spaces are to be illuminated with lighting fixtures located in adjacent safe spaces through gas-tight windows or with explosion-proof lighting fixtures installed inside such spaces.

6.1.8 Two-pole switches are to be used in lighting circuits. In dry accommodation and service spaces, single-pole switches may be used in circuits of individual and group lighting fixtures with the current not more than 6 A, as well as in safety-voltage lighting fixtures.

6.1.9 Permanently installed ship's external lighting fixtures are to be provided with central switches located in the wheelhouse.

6.1.10 The lighting switches behind free-standing switchboards are to be installed near each entry behind the switchboard.

6.1.11 The main lighting switchboards are to be supplied by separate feeders intended only for that purpose.

In addition to the lighting final sub-circuits, the main lighting switchboards may supply the electric drives of non-essential services rated up to 0.25 kW and individual space heaters rated up to 10 A.

6.1.12 Permanently-installed lighting fixtures in holds are to be supplied independent and fitted with switchgear and protective devices, not available for unauthorised persons and with visual signals to indicate the presence of voltage in individual lighting circuits.

6.1.13 The number of lighting fixtures supplied from the lighting final circuits is not to be more than:

.1 10 of lighting fixtures for voltage up to 50 V;
.2 14 of lighting fixtures for voltage up to 127 V;
.3 18 of lighting fixtures for voltage up to 230 V.

It is permitted to install more lighting fixtures in the case when the protective devices are set on rated current no greater than 10 A.

The final lighting circuits of machinery spaces, decks and holds are not be loaded more than 20 A.

The cabin fans and other minor consumers may be supplied from the lighting final circuits.

6.1.14 Lighting in machinery spaces and other spaces containing refrigerating installations, hydraulic installations or electric motors shall be supplied from at least two independent circuits.

6.2 Socket Outlets and Plugs

6.2.1 Socket outlets for portable lighting fixtures are to be installed at least:

.1 on deck near the windlass;
.2 in the steering gear compartment;
.3 in the machinery spaces;
.4 behind the main switchboard;
.5 in special enclosed electrical spaces;
.6 on the navigation bridge.

6.2.2 Socket outlets installed in circuits with different voltages are to be so designed as to prevent insertion of a plug intended for one voltage into a socket intended for another voltage.

6.2.3 Socket outlets of portable lighting and other electric appliances, installed on weather decks, are to be adapted for insertion of the plug from the underside.

6.3 Illumination Intensity

6.3.1 The intensity of illumination of rooms and spaces is not to be below that specified in Table 6.7. These requirements are not applicable to ships provided with lighting circuits supplied at a voltage below 30 V.

The general illumination standards, stated in Table 6.7, refer to the level of 800 mm above the compartment floor, while the general illumination standards, plus local ones, refer to the level of the working areas.

Table 6.3.1

No.	Spaces and surfaces		Illumination intensity, lux			
			Lighting other than incandescent		Incandescent lighting	
			general and local	general	general and local	general
1	Wheelhouse	at level of 800 mm above floor	–	50	–	30
2	Engine rooms, spaces for switchboards, control and monitoring stations	at level of 800 mm above floor	–	50	–	30
		surfaces of switchboards and control and monitoring desks	100	–	50	–
		main engine controls stand	100	–	50	–
		passageways between engines, machinery, stairs, etc.	–	30	–	20
3	Steering room	at level of 800 mm above floor	–	30	–	20
4	Battery compartments	at level of 800 mm above floor	–	30	–	20
5	Passageways and communication spaces on the deck and near gangways	at level of 800 mm above floor	–	20	–	10
6	Overside spaces in way of lifeboat and liferaft lowering	near the load line	–	–	–	5

The intensity of illumination of control desks fitted in the wheelhouse may be reduced to the optimal intensity during night voyage.

Control desks with variable intensity of illumination are recommended.

6.4 Emergency Lighting

6.4.1 The intensity of emergency lighting in the respective spaces, locations and areas, mentioned in 6.3.1, is to be equal to at least 10 per cent of the general lighting intensity specified in Table 6.3.1.

6.4.2 The intensity of lighting in corridors, passageways and the deck is to be sufficient for safety abandon ship. The intensity of lighting is to be at least 0.2 lx in the worse illuminated place.

6.4.3 Light fittings for the emergency lighting shall be marked in red. This requirement apply also to fixtures with two bulbs, in which one of the bulb is supplied by from emergency network and the remaining from the main source of electric power.

6.4.4 Stationary fixtures may be used as emergency lighting fixtures, when supplied by emergency source of electric power.

6.4.5 In the emergency lighting circuits, as a rule, no switches are to be fitted, except these in the emergency switchboard placed in the wheelhouse. A switch is to be placed next to the wheelhouse door in the emergency lighting circuit of the wheelhouse.

6.5 Navigation Lights

6.5.1 The navigation lights switchboard is to supply, by separate feeders, the masthead lights, side lights, stern light and the tug lights.

6.5.2 The navigation lights switchboard is to be supplied by two feeders:

.1 one feeder from the main switchboard through the emergency switchboard;
.2 the second feeder from the nearest branch circuit board.

The navigation lantern switchboard installed in the ship control and monitoring console may be supplied directly from the console, provided it is supplied in compliance with 4.4.2.

In ships where the main source of electric power is an accumulator battery and the main switchboard is located on the navigation bridge, the navigation lanterns may be supplied directly from the switchboard.

6.5.3 The masthead lights and stern lights as well as lights of pontoons and floating units without self propulsion not to be designed for sailing, may be supplied by separate feeders from the lighting network, without necessary switchboards for the lights.

6.5.4 Navigation lanterns are to be connected to the network by flexible cables and plug-in sockets.

6.5.5 Each feeding circuit of navigation lanterns is to be of two-wire type with a double-pole switch installed in the navigation lantern switchboard.

6.5.6 Each circuit of the navigation light power supply shall be fitted with effective means of protection as well as light signals to indicate operation of each lantern.

The visual indicator is to be designed and installed in such a manner that its damage does not cause the disconnection of the navigation lantern.

The arrangement and colour of the repeater lights for the navigation lights and light signals shall correspond to the actual position and colour of those lights and signals.

When the navigation lights are installed in steersman's visibility zone, the indicator does not have to be installed.

6.5.7 A voltage drop on the supply switchboard of navigation lanterns, including the signaling system of functioning of the lantern, is not to exceed 5 per cent at the rated voltage up to 30 V and 3 per cent at the voltage over 30 V.

6.5.8 Irrespective of the signals required in 6.5.6, provision is to be made for visual and audible signals functioning in the case of failure of any navigation light with the switch in the "on" position.

The power supply of signals is to be taken:

- from a circuit or a source other than that used for the power supply of navigation light switchboard or
- from an accumulator battery.

6.5.9 Redoubled navigation lights (mounted one navigation light on the other) are not be simultaneously on.

6.5.10 It is permissible to simultaneously supply, control and monitoring group of lights intended to one purpose, fitted in one place when a fault of the single light from the group can be identified. The possibility for simultaneous operation of double navigation lanterns installed one above the other or in one housing shall be precluded.

7 INTERNAL COMMUNICATION AND SIGNALING

7.1 Electric Engine Room Telegraphs

7.1.1 In addition to the requirements of the present section, the electric engine-room telegraphs are to meet the requirements given in 1.16.1 of *Part VI – Machinery and Pipeline Installations.*

7.1.2 The engine-room telegraphs are to be provided with a visual signal of the presence of voltage in the power supply circuit supplying the engine-room telegraphs.

7.1.3 The engine-rooms telegraphs installed in the wheelhouse are to be provided with scale lighting permitting adjustment of illumination intensity.

7.1.4 The engine-room telegraphs are to take their power supply from the main switchboard or from the ship's control and monitoring desk.

7.1.5 The telegraph transmitter in the wheelhouse is to be installed in such a way that in the case of transmitting commands concerning the running of the ship, the handle of the transmitter is set in accordance with the direction of the ship's running. The vertical position of the handle is to correspond to the command "Stop".

7.1.6 When the engine-room telegraph, as well as remote controls of the main engines and controllable pitch propellers are installed on an inclined panel of the control desk, the handle in the "Stop" position is to be vertical to the desk and is to remain exactly in this position.

7.1.7 Each engine-room telegraph is to be provided with an audible signal, in the wheelhouse and in the machinery space, operating at communicating orders and switching off after receiving a correct response. When the response is incorrect, the audible signal should remain operating.

7.2 Internal Service Communication

7.2.1 Where no direct communication is possible, internal voice communication facilities shall be provided on board vessels with the bow and stern of the vessel or convoy from the steering position and also with the machinery and service spaces. For this purpose telephone or master communicator may be used. Visual and optical communication with the machinery spaces independent of the switch required in 7.3.10 may alternatively be used.

Direct communication is considered as ensured if:

- direct visual contact is possible between the wheelhouse and the control positions for the winches and bollards on the fore section or the stern of the vessel and in addition the distance from the wheelhouse to these control positions is not more than 35 m, and
- direct access is provided from the wheelhouse to the crew spaces.

7.2.2 The telephones are to work properly in the case of power cut on the main switchboard.

7.2.3 It is recommended to use batteryless telephones in the service communication systems.

7.2.4 Radiotelephone communication with the fore and after parts of the vessel or convoy is permitted.

7.3 General Alarm System

7.3.1 Vessels on which the general alarm given by human voice or by any other means is not heard simultaneously in all locations where people may be present, are to be equip with electric general alarm system audible in the all mentioned locations.

7.3.2 Signaling devices are to be installed in the following places:
- **.1** in machinery spaces;
- **.2** in corridors of accommodation, service and public spaces;
- **.3** on open decks.

7.3.3 The general alarm system is to be supplied from the ship's network and from the emergency switchboard in accordance with the requirements of 9.3.1 or 16.1.4.1.

The general alarm system may be supplied from the ship's network and from own accumulator battery, provided that automatic switch-over of supply circuit to accumulator battery is ensured. In such case, supply from emergency and transitional source of electric power is not required.

7.3.4 The general alarm system is to be power supplied continuously, irrespective of the accumulator battery being set in position for charging or discharging.

7.3.5 Power supply circuits of general alarm system are to be provided only with short-circuit protection. Protection devices are to be fitted in both wires of supply circuit, as well as in circuits of each signaling device. One common protection for several signaling devices may be fitted if, in the space in which signaling devices are installed, good audibility of other signaling devices with independent protection is ensured.

7.3.6 Sound devices of general alarm system are to be so located that a signal is clearly heard against the noise and other signaling systems. Sound devices installed in spaces with high intensity of noise are to be also fitted with visual signals.

7.3.7 The sound level of the general alarm in crew's cabin is to be at least 75 dB(A).

7.3.8 The sound level of the general alarm in machinery spaces is to be 5 dB(A) above the ambient noise level.

7.3.9 The general alarm signal is to be activated from the wheelhouse and also from the compartment intended for the watch when the ship is in port.

7.3.10 The alarm should continue to operate until it is manually turned off or overridden by the public address system broadcast.

If the general alarm is not to be audible from the wheelhouse or a station where it is activated, than near the switch a control lamp indicating the general alarm is to be fitted. The switch is to be labeled according to the purpose.

7.3.11 Signaling devices, switches and distribution boxes of the general alarm system are to be provided with readily visible distinctive marking.

7.4 Fire Detection System

7.4.1 In addition to the requirements of the present section, fire detection system is to meet the requirements given in Chapter 4 of *Part V – Fire Protection*.

7.4.1.1 The installation of detectors of the fire detection system in explosion- hazardous spaces or located in the stream of air sucked from these spaces is to comply with the requirements of 2.8.

7.4.2 The self-controlled, available for periodic service and certificated fire detection system is to be fitted in machinery spaces.

7.4.3 Fire detection system is to be supplied by separate feeders from two independent electric power supply sources. Where the main source of power supply is the main source of electric power, the second (stand-by) source of power supply is to be the emergency source of electric power or an accumulator battery meeting the requirements of 9 or 16.1.4 in respect of its capacity and location.

Where the main source of electric power supply is an accumulator battery, the second (stand-by) battery is to be provided. Each of the batteries is to meet the requirements of 9 or 15.2 in respect of its capacity and location.

7.4.4 Fire detection system shall be supplied by separate circuits from two independent power sources. The power supply circuits shall be led to an automatic switch located on or in way of the fire detection control panel. If the main power source is the vessel's power supply network, then another power supply shall be either an emergency power source or accumulator batteries having both the capacity and location in accordance with the requirements specified in 16.1.4. For vessels of 25 m or less in length and motor vessels, a separate emergency power source is sufficient.

7.4.5 The fire detection system is to be able quickly detect the fire in any machinery space, in normal conditions for machinery equipment and working ventilation adjusted to ambient temperature.

7.4.6 Heat detectors may be fitted only in spaces with limited height or where it is justified.

7.4.7 Visual and audible signals of the fire detector system are to be different than any other alarm system.

7.4.8 Signals of fire detection system are to be audible or visible in the wheelhouse and cabin's crew on the watch.

7.4.9 Warnings given by the fire detection system shall be audible or visible in the wheelhouse, spaces manned by crew members and in the space protected.

7.4.10 Warning signaling of fire-fighting system is to be supplied from accumulator battery.

7.4.11 The warning signaling is to be supplied from the battery of smoke detection system, if exist.

7.4.12 In the wheelhouse or other space permanently manned by crew members, a system displaying activation of automatic pressurised water sprinklers for each section shall be provided.

7.4.13 Power supply of the installation of automatic pressurised water sprinklers shall be provided by two independent power sources that shall not be installed in the same location. Each power source shall be capable of supplying the entire system unassisted.

7.5 Bilge Alarm

7.5.1 Each machinery space shall be fitted with a high bilge water level alarm. The space containing bow thruster is also considered as machinery space if its operation is required to ensure the vessel manoeuvrability..

7.6 Mobile Wheelhouse

7.6.1 In addition to the requirements of the present sub-chapter, Mobile Wheelhouses shall fulfil the requirements specified in Chapter 9, *Part VI – Machinery Installations and Refrigerating Plants.*

7.6.2 All lowering and lifting operations shall automatically trigger a clearly audible acoustic warning signal.

7.6.3 It shall be possible to operate the lifting mechanism from inside the wheelhouse. The following indications shall be arranged at the steering position:

- voltage present,
- wheelhouse in lowest position,
- wheelhouse in highest position,
- wheelhouse locked in fixed position.

8 PROTECTIVE DEVICES

8.1 General Requirements

8.1.1 The outgoing circuits of switchboards are to be protected against short-circuits and overloads by means of suitable devices installed at the beginning of each circuit.

When every supplied consumer has own overload protection and the cable is chosen for maximum expected current, the outgoing feeders of switchboard may not be protected against overload.

8.1.2 Protective devices are to be so matched with the characteristics of the equipment under protection as to operate at all inadmissible overloads.

8.1.3 The protection system is to be discriminative both with regard to overload currents and to the prospective short-circuit currents.

Protection devices are to be so adjusted that the damage of non-essential consumers or their circuits does not affect harmfully the operation reliability of ship's generating plant and the continuity of supplying essential services.

Overload and short-circuits protection is not to operate under the effect of starting currents of the protected devices.

8.1.4 Overload protection is to be provided in:

.1 not less than one phase or positive pole in a two-wire system;

.2 not less than two phases in an insulated three-wire three-phase alternating- current system;

.3 all phases in a three-phase four-wire alternating-current system.

8.1.5 Short-circuit protection is to be fitted in each insulated pole of a direct-current system and in each phase of an alternating-current system.

Short-circuit current protective devices are to be set to operate at not less than 200 per cent of the rated current. Operation may be instantaneous or after a time-lag to allow for the proper discrimination.

To protect feeder cables and consumers against short-circuits, the same protective devices may be used.

8.1.6 Where, in any part of supply circuits, the cable cross-section is reduced, additional protection is to be provided unless the previous protective device is capable of protecting the cable of the reduced cross-section.

8.2 Protection of Generators

8.2.1 Generators not intended for parallel operation are to be provided with means of protection against overload and short-circuits. Fuses may be used as protective devices for generators rated under 50 kW (kVA).

8.2.2 Generators intended for parallel operation are to be at least provided with the following means of protection:

.1 against overloads;
.2 against short-circuits;
.3 against reverse current or reverse power;
.4 against under-voltage.

Generator protection system against overload is to be provided with visual and audible signals of overload operating with a time-lag of up to 15 minutes at overloads from 100 to 110 per cent of the rated current and be capable of disconnecting the generator after a time-lag corresponding to the generator thermal time constant at overloads within 110 to 150 per cent of the rated current of the generators.

For a setting of the protection to operate at 150 per cent of the rated current of generator, it is recommended that the time-lag should not exceed 2 minutes for a.c. generator and 15 seconds for d.c. generator.

At overloads exceeding 150 per cent of the rated current, the disconnection of the generator under such overload is to be instantaneous.

Overload protection setting and time delay values are to be selected to correspond to the overload characteristics of the generator prime mover so that the prime mover is capable of developing the necessary output within the time delay period adopted. The protective devices used for generator overload protection are not to prevent the possibility of re-starting the generator immediately.

8.2.3 It is recommended to install devices that automatically and selectively disconnect the less essential services in the event of the generator being overloaded.

8.2.4 Reverse-power protection for generators intended to operate in parallel are to be selected to correspond to the prime mover characteristics. The respective protection settings are to operate when reversing current of 5 to 15 per cent generator rated current. Reverse-power and reverse-current protection for direct-current generators is to be installed in the pole opposite to that in which the equalizer is connected.

8.2.5 The under-voltage protection is to provide the possibility of connecting the generators to busbars at a voltage equal to 85 per cent or over of the rated value and to preclude their connecting to busbars at a voltage lower than 35 per cent of the rated value, as well as to disconnect generators when the voltage drops at their terminals to a value from 70 per cent to 35 per cent of the rated voltage.

The under-voltage protection is to operate with a time-lag necessary for disconnecting the generators from the busbars in the case of voltage drop and is to operate immediately during the attempt of connecting to busbars a generator, whose voltage has not reached the above-mentioned value.

8.2.6 Feeders of protective devices, measuring equipment, synchronising and controlling systems, supplied directly from the generator are to be protected against short-circuit.

8.2.7 Short-circuit protection of the generator is to be set to not less than 300% of the rated current. The generator including excitation, is to withstand one second short-circuit.

8.2.8 Buffer generators with the accumulator battery are to be fitted with a reverse-current cutouts or diode that prevents current flow from the battery to the generator.

8.3 Protection of Electric Motors

8.3.1 Outgoing feeders from switchboards supplying electric motors rated at over 0.5 kW are to be provided with means of protection against short-circuit currents and overloads, as well as with no-voltage protection if motors need not be automatically re-started.

It is admissible for overload and no-voltage protective devices to be installed in the motor starting apparatus.

8.3.2 The overload protective devices for continuously-loaded motors are to be set to disconnect the motor under protection in a range of 105 to 125 per cent of the rated current.

8.3.3 The feeders of the electric drives of fire pumps are not to be fitted with overload protection operating on the thermal relay basis. Overload protection may be substituted with visual and audible signals.

8.4 Protection of Steering Gear Motors

8.4.1 Only short-circuit current protection is to be provided for electric motors and control systems of electric and electro-hydraulic steering gear.

Visual and audible alarms warning of motor overload and voltage failure in any of the phases are to be provided. Thermal circuit-breaker may disconnect the motor at least at 200 per cent of the rated current.

8.4.2 Short-circuit protection of the circuit-breakers of the d.c. motors of the electric and electro-hydraulic steering gears are to be set for instantaneous release at current not lower than 300 per cent and not higher than 400 per cent of the rated current of the motor under protection, while those used in conjunction with alternating-current motors are to be set for instantaneous release at current exceeding by about 25 per cent the peak starting current of the motor under protection.

Where fuses are used for protection of steering gear motors, the rated current of the fuse elements is to be chosen by two degree higher than that resulting from the choice made on the basis of the starting current of these electric motors. The rated current of the fuse elements are not to be more than 160 per cent for motors under intermittent service.

8.4.3 The electric motors of active means of steering the ship (e.g. bowthrusters, propellers, stabilizers, etc.) are to have short-circuit and overload protection. Overload protection is to give audible and visual signals and is to cause the disconnection of the electric motor within the range required by 8.3.2.

Short-circuit protection is to comply with the requirements of 8.4.2.

8.5 Protection of Transformers

8.5.1 Short-circuit and overload protective devices are to be installed on the supply feeders of transformer primaries.

Transformers rated up to 6.3 kVA may be protected with fuses only.

Overload protection of transformers may be replaced by appropriate visual and audible signals subject to consideration by PRS.

Overload protection or alarms need not be provided for voltage transformers and transformers supplying control circuits.

8.5.2 Transformers intended for parallel operation are to be provided switches to disconnect their primary and secondary windings, but not necessarily at the same time.

8.5.3 The connection of current transformers is to be so arranged as to prevent the possibility of their secondary windings being opened during the switching of circuits.

8.6 Protection of Storage Batteries

8.6.1 Means of protection against short-circuit currents are to be provided for storage batteries other than those which are designed to start up internal combustion engines.

8.6.2 Each battery charging system is to be provided with a suitable protection against battery discharge due to a drop or loss of voltage at the outlet from the charger.

8.7 Protection of Pilot Lamps, Voltmeters, Capacitors and Voltage Coils

8.7.1 Pilot lamps as well as measuring and recording instruments are to be provided with short-circuit protection or elements limiting short-circuit current.

Pilot lamps need not have such protective devices or elements of their own, provided that:

.1 the lamps are supplied through circuits inside the enclosure of the device;
.2 the protection of the device circuit is not exceeding 25 A;
.3 a fault in the lamp circuit is not liable to cause an interruption in the operation of an essential service.

Short-circuit protection and current limiting devices are to be located as close as practicable to the terminals on the supply side.

8.7.2 Radio interference suppression capacitors installed in the circuits of main and emergency switchboards, generators, and essential electrical installations, are to be protected against short-circuit currents.

8.7.3 The voltage coils of apparatus and control or protective devices are to be protected against short-circuit current, but they need not have protection of their own, provided that:

.1 the coils are in the common enclosure of the device, they have common protective devices and they refer to the control system of one device;
.2 the coils are supplied through circuit of the device with protection not exceeding 25 A.

8.8 Protection of Power-electronic Equipment

8.8.1 Power-electronic semiconductor equipment is to be protected against internal and external overvoltage.

8.8.2 Blocks of semiconductor elements are to be protected against short-circuit. The protection of diodes and thyristors is to be independent of the load circuits protection.

8.8.3 If only one consumer is to be supplied by power-electronic equipment, the blocks of diodes and thyristors as well as load may have a common protection.

8.9 Protection of Emergency Circuits

8.9.1 The emergency sources of electric power are to be provided with a short-circuit protection only. Where the emergency source is a generator with an independent drive, visual and audible signals indicating the generator overload are to be fitted in the central control station.

8.9.2 Protection devices preventing immediate switching-on after operation of protection are not to be used in supply circuits of the emergency switchboard and emergency consumers.

8.9.3 Protection of emergency circuits is to be set in a manner that the cable is effectively protected.

9 EMERGENCY SOURCE OF ELECTRIC POWER AND DISTRIBUTION OF POWER FROM EMERGENCY SOURCES

9.1 General Requirements

9.1.1 Vessels having a length of at least 25 m and cabin craft are to be equipped with emergency source of electric power.

9.1.2 The emergency source of power may be:

– an auxiliary set whose fuel supply system and cooling system are independent of the main power plant and which, in the event of a network failure, is started automatically and can provide the entire power supply within 30 seconds.

PRS can allow start the auxiliary set manually if it is installed in the immediate vicinity of the wheelhouse or other station that is manned continuously by qualified crew members;

– an accumulator battery which, in the event of a network failure, is automatically phased to the line and can provide the consumers with power for the time specified in 9.1.3 without being recharged and without any unacceptable fall in voltage.

PRS can allow start the accumulator battery manually if it is installed in a station outside machinery spaces that is manned continuously by qualified crew members.

9.1.3 The capacity of the emergency source of electrical power is to be sufficient to supply power for at least 30 minutes to all consumers, whose simultaneous operation is necessary to ensure safety in case of emergency.

9.2 Spaces of Emergency Sources of Electric Power

9.2.1 The emergency source of electric power and the emergency switchboard are to be fitted aback the collision bulkhead, outside the main engine room and the space where the main switchboard is located and is to be separated from those spaces by fire-resistant (class A) and watertight bulkheads.

9.2.2 Space where the emergency source of power is fitted is to be easy available from the open deck, if fitted below it.

9.2.3 The emergency source of electric power and the emergency switchboard may be installed in the machinery space within provisions of locate them as high as possible but is to be each time considered by PRS.

9.2.4 The emergency switchboard is to be installed as near as practicable to the emergency source of electric power.

9.2.5 Where the emergency source of electric power is a generator with an independent drive, the emergency switchboard it is recommended to locate in the same space.

9.2.6 The space of the emergency generating set is to be provided with heating arrangements to ensure appropriate temperature for ready starting of the set and also ventilated in compliance with requirements of *Part VI – Machinery and Pipeline Installations*.

9.2.7 If the emergency source of energy is an accumulator battery than the place where the battery is located is to fulfil requirements given in 11.2 and 11.3.

9.3 Distribution of Electric Power from Emergency Sources

9.3.1 The following consumers are to be supplied from emergency source, if they do not have own emergency source of power:

.1 navigation lanterns;
.2 navigation lights;
.3 alarm and safety systems;
.4 internal communication system;
.5 radio and telephone equipment;
.6 emergency floodlight;
.7 fire-fighting installations;
.8 fire detection and alarm system;
.9 emergency steering gear.

9.3.2 The emergency lighting is to comply with the following spaces:

.1 the points where collective life-saving appliances are stored, handled and launched;
.2 corridors, stairs and evacuation routes from accommodation areas and cabins;
.3 engine rooms and their exits;
.4 emergency switchboard;
.5 wheelhouse;
.6 the room where the emergency power source is placed;
.7 the points where fire installations, fire detection and alarm system are serviced;
.8 emergency assembly stations for passengers and crew.

9.3.3 The emergency switchboard is to be supplied from the main switchboard and the feeder is to be protected at the main switchboard against short-circuit and overload. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

9.3.4 The following devices may be used as the starting arrangements of emergency generating sets:

.1 electrical starting system with its own accumulator battery and the charging system;
.2 compressed air starting system supplied from the independent air receiver;
.3 hydraulic starting system;
.4 manual starting arrangements.

10 ELECTRIC MACHINES

10.1 General Requirements

10.1.1 Electric machines installed on board are to satisfy requirements of the current standards for marine equipment as well as others but which in turn satisfy additional requirements of the *Rules* and *Publication No. 42/P – Testing of Electrical Rotating Machines*, in the scope each time established by PRS.

10.1.2 Rotors of alternating and direct-current machines are to be capable of withstanding, for 2 minutes, without damage and permanent deformations, the following increased speed of rotation:

.1 generators, converters, electric couplings and brakes: 120 per cent of the rated speed, but not less than 3 per cent of the maximum number of revolutions in transient conditions:
.2 series-wound motors: 120 per cent of the permissible speed as indicated on the rating plate, but not less than 150 per cent of the rated speed;
.3 all motors (other than mentioned in .2): 120 per cent of the maximum no-load speed.

10.1.3 A flexible copper is to be used for drawing current from brushes. Brush holder springs are not to be used for this purpose.

10.1.4 The position of brushes in direct-current machines is to be clearly and indelibly marked. Direct-current machines are to be so constructed as to be capable of working with fixed brush setting under all conditions.

10.1.5 Commutator type machines are to be capable of operating practically without sparking at any load from zero to the rated value. No sparking is to be possible at the specified overloads, reversals or starts, to such an extent as to cause damage to brushes or commutators.

10.1.6 Generators are to be so designed that after reaching the steady-state temperature corresponding to the rated load they are capable of sustaining overcurrent such as specified in Table 10.1.6.

Table 10.1.6

No.	Type of generator	Overcurrent, [%]	Duration of overcurrent, [s]
1	A.C. generator	50	120
2	D.C. generator	50	15

10.1.7 The terminals of the electric machines and feeders are to be located in easily accessible position for the crew. The class of protection must match that of the machine, but not less than IP44. Exception to this rule may be given by PRS for electric machines with a working voltage less than 50 V.

10.2 Alternating-current Generators

10.2.1 Each alternating-current generator is to have a separate independent system for automatic voltage regulation.

10.2.2 Alternating-current generators are to have voltage regulation system so adjusted to the regulation characteristics of the prime movers that the rated voltage is maintained within ±2.5 per cent.

10.2.3 A sudden change in the balanced load of a generator running at rated speed and rated voltage, under given current and power factor conditions, is not to cause a fall of voltage below 85 per cent of the rated value or a rise above 120 per cent.

Following such a change, the generator voltage is to be restored within not more than 1.5 seconds to the rated value with a tolerance of ±4 per cent, in the case of emergency set – up to 5 seconds.

Where no precise data are available on peak values of sudden load that may be connected additionally to the existing generator load, this may be taken equal to a load of 60 per cent of the rated current at a leading power factor of 0.4 or less, which is connected at idle speed and then disconnected.

10.3 Direct-current Generators

10.3.1 Shunt-wound direct-current generators may be used only when equipped with automatic voltage regulators.

10.3.2 Voltage regulators of compound-wound generators are to provide for reduction of no-load voltage, with the generator cold, by not less than 10 per cent of the rated generator voltage, with due account taken of the increased revolutions of the prime mover running at no-load.

10.3.3 Manual voltage regulators are to be so designed that the voltage increases when their setting knobs are rotated clockwise.

10.3.4 Voltage regulators of shunt-wound generators are to be so designed that when the field current is switched off, field winding is shorted.

10.3.5 Compound-wound generators are to have independent devices for voltage regulation with an accuracy of ±1 per cent for generators rated at up to 100 kW, or with an accuracy of ±0.5 per cent for generators of rating exceeding 100 kW. The said regulation limits are to be maintained with both the generator cold and hot and at any load within the operating load range of the generator.

10.3.6 Direct-current sets comprising compound-wound generators are to have such external characteristics that voltage of a warm generator adjusted to the rated value with an accuracy of ±1 per cent at 20 per cent load does not vary, at full load, by more than ±1.5 per cent for generators rated at 50 kW or over, and by more than ±2.5 per cent for generators of the lower output.

Voltage variations in a compound-wound generator running at 20 to 100 per cent of the rated load is not to exceed the following limits:

.1 ± 4 per cent for generators rated at 50 kW or more;
.2 ± 5 per cent for generators rated at over 15 kW but not higher than 50 kW;
.3 ± 6 per cent for generators not exceeding 15 kW.

10.3.7 Direct-current sets comprising shunt-wound generators are to have such external generator characteristics and such automatic voltage regulators that voltage is maintained within ±5 per cent of the rated value at all load variations from zero to the rated load.

10.4 Transformers

10.4.1 Transformers are to have electrically separated windings for primary and secondary voltages.

10.4.2 Dry transformers cooled by air are to be used in ships. The use of transformers of other design (e.g. liquid-cooled) will be considered by PRS separately.

10.4.3 Transformers are to be capable of withstanding 10 per cent overloads for 1 hour and 50 per cent overloads for 5 minutes.

10.4.4 Voltage variations at an active load between zero and rated load are not to exceed 5 per cent for transformers rated at up to 6.3 kVA and 2.5 per cent for transformers of higher rating.

10.5 Electromagnetic Brakes

10.5.1 The brake is to operate when the brake operating coil becomes de-energized.

10.5.2 Voltage drop of 30 per cent of the rated value is not to cause a hot brake to operate.

10.5.3 Electromagnetic brakes are to allow a manual release.

10.5.4 Electromagnetic brakes are to be fitted with at least two pressure springs.

11 POWER-ELECTRONIC EQUIPMENT

11.1 A separate device for disconnecting from the mains must be provided for each power electronics system. The combination fuse – switch may be used for consumer equipment up to a nominal current of 315 A. In all other cases, a circuit-breaker must be provided on the network side.

11.2 Control and signal electronics must be galvanically separated from power circuits.

11.3 Converter systems must ensure safe operation even with the largest permissible voltage and frequency fluctuations. For impermissibly high frequency and/or voltage variations in the supply voltage, the system must switch itself off or remain in a safe operating condition.

11.4 Electric charges in assemblies should be reduced to a voltage below 50V in less than 5 seconds after disconnecting from the network. If longer discharge times are required, a warning sign must be affixed to the device.

11.5 The failure of external control signals, must not lead to a dangerous condition.

11.6 Power electronics must be designed and installed in such a way that the failure of control voltages cannot lead to threats or damage to the system or device where the power electronics is installed, or to the overall system.

11.7 In installation which is required for propulsion and manoeuvrability as well as safety of the crew, craft or cargo, components must be provided for monitoring the individual power electronic assemblies and subsystems in order to facilitate error detection in the event of a malfunction and prevent the existence of undetected errors.

12 STORAGE BATTERIES

12.1 General Requirements

12.1.1 Storage batteries are to be so constructed that the loss of capacity of a fully charged battery due to self-discharge after 28 days out of operation at temperature of 25 ± 5°C does not exceed 30 per cent of the rated capacity for acid batteries and 25 per cent for alkaline batteries.

12.1.2 Battery containers and caps for holes are to be so constructed and secured as to prevent spilling or splashing of the electrolyte when the container is inclined on any side to an angle of 40° from the vertical.

Caps are to be made of a durable material resistant to electrolyte. The cap design is to be such as to avoid the building up of excess gas pressure inside the battery.

12.1.3 The electrolyte used are not to change their properties and deteriorate at the ambient temperature changes within –30°C to +60°C.

12.1.4 Materials used for fabrication of casing to house battery cells are to be resistant to electrolyte. Batteries arranged within the casing are to be so secured as to preclude their relative movement.

12.1.5 The possibility of application of the maintenance-free batteries is each time subject to a special consideration by PRS.

12.1.6 The use of valve regulated accumulators will be specially considered by PRS.

The requirements of European Standard EN 62619 or newer and EN 62620 shall apply for lithium-ion accumulators. Accumulator management systems for monitoring the lithium-ion accumulators have to be used.

12.1.7 These systems shall at a minimum comprise the following functionality:

.1 cell protection (short-circuit, external, internal, overcurrent, deep discharge, etc.);
.2 charge control;
.3 load management;
.4 determination of the charge level;
.5 balancing of the cells;
.6 thermal management.

12.2 Arrangement of Accumulator Batteries

12.2.1 Batteries are to be installed in dry spaces, which are not hazard of too high or too low temperatures, splashes of water and other harmful vapour and in a manner that running and periodic service is possible.

12.2.2 Batteries having voltage exceeding the safety voltage and batteries having a capacity of over 2 kW (computed from the maximum charging current and the rated voltage) are to be located in special battery compartments accessible from the deck or in appropriate boxes installed on the open deck. These spaces are to be special electrical spaces. Batteries having capacity of 0.2 kW up to 2 kW may be installed in boxes or cabinets located inside the ship's hull.

In ships with the low-rated electrical installation (except passenger ships), the above-mentioned batteries may be installed in the machinery space as high as possible, taking into account possibility of servicing the battery.

Accumulator batteries intended for starting up internal combustion engines, except emergency sources of power, may be located in the engine room in special boxes or cabinets with suitable ventilation.

Batteries having capacity of less than 0.2 kW are allowed to be installed in any space other than accommodation spaces, provided they are protected from the action of water and mechanical damages, and do not harmfully affect the surrounding equipment.

The use of batteries not emitting flammable gas during operation, e.g. gel batteries, (in the case where gas emits under permissible pressure inside the casing) will be specially considered by PRS.

12.2.3 The acid and alkaline batteries are not to be placed in one compartment or in one box.

The vessels and instruments intended for the batteries with different electrolytes are to be placed separately.

12.2.4 The inside part of battery compartments or boxes, as well as structural parts which may be subjected to harmful effect of electrolyte or gas are to be suitably protected.

12.2.5 The accumulator batteries and the individual accumulator cells are to be properly secured in position. When they are placed on racks, the distance between the deck and the caps of the upper level of cells is not to exceed 1500 mm.

12.2.6 When installing the accumulator batteries or the individual accumulator cells, fitting linings and distance pieces between them are to be provided to ensure a clearance for circulation of at least 15 mm.

12.2.7 Warning notices indicating the danger of explosion are to be provided on the doors leading to the battery compartment on near thereto, as well as on the boxes containing accumulators; the letters are to be at least 100 mm high.

12.3 Heating and Ventilation

12.3.1 The battery compartments in which temperature during operation may drop to + 5°C, except battery boxes or cabinets installed on deck, are to be heated. The heating is allowed to be effected by the heat produced in adjacent spaces, as well as with water or steam radiators located inside the battery compartments.

12.3.2 The heating system valves are to be located outside the battery compartments.

12.3.3 The battery compartments as well as cabinets and boxes are to have sufficient ventilation that will prevent possible formation and accumulation of explosive mixtures.

The ventilation system is to meet the requirements given in *Part VI – Machinery and Pipeline Installations.*

12.3.4 The battery compartments equipped with mechanical ventilation are to be provided with devices that will prevent possible charging of accumulator batteries before ventilation has been switched on. The charger is to be automatically discontinued if the ventilators stop.

12.4 Charging the Accumulator Batteries

12.4.1 Charging facilities are to be provided for charging accumulator batteries supplying essential services. These facilities are to be capable of charging a battery within a period of time not exceeding 8 hours. If an additional battery, which replaces the battery being charged, is available, the charging time may be extended.

12.4.2 For generator and accumulator battery running in parallel (buffer work), diagram and construction of the charging device is to be each time considered by PRS.

12.4.3 The charging facilities are to have means for measuring the voltage across battery terminals and charging current, as well as discharging current for emergency sources of electric power.

12.4.4 In ships which are fitted with portable accumulator lanterns or which are fitted with spare accumulator-fed navigation lanterns, facilities for charging the accumulators of these lanterns are to be provided.

12.4.5 Only automatic charging devices which correspond to the charging characteristics of the accumulator type must be used.

12.5 Installation of Electrical Equipment in Battery Compartments

12.5.1 Except for explosion-proof lighting fixtures (for explosive mixtures of explosion group IIC and temperature class at least T1) and cables led to accumulators and lighting fixtures, no other electrical equipment is to be installed in battery compartments. Cables leading to accumulators and lighting fixtures may be run without covers, provided that they have a metal armour or braid covered by non-metallic sheath, and that the armour or the braid are effectively earthed on both ends.

12.6 Electric Starters for Internal Combustion Engines

12.6.1 Number of Starter Batteries

12.6.1.1 For the purpose of start combustion engines up, irrespective of number of the engines, individual accumulator batteries may be used for each engine or a group else one common battery. If an accumulator battery is used for start up more than one engine, a permanent feeders with connectors are to be used for the purpose of start any of the combustion engines supplied from the battery.

12.6.1.2 The start-up battery is to be located as closed as possible to the engine, hence the feeders are short.

12.6.2 Battery Characteristics

12.6.2.1 Each starter battery is to be designed to withstand the discharging current during starting that will correspond to the maximum current through the most powerful starting electric motor.

12.6.2.2 The capacity of each battery is to be sufficient for six starts (within 30 minutes) of the engine in the ready-for-start condition; in the case of two or more engines – for not less than three starts of each engine.

12.6.2.3 When calculating battery capacity, the duration of each start is to be considered to be at least 5 s.

12.6.2.4 From the start-up battery lighting may be supplied, but capacity of the battery is to be enhanced (in comparison with capacity requirements given in 11.6.2.2 and 11.6.2.3) that a sufficient number of starts engines up may be performed in normal conditions.

12.6.3 Charging Facilities

12.6.3.1 A starter battery charging facility is to be supplied by a separate feeder from the main switchboard or by a separate feeder from a generator located on internal combustion engine.

13 ELECTRICAL APPARATUS AND ACCESSORIES

13.1 Electrical Apparatus

13.1.1 General Requirements

13.1.1.1 The electrical apparatus installed on board are to satisfy requirements of the current standards for marine equipment as well as others but which in turn satisfy additional requirements of the *Rules* in the scope each time established by PRS.

13.1.1.2 All non-manoeuvring switches, except for cabin switches, are to be provided with mechanical or electrical contact position indicators.

13.1.1.3 Controllers and master controllers are to be provided with drums fixing the particular position of controls; location in the zero position is to be more perceptible than elsewhere. Controller and master controller drums are to be fitted with a scale and a position indicator.

13.1.1.4 Machine control gear, except that used for continuous regulation, is to be so constructed that the end and intermediate fixed positions are easy to feel at various control stages, while movement beyond the end positions is impossible.

13.1.2 Manually Operated Apparatus

13.1.2.1 The direction of movement of manual operating controls of switchgear or machine control gear is to be such that clockwise rotation of a handle (handwheel) or upward/forward shifting of a handle (lever) corresponds to closing of an apparatus, start-up of a motor, increased speed, increased voltage, and so forth.

When controlling the lifting or lowering arrangements, clockwise rotation of a handle (handwheel) or shifting of a handle (lever) towards the operator is to correspond to lifting movement, and counter-clockwise rotation or shifting away from the operator – to lowering movement.

13.1.3 Motor-operated Apparatus

13.1.3.1 Actuators of motor-operated non-manoeuvring switches are to be so designed that in the event of loss of supply to the actuating motor the switch contacts remain in closed or in open position only.

13.1.3.2 Motor-actuated non-manoeuvring switchgear is to be provided with a device for manual operation.

13.1.4 Coils

13.1.4.1 A conductor or a damp is to be so attached to a coil winding as to avoid the weight or pressure of the connection affecting the coil turns. The tappings of voltage coils are to be made of a flexible stranded conductor, except the contact terminals secured directly to the coil frame.

13.1.4.2 The coils of electromagnetic apparatus are to bear notations giving particulars of their characteristics.

13.1.5 Fuses

13.1.5.1 Fuse elements are to be of a totally enclosed type and allow no arc ejection to the outside, sparking, or any other harmful effect upon the adjacent parts in the case the fuse blows.

13.1.5.2 It is recommended to design fuses in this manner that burnt fuse elements are to be visible.

13.1.5.3 Fuse elements are to be made of incombustible and non-hygroscopic insulating material.

13.2 Installation Fittings and Lighting

13.2.1 General Requirements

13.2.1.1 Enclosures of accessories and fittings are to be constructed of corrosion-resistant or suitably protected from corrosion and at least low flame-spread materials of adequate mechanical strength.

If steel or aluminium alloys are used, adequate anticorrosive protection is to be provided.

13.2.1.2 Insulating parts, to which current-carrying components are fixed, are to be made of materials that do not evolve gases that would ignite from an electric spark at a temperature up to 500°C inclusive.

13.2.1.3 The lighting fitting intended to be mounted on or close to combustible materials are to be so constructed as not to get heated over 90°C (for ambient air temperature of +40°C).

13.2.2 Lampholders

13.2.2.1 The design of lampholders, fitted with screw caps, is to be such as to effectively prevent the lamps from getting loose in service.

13.2.2.2 No switches are allowed to be fitted in lampholders.

13.2.2.3 Each lampholder is to be marked to indicate the rated voltage, as well as the permissible current or the lamp power.

13.2.3 Fluorescent and Gas Discharge Lamps

13.2.3.1 Reactors, capacitors and other ancillary gear of gas discharge lamps are to be protected by securely earthed metal enclosures.

13.2.3.2 Capacitors of 0.5 μF and above are to be fitted with discharging devices. The discharging device is to be so designed that the voltage of the capacitor does not exceed 50 V after 1 minute disconnection from the supply.

13.2.3.3 Reactors and transformers having a high reactance are to be installed as close as possible to the lighting lamp they serve.

13.2.3.4 Gas discharge lamps supplied by a voltage exceeding 250 V are to be provided with warning notices stating the voltage rating.

13.2.3.5 All live parts of such lamps are to be suitably protected.

13.2.4 Plug and Socket Connectors

13.2.4.1 The pin jacks of socket outlets are to be so constructed as to ensure permanent pressure in contact with the plug pins.

13.2.4.2 Plugs with slotted pins are not allowed for use. The pins of plugs designed for currents in excess of 10 A are to be cylindrically shaped, solid or hollow, as the case may be.

13.2.4.3 Socket outlets and plugs for voltage higher than the safety value are to have contacts for connecting the earth conductors of enclosures of the connected consumers.

13.2.4.4 Socket outlets installed in circuits with different voltages are to be so designed as to prevent insertion of a plug intended for one voltage into a socket intended for another voltage.

13.2.4.5 Socket outlets having enclosures are to be so constructed that the required degree of protection is ensured, regardless of whether the plug is in or out of the socket outlet.

13.2.4.6 All the socket outlets rated at over 16 A are to be provided with built-in switches. Such socket outlets are to be interlocked to prevent the possibility of inserting or withdrawing the plug when the socket switch is in the ”closed” position.

13.2.4.7 Where socket outlets are not interlocked, the clearances between contacts in the air or across the insulation surface are to be such that no short-circuit is possible due to arcing over when the plug is withdrawn while carrying a load 50 per cent above the rated current at rated voltage.

13.2.4.8 Socket outlets and plugs are to be so designed that it is not possible to insert only one live contact pin into the socket outlet, or insert a live contact pin into the earthing contact. Besides, the design of the outlets intended for connecting the motors (or gear), the direction of rotation (or operation) of which depends on the change of the sequence of phases or poles connected, is to exclude the possibility of this change.

When the plug is inserted into the socket outlet, the earthing part of the plug is to make contact with the earthing part of the socket outlet before connecting the live pins.

13.2.4.9 No fuses are to be fitted in socket outlets, plugs or tapping boxes.

14 HEATING APPLIANCES

14.1 General Requirements

14.1.1 Only heating appliances of stationary type are to be used.

14.1.2 Heating appliances are not be used in spaces where inflammable gas or fumes may accumulate or where self-ignition can occur.

14.1.3 Heating appliances are to be supplied from the main switchboard or section switchboard adopted for this purpose, or from the lighting switchboard, with due regard paid to the requirements of 6.1.11.

14.1.4 The supporting structural parts of heating appliances, as well as the internal surfaces of enclosures, are to be made entirely of incombustible materials.

14.1.5 The permissible leakage current for hot heating appliances of stationary type is not to be more than 1 mA per 1 kW rated input of any separately connected heating element, but not more than 10 mA for the appliance taken as a whole.

14.1.6 Heating appliances and space heaters are to be so designed that the temperature of their components which are to be handled by the personnel or which can be touched accidentally does not exceed the values indicated in Table 14.1.6.

Table 14.1.6

No.	Item		Permissible temperatures, [°C]
1	Control handles and other parts to be handled during substantial periods of time	metallic remaining	55 65
2	Enclosures of electric space heating appliances at 20°C ambient temp.		80
3	Air coming out from space heaters		110

14.2 Space Heating Appliances

14.2.1 Electric heaters intended for space heating are to be of stationary type.

The electric heaters are to be provided with a suitable system to disconnect the supply source when the temperature rise exceeds the permissible limits for the heater enclosures. Reactivation is to be performed manually.

14.2.2 The space heaters are to be installed in compliance with the requirements of 7.4.4 of *Part V – Fire Protection*.

14.2.3 If built-in switches are not provided in the heating appliances, such switches are to be installed in the rooms in which these appliances are located. Switches are to disconnect power supply at all poles or phases.

14.2.4 The enclosures of electric heaters are to be so constructed as to prevent the possibility of placing any objects on them.

14.2.5 Stationary space heating appliances, rated at over safe voltage, are to be protected against access to live parts except with the aid of special tools. The enclosures are to have notices giving the voltage value.

14.3 Cooking Appliances

14.3.1 Heating appliances forming part of galley equipment are to be so constructed as to avoid the possibility of bringing cooking utensils into contact with live parts, and to prevent short-circuits or damage to insulation due to liquid spilling or leakage.

14.4 Oil and Fuel Heating Appliances

14.4.1 The electrical heating appliances may be used for heating oil and fuel having a flash point of vapour above 60°C, provided that the requirements of 14.4.2 and 14.4.3 are complied with.

14.4.2 The heating appliances of the oil and fuel pipelines are to be provided with temperature control devices, visual signal of operation conditions, as well as visual and acoustic alarms indicating a failure in the system or that the permissible temperature values have been exceeded.

14.4.3 The heating appliances for oil and fuel tanks are to be provided with temperature control devices for the heated medium, temperature indicators for surfaces of heating elements, minimum level sensors, as well as with means for the disconnection of power supply to the heating devices when the maximum permissible parameters have been reached.

Such appliances are to be provided with visual signal on operation conditions and with audible and visual signals indicating a failure in the system.

14.4.4 The oil and fuel heating appliances are to be fitted with a device controlling the temperature of the heated agent. In addition, a safety cut-out switch is to be provided for disconnecting the supply voltage when the temperature of the heated agent reaches 220°C. The switch is to allow re-set manually when the temperature dropped.

15 CABLES AND CONDUCTORS

15.1 General Requirements

15.1.1 Cables used on board the vessel shall be of marine type and made of materials which are self-extinguishing and flame-retardant as well as water-resistant and oil-resistant in accordance with the requirements specified in this Chapter or – subject to PRS consent in each particular case – other international or national standards (e.g. IEC 60092, IEC 60332).

Application of another type cables is subject to PRS consent in each particular case.

15.1.2 The requirements of the present Chapter do not apply to concentric, telephone cables and also power cables for the voltage over 1000 V.

15.2 Conductors

15.2.1 Cable conductors intended for supplying essential services are to be of multi-wire type. The minimum number of wires per conductor is given in Table 15.2.1.

Table 15.2.1

No.	Nominal cross-sectional area of conductor, [mm²]	Minimum number of wires per conductor	
		Circular non-compacted conductors	Compacted circular and shaped conductors
1	0.5 – 6	7	–
2	10 – 16	7	6
3	25 – 35	19	6
4	50 – 70	19	15
5	95	37	15
6	120 – 185	37	30
7	240 – 300	61	30

Note: The ratio of nominal diameters of any two wires of mechanically compacted conductors is not to exceed the value of 1.3 and that of shaped non-compacted conductors – 1.8.

15.2.2 Wires of rubber-insulated copper conductors are to be tinned or coated with a suitable alloy. Tinning or other anticorrosive coating of external wiring or of all wires of a rubber-insulated conductor may be dispensed with if the manufacturer takes measures to guarantee that the rubber insulation does not affect adversely the metal of the conductor.

15.3 Insulating Materials

15.3.1 The types of insulation that may be used for insulating current-carrying conductors in cables are listed in Table 15.3.1. The use of other types of insulation will be specially considered by PRS in each particular case.

Table 15.3.1

Standard types of insulating materials	Designation of insulation	Maximum rated conductor temperature[1], [°C]	
		Normal operation	Short-circuit
a) Thermoplastic			
– based upon polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate	PVC/A	60	150
b)Elastomeric or thermoset			
– based upon ethylene-propylene rubber or similar (EPM or EPDM)	EPR	85	250
– based upon cross-linked polyethylene	XLPE	85	250
– based upon silicone rubber	S 95	95	350[2]
– based upon ethylene-propylene rubber or similar (EPM or EPDM) halogen-free	HF EPR	85	250
– based upon halogen-free cross-linked polyethylene	HF XLPE	85	250
– based upon halogen-free silicone rubber	HF S 95	95	350[2]
– based upon cross-linked polyolefin material for halogen-free cables	HF 85	85	250

[1] Temperature of the conductor assumed for the calculation of current rating in continuous service of cables.
[2] The temperature is applicable only to galvanized cores.

15.4 Cable Sheaths

15.4.1 Cable and conductor sheaths may be made of materials given in Table 15.4.1.

The use of other materials for cable sheaths will be specially considered by PRS in each particular case.

Table 15.4.1

Type of cable sheath	Designation	Maximum temperature of cable in sheath, [°C]
a) Thermoplastic		
– based upon polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate	ST 1 ST 2	60 85
– halogen-free materials	SHF 1	85
b) Elastomeric or thermoset		
– polychloroprene rubber compound	SE 1	85
– chlorosulfonized polyethylene or polyethylene rubber compound	SH	85
– halogen-free materials	SHF 2	85

15.4.2 Sheaths are to be of uniform thickness, within permissible limits, throughout the manufacturing length of cable, and are to envelope the cable cores concentrically.

The sheaths are to form an impervious cover adhering to the protected cores.

15.5 Wiring

15.5.1 Insulated single-core conductors are to be used for internal wiring of switchboards and electrical devices (see also 2.3.3).

15.5.2 Non-insulated wires and busbars are permitted for use only for internal wiring of electrical devices. The external wiring with non-insulated wires or busbars is not allowed unless they are reliably guarded.

15.6 Cabling

15.6.1 General Requirements

15.6.1.1 There are to be used cables and conductors having multi-wire cores with the cross-sectional area not less than:

.1 1.5 mm^2 – for power and lighting installation;
.2 0.75 mm^2 – for monitoring and indicating circuits as well as for signaling and control circuits;
.3 0.5 mm^2 – for internal communication, that do not influence on safety.

15.6.1.2 Maximum permissible temperature for the insulating material of the cable cores or conductors is to be at least 10°C higher than the maximum ambient temperature likely to exist in the space where the cable is installed.

15.6.1.3 In locations affected by the action of crude oil products and other aggressive media, the cables having a sheathing that will withstand the action of a given medium are to be used.

Cables of other types may be installed in such locations, provided they are laid in metallic pipes (see 14.6.8).

15.6.1.4 In locations where cables may be subjected to mechanical damage, they are to have an appropriate armour, while other types of cables in such locations are to be protected with special reliable covers or are to be installed in pipes (see 14.6.8).

15.6.2 Selection of Cables and Conductors for Loads Required

15.6.2.1 Permissible continuous loads on single-core cables and on conductors insulated by various materials are to comply with the values given in Table 15.6.2.1, except those where permissible continuous load is given.

The values of loads given in the Table refer to the following cases of cable installation:

.1 not more than 6 cables installed in one bunch or one layer, adhering to one another;
.2 in two layers, irrespective of the number of cables in the layer, provided that there exists clearance for free circulation of the cooling air between the group or bunch of six cables.

Table 15.6.2.1
Permissible current ratings in continuous service of single-core cables and conductors with various insulation at the ambient temperature of 40°C

Cross-sectional area of conductor, [mm²]	Permissible current rating in continuous service, [A]		
	polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate	based upon ethylene-propylene rubber, cross-linked polyethylene	silicone rubber
	+ 60[X]	+85[X]	+95[X]
1	2	5	6
1	9	16	21
1.5	13	21	25
2.5	19	29	33
4	25	40	44
6	33	50	57
10	46	71	78
16	62	95	105
25	81	127	141
35	100	153	173
50	120	190	210
70	155	238	267
95	189	291	325
120	218	339	378
150	253	386	430
185	287	439	493
240	333	519	577
300	385	593	667

[X] Maximum rated conductor temperature, [°C].

15.6.2.2 Permissible current ratings for two-, three- or four-core cables are to be reduced in relation to the values given in Table 15.6.2.1, using the following correction factors:

0.85–for two-core cables;
0.70–for three- and four-core cables.

15.6.2.3 Permissible current ratings for cables and conductors, installed in circuits with intermittent or short time service, are to be determined by multiplying the value of current rating in continuous service of these cables, calculated in accordance with Table 15.6.2.1 by the correction factor taken from Table 15.6.2.3.

Table 15.6.2.3
Values of correction factors in relation to load

Nominal cross-sectional area, [mm²]	Intermittent service, 40%		Short-time service, 30 min.		Short-time service, 60 min.	
	Cables and conductors					
	with metal coverings	without metal coverings	with metal coverings	without metal coverings	with metal coverings	without metal coverings
1	1.24	1.09	1.06	1.06	1.06	1.06
1.5	1.26	1.09	1.06	1.06	1.06	1.06
2.5	1.27	1.10	1.06	1.06	1.06	1.06
4	1.30	1.14	1.06	1.06	1.06	1.06
6	1.33	1.17	1.06	1.06	1.06	1.06
10	1.36	1.21	1.08	1.06	1.06	1.06
16	1.40	1.26	1.09	1.06	1.06	1.06
25	1.42	1.30	1.12	1.07	1.06	1.06
35	1.44	1.33	1.14	1.07	1.07	1.06
50	1.46	1.37	1.17	1.08	1.08	1.06
70	1.47	1.40	1.21	1.09	1.09	1.06
95	1.49	1.42	1.25	1.12	1.11	1.07
120	1.50	1.44	1.28	1.14	1.12	1.07
150	1.51	1.45	1.32	1.17	1.14	1.08
185	–	–	1.36	1.20	1.16	1.09
240	–	–	1.41	1.24	1.18	1.10
300	–	–	1.46	1.28	1.20	1.12

15.6.2.4 Permissible current ratings specified in Table 15.6.2.1 refer to the ambient temperature of + 40°C. The values of correction factors for other ambient temperatures of the calculation of permissible current ratings of cables and conductors are to be obtained from Table 15.6.2.1 by multiplying an appropriate correction factor given in Table 15.6.2.4.

Table 15.6.2.4
Values of correction factors in relation to the ambient temperature

Maximum permissible temperature of conductor, [°C]	Ambient temperature, [°C]										
	35	40	45	50	55	60	65	70	75	80	85
60	1.29	1.15	1.00	0.82	–	–	–	–	–	–	–
65	1.22	1.12	1.00	0.87	0.71	–	–	–	–	–	–
70	1.18	1.10	1.00	0.89	0.77	0.63	–	–	–	–	–
75	1.15	1.08	1.00	0.91	0.82	0.71	0.58	–	–	–	–
80	1.13	1.07	1.00	0.93	0.85	0.76	0.65	0.53	–	–	–
85	1.12	1.06	1.00	0.94	0.87	0.79	0.71	0.61	0.50	–	–
90	1.10	1.05	1.00	0.94	0.88	0.82	0.74	0.67	0.58	0.47	–
95	1.10	1.05	1.00	0.95	0.89	0.84	0.77	0.71	0.63	0.55	0.45

15.6.2.5 Instead of execution of calculations resulting from 15.6.2.1 – 15.6.2.4, permissible current ratings may be obtained from *Publication No. 15/P – Current Rating Tables for Cables, Wires and Busbars in Marine Installations*.

15.6.2.6 When choosing cables for the final branch circuits of lighting or the heating appliances, neither correction nor demand factors are to be used.

15.6.3 Selection of Cable Cross-sectional Areas for Permissible Voltage Drop

15.6.3.1 The voltage drop on the cables connecting the generators to the main switchboard or the emergency switchboard is not to exceed 1 per cent.

15.6.3.2 The voltage drop on the cables connecting the main switchboard to a consumer for rated current is not to exceed:

.1 5% – for lighting and signaling devices supplied by voltage exceeding 50 V;
.2 10% – for lighting and signaling devices supplying by voltage not exceeding 50 V;
.3 7% – for power and heating consumers, irrespective of voltage;
.4 10% – for power consumers at short-time and intermittent service, irrespective of voltage.

15.6.3.3 Cables used for supplying the directly-started alternating-current electric motors are to be so calculated that the total drop of voltage on motor terminals at starting does not disturb electrical appliance supplied from the same source of energy.

15.6.4 Installation of Cables

15.6.4.1 Cable runs are to be, as far as possible, straight and accessible and are to pass through locations where cables are not affected by any oil, fuel, water and excessive heating to which they are likely to be exposed.

Cable runs are to be installed not closer than 100 mm to the sources of heat.

15.6.4.2 No cables are to be installed at a distance less than 50 mm from the double bottom and from the liquid fuel and lubrication oil tanks. The distance of cables from the shell plating, as well as from fire-resistant and watertight bulkheads and decks is not to be less than 20 mm.

15.6.4.3 Cables are not installed in tanks or holds intended to transport flammable fluids, except cases specified in 2.7.

15.6.4.4 Cables having external metallic sheathing may be installed on structures of light alloys or be fastened in position with holders of such alloys only in cases where reliable anti-corrosive protection is provided.

15.6.4.5 In holds of dry-cargo ships intended for the carriage of dangerous cargoes, as a rule, no through runs of cables are to be installed. Admissibility and methods of installation of cables in such holds are subject to special consideration by PRS in each particular case.

15.6.4.6 No cables are recommended to be installed under the flooring of machinery spaces. If such an installation is required, cables are to be installed in metallic pipes or in closed ducts (see 15.6.8).

15.6.4.7 Installation of cables having insulation intended to withstand different permissible temperatures in the common cable runs is to be effected in such a manner that the cables are not heated above their permissible temperature.

15.6.4.8 Cables with different protective coverings, the less resistant of which may be subjected to damage, are not to be installed in one common pipe, one common duct or in other runs of unsupported common laying.

15.6.4.9 The current cables of the main electric propulsion machinery are to be installed separately from the cables intended for other purposes.

15.6.4.10 Conductors in multi-core cables are not to be used for supplying power and control the circuits of essential services not associated with one another. Multi-core cable is not to be used for both the safe voltage circuits and working voltage circuits greater than the safe voltage.

15.6.4.11 When installing cables in ducts and other structures of combustible material, the ways of cable installation are to be protected from igniting by means of suitable fire protection, such as surface plating, coating or impregnation.

15.6.4.12 Cables are not to be embedded in thermal or acoustic insulation if it is made of combustible materials. From such an insulation, cables are to be separated with plating of incombustible material or are to be located at a distance not less than 20 mm from it.

Where cables are installed in thermal or acoustic insulation made of incombustible materials, the cables are to be calculated with a corresponding load reduction.

15.6.4.13 The minimum internal bending radii of the cables are not to be less than those specified in Table 15.6.4.13.

Table 15.6.4.13

Type of cable		External diameter of cable, *d*,[mm]	Minimum bending radius
Insulation	Protective covering		
Thermoplastic and elastomeric materials	Armoured with metal tape or wires	any	10 *d*
	Lead alloy or protected with braid of metal wires	any	6 *d*
	remaining	up to 9.5	3 *d*
		9.5 to 25.4	4 *d*
		over 25.4	6 *d*

15.6.4.14 Cables and earthing conductors of equipment mounted on shock absorbers are to be installed in such a manner that they cannot be damaged in service.

15.6.4.15 Between cables and pipes or hydraulic lines used for mobile wheelhouse a distance of at least 100 mm is to be retained.

15.6.4.16 Cables linking the mobile wheelhouse are to be sufficient flexible and be fitted with insulation with sufficient flexibility down to –20ºC and resistance to environmental hazards.

15.6.4.17 Main and emergency power supply cables must not run through the same room. PRS may waive this requirement if:

.1 main and emergency power supply cables are laid as far apart from each other as possible or

.2 the emergency power supply cables are fire-resistant. This requirement shall have been fulfilled if they satisfy the requirements of the International Standards series IEC 60331.

15.6.5 Fastening of Cables

15.6.5.1 Cables are to be suitably fastened in position by means of clips, holders, hangers, etc. made of metal or other incombustible or low flame spread material. The fastener surface is to be sufficiently wide and is to have no sharp edges. The fasteners are to be selected in such a manner that the cables are fastened in position securely but without damage to their protective coverings.

15.6.5.2 Distances between the cable fastening points in the case of horizontal installation are not to exceed the values given in Table 15.6.5.2. For vertical runs of cables, these distances may be increased by 25 per cent.

Table 15.6.5.2

External diameter of cable, [mm]		Distance between fastening points, [mm]	
over	up to	without armour	with armour
–	8	200	250
8	13	250	300
13	20	300	350
20	30	350	400
30	–	400	450

15.6.5.3 Cables are to be fastened in such a manner that mechanical strains in cables are not transmitted to their inlet connections.

15.6.5.4 Cable runs and cables installed parallel to the shell plating are to be fastened to the hull structural members and not to the shell plating.

On watertight bulkheads and masts, cables are to be fastened by means of suitable structures, such as perforated tray plates or panels.

15.6.5.5 Cables running parallel to bulkheads subject to sweating are to be installed on bridges or on perforated panels in such a manner that a free space is reserved between cables and bulkheads.

15.6.5.6 Cable runs are to be installed with a minimum number of crossings. Bridges are to be used at places where cables cross each other. An air gap of not less than 5 mm is to be left between the bridge and the cable crossing it over.

15.6.5.7 For ships made from plastic (laminated glass) may be used simultaneously changed rules for installation and fastening cables, conduits with reference to the Rules for ships with metal hulls conditioning plastic ship building technology, used materials, etc.

15.6.6 Cables Penetrating Decks, Bulkheads and Elements of Ship's Structure

15.6.6.1 Penetration of watertight, gas-tight and fire-resisting bulkheads and decks is to be made tight in a manner that the bulkheads and decks are not to reduce their tightness or resistance; no force resulting from elastic deformations of the ship's hull is to be transmitted to the cables.

15.6.6.2 When installing the cables through non-watertight bulkheads or elements of the ship's structure less than 6 mm thick, lining or bushings that will prevent damage to cables are to be provided. Where bulkheads or the ship's structures are more than 6 mm thick, no lining or bushings are required, but the edges of the holes are to be rounded off.

15.6.6.3 Cables passing through decks are to be protected from mechanical damage up to a suitable height above the deck, and in locations where mechanical damage is less probable, up to a height of at least 200 mm. Cable penetrations are to be filled with cable compound. For single cables, the use of glands is permitted instead of filling with compound.

15.6.7 Cable Compounds and Packing

15.6.7.1 To fill the cable boxes in watertight bulkheads and decks, the use is to be made of packing compounds having good adhesion to the inside surfaces of cable boxes and cable sheathing, that will withstand the action of water and oil products, will not shrink and lose its tightness in continuous service under conditions specified in 2.1.1.1, 2.1.1.2 and 2.1.2.1.

15.6.8 Installation of Cables in Pipes and Conduits

15.6.8.1 Pipes and conduits in which cables are installed are to be metallic and protected from corrosion on the inside and outside surface. The inside surface of pipes and conduits is to be even and smooth. Ends of pipes are to be machined or protected in such a manner that no damage is caused to the cables when they are being pulled in.

The use of pipes made of plastic materials is subject to special consideration by PRS.

15.6.8.2 Pipe and conduit bending radius is not to be smaller than the permissible radius for cable of the largest diameter installed in this pipe (see 15.6.4.13).

15.6.8.3 The sum of the cross-sectional areas of all cables as measured on their outside diameters is not to exceed 40 per cent of the inside cross-sectional area of the pipe.

15.6.8.4 The pipes and conduits are to be mechanically and electrically continuous and are to be securely earthed if the method of their installation does not present in itself a reliable earthing.

15.6.8.5 The pipes and conduits are to be installed in such a manner that no water can accumulate in them. When required, ventilation holes are to be provided in the pipes, in the highest and lowest points possible, to ensure circulation of air and to prevent steam condensation. Holes in pipes are permissible only in places where they will not increase the danger of explosion or fire.

15.6.8.6 Cables with flammable insulation may be used if PRS gave assent based on 15.1.1, but the cables are to be installed only in metal pipes.

15.6.9 Special Requirements for Installation of Single-core Alternating-current Cables

15.6.9.1 Single-core cables are not recommended for alternating-current installation. If installation of such cables is unavoidable, the cables rated in excess of 20 A are to meet the following requirements:

- **.1** cables are not to have coverings of magnetic material;
- **.2** cables which belong to one common circuit are to be installed in one run or in one pipe; installation of such cables in different pipes is permitted only when pipes of non-magnetic materials are used;
- **.3** cable fasteners other than those made of non-magnetic materials are to embrace all single-core cables in one circuit;
- **.4** distance between cables is not to be over one cable diameter.

15.6.9.2 When single-core cables are passed through bulkheads or decks, there is to be no magnetic material between the cables which belong to one common circuit. Distance between such cables and magnetic material is not to be less than 75 mm.

15.6.10 Connecting and Tapping of Cables

15.6.10.1 Ends of cables are to be packed in a manner that would prevent the entry of moisture inside the cable.

15.6.10.2 Protective covering of a cable led into a device from below should enter inside the device to not less than 10 mm above the inlet hole.

15.6.10.3 Connection of cables at places of tapping is to be effected in junction boxes by means of clamps.

15.6.10.4 If during installation of cables, it is found necessary to make additional connections, they shall be effected in the suitable junction boxes fitted with clamps. The connection, as a whole, shall be protected against the effect of ambient conditions. The possibility for application of additional connections of cables or connecting damaged cables is subject to PRS consent in each particular case taking account of the requirements of standard IEC 60092-352 (item 3.28 and Annex D).

15.6.10.5 Cables linking the mobile wheelhouse, which can be move up and down, are to be run through the junction box equipped with terminals. Cables running from the junction box to electrical equipment fitted in the mobile wheelhouse are to be flexible with sufficient reserve of length and installed in a manner that cannot be damaged during operation of the mobile wheelhouse.

16 AUTOMATION AND REMOTE CONTROL SYSTEMS

16.1 Application

16.1.1 Requirements of the current section apply to all automated devices, particular automatic systems as well as components which are to be surveyed by PRS.

16.1.2 Automated devices and installations are not to be necessary to obtain PRS class, except particular cases determined in the *Rules*, but when it is applied all of the requirements of this section are to be fulfil.

16.2 Design Requirements

16.2.1 General Requirements

16.2.1.1 Automated machinery provided with automatic or remote control system, as well as, to the necessary extent, with monitoring systems, is, in addition, to be provided with means of local manual control.

In each case of failure in automatic or remote control system, the possibility of local control is to be maintained.

16.2.1.2 Where machinery or installation is remotely controlled, it should be possible for the operator to check, with sufficient reliance, from his control station whether his command has been carried out by remote control system.

16.2.2 Requirements for Components and Units of Automatic Systems

16.2.2.1 Components and units used in automatic systems, aside from the following section are to comply additionally with the requirements of the relevant parts of the *Rules*.

16.2.2.2 Individual components and units of systems and their external connections are to be permanently and clearly marked. The marking is to ensure an easy identification with the drawings and, in the case of sensors, is also to indicate their purpose and the set point.

16.2.2.3 Damping arrangements (shock absorbers), which are used to protect components and units against the influence of shocks and vibration, are to be provided with stops to protect them against damage in case of excessive rolling amplitudes.

16.2.2.4 Components and units to be installed in spaces or areas of explosion risk are to be of intrinsically safe or flame-proof type.

16.2.2.5 Control elements intended for fixing the settings are to be secured against unintentional change of the position. Their repeated securing in case of readjustment is to be enabled.

16.2.2.6 Replaceable blocks (printed cards) with plug-in connections are to be so designed as to preclude the possibility of erroneous replacement. They should also be capable of being effectively and permanently fixed in working position.

When it is necessary, due to design or functional features of the component or unit, the permanent marking of correct mounting position should be provided or the component or unit itself should be so designed that mounting in other than correct position is impossible.

16.2.2.7 Printed circuit cards are to be covered with electroinsulating varnish on the side on which current lines are located.

16.2.2.8 Final control elements (servo-motors, controllers, etc.) are to be so designed that no uncontrollable movement of their working parts is possible.

16.2.2.9 Pneumatic and hydraulic components and units are to withstand, without damage, short-time overloads caused by an increase of the working medium pressure equal to 1.5 times the rated value.

16.2.2.10 Pressure sensors are to be connected to the piping installation by means of 3-way cocks in order to supply:
- the testing pressure,
- de-aeration of the piping,
- disconnecting of the damaged sensor.

16.2.2.11 Pneumatic and hydraulic components and units are to maintain their performance characteristics under the deviation of supply pressure from the rated value within ± 20%.

16.2.3 Requirements for Automatic Systems

16.2.3.1 Electric and electronic circuits of automatic systems are to be provided with means of protection capable of selective disconnecting the damaged parts of the system.

16.2.3.2 Each automatic system is to be so designed that the failure in one circuit of lamps, sirens and similar signaling devices does not interfere with the operation of other circuits.

16.2.3.3 Failure of power supply to automatic or remote control systems is not to result in dangerous conditions.

16.2.3.4 Automatic systems are to be built of such components and units that their replacement with the other ones of the same type does not affect the operation of the system. If readjustment is necessary, it should be possible by simple means.

16.2.3.5 Automatic systems are to be protected against malfunctions as a result of short time deviations of parameters due to rolling and pitching, starting or stopping of the machinery or due to other similar, normal fluctuation of parameters.

16.2.3.6 Automatic systems are to be so designed that typical failures of such systems do not result in hazardous conditions and do not lead to the secondary failures in the system itself and in automated machinery concerned.

16.2.3.7 Each automatic or remote control system is to prevent the automatic restart of controlled machinery after its stopping by the safety system. Restart should be possible after manual reset (e.g. by control lever being brought to start position).

16.2.3.8 Replaceable and controllable components, as well as the test points are to be arranged with permanent and easy access.

16.2.3.9 Components or units of automatic systems are to be so designed as to ensure the possibility of their checking and calibration during operation.

16.2.3.10 Measuring range of analogue sensors should be at least 20% greater than the expected deviation of the input signal value (measured parameter).

16.2.3.11 Liquid used in hydraulic installations is to:

.1 remain physical properties for long-term at operation;
.2 have sufficient lubricating properties;
.3 have flashing point of vapours at least 60°C;

and should not:

.4 damage materials and pipe lines;
.5 be toxic.

Viscosity of the liquid is to be constants for range of working temperatures.

16.2.3.12 Filters used in automation systems are to be designed in such a way and located in a manner that cleaning them is possible when the system works.

16.2.3.13 Hydraulic automation systems are not to be connected with other installations and are to be supplied of separate tanks.

Based on separate agreement with PRS, in hydraulic devices exceptionally liquid from other installation may be used, but effective filters are to be applied.

16.2.3.14 Endings of inlet and return pipes to tanks are to be connected below liquid level in the tank, taking into consideration all normal angles of heel and trim.

16.2.3.15 Pneumatic systems are to be fitted with effective means for ensuring the required degree of purity and dryness of air supplied.

16.2.3.16 Drying and filtering equipment used in automatic systems of main propulsion and electric generating sets are, as a rule, to be doubled and so arranged as to ensure the operation of one of them when the other is out of action. Double drying and filtering equipment need not be used, provided it is of self-cleaning type or of such design that quick replacement of contaminated inserts is possible without stopping the air supply.

16.2.3.17 In supply piping of pneumatic systems, safety valves are to be provided to prevent an increase of pressure by more than 1.1 of the working pressure. Reduction valves are to be redoubled.

16.2.3.18 Where hydraulic, pneumatic, electric and electronic components are situated in common desks, consoles and other similar units, they are to be so separated from each other that possible leakage of working medium does not affect the electric, electronic or pneumatic components.

The sections of desks, consoles and other units which incorporate the equipment containing liquid medium, are to be provided with drip trays fitted with drain pipes.

16.2.3.19 Where components and units requiring forced cooling are used, effective means are to be provided to prevent their damage in case of cooling failure.

Measures are also to be taken to enable components or units to operate in case of contamination by the cooling air.

16.2.3.20 Elements intended for control are to be arranged with easy access, and are to be marked appropriately to their assignment, as well as are to be secured against self-acting change of the position.

16.3 Power Supply of Automatic Systems

16.3.1 Control system of the main propulsion is to be supplied through two independent feeders. Switching these feeders may be automatic or manual from local station. Control system for generator sets is to be so arranged that the systems are capable of operating, irrespective of the voltage on the main switchboard.

16.3.2 Where control systems of auxiliary machinery are supplied from the circuit supplying the prime mover of the machinery, starting of the stand-by units is to be possible also in case of voltage failure in the supply circuit of the machinery actually in operation.

16.3.3 Automatic systems or their hydraulic and pneumatic parts are to be supplied by means of two compressors or two pumps.

The emergency source of power is to be automatically operated in the case of failure of the power system. The emergency source may be accumulator battery capable to supply the automatic system at least 15 min.

Failure of power supply is to be signaled.

16.3.4 Automatic systems or their hydraulic and pneumatic parts are to be supplied by means of two compressors or two pumps.

16.4 Monitoring Systems

16.4.1 Alarm System

16.4.1.1 Depending on the extent of machinery automation, the alarm system is to give the following types of alarms:

- **.1** alarm to indicate that limit values of parameters have been exceeded;
- **.2** alarm to indicate that safety system has operated;
- **.3** alarm to indicate the failure of power supply to particular automatic system or that the stand-by power supply has been switched on;
- **.4** alarm to indicate that other values or conditions resulting from the detailed requirements of the present Part of the *Rules* have been changed.

Alarm conditions of machinery are to be indicated in the relevant control stations.

16.4.1.2 Alarm system is to function independently of control and safety systems so that a failure or malfunction in these systems will not prevent the alarm system from operating. Possible interconnection of these systems, restricted to the source of alarm only, will be specially considered by PRS.

16.4.1.3 Alarm system is to have such self-monitoring properties that alarm signal will be given in the case of a broken circuit or other typical failures.

16.4.1.4 The alarm system is to operate simultaneously both visual and audible signals. The system is to properly operate in a case of a number of alarms indicated.

16.4.1.5 Visual signal is to be given by intermittent light and should indicate the reasons causing the alarm. Cancelling the visual signal should be possible only after the reasons of its operation have been eliminated. Acknowledgement of visual signal is to be clearly indicated by the change of its form (i.e. change from blinking light to continuous light or change in flickering frequency).

16.4.1.6 Audible signal may be common for all types of alarms. If the possibility of switching off the audible signal is provided – the readiness of actuating new alarms from other parameters is to be maintained until the reason of previous signal has been eliminated.

Audible signals for machinery are to be clearly distinguished from surrounding sounds and other audible signals, e.g. fire, CO_2 releasing, etc.

16.4.1.7 For easy identification of transitory alarm conditions which are automatically eliminated, the alarm system is to have memory features, so that the transitory alarm conditions can be maintained until they are acknowledged.

16.4.1.8 Disconnection or omission of any part of the alarm system is to be clearly indicated.

16.4.1.9 Alarm system is to be capable of being tested during normal machinery operation. Where practicable, means are to be provided at convenient and accessible locations to permit the sensors to be tested without affecting the operation of the machinery.

16.4.1.10 A short-time interruption of power supply to the alarm system is not to cause a loss of information on alarm conditions prior to the interruption.

16.4.1.11 The colour of a visual signal is to be adequate to the character of this signal in accordance with 4.5.5.

16.4.1.12 Where it is intended to provide dimming arrangement for any alarm system annunciators on the navigation bridge, arrangement is to be such that the total extinguishing of annunciators luminescence is impossible.

16.4.1.13 Internal combustion engines fitted with high-pressure pipes connecting the fuel pump with injectors shall be provided with an alarm giving warning of any leakage from such a pipe. The alarm is not required for two-cylinder engines and engines installed on the open deck to power windlasses and capstans.

16.4.1.14 The following shall be monitored by suitable devices which trigger an alarm once the critical level has been reached:
- main-engine cooling water temperature,
- lubricating-oil pressure for the main engines and transmissions,
- oil and air pressure of the main engine reversing units, reversible transmissions or propellers.

16.4.2 Safety System

16.4.2.1 Safety system of particular units of automated machinery plant is to operate automatically after exceeding limit values of the given parameters causing a failure and is to cover all foreseeable fault conditions assumed with regard to operational properties and characteristics of the machinery concerned so that:

.1 normal operating conditions are restored (before the emergency set is started), or
.2 the machinery operation is temporarily adjusted to the prevailing conditions (by reducing the load of machinery), or
.3 machinery is protected from failure by stopping it.

16.4.2.2 The main engine or a part of the power transmission shall not be automatically shut down unless the risk of sudden failure, complete destruction or explosion occurs, e.g. as a result of overspeed.

16.4.2.3 Means are to be provided to trace the cause of the safety system action.

16.4.2.4 The safety system is to be independent of all other control and alarm systems so that a failure or a malfunction in these systems will not prevent the safety system from operating.

16.4.2.5 Safety system is to have such self-monitoring properties that, alarm signal will be given at least in case of short circuit, earth fault, broken fuse or broken circuit.

16.4.2.6 Safety systems of different units of the machinery plant are to be independent. Failure in the safety system of one part of the plant is not to interfere with the operation of the safety system in another part of the plant.

16.4.2.7 In multi pitch propeller and multi-engine propulsion system, activation of the safety system due to too low oil pressure of one engine should not to influence on the properties of remaining.

16.4.2.8 Safety system is to intervene after operation of the alarm system in the relevant sequence of functions.

16.4.2.9 Activation of the safety system is to cause an alarm.

16.4.2.10 Safety system is to be so designed that the failure in the system does not cause hazardous conditions. This feature is to be maintained, not only with regard to the safety of the system itself and associated machinery, but also to the safety of the whole machinery installation and the ship.

16.4.2.11 When the safety system has stopped an unit, the unit is not to be restarted automatically, but only after a manual reset has been carried out (see also 16.2.3.7).

16.4.2.12 When the switching-off facilities in the safety system of the main propulsion are provided, the switching-off device is to be of such a design as to exclude the possibility of its unintentional use, and in the case of the safety system being switched off, its position is to be indicated by means of a special signal.

16.4.2.13 Overload protection of the engine is to be provided in ships where control pitch propellers is installed.

16.4.2.14 In propulsion with the variable pitch propeller an overload protection of the engine is to be provided when the pitch propeller changes.

16.5 Control Systems

16.5.1 Main Propulsion Control Systems

16.5.1.1 The remote control station in the wheelhouse is to be equipped with the device for emergency stopping the main engine independently of the remote control system.

16.5.1.2 Each remote control station or automatic main propulsion control system is to be equipped with the following measuring and monitoring instruments:

- **.1** indicators of the alarm system taking into consideration purpose of the control station and type of direct supervision of the machinery and particularly affecting ship's manoeuvrability;
- **.2** indicators informing which station is in charge of control;
- **.3** switching-off device of the main engine safety system;
- **.4** indicator of starting air pressure;
- **.5** indicators of number of revolutions and direction of rotation of the propeller shaft – in the case when the disengaged clutch is used for power 75 kW and more;
- **.6** indicators informing the pitch position in the case of controllable pitch propeller;
- **.7** emergency shut-down device of the main engine, required by 16.5.1.1.

16.5.1.3 Visual alarm is be provided when the starting air pressure of the main engine is below permissible level.

16.5.1.4 The remote control system is to be so designed as to give alarm in case of a failure, and the number of revolutions, as well as the direction of pitch propeller be maintained till the local station takes over the control.

16.5.1.5 In the case where a number of control station exist, a possibility simultaneously control of the main engine from different control stations is to be excluded. One of such stations is to be superior with regard to others.

16.5.1.6 The change over between the wheelhouse and machinery space is to be possible only from the wheelhouse.

16.5.1.7 The superior control station is to change over the control at any time as well as control properties of the propulsion and its installations, irrespective of where the control is. Overtaking the control station by the superior control station is to be indicated at least at previous control station.

16.5.1.8 Transfer of the control from one station to another is to be accompanied by audible and visual signals at both stations.

It is recommended that time of the transfer of the control to individual stations, including the local control station, is not to exceed 10 seconds.

16.5.1.9 The control is to be designed in such a manner that the control from a new control station is to be possible only after it has been acknowledged in a suitable form that the control was taken over.

Transfer of the control from one station to another is not to cause stop the main engine.

16.5.1.10 In the case when the ship is controlled from the steering gear compartment control activities are to be restricted to simple duties and the control signal is to be set using single control devices (levers, knobs, etc.). Propulsions with controllable pitch propeller or reversing gear, the arrangement with two control elements may be used, provided that the control system is so designed that an erroneous manoeuvre does not result in stopping the engine.

16.5.1.11 The remote control system is to be so designed that in the case of rapid commands following each other, the last one is always performed. The process of executing the commands is not to depend on the speed with which the control element has been moved.

16.5.1.12 In multi-engine propulsion system, each propulsion engine or a group of such engines driving one propeller is to be provided with an independent remote control system.

16.5.1.13 It is recommended that the remote control system of two or more main propulsion engines driving one propeller is to be capable of automatic equalizing the load of operating engines.

16.5.1.14 If means for reducing torque of the main engine down to the rated torque are not provided, exceeded rated torque is to be indicated at each control station.

16.5.1.15 It is recommended to design automatic control or remote control the main engine in such a manner that may be excluded continuous operation of the propulsion within a particular speed range, if necessary due to torsional vibration.

16.5.1.16 The number of the repeated starting (reversing) attempts in the case of faulty starts (reverses) is to be limited by automatic control or remote control the main engine in order to preserve enough starting energy accumulated in starting air or accumulators to perform at least three startings from the local station.

16.5.1.17 The alarm is to be given in the control station in the case of repeated faulty starts (reverses) of the main engine.

16.5.2 Electrical Power Supply and Distribution Control System

16.5.2.1 For automated generating sets, when the stand-by generator starts in the case loss of voltage or voltage drop in the main switchboard busbars, the lack of voltage is not to be longer than for 15 seconds. In such a case restarting the essential services, indispensable for manoeuvring and which were running before black-out, are to be started automatically in an order.

16.5.2.2 The automatic control system of generating sets is to be provided with interlocking arrangement preventing the generating set from being automatically connected when a short-circuit occurs on the busbars of the main switchboard.

16.5.2.3 In the case of the first failure of automatic or remote starting the engine driven generating set, the control system is to limit the number of repeated automatic starting attempts of the same engine or engines driving the remaining sets that the quantity of air left in air receives or, in the case of electric starting, the quantity of electric energy left in the battery is sufficient to perform, from the local control station, at least three starts of one of the generating sets.

16.5.2.4 Failure to start the set is to be signaled by the alarm system.

16.5.3 Control Systems of Piping Installations

16.5.3.1 Power operated valves of piping systems controlled automatically or remotely are also to be provided with means for local manual control.

16.5.3.2 The valves, mentioned in 15.5.3.1, are to be situated in places readily accessible for manual operation under all normal service conditions.

16.5.3.3 Where piping systems are intended to be alternately used for different purposes (e.g. for ballast or fuel transfer), their control system is to be provided with such interlocking and protection arrangements as to meet the relevant requirements for interconnection of such piping systems given in *Part VI – Machinery and Pipeline Installations*.

16.5.3.4 When the outlet valves of the fuel service tank use auxiliary energy (pneumatic, electric, etc.) than the valves are to be so constructed that normal open position is to remain in the case of black-out and also outside the machinery space means of remote closing the valves are to be provided.

16.5.3.5 If fuel oil tanks are fitted with the bunkering system including an automatic shut-off device, then the sensor shall stop fuelling when the tank is 97% full and this equipment shall meet the "fail-safe" requirements. Bunkering remote control system, if applied, shall also fulfil the requirements specified in paragraph 16.2.4.3.

16.5.4 Bow Thruster Control System

16.5.4.1 Bow thruster control equipment shall be permanently fitted in the wheelhouse. Remote-control equipment not permanently installed shall be acceptable provided that such a subsidiary installation can be activated by means of an override at any time within the wheelhouse.

16.6 Additional Recommendations for Automation

16.6.1 General Requirements and Application

16.6.1.1 Requirements of this section assume that the inland vessels are operated without permanent watch in machinery spaces and service is due to periodic maintains, regulations and small repairs.

16.6.1.2 Scope of automation, specified in this subsection, is to be such that is recommended for type of supervision over the machinery determined in 15.6.1.1 and is related to obtain additional remark in the symbol class.

16.6.2 Monitoring Systems

16.6.2.1 It is recommended that the scope and mode of the control systems be in accordance with Table 16.6.2.1, however the alarm system required in 16.4.1.14 is not compulsory.

Applying the automatic change-over of stand-by machinery specified in Table 16.6.2.1 is appropriate when this machinery is necessary for ship manoeuvring.

Table 16.6.2.1

No.	Machinery, installation or equipment	Parameters	Alarm system/ monitored value	Safety system	Remarks
1	**Main propulsion**				
1.1	Main internal combustion engine				
1.1.1	Lubricating oil installation	– pressure of lubricating oil at inlet to the engine (after filter)	minimum	first stage: start of stand-by pump; second stage: stop of engine	
		– temperature at inlet to engine	maximum	–	
		– level in circulating oil tank	minimum	–	
1.1.2	Cooling installation	– temperature of cooling water at outlet from engine	maximum	–	on outlet manifold after cylinders
		– pressure or cooling water flow at inlet	minimum	start of stand-by pump	
		– level in compensating tanks	minimum	–	
1.1.3	Fuel installation	– level in service tanks	minimum	–	
1.1.4	Exhaust system	– temperature of exhaust gases	maximum	load reduction *	on exhaust manifold after cylinders
1.2	Main gear	– pressure of lubricating oil at inlet	minimum	start of stand-by pump	
		– temperature of lubricating oil at inlet	maximum	–	
1.3	Shaft line	– temperature of thrust bearing	maximum	–	only in the case of separate oil system
		– oil pressure in hydraulic coupling	minimum	–	
		– level in gravity tank of stern tube lubrication	minimum	–	
		– oil pressure in servo-system of control pitch propeller	minimum	start of stand-by pump	
2	**Electrical installation**				
2.1	Main switchboards	– insulation resistance	minimum		
2.2	Internal combustion engines driving electrical generators	– pressure of lubricating oil at inlet	minimum	shut down of the engine	
		– temperature of lubricating oil at inlet	maximum	–	
		– temperature of cooling water or air at outlet	maximum	–	
3	**Piping installation**				
	Bilge installation	– level in bilge wells of machinery space	maximum	–	separate alarm signal in the wheelhouse

* The function of safety system may be performed by the operator according to the alarm signal.

16.6.2.2 If periodic disconnection of any part of the alarm system is to be expected, the state is to be indicated in the wheelhouse.

16.6.2.3 Where the repeaters of alarm system are located within the accommodation spaces, the switching off of the alarm signal (alarm acknowledgment) in the accommodation spaces it is recommended also to be indicated in the wheelhouse.

16.6.3 Control Systems

16.6.3.1 It is recommended that automatic temperature regulators are to be in:

- main engine lubricating oil,
- main engine cooling water,
- main gear lubricating oil.

The temperature regulator is to be so constructed that agent (e.g. oil, fuel, water) temperature is to remain in the permissible range even during manoeuvring.

16.6.3.2 For starting the main engine by means of compressed air it is recommended to use automatic control of the air compressors, which allow to keep minimum pressure in the air receives.

16.6.3.3 In the case when the fuel service tank is fill up using a service pump with mechanical propulsion, it is recommended to use automatic control of the pump, hence continuous fuel supply remain without necessary service.

16.6.3.4 Systems specified in 15.6.3.2 and 15.6.3.3 are to include not only machinery of the particular installation but also essential fittings of this installation.

16.6.3.5 It is recommended to use an automatic or remote control of the source of electrical energy, specified in 3.1.11.

16.6.3.6 Requirements of fitting combustions engines in hi-pressure pipes are in *Part VI – Machinery and Pipeline Installations.*

17 REQUIREMENTS FOR ASSIGNING ADDITIONAL MARK TO THE SYMBOL CLASS

Requirements given in this section are supplement to the remaining sections of the Rules, for assigning additional mark.

For explanation of the marks see Part I – Classification Regulations.

17.1 Passenger Vessels– mark: pas

17.1.1 General

The requirements specified in sub-chapter 16.1 apply to the electrical equipment of passenger vessels.

Derogations from the requirements specified in sub-chapter 16.1 may be granted to passenger ferries and passenger vessels engaged on day trips within the restricted operating area as specified in the Certificate of Class.

17.1.2 Main Power Source

17.1.2.1 Passenger vessels with overnight cabins shall be fitted with at least two power-generating sets. Capacity of the particular sets shall be so determined as to ensure – after one of the generating sets has been rendered inoperative – normal power supply for essential services in the conditions specified in 3.1.3. One of the generating sets shall be independent of the main propulsion.

17.1.2.2 Power sources required in 3.1.1 and 3.1.11 shall be mutually independent..

17.1.3 Emergency Power Source

17.1.3.1 Emergency power source independent of those specified in 3.1.1 and 3.1.11 shall be provided. Such an emergency power source can be:

– power generating set with its own fuel supply and independent cooling system which, in the event of power failure, turn on and take over the supply of power within 30 seconds automatically.

PRS may permit manual actuation of the generating set where such a set is installed outside the machinery space and is located in the immediate vicinity of a control position permanently manned by crew members;

– accumulator batteries, which, in the event of power failure in the power mains, turn on automatically shall be capable of powering the above mentioned power consumers throughout the period specified in 9.1.3 without recharging and without an unacceptable voltage reduction; the accumulators shall have a recharging system capable of connecting to the emergency network also when the accumulators are being recharged.

PRS may permit manual actuation of the accumulator batteries from the control position permanently manned by crew members located outside the machinery space.

17.1.3.2 Emergency power source shall supply the following receivers unless they have their own independent emergency power source:

.1 emergency lighting of:
- locations where life-saving equipment is stored and where such equipment is normally prepared for use;
- markings on the escape routes and exits, including low-location lighting system required in 16.1.6 if it requires electric power;
- escape routes, access for passengers and crew, including gangways, entrances and exits, connecting corridors, lifts and accommodation area companionways, cabin areas and accommodation areas;
- operations rooms, engine rooms, steering equipment rooms and their exits;
- wheelhouse;
- emergency power supply room;
- points at which extinguishers and fire extinguishing equipment controls are located;
- areas at which passengers, shipboard personnel and crew muster in the event of danger;
- other areas intended for use by persons with reduced mobility;

.2 signal lights;
.3 searchlights;
.4 audible warning devices (tyfon);
.5 radiotelephone installations;
.6 alarm, loudspeaker as well as on-board message communication systems including command broadcast apparatus, general alarm system and emergency radio communication;
.7 fire alarm system;
.8 fire detection system;
.9 automatic pressurised sprinkler system, fire extinguishing pumps and other safety equipment whose operation is considered by PRS necessary to ensure safety of the vessel and people aboard;
.10 lifts and lifting equipment for persons with reduced mobility.

17.1.3.3 Capacity of the emergency power supply shall be sufficient to provide for simultaneous operation of all the services essential for safety of the people aboard for the period determined according to the defined purpose of the passenger vessel, not less, however, than 30 minutes.

17.1.3.4 Means shall be provided to enable inspection of all emergency electrical installations including the automatic start-up arrangements.

17.1.3.5 For the start-up of emergency generating sets the following arrangements may be used:

.1 electrical starting system with its own accumulator battery and recharging system;
.2 compressed air starting system supplied from its own independent compressed air tanks;
.3 hydraulic starting system;
.4 manual starting arrangements.

17.1.4 Emergency Power Supply Rooms

17.1.4.1 Emergency power sources and emergency switchboard shall be located aft of the collision bulkhead as well as outside of the machinery space and the space containing the main and additional power sources. The compartment containing the emergency power source and emergency switchboard shall be separated from the spaces containing the main and additional power sources including their switchboards by fire divisions of class A-60.

17.1.4.2 Emergency power plant shall be installed either above the margin line or as far away as practicable from the power sources required in paragraphs 3.1.1 and 3.1.11 so as to ensure that, in the event of flooding it is not flooded at the same time as the compartment containing the main and additional power sources.

17.1.4.3 Emergency switchboard shall be installed as close to the emergency power source as practicable.

17.1.4.4 If a generator with independent prime mover is an emergency power source, it is recommended that the emergency switchboard be located in the same compartment.

17.1.4.5 Emergency power generator room shall have effective heating and ventilation to ensure the temperature required for its correct operation in accordance with the requirements specified in *Part VI – Machinery and Piping Systems*.

17.1.4.6 If an accumulator battery is the emergency power source, than the accumulator battery room shall fulfil the requirements specified in sub-chapters 11.2 and 11.3.

17.1.5 Power Supply

17.1.5.1 Emergency switchboard shall be supplied from the main switchboard. Feeder circuit shall be protected against the effects of short-circuit and overcurrent in the main switchboard. Where the possibility for the main switchboard to be supplied from the emergency switchboard is also provided, the feeder circuit shall be protected in the emergency switchboard at least against the effects of short-circuit.

17.1.5.2 Feeder cables which feed power consumers from the emergency switchboard shall be so led as to ensure continuous power supply in case of fire or the machinery space flooding. The feeder cables shall not run through the machinery spaces, galleys or other spaces containing main power sources unless they feed the emergency arrangements installed in those spaces. In that case, such feeder cables shall not be led over the I.C. engines, oil fuelled equipment, hot surfaces of exhaust gas pipes or in their immediate vicinity. Where such locations are impossible to be avoided, the cables shall be effectively protected against heat and fire.

17.1.5.3 Feeder cables from the emergency switchboard shall be so arranged that the rise of bulkhead or deck temperature due to fire in the adjacent space does not impede their power supply capabilities.

17.1.5.4 Main and emergency feeder cables led through any space bounded by fire divisions shall be arranged as far from each other in both horizontal and vertical directions as practicable. Where such arrangement is impracticable, a fireproof cable shall be used to feed the emergency equipment.

17.1.5.5 Cables arranged in groups shall fulfil the requirements of Publication IEC 332-3 or equivalent ones approved by the Administration regarding flame-retardant properties of the groups of cables. Alternatively, long partitions throughout long stretches of cable groups (above 6 m in the vertical and 14 m in the horizontal directions) shall be applied unless the cables are completely closed in ducts.

17.1.5.6 Lighting of gangboards, corridors, and staircases leading to the boat deck as well as lighting of restaurants and leisure centres shall be fed from at least two independent circuits.

17.1.5.7 Single-pole switches mentioned in paragraph 6.1.8 are permitted only in circuits fed with safe voltage

17.1.6 Additional Low-location Lighting

17.1.6.1 To clearly identify the escape routes and emergency exits, when the normal emergency lighting is less effective due to smoke, an additional low-location lighting shall be provided to function for at least 30 minutes after its activation.

17.1.6.2 The requirements regarding the low-location lighting, which may be arranged using photoluminescent materials or as an electrically powered system, are detailed in sub-chapter 4.2 of *Part V – Fire Protection*.

17.1.6.3 Photoluminescent materials and electrically powered lighting shall be type-approved by PRS or another EU-recognised body.

17.1.7 Alarm and Communication Systems

17.1.7.1 Two independent alarm systems: one for passengers and the other for the crew shall be provided. On vessels having a low-power installation, one common alarm system is permitted.

17.1.7.2 The alarm system enabling the passengers to be alerted shall be audible in all rooms accessible to passengers and capable of being triggered from the wheelhouse and from a permanently staffed location.

17.1.7.3 The alarm system enabling the vessel's command to alert the crew and shipboard personnel arranged in accordance with the requirements specified in sub-chapter 7.3 shall also reach the recreation rooms for the shipboard personnel, cold-storage rooms and other store-rooms.

17.1.7.4 Passenger cabins and lounges not constantly supervised by shipboard personnel or crew members, galleys, engine rooms and other rooms presenting a fire risk shall be connected to an appropriate, approved by PRS, fire alarm system in accordance with the requirements specified in sub-chapter 7.4.

17.1.7.5 Additionally, manual call points shall be provided in the following locations:

- cabins,
- corridors and stairways, taking into account that the distance to the nearest call point shall not exceed 10 m and that at least one manual call point shall be provided in one watertight compartment,

– elevators,
– restaurants, leisure centres and salons,
– galleys, machinery spaces and spaces of similar risk of fire,
– toilets intended for persons with reduced mobility,
– cold-storage rooms and other store-rooms.

The alarm shall be capable of being triggered solely from the wheelhouse and from a location that is permanently staffed. The alarm triggers shall be installed at a height above the floor of 0.85 m to 1.10 m.

17.1.7.6 Alarm triggers shall be protected against their unintentional use.

17.1.7.7 In addition to the internal communication facilities required in sub-chapter 7.2, voice communication shall be provided between the wheelhouse and operation rooms, and where there is no direct communication from the wheelhouse, in the access and evacuation areas for passengers.

17.1.7.8 All passenger areas shall be reachable via a loudspeaker system. The system shall be so designed as to ensure that the information transmitted can be clearly distinguishable from the background noise. Loudspeakers are optional where direct communication between the wheelhouse and the passenger area is possible.

17.1.7.9 Each watertight compartment shall be fitted with a bilge level alarm.

17.1.7.10 For passenger vessels of a length not exceeding 24 m constructed or modified before 31 December 2005 having an additional mark **pas B**, **pas C** or **pas D** and engaged only on short domestic day trips, an on-board message communication system need not fulfil the requirement specified in paragraph 22.1.5.4.1 of *Part VIII – Electric Installations and Control Systems*.

17.1.8 Specific Safety Needs of Persons with Reduced Mobility

17.1.8.1 In rooms in which, as a general rule, persons with reduced mobility cannot be seen by crew members, on-board personnel or passengers, the possibility of triggering an alarm shall be provided for. This also applies to toilets intended for use by persons with reduced mobility.

17.1.8.2 For persons with impaired eyesight or hearing, the passenger alarm system shall provide suitable visual and audible alarms.

17.1.8.3 In areas intended for use by persons with impaired eyesight, sufficient lighting shall be provided to fulfil higher requirements than those for lighting in other passenger areas.

17.2 Tank Vessels for Carrying Dangerous Goods – Marks: zb ADN-C, zb ADN-G, zb ADN-N

17.2.1 Documents Concerning Electrical Installations

17.2.1.1 The following documents are to be available on board:

– a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area;
– a list of the electrical equipment installed in cargo area including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number;
– a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing.

The documents listed above are to bear the stamp of the competent authority issuing the certificate of approval.

17.2.2 Electrical Installations

17.2.2.1 Only distribution systems without return connection to the hull are permitted.

This provision does not apply to:
- local installations outside the cargo area (e.g. connections of starters of diesel engines);
- the device for checking the insulation level referred to in 4.5.4.8.

17.2.2.2 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried in the list of substances are to be taken into consideration – see *ADN – List of materials*.

17.2.3 Type and Location of Electrical Equipment

17.2.3.1 Only the following equipment may be installed in cargo tanks and pipes for loading and unloading (comparable to zone 0): measuring, regulation and alarm devices of the EEx (ia) type of protection.

17.2.3.2 Only the following equipment may be installed in the cofferdams, double hull spaces, double bottoms and hold spaces (comparable to zone 1):
- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection;
- hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck;
- cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices.

17.2.3.3 Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):
- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection;
- motors driving essential equipment such as ballast pumps; they are be of the certified safe type.

17.2.3.4 Accumulators are to be located outside the cargo area.

17.2.3.5 Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area (comparable to zone 2) are to be at least of the "limited explosion risk" type.

This provision does not apply to:
- lighting installations in the accommodation, except for switches near entrances to accommodation;
- radiotelephone installations in the accommodation or the wheelhouse;
- electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:
  - **.1** these spaces are fitted with a ventilation system ensuring an overpressure of 0.1 kPa (0.001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system located as far away as possible, however, not less than 6.00 m from the cargo area and not less than 2.00 m above the deck;

.2 the spaces are fitted with a gas detection system with sensors:
- at the suction inlets of the ventilation system;
- directly at the top edge of the sill of the entrance doors of the accommodation and service spaces;

.3 the gas concentration measurement is continuous;

.4 when the gas concentration reaches 20% of the lower explosive limit, the ventilators are to be switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with .2, are to be switched off. These operations should be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which comply at least with the "limited explosion risk" type. The switching-off is to be indicated in the accommodation and wheelhouse by visual and audible signals;

.5 the ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of 17.2.3.1;

.6 the automatic switch-off device is set so that no automatic switching-off may occur while the vessel is under way.

17.2.3.6 The electrical equipment which does not meet the requirements set out in 17.2.3.5 together with its switches is to be marked in red. The disconnection of such equipment is to be operated from a centralised location on board.

17.2.3.7 An electric generator which is permanently driven by an engine and which does not meet the requirements of 17.2.3.5, is to be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions is to be displayed near the switch.

17.2.3.8 Sockets for the connection of signal lights and gangway lighting are to be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting is not to be possible except when the sockets are not live.

17.2.3.9 The failure of the power supply for the safety and control equipment is to be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated and watch is kept (e.g. wheelhouse, engine room, watch office).

17.2.3.10 Electrical generation and distribution systems and associated control systems shall be designed such that a single failure will not result in the release of gas.

17.2.3.11 The lighting system in hazardous areas shall be divided between at least two branch circuits. All switches and protective devices shall interrupt all poles and phases and shall be located in a non-hazardous area.

17.2.3.12 Submerged gas pump motors and their supply cables may be fitted in LNG containment systems. Arrangements shall be made to alarm in low liquid level and automatically shut down the motors in the event of low-low liquid level. The automatic shutdown may be accomplished by sensing low pump discharge pressure, low motor current, or low liquid level. This shutdown shall give an acoustic and optical alarm in the wheelhouse. Gas pump motors shall be capable of being isolated from their electrical supply during gas-freeing operations.

17.2.3.13 Required ventilation systems shall have at least two ventilators with independent power supply, each of sufficient capacity, to avoid any gas accumulation. An acoustic and optical alarm shall be triggered at a permanently manned location (e.g. wheelhouse) in the event of any loss of the required ventilating capacity.

17.2.4 Safety and Control Installations

17.2.4.1 Cargo tanks are to be with the following equipment:

- a level alarm device which is activated at the latest when a degree of filling of 86% is reached;
- a high level sensor for actuating the facility against overflowing at the latest when a degree of filling of 97.5% is reached;
- an instrument for measuring the pressure of the vapour phase inside the cargo tank;
- an instrument for measuring the temperature of the cargo, if in list of materials (Appendix B.2, Annex 4, column 8) a heating installation is required, or if a maximum temperature is indicated in column 20 of that list;
- level gauges.

17.2.4.2 The level alarm device is to give a visual and audible warning on board when actuated.

The level alarm device is to be independent of the level gauge.

17.2.4.3 The high level sensor referred to 17.2.4.1 is to give a visual and audible alarm on board and at the same time actuate an electrical contact which in the form of a binary signal interrupts the electric current loop provided and fed by the shore facility, thus initiating measures at the shore facility against overflowing during loading operations. The signal is to be transmitted to the shore facility via a watertight two-pin plug of a connector device in accordance with IEC Publication 60309, for direct current of 40 to 50 volts, identification colour white, position of the nose 10 h.

The plug is to be permanently fitted to the vessel close to the shore connections of the loading and unloading pipes.

The high level sensor is to be independent of the level alarm device, but it may be connected to the level gauge.

17.2.4.4 The visual and audible signals given by the level alarm device are to be clearly distinguishable from those of the high level sensor.

The visual alarm is to be visible at each control position on deck of the cargo tank stop valves.

It is to be possible to easily check the functioning of the sensors and electric circuits or these are to be of the "failsafe" design and on tank vessels **ADN-C** and **ADN-N** the equipment is to be intrinsic safety type.

17.2.4.5 When the pressure or the temperature exceeds a set value, the instruments for measuring the pressure and the temperature of the cargo are to activate a visual and an audible alarm in the wheelhouse and crew's accommodation. When the pressure exceeds a set value during loading or unloading, the instrument for measuring the pressure is to simultaneously initiate an electrical contact which, by means of the plug referred to in 16.2.4.3, enables measures to be taken to interrupt the loading operation. When the vessel's own discharge pump is used, it is to be switched off automatically.

If the overpressure or the vacuum measurement is effected using a manometer, its indicator scale is not be less than 0.14 m in diameter. The maximum permissible overpressure or vacuum values are to be indicated by a red mark. The manometers are to be capable of being read at any time from the location where it is possible to interrupt loading or unloading.

The instrument for measuring the overpressure or vacuum are to activate the alarm at latest when an overpressure equal to 1.15 times the opening pressure of the pressure relief device, or a vacuum pressure of 1.1 times the opening pressure of the vacuum valve is reached. The maximum allowable temperature is indicated in list of materials of ADN (Appendix B.2, Annex 4, column 20). The sensors for the alarms mentioned above may be connected to other alarm installation.

17.2.4.6 When a manometer is used to measure the overpressure or the vacuum pressure, its indicator scale is not to be less than 0.14 m in diameter. The maximum permissible overpressure or vacuum values are to be indicated by a red mark. The manometers are to be capable of being read at any time from the location where it is possible to interrupt loading or unloading.

17.2.4.7 The level gauge, referred to in 17.2.4.1, are to allow readings from the control position of the shut-off devices of the particular cargo tank.

17.2.4.8 Where the control elements of the shut-off devices of the cargo tanks are located in a control room, reading of the level gauges is to be possible in the control room and the visual and audible warning given by the level alarm device, the high level sensor referred to in 17.2.4.1 and the instruments for measuring the pressure and temperature of the cargo are to be clearly noticeable in the control room and on deck.

Satisfactory monitoring of the cargo area are to be ensured from the control room.

17.2.4.9 Signal from the fire detection system is to be audible in the wheelhouse, a mess and also in every space monitored by the system.

17.2.4.10 Gas warning equipment shall be designed, installed and tested in accordance with European Standard EN 60079-29-1.

17.2.4.11 Permanently installed gas detectors shall be fitted in:

.1 tank connection areas including fuel tanks, pipe connections and first valves,
.2 ducts around gas piping,
.3 engine rooms containing gas piping, gas equipment or gas consuming equipment,
.4 the room containing the gas preparation system,
.5 other enclosed rooms containing gas piping or other gas equipment without ducting,
.6 other enclosed or semi-enclosed rooms where gas vapours may accumulate including interbarrier spaces and tank rooms of independent LNG fuel tanks other than type C,
.7 air locks, and
.8 ventilation inlets to rooms in which gas vapours may accumulate.

17.2.4.12 Permanently installed gas detectors shall be located where gas may accumulate and in the ventilation outlets of these rooms. An acoustic and optical alarm shall be activated before the gas concentration reaches 20 % of the lower explosive limit. The gas safety system shall be activated at 40 % of the lower explosive limit.

17.2.5 Warning Signalisation of Fire Extinguishing Systems

17.2.5.1 In addition to the requirements of the present section, warning signaling systems indicating that a fire extinguishing system is put into action, is to meet also the requirements given in 7.4.11 of the present *Part VII* and requirements specified in Chapter 4 of *Part V – Fire Protection*.

17.2.5.2 Audible and visual warning signal is to be:

– automatically on when the fire extinguishing system is activated, e.g. by opening doors of control boxes of manual and remote mechanism activating fire extinguishing system;
– activated at least 20 seconds ahead of activation of fire extinguishing system operation. Manual switch off is to be impossible;
– audible in highest noise conditions in protected spaces (e.g. spaces with fire extinguishing system) and adjacent spaces jointed with protected spaces (when the door is closed).
– different than any other audible signal;
– self tested circuits as specified in 16.4.2.5 or ability to check it out without activating it.

17.2.6 Earthing

17.2.6.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service are to be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel. This requirements also apply to equipment having service voltages of less than 50 V.

17.2.6.2 Each element of pipes for cargo tanks is to be earthed.

17.2.6.3 Cargo tanks including metal intermediate bulk containers (IBCs) and containers, used as tanks, are to be earthed.

17.2.6.4 All metal wires passing over the holds and all masts are to be earthed, unless they are electrically bonded to the metal hull of the vessel through their installation.

17.2.7 Cables and Wires

17.2.7.1 All cables in the cargo area are to have a metallic sheath.

17.2.7.2 Cables and sockets in the cargo area are to be protected against mechanical damage.

17.2.7.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights and gangway lighting.

17.2.7.4 Cables of intrinsically safe circuits are to be only used for such circuits and are to be separated from other cables not intended for being used in such circuits (e.g. they are not to be installed together in the same string of cables and they are not to be fixed by the same cable clamps).

17.2.7.5 For movable cables intended for signal lights and gangway lighting, only sheathed cables of type H07RN-F in accordance with PN-EN 50525-2-21 or cables of at least equivalent design having conductors with a cross-section of not less than 1.5 mm^2 are to be used.

These cables are to be as short as possible and installed so that damage is not likely to occur.

17.2.7.6 Cables installed on gangways are to be laid in appropriate conduits or pipes (see 14.6.8).

17.2.8 General Transitional Requirements

17.2.8.1 For additional mark issued for existing vessels which are under reconstruction, requirements of 16.2 are to be fulfil in the scope each time considered by PRS, including transitional requirements of ADN.

17.3 Vessels Carrying Dangerous Goods Packed in Containers or Dry Cargo – Mark: ADN

17.3.1 Type and Location of Electrical Equipment

17.3.1.1 It is to be possible to isolate the electrical equipment in the protected area by means of centrally located switches except where:

- it is of a certified safe type corresponding at least to temperature class T4 and explosion group II B;
- and in the protected area it is of the limited explosion risk type.

17.3.1.2 The corresponding electrical circuits are to have control lamps to indicate whether or not the circuits are live. The switches are to be protected against unintended unauthorized operation. The sockets used in this area are to be so designed as to prevent connections being made except when they are not live.

Electric motors for hold ventilators which are arranged in the air flow are to be intrinsic safety (Exe), flameproof enclosure (Exd) or encapsulation (Exp).

17.3.1.3 Sockets for the connection of signal lights, gangway lighting and containers are to be fitted to the vessel close to the signal mast or the gangway or the containers. Sockets intended to supply the submerged pumps and hold ventilators are to be permanently fitted to the vessel in the vicinity of the hatches.

17.3.1.4 Audible signal of the fire-extinguishing system is to fulfil requirements of 16.2.4.9.

17.3.2 Warning Signalisation of Activating the Fire Extinguishing Systems

17.3.2.1 Warning signalisation of activating the fire extinguishing systems is to fulfil requirements of 16.2.5.

17.3.3 Cables and Wires

17.3.3.1 Cables and sockets in the protected area are to be protected against mechanical damage.

17.3.3.2 Movable cables are prohibited in the protected area, except for intrinsically safe electric circuits or for the supply of signal lights and gangway lighting, for containers, for submerged pumps, hold ventilators and for electrically operated cover gantries.

17.3.3.3 For movable cables permitted in accordance with 16.3.2.2 above, only cables of type H07RN-F in accordance with PN-EN 50525-2-21 or cables of at least equivalent design having conductors with a cross-section of not less than 1.5 mm^2, are to be used.

These cables are to be as short as possible and installed so that accidental damage is not likely to occur.

17.3.3.4 All metal wires passing over the holds and all masts are to be earthed, unless they are electrically bonded to the metal hull of the vessel through their installation.

17.4 Floating Cranes – Mark: dp

17.4.1 The requirements of the present sub-chapter apply to electrical equipment of floating cranes.

17.4.2 For floating cranes having their own propulsion, the output of the main sources of electric power is to be sufficient for ensuring the operation of the crane under one of the conditions: when travelling or during loading operations.

17.4.3 The rooms and lockers intended for the location of accumulator batteries, as well as the rooms of emergency sources of electric power are allowed to be situated below the main deck, provided all other requirements specified in 11.2 are fulfilled.

17.4.4 Floating cranes are to be provided with an audible signaling system operated from the operator cabin to give audible signals during loading operations.

17.5 Ships Intended for the Carriage of Containers – Mark: con

17.5.1 Application

The requirements of this section are applicable to electrical equipment of container ships and ships intended for carrying isothermal containers.

17.5.2 Supply and Distribution of Electric Power

17.5.2.1 Apart from complying with the requirements given in 3.1.2, the output of the main sources of electric power and of power converters is to provide the supply to all isothermal containers to be carried.

In order to ensure the supply to isothermal containers during loading operations on board the ship, all main sources of electric power and all power converters, including the reserve ones, may be used.

As the power value of electrical equipment of isothermal containers, their installed power is to be assumed. The power consumption of electrical equipment of thermal containers under rated operating conditions is not to exceed 15 kW (18.75 kVA).

The application of diversity and load factors will be specially considered by PRS in each particular case.

17.5.2.2 The means of overload protection of electric power sources, specified in 8.2.3, are to provide for the feeder of the thermal container switchboard to be the last to be disconnected from the main switchboard.

17.5.2.3 Electrical network supplying the electrical equipment of isothermal container equipment is to be separated from the ship's network by means of separating transformers supplied from the main switchboard.

17.5.2.4 The electrical equipment of isothermal containers is to be supplied from special switchboards supplied by separate feeders.

17.5.2.5 The socket outlets installed in holds or on weather decks in places where isothermal containers are located are to be supplied by separate feeders from special switchboards specified in 16.5.2.4 and 16.5.3.3.

17.5.2.6 Electrical network of socket outlets intended to supply electrical equipment of isothermal containers is to have the rated voltage of 230 V or 400 V of 3-phase alternating current of a frequency of 50 Hz or 277 V or 480 V of 3-phase alternating current of a frequency of 60 Hz.

17.5.3 Distribution Switchboards and Transformers

17.5.3.1 The switchboards of isothermal containers, electric converters (if any) and separating transformers are to be located in special electrical spaces.

17.5.3.2 The secondary windings of separating transformers are to have the neutral point insulated.

17.5.3.3 Each switchboard is to be fitted with apparatus providing for:

- **.1** visual signals to indicate that the switchboard is in live condition;
- **.2** switching on and off each feeder of socket outlets;
- **.3** protection of feeders supplying socket outlets against short-circuit;
- **.4** measuring of insulation resistance.

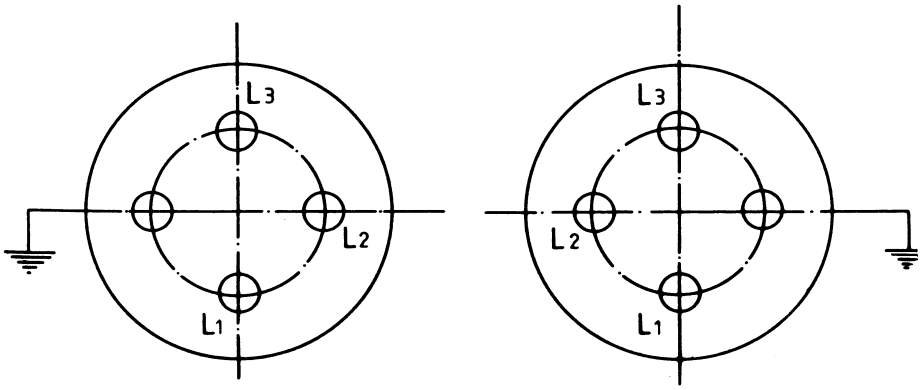
17.5.4 Socket Outlets

17.5.4.1 In holds intended for carrying isothermal containers, only the socket outlets to supply containers may be installed. The socket outlets installed in the hold are to have a protection degree of at least IP55 and those installed on the weather deck – at least IP56.

Where electrical system of remote monitoring of temperature, humidity, ventilation and other parameters of isothermal containers in holds and on decks is employed, additional socket outlets may be installed in holds and on decks to connect such a monitoring system.

17.5.4.2 Irrespective of the requirements of 12.2.4, socket outlets supplying electrical equipment of isothermal containers are to be fitted with a switch interlocked so that the plug cannot be inserted or withdrawn while the switch is in the ”on” position. They are also to be provided with informative plates indicating their voltage value.

17.5.4.3 The electrical equipment of isothermal containers is to be supplied from the ship’s network through socket outlets with the direction of phase rotation in the sequence L1, L2, L3 as shown in the diagram presented in Fig. 16.5.4.3.



The front view of plug The front view of socket outlet

Fig. 16.5.4.3. Sequence of phase connections of plug and socket outlet

17.5.4.4 Socket outlets intended to supply electrical equipment of isothermal containers are to be designed for the following rated currents:

- 60 A for voltages 230 V, 50 Hz or 277 V, 60 Hz,
- 32 A for voltages 400 V, 50 Hz or 480 V, 60 Hz.

17.5.4.5 The design and dimensions of contacting parts of plugs are to be such as to exclude the possibility of connecting the plugs rated for one voltage with the socket outlet rated for another voltage.

17.5.4.6 The design and dimensions of contacting parts of the socket outlets and plugs are to comply with the international standards.

17.5.5 Protective Earthing

The socket outlet intended to connect the earthing conductor of the flexible cable of an isothermal container is to be earthed by means of an earthing conductor in the supplying feeder. The earthing conductor in the supply cable is to be earthed in the location of the switchboard supplying socket outlets of isothermal containers.

17.6 High-speed Craft, mark – hsc

Additional requirements for high-speed craft have been specified in *Publication No. 92/P – Specific Requirements for Inland Waterways High-Speed Vessels – 2010*.

17.7 Ecological Ships – Mark: ECO AIR.

17.7.1 Technical requirements for shore power supply systems are given in PRS Rule *Publication No. 106/P*.

Appendix 1

INSULATION RESISTANCE OF CABLE NETWORK

1 The insulation resistance to hull of electrical circuits of the cable network measured during trials on completion of the ship construction or during surveys of ships in service is not to be less than that given in Table 1.

Table 1

No.	Designation of circuit	Minimum insulation resistance, [MΩ]		
		up to 125 V	125 to 500 V	over 500 V
1	Supply to lighting installations	0.3	1.0	–
2	Supply to power consumers	–	1.0	2000 Ω per volt of the rated voltage
3	Communication installation (unless otherwise specified)	0.3	1.0	–

2 During test, each circuit can be divided into any number of individual sections by means of switches installed in it or by withdrawing the fuses, or by disconnecting the consumers.

Appendix 2

VALUES OF MECHANICAL AND ELECTRICAL PARAMETERS TO BE CHECKED IN COURSE OF TESTING TYPE OF EQUIPMENT AND THE SHIP'S ELECTRICAL INSTALLATIONS

1 INSULATION RESISTANCE

1.1 The value of insulation resistance of the new electrical equipment measured at the manufacturer's or research laboratory is to meet the requirements of the relevant national standards but is not to be less than:

- 10 MΩ in cold condition, 1 MΩ in hot condition – for equipment of rated voltage up to 65 V,
- 100 MΩ in cold condition, 10 MΩ in hot condition – for equipment of rated voltage over 65 V.

For electric machines, at the insulation resistance measurements after the electric strength test, the value of insulation resistance in hot condition equal to 1 MΩ is permitted (see also *Publication No. 42/P – Testing of Electric Rotating Machines*).

1.2 The value of insulation resistance to hull, as well as between phases (poles) of electrical equipment measured during testing after completion of the ship construction is not to be less than the values indicated in Table 1.2.

The insulation resistance of the equipment measured during surveys of ships in service may be less than the values indicated in Table 1.2, but is not to be below 2000 Ω per volt of the rated consumer voltage.

The insulation resistance values indicated in Table 1.2 are applicable to electrical equipment having a voltage up to 500 V. The minimum values of insulation resistance of electrical equipment having a voltage of over 500 V and for electric machines rated at over 1000 kW (kVA), irrespective of the voltage value, will be specially considered by PRS in each particular case.

Insulation resistance readings are to be taken one minute after the application of the test voltage.

Table 1.2

No.	Type of electrical equipment	Minimum insulation resistance at 20 ± 5°C ambient temperature and normal humidity, [MΩ]	
		in cold condition	in hot condition
1	Electric machines	1	1
2	Transformers	5	2
3	Switchboards	1	–
4	Machine control gear	5	–

2 DIELECTRIC STRENGTH OF INSULATION

2.1 General Requirements

The dielectric strength of insulation in electrical installations is to be tested by applying, for 1 minute, an alternating sinusoidal test voltage having a frequency of 50 Hz and the r.m.s. value as shown in Table 2.1.

Table 2.1

Rated voltage U_n, V	Test voltage U_p, V
up to 65	$2\,U_n + 500$
66 to 250	1500
251 to 500	2000
501 to 1000	$2\,U_n + 1000$
over 1000	$3U_n$

Table 2.1 is not applicable to communication appliances and electrical devices incorporating semiconductor elements for which the test voltage value will be specially considered by PRS in each particular case.

3 TEMPERATURE RISE LIMITS

3.1 The temperature rise limits for insulation material under continuous duty conditions are listed in Table 3.1.

Table 3.1

Class of insulation, according to IEC 60085	Temperature rise limit, [°C]
A	105
E	120
B	130
F	155
H	180
200, 220, 250	over 180

Where the insulation is composed of different materials, the temperature that each of the materials is allowed to reach is not to be higher than the temperature rise limit for a given material.

Where the insulation consists of several layers of different materials and it is not possible to measure the temperature reached by particular materials, the temperature rise limit for the composite is to be assumed to be that applicable to the lowest class of the material used.

A material used solely for mechanical protection or for separating shims may be of a lower class of insulation.

4 ENVIRONMENTAL HAZARDS RESISTANCE

4.1 Environmental hazards resistance requirements are given in *Publication No. 11/P – Environmental Tests on Marine Equipment*, each time considered by PRS.

List of amendments effective as of 1 July 2019

Item	*Title/Subject*	*Source*
1.2	New definition added: rate of turn regulator; standards' numbers updated	ES-TRIN 2017; PRS
4.4.2	Added requirements for control and monitoring consoles	ES-TRIN 2017
5.2.14	Changed protection requirements for electrically driven steering gear	ES-TRIN 2017
5.2.20 -5.2.22	Added requirements for rate of turn regulators	ES-TRIN 2017
6.5.6	Added requirements for navigational lights circuits	ES-TRIN 2017
7.6.1, 7.6.3	Added requirements for mobile wheelhouses	ES-TRIN 2017
Chapter 11	Added requirements for power electronics	ES-TRIN 2017
12.1.6-12.1.7	Added requirements for accumulators	ES-TRIN 2017
12.4.5	Added requirements for charging of accumulators	ES-TRIN 2017
15.6.4.17	Added requirements for cable installation	ES-TRIN 2017
17.2.3.10 – 17.2.3.13, 17.2.4.10 -17.2.4.12	Added requirements for tank vessels for carrying dangerous goods systems	ES-TRIN 2017
17.2.7.5, 17.3.3.3	Standard's number updated	PRS
