RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF SMALL SEA-GOING SHIPS

PART VII
ELECTRICAL INSTALLATIONS AND CONTROL SYSTEMS

July
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GDAŃSK

RULES FOR CLASSIFICATION AND CONSTRUCTION OF SMALL SEA-GOING SHIPS
prepared and edited by Polski Rejestr Statków, 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 Installations and Control Systems
and
Part IX – Materials and Welding of the Rules for the Classification and Construction of Sea-going Ships.

Part VII – Electrical Installations and Control Systems – July 2023 was approved by the PRS Board on 29 June 2023 and enters into force on 1 July 2023.

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

For existing ships, the requirements of the present Part are applicable within the scope specified in *Part I – Classification Regulations*.

The requirements of *Part VII – Electrical Installations and Control Systems* are extended by the below-listed Publications:
Publication 9/P – Requirements for Computer Systems
Publication 11/P – Environmental Tests on Marine Equipment
Publication. 15/P – Current Rating Tables for Cables, Wires and Busbars in Marine Installations
Publication 106/P – ECO Class Rules
Publication 100/P – Safety requirements for sea-going passenger ships and high-speed passenger craft engaged in domestic voyages

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1 GENERAL PROVISIONS

1.1 Application

1.1.1 *Part VII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Small Sea-going Ships* (hereinafter referred to as the *Rules*) applies to electrical installations in ships specified in sub-chapter 1.1, *Part I – Classification Regulations.*

1.1.2 It is recommended that the relevant requirements of the present Part of the *Rules* should be extended to cover other electrical installations and electrical equipment installed on ships, not specified in 1.3.2.1.

1.2 Definitions

Definitions and explanations relating to the general terminology of the *Rules* are given in *Part I – Classification Regulations.*

For the purpose of *Part VII*, the following additional definitions have been adopted:

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.

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

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

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

Dead ship condition – a condition under which the main propulsion plant and auxiliaries are not in operation due to absence of electric power.

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

Emergency source of electric power – a source of electric power intended to supply emergency switchboard for distribution of power to all the essential consumers on board the ship in the case of the loss of voltage in the main switchboard busbars.

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

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

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

Lightning protection zone – zone protected against direct lightning stroke.

Main source of electric power – a source intended to supply electric power to the main switchboard for distribution to all services necessary for maintaining the ship in normal operational and habitable conditions.

Main switchboard – a switchboard, which is directly supplied by the main source of electric power and is intended to distribute electric energy to the ship's services.

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

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

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.

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

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

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

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

1.3 Scope of Survey

1.3.1 General Provisions

The general provisions relating to the classification procedure, ship construction survey, equipment manufacture survey and survey activities are given in *Part I – Classification Regulations* and PRS *Supervision Activity Regulations.*

1.3.2 Survey of Electrical Installation in Ship

1.3.2.1 The following types of equipment and systems are subject to PRS' survey during installation on board:

.1 main and emergency sources of electric power;
.2 power and lighting transformers;
.3 distribution gear and control and monitoring panels;
.4 electric drives for:
- machinery essential for the operation of propulsion engines,
- steering gear,
- controllable pitch propellers,
- windlasses, mooring and towing winches,
- pumps and compressors,
- ventilating fans;

.5 lighting installation;
.6 navigation lights;
.7 electric engine-room telegraphs;
.8 internal service communication;
.9 general alarm system;
.10 fire signalling system;
.11 electrical equipment in explosion hazardous rooms and spaces;
.12 cabling;
.13 lightning and earthing conductors;
.14 heating appliances and space heaters;
.15 main propulsion control system;
.16 generating sets automatic control system;
.17 safety system of main propulsion and engines driving generating sets;

.18 automatic system of pumps and machinery;
.19 machinery alarm system;
.20 other machinery and equipment not listed above, as required by PRS.

1.3.3 Survey of Electrical Equipment Manufacture

1.3.3.1 Items of electrical equipment and automation intended for systems and devices, defined in 1.3.2.1, are subject to PRS' survey during manufacture within the scope specified in paragraph 1.3.3.1, *Part VIII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Sea-going Ships.*

1.3.3.2 Items of electrical equipment and automation with the rated voltage of 12 V and 24 V, which are not manufactured under PRS' survey, may be applied subject to agreement with PRS in each particular case.

1.3.3.3 Explosion-proof electrical equipment shall be surveyed (with respect to explosion proofness) by competent bodies, irrespective of whether such equipment is subject to PRS' manufacture survey. Documents issued by the competent bodies shall be submitted to the PRS Head Office.

1.3.3.4 The requirements relating to construction of particular items of electrical equipment specified in 1.3.2.1, not described in the present Part, are given in *Part VIII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Sea-going Ships.*

1.4 Technical Documentation of Ship

1.4.1 Classification Documentation of Ship under Construction

1.4.1.1 Prior to the commencement of ship construction, documentation listed in 1.4.1.2 and 1.4.1.3, shall be submitted to the PRS Head Office for consideration and approval.

1.4.1.2 Classification documentation of electrical equipment:
.1 Principle diagram of electrical installation, including specification of data on the circuits, the applied switchgear and protective devices, as well as cross-sectional areas of cables.
.2 Diagrams of the main switchboard, control panels and section switchboard.
.3 Electric power balance of the main and emergency sources of electric power and transformers.
.4 Diagrams of internal communication and signalling.
.5 Diagram of protective earthing and lightning conductors (only for laminate ships).
.6 Arrangement plans of accumulator batteries installation.
.7 Data on electrical equipment in explosion hazardous spaces.

1.4.1.3 Classification documentation of shipboard automated machinery:
.1 Technical description including: specification of parameters covered by alarm, safety, as well as remote and automatic control systems.
.2 Functional diagrams of particular automatic systems, machinery and installations, giving information concerning: method of supply, functional features, structure, possible connections with other systems, as well as the kind and limit values of parameters covered by these systems.
.3 Drawings of particular units of automatic systems (consoles, desks, etc.) showing their elevation and arrangement of internal components, as well as their location on board the ship.
.4 List of applied elements and units indicating their function, type, manufacturer and setting range.

1.4.2 Workshop Documentation of Ship under Construction

1.4.2.1 Upon approval of the classification documentation specified in 1.4.1, by the PRS Head Office, the following workshop documentation shall be submitted to the relevant PRS Branch Office or Survey Station for agreement:

.1 Drawings of cable runs and cable fastening.

.2 Test programme for the ship's electrical equipment and automated machinery carried out alongside the quay and at sea.

1.4.3 Classification Documentation of Ship under Alteration or Reconstruction

1.4.3.1 Prior to the commencement of ship alteration or reconstruction, documentation relating to parts of the ship's hull, machinery and equipment subject to alteration or reconstruction shall 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 the machinery installed differs substantially from that initially fitted, the relevant additional documentation, within the scope required for a new ship, shall be submitted to the PRS Head Office for consideration and approval (see 1.4.1).

1.5 Technical Documentation of Equipment

1.5.1 Prior to the commencement of electrical equipment manufacture survey, the documentation specified in sub-chapter 1.5*, Part VIII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Sea-going Ships* shall be submitted to PRS for consideration.

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 shall be taken into account.

2.1.1 Climatic Hazards

2.1.1.1 The temperature values specified in Table 2.1.1.1 shall be taken as the rated ambient air and cooling water temperatures for electrical equipment.

Table 2.1.1.1

Item	Location in the ship	Ambient air and cooling water temperature, [°C]			
		Unrestricted service		Service outside the tropics	
		Air	Water	Air	Water
1	Rooms and spaces, except open decks	from 0 to 45	30	from 0 to 40	25
2	Open decks and spaces	from –25 to 45	–	from –25 to 40	–

Notes:

1) For electrical machines located in machinery space, maximum air temperature equal to 50 °C shall be taken.
2) Electronic equipment and components intended to be installed in switchboards, desks and enclosures shall be capable of correct operation at the ambient air temperature of up to 55 °C. The temperature of up to 70°C should not cause damage to components, equipment and systems.

2.1.1.2 Electrical equipment shall be capable of correct operation at a relative air humidity of 75 ± 3 per cent and a temperature of +45 ± 2°C or at a relative air humidity of 80 ± 3 per cent and a temperature of +40 ± 2°C or at a relative air humidity of 95 ± 3 per cent and a temperature of +25 ± 2°C.

2.1.1.3 The structural parts of electrical equipment shall be made of materials resistant to marine atmosphere or shall be reliably protected against its effects.

2.1.2 Mechanical Hazards

2.1.2.1 Electrical equipment shall be capable of correct operation at vibrations with a frequency of 2 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 ± 0.7*g*.

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 shall 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 ± 4.0*g*.

2.1.2.2 Electrical equipment shall be capable of reliable operation with the ship continuously inclined from the normal up to 15° transversely and up to 5° of trimming, as well as with the ship rolling up to 22.5° with the period of rolling of 10 s or pitching up to 10°.

2.1.2.3 Electrical equipment shall have adequate mechanical strength and shall be so located that it will not be exposed to a risk of mechanical damage (see also 2.6.1).

2.1.3 Power Supply Parameters

2.1.3.1 Electrical equipment shall be so designed as to remain 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 [sec]
Voltage	+ 6	± 20	1.5
	– 10		
Frequency	± 5	± 10	5

Note:
Where the source of power supply is an accumulator battery, the following prolonged deviations of voltage shall be taken:
- from +30% to –25% for equipment connected to the battery during charging;
- from +20% to –20% for equipment not connected to the battery during charging.

2.1.4 Electromagnetic Interference

2.1.4.1 Ship's electrical and electronic equipment shall be resistant to electromagnetic interferences with test parameters specified in *Publication No. 11/P – Environmental Tests on Marine Equipment.*

2.1.4.2 Electromagnetic interference emission generated by the ship's electrical and electronic equipment shall comply with the requirements specified in *Publication No. 11/P – Environmental Tests on Marine Equipment.*

2.1.4.3 Screens of power cables, metal coating and armouring of cables shall be earthed at as many points as practicable, at least at the points of their connections and at each end, connecting them to the metal enclosures of electrical equipment and to the ship's hull.

2.1.4.4 All signal, control and information cables shall be screened. Metallic screens of these cables shall be earthed appropriately to the number of screens. In the case of double-screened cables and high frequency field interference, internal and external screens shall be earthed on both sides and shall be connected to equipment earthing. Internal cable screens may be earthed on one side if low frequency interference occurs. The above-mentioned principles do not apply to screened concentric cables.

2.1.4.5 All cables of radio communication, radio navigation equipment and internal service communication systems shall be screened and the cable screening continuity shall be maintained. All cables laid in rooms containing radio communication or radio navigation equipment shall be screened, the cable screening continuity being maintained.

2.1.4.6 In all cases, provision shall be made for the electrical continuity of all cable sheaths, i.e. in cable junction and connecting boxes, as well as at the point of cable penetrations of bulkheads.

2.1.4.7 Conductors which earth cable screens may be star connected to the earthing bus of switchboard, if such bus exists or directly to the ship's metal hull.

2.1.4.8 To prevent contact with the ship's hull, screens of signal conductors shall be covered with an insulated outer sheath.

2.1.4.9 The screens and enclosures of electrical equipment placed in rooms containing radio communication and radio navigation equipment shall be earthed. The screens of cables and flexible cords shall be also earthed in accordance with 2.4.3.5.

The screens and enclosures of electrical equipment which do not generate radio interference need not be earthed, provided the electrical equipment itself does not require protective earthing.

2.1.4.10 To increase resistance to electromagnetic interference, it is advisable to use screened cables with pair or multipair twisted wires.

2.1.4.11 Navigational equipment, cables and other equipment installed on navigation bridge shall be so arranged that the magnetic field generated by this equipment will not cause the deviation of the ship's magnetic compass greater than 0 ± 0.5°.

2.2 Materials

2.2.1 Construction Materials

2.2.1.1 The structural parts of electrical equipment shall be made of metal or at least not readily ignitable insulating materials, resistant to marine atmosphere and oil vapour effects, or they shall 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 shall be made of corrosion-resistant materials or shall have effective corrosion-resistant covering.

2.2.1.3 All current-carrying parts of electrical equipment shall be made of copper, copper alloys or other materials of equivalent qualities, with the exception of:

.1 rheostat elements which shall be made of mechanically strong materials having high resistivity and capable of withstanding high temperature;

.2 rotor cages windings of asynchronous and synchronous motors which can be made of aluminium or its alloys resistant to sea conditions;

.3 carbon brushes and rings, cermet contacts and similar parts when the properties specified so require;

.4 parts of electrical equipment connected directly to the hull used as return conductor in one-wire system.

The use of other materials for current-carrying parts is subject to consideration of PRS in each particular case.

2.2.2 Insulating Materials

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

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

2.2.2.2 Uninsulated parts of electrical equipment shall be cooled by non-combustible liquids only.

2.2.2.3 It is recommended that the insulating materials used for winding insulation in machines, apparatus and other equipment should be at least Class E materials.

2.2.2.4 Conductors used in electrical devices for internal connections shall have insulation made of at least not readily ignitable materials. For apparatus with increased heating, as well as those specified in Chapter 12 – of non-combustible materials.

2.2.2.5 Insulating materials used for cables manufacture shall comply with the requirements specified in 13.3.

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 shall be easily dismountable.

2.3.1.2 Where screw fastenings are used, measures shall be taken to exclude self-loosening of screws and nuts; in the case of frequent dismantling and opening, they shall be protected against being lost.

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

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

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

2.3.1.6 Where oil, steam or water are led to the measuring instruments used in the control desk or in the switchboard, measures shall be taken not to allow oil, steam or water to penetrate the live parts of the electrical equipment in case of damage of the measuring instruments or pipes.

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 insulant surface, shall 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 shall be used for all the internal wiring in electrical equipment. The use of single-wire conductors is subject to consideration of PRS in each particular case.

2.3.3.2 The conductors used for the internal wiring in switchboards, control and monitoring desks and other distribution and switching gear shall have the cross-sectional area of not less than 1 mm^2. For control, protection, measurement of parameters, signal 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, subject to consideration of PRS in each particular case.

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

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

2.3.3.5 Insulated conductors shall be laid out and secured in such a manner as not to lead to reduced insulation resistance and so that they are not exposed to damage due to short-circuit electrodynamic loads or dynamic loads caused by vibrations or shocks.

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

2.3.4 Degrees of Enclosures Protection

2.3.4.1 Electrical equipment shall be provided with appropriate protective enclosures depending on their location or other suitable measures shall 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 ship rooms and spaces shall be chosen in accordance with Table 2.3.4.2.

Table 2.3.4.2

Item	Location of electrical equipment	Equipment location characteristics	Design according to degree of protection
1	Accommodation, service and public spaces, with adjacent corridors and stairs – not having direct access to deck, machinery spaces and refrigerating machinery rooms	Dry spaces Danger of dripping liquid and/or minor mechanical damage	IP20 IP22
2	Parts of spaces and rooms near to open deck entrances	Possibility of liquid drops or sprays	IP23
3	Engine rooms below floor Refrigerated rooms Galleys, toilets, washrooms, etc.	Increased danger of liquid occurrence and mechanical damage	IP44
4	Holds	Danger of liquid spray. Danger of serious mechanical damage	IP55
5	Rooms intended for fish processing Open decks	Danger of occurrence of liquid in massive quantities	IP56

2.4 Earthing of Non-Current-Carrying Metal Parts

Metal enclosures of electrical equipment designed for higher than the safe voltage, having no double or reinforced insulation, shall be fitted with an earth terminal marked with the symbol ⏚.

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

2.4.1 Parts Subject to Earthing

2.4.1.1 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 2.4.1.2) shall have a reliable electric contact with a component fitted with an earth terminal (see also 2.4.3).

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

.1 electrical equipment supplied with current at safe voltage;
.2 electrical equipment provided with double or reinforced insulation;
.3 metal parts of electrical equipment fastened in or passing through an insulating material and isolated from the earthed and live parts 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 cable hangers and brackets;
.5 single sets of 250 V supplied by a separating transformer.

2.4.1.3 The secondary windings of all measuring current and voltage transformers 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 there from, shall be earthed with a special conductor having a cross-section not less than 16 mm^2 which shall 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 shall be effected with at least two conductors provided at different locations situated opposite each other, accessible for inspection and suitably protected against damage.

2.4.3 Earthing Terminals and Earthing Wires

2.4.3.1 Bolts for fastening the earthing wire to the ship's structure shall 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 shall not be used for other purposes than fastening the earthing wires. Bolts which are screwed to a material (without nuts) shall be made of brass or other corrosion-resistant material.

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

2.4.3.2 Fixed electrical equipment shall 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 shall 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 shall 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 shall not 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]	Minimum cross-section of external earthing conductor of fixed equipment [mm^2]	
	Single-wire conductor	Multi-wire conductor
Up to 2.5	2.5	1.5
Over 2.5 to 120	Half the cross-section of a cable conductor connected, but not less than 4	
Over 120	70	

For the earthing effected with a special core in the feeding cable, the cross-section of this core shall be equal to the nominal section of the feeding cable core for cables up to 16 mm^2 and shall be equal to at least half the cross-section of the feeding cable core, but not less than 16 mm^2 for cables having a cross-section over 16 mm^2.

2.4.3.3 Earthing of the movable and portable appliances shall 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 shall not 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 and earthing conductors of cables in fixed equipment shall not be disconnectable.

2.4.3.5 Earthing of screens and metal sheaths of cables shall 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 shall 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 would cause failures in the equipment operation, the screens, metal sheaths and armour of cables may be earthed by other approved means.

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

2.5 Lightning Protection

2.5.1 General Requirements

2.5.1.1 The ship shall 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 lightnings, the earthing installation which would preclude secondary sparking shall be provided.

2.5.1.2 The lightning installation shall consist of a spike, lightning conductors and earthing. On metal masts, the lightning conductors need not be fitted if provision has been 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. shall be used as spikes if provision has been 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 shall be provided.

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

2.5.2.4 Spikes shall 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 shall be fitted to the mast in such a way as to project at least 300 mm above the top of the mast or above any equipment fitted on its top.

2.5.3 Lightning Conductor

2.5.3.1 The lightning conductor shall 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 shall 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 shall not 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 shall be made for earthing the lightning conductors or the ship's steel hull to an efficient earth on shore 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 shall be welded, clamped, riveted or bolted with clamps.

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

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

2.5.5.3 All connections in the earthing installation shall be accessible for inspection and shall be protected against mechanical damage.

2.6 Arrangement of Equipment

2.6.1 Electrical and automation equipment shall 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 horizontal-shaft electric machines shall be so installed that the shaft is situated parallel to the fore-and aft plane of the ship. Location of such machines with the shaft situated in another direction is permitted only in those cases when the construction of the machine will ensure its normal operation under conditions specified in 2.1.2.2.

2.6.3 The air-cooled electrical equipment shall 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, as well as on conductor and construction materials.

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

2.6.5 The electrical equipment shall 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.

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

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

2.7 Electrical Equipment in Explosion Hazardous Spaces

2.7.1 Installation of the electrical equipment in explosion hazardous spaces shall be limited as far as practicable.

2.7.2 In explosion hazardous spaces, only electrical equipment of explosion- proof or intrinsic safety construction may be installed (see also 1.3.3.3).

2.7.3 Electrical equipment shall be permanently fixed.

2.7.4 An adequate ventilation system shall be provided in the spaces to eliminate the possibility of creating explosive mixtures.

2.7.5 In explosion hazardous spaces, only cables intended for electrical equipment located in these spaces may be installed subject to the condition that the cables are suitably protected against mechanical damage by sheaths (see also 13.8.16).

The possibility of running cables through hazardous spaces, which supply equipment located in other spaces, is subject to consideration of PRS in each particular case.

2.7.6 All devices of explosion-proof construction shall be fitted with switches capable of switching off all live conductors, located outside hazardous rooms and spaces.

2.7.7 Warning notices indicating explosion hazard shall be provided on the doors leading to hazardous spaces.

3 MAIN SOURCE OF ELECTRIC POWER

3.1 Structure and Capacity of Main Source of Electric Power

3.1.1 The main source of electric power may comprise:
- a generator with an independent prime mover,
- a shaft generator,
- an accumulator battery.

3.1.2 Each ship shall be provided with the main source of electric power of sufficient capacity to supply all essential services of the ship in conditions specified in 3.1.5. The main source of electric power shall consist of at least two generators; at least one generator shall be provided with an independent prime mover. In ships other than passenger ships, the main source of electric power may also consist of an accumulator battery charged by a shaft generator – in such case the battery capacity shall be sufficient to satisfy the requirements specified in 3.1.3 for at least 8 hours without recharging.

3.1.3 The number and the capacity of generators, accumulator batteries and power converters composing the main source of electric power shall be such that in the event of any one of them being failed, it will still be possible to:

.1 supply the essential services, in conditions specified in 3.1.5,

.2 start the electric motor with the maximum starting current.

3.1.4 In ships of restricted service **III** with electrical installation rated below 10 kW, other than passenger ships, a generator with an independent prime mover or an accumulator battery may be used as the main source of electric power.

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

.1 running conditions;
.2 manoeuvring;
.3 in the event of fire, piercing of the hull or in other conditions having effect on the ship's safety;
.4 other – according to the ship's designation.

3.1.6 Generators with an independent prime mover, as well as shaft generators shall be provided with voltage regulation within the limits specified in 9.2 and with frequency regulation within the limits specified in 2.1.3.1.

3.1.7 Where the power generators are not adapted for a prolonged operation in parallel to feed common busbars, the system of connections shall be so arranged as to provide the possibility of their parallel operation during the time necessary for load transfer from one generator to another.

3.1.8 In the event of short-circuit in the ship's network, the main source of electric power shall be capable of maintaining the design short-circuit current of the value sufficient for the operation of protective devices.

3.2 Number and Power of Transformers

In ships where lighting and other essential services are powered through transformers, provision shall be made for not less than two transformers of such capacity that in the case of failure of the largest unit, the remaining transformers are capable of satisfying the complete demand for electric power under all operating conditions of the ship.

In ships of restricted service **III** and in ships of restricted service **II** with the electrical installation rated below 10 kW, only one transformer may be provided.

3.3 Power Supply from an External Source of Electric Power

3.3.1 If provision has been made for the ship's network to be supplied from an external source, then:

.1 a terminal for power supply from an external source of electric power shall be installed in the ship;
.2 the external power supply terminal or socket outlet shall be connected to the main switchboard by permanently fixed cables;
.3 the external power supply terminal shall be located in a place convenient for connection of external cables and shall be provided with:
- switchgear and protective devices,
- clamps to connect flexible cables,
- signal lamp to show the presence of voltage on terminals,
- a plate indicating voltage level, kind of current and frequency,
- a possibility to connect a device for checking the polarity and the phase sequence.

3.3.2 The socket outlets may be used as external supply terminals, provided that:

.1 current capacity of the circuit does not exceed 63A;

.2 the possibility of non-current connection of power supply from an external source has been provided (the possibility of the ship's installation disconnection from the cable running to the external supply terminal).

3.4 In ships with safe voltage electrical installation, it is permitted to connect the cable supplying the ship's network from an external source of electric power directly to the main switchboard.

4 DISTRIBUTION OF ELECTRIC POWER

4.1 Distribution Systems

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

.1 for voltages up to 500 V alternating current:
- **.1.1** three-phase three-wire insulated system;
- **.1.2** three-phase four-wire system with neutral earthed but without hull return;
- **.1.3** single-phase two-wire insulated system;
- **.1.4** single-phase two-wire system with one wire earthed;

.2 for direct current:
- **.2.1** two-wire insulated system;
- **.2.2** single-wire system with hull return – for voltages of up to 50 V only;
- **.2.3** two-wire system with one pole earthed;
- **.2.4** three-wire system with neutral earthed.

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

4.2 Permissible Voltages

4.2.1 The permissible rated voltages across the terminals of the sources of electric power shall not exceed:

.1 400 V at the frequency of 50 Hz three-phase alternating current and 460 V at the frequency of 60 Hz three-phase alternating current;

.2 230 V at the frequency of 50 Hz single-phase alternating current and 250 V at the frequency of 60 Hz single-phase alternating current;

.3 230 V of direct current.

4.2.2 For installations with rated power of electrical sources not exceeding 3 kW, the voltages of 12 V and 24 V are recommended.

4.2.3 The permissible rated voltages across the terminals of consuming appliances shall not exceed the values specified in Table 4.2.3.

Table 4.2.3

Item	Type of consumers	Permissible voltages (V)	
		Direct current	Alternating current
1	Power consumers, control circuits and heating appliances permanently installed in spaces other than those specified in item 2	230	400[4)]
2	Heating appliances in cabins and spaces where passengers may be present	230	230[1), 5)]
3	Lighting, signalling and internal communication	230	230[5)]
4	Socket outlets	230[2)]	230[2), 3), 5)]

[1] Application of 400 V alternating current is permitted, provided special means of protection specified in 12.2.5 are used.
[2] At socket outlets for a voltage exceeding the safe voltage, installed in spaces with increased humidity or in particularly humid spaces, inscriptions shall be provided stating that only the appliances with double or reinforced insulation or appliances separated from the voltage exceeding the safe voltage may be used.
[3] Socket outlets at voltages up to 400 V may be used for supplying portable appliances, fixed in position during operation.
[4] 440 V, 60 Hz alternating current may be used for power consumers.
[5] 250 V, 60 Hz alternating current may be used.

4.3 Power Supply to Essential Services

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

.1 steering gear electric drive,
.2 fire pump electric drives,
.3 bilge pump electric drives,
.4 windlass electric drives,
.5 radio communication and navigational equipment switchboards,
.6 navigation lights switchboard,
.7 switchboards of the ship's control and monitoring desk,
.8 electric drives of machinery ensuring the operation of the main propulsion,
.9 control system of controllable pitch propellers,
.10 chargers of accumulator batteries,
.11 other consumers which will be specially considered by PRS in each particular case.

The consumers specified in .3, .5, .6, .8, .9 may be supplied from switchboards specified in .7 by separate circuits equipped with switchgear and protective devices.

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

4.3.3 Power supply to automatic systems shall comply with the requirements specified in 14.3.

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

4.4.1 When locating the electrical equipment, navigational equipment, radio equipment, electrical automatic and remote control equipment for the main and auxiliary machinery in the console, such equipment shall be supplied by separate feeders, in accordance with the requirements of the present Part of the *Rules*.

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 the requirements of paragraphs 4.4.2 – 4.4.5 are complied with.

4.4.2 The switchboards of control and monitoring console shall be supplied from the main switchboard directly or through transformers by two independent feeders.

4.4.3 The switchboards of control and monitoring console shall 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 shall also be ensured. In this case, provision shall be made for appropriate interlocking.

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

4.4.5 In the control and monitoring console, a visual signalling device indicating the presence of voltage shall be fitted.

4.5 Distribution Switchboards

4.5.1 Construction of Switchboards and Consoles

4.5.1.1 The frames, front panels and casings of switchboards and consoles shall be made of steel or steel equivalent material having regard to strength, fire resistance and humid atmosphere resistance.

4.5.1.2 Switchboards and consoles shall be at least protected against drip.

4.5.1.3 The design of the switchboard and console doors shall be such that with the doors opened access will be assured to all parts which require maintenance, live parts installed on the doors being protected against accidental touch.

4.5.1.4 The switchboard and console doors shall be locked in the open position.

4.5.1.5 Openable panels and doors, on which electrical control devices and measuring instruments are located, shall be securely earthed with at least one flexible connection. Flexible wires shall be also used for connections of apparatus and devices.

4.5.1.6 Where hydraulic, pneumatic, electric and electronic components are situated in common desks, consoles and other similar units, they shall be so separated from each other that possible leakage of working medium will not have harmful effect on these components.

The sections of desks, consoles and other units which incorporate the equipment containing liquid working medium shall be provided with drip trays fitted with drain pipes.

4.5.1.7 The busbars and internal wiring used in switchboards and consoles shall be made of electrolytic copper and shall be so dimensioned as not to get heated in excess of the permissible temperature specified in the relevant standards.

4.5.1.8 Apparatus, instruments, as well as outgoing circuits of the switchboards and consoles shall be provided with marking indicating the circuit designation, the setting of overload protection and the rated current of the used fuses.

4.5.1.9 Main switchboards or panels shall be fitted with measuring instruments indicating parameters of sources of electric power, as well as a device for insulation resistance measurement. The limit values shall be marked with red colour.

4.5.1.10 For visual signals, colours given in Table 4.5.1.10 shall apply.

Table 4.5.1.10

Item	Colour	Meaning	Type of signal	Application
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

Item	Colour	Meaning	Type of signal	Application
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. All in order
5	White	General information	permanent	Notations relating to automatic action. Other additional signals

4.5.2 Arrangement of Switchboards and Panels

4.5.2.1 The switchboards and panels shall be located in spaces accessible to personnel, affording normal operation and maintenance.

4.5.2.2 Recesses in which switchboards are located shall be made of non-combustible material or shall be lined with such material.

4.5.2.3 Suitable measures shall be provided to preclude concentration of gases, steam, dust and acid evaporations in the switchboards and panels location.

4.5.2.4 The navigation lights switchboard shall be located on the navigation bridge where it will be readily accessible and visible for the personnel on watch. The navigation lights switchboard may be a part of the main switchboard or the ship's control and monitoring panel.

5 ELECTRIC DRIVES FOR MACHINERY AND EQUIPMENT

5.1 General Requirements

5.1.1 The control stations and automatic features of the drives shall comply with the applicable requirements specified in *Part VI – Machinery and Piping Systems;* the power supply of electrical automation systems shall comply with the requirements specified in 14.3.

5.1.2 Electrically driven machinery shall 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 shall be designed in such a manner that the automatic or remote control is switched off when changing over to the manual control. Manual control shall be independent of automatic or remote control.

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

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

5.1.6 The control systems of electric drives, whose operation under certain conditions may endanger the safety of the ship or the people on board, shall be provided with safety switches or other safety arrangements that will ensure the disconnecting of the power supply from the electric drive.

The safety switches or other safety arrangements shall be painted red. A notation indicating their purpose shall be placed near the safety switch.

The safety switches shall be protected against accidental, unintended use.

5.1.7 The machine control gear employed shall enable starting an electric motor only from the stop position.

5.1.8 For each electric motor rated at 0.5 kW and more and its control gear, an appropriate device to disconnect the power supply shall 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 the electric motor installation, non-manoeuvring switches mounted on the switchboard may be used for this purpose.

If the above requirements concerning the location of machine control gear are not complied with, the following shall 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 specified in *Part III – Hull Equipment*, steering gear shall comply with the requirements of the present sub-chapter.

5.2.2 Electric or electrohydraulic drive of the main steering gear comprising one or more power units shall be supplied directly from the main switchboard by two separate circuits laid on separate routes.

Electric or electrohydraulic drive of the auxiliary steering gear required by sub-chapter 2.3, *Part III – Hull Equipment* may be fed from one of the circuits supplying the main steering gear.

5.2.3 The electric and electrohydraulic drive for the steering gear shall ensure:

.1 putting the rudder over from one side to the other side within the time and angle stated in sub-chapters 2.2 and 2.3, *Part III – Hull Equipment*;
.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 arising at maximum speed astern; it is recommended that a possibility of putting the rudder over at the average speed astern should be provided.

5.2.4 Starting and stopping of the steering gear electric motors, other than the electric motors of rudders with direct electric drive, shall be effected from the steering gear room and from the navigation bridge.

5.2.5 Visual signals shall be provided at the steering gear electric or electrohydraulic drive control station to indicate that the steering gear electric motors are running.

5.3 Electric Drives for Anchor and Mooring Machinery

5.3.1 In addition to the requirements set forth in Chapters 3 and 4, *Part III – Hull Equipment*, the drives of windlasses, anchor and mooring capstans and mooring winches shall comply with the requirements of the present sub-chapter.

5.3.2 The alternating-current squirrel-cage electric motors for driving the wind- lasses and mooring winches shall 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 shall 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 shall withstand the above stalling conditions 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 shall not be over 130 per cent of the permissible value for the insulation used.

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

5.3.4 The power supply of windlass electric drives shall satisfy the requirements of 4.3.

5.4 Electric Drives for Pumps

5.4.1 The electric motors of fuel and lubricating oil transfer pumps, as well as of oil separators shall be provided with remote switching devices located outside the spaces in which these pumps are located and outside the machinery casing, but in direct vicinity of the exits from these spaces.

5.4.2 The electric motors of submersible bilge pumps and emergency fire pumps shall be provided with a remote starting device located above the bulkhead deck. The remote starting device shall be provided with the visual signal to indicate that the electric drive is switched on.

5.4.3 The remote switching devices, referred to in 5.4.1, shall be located in conspicuous places under glass covers and shall be provided with informative notices.

5.4.4 The local starting of fire and bilge pumps shall be possible even in case of failure in their remote control circuits.

5.5 Electric Drives for Fans

5.5.1 The electric motors for ventilation fans in machinery spaces shall be provided with at least two remote switching devices, one of which shall be located outside these spaces but in direct vicinity of the entries to these spaces. It is recommended that such switching devices should be installed in one place, together with the switching devices, referred to in 5.4.1.

5.5.2 The electric motors for general shipboard ventilation shall have at least one device for their remote switching off from the navigation bridge or from a place easily accessible from the main deck.

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 the crew, stationary fixtures of the main lighting supplied from the main source of electric power shall be installed.

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

6.1.3 Lighting fixtures shall 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 shall be taken to prevent stroboscopic effect.

6.1.5 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 shall be provided.

6.1.6 The number of lighting fixtures supplied from the lighting final circuits shall not exceed that specified in Table 6.1.6.

Table 6.1.6

Item	Voltage	Maximum number of lighting fixtures
1	up to 50 V	10
2	from 51 V to 120 V	14
3	from 121 V to 250 V	24

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

6.1.7 Lighting of attended machinery spaces on motor ships with separated engine rooms shall be supplied by two independent feeders.

6.1.8 Permanently installed ship's external lighting fixtures shall be provided with central switches located on the navigation bridge.

6.1.9 Two-pole switches shall be generally used in lighting circuits. Single-pole switches may be used in safe voltage lighting circuits and above the safe voltage circuits in dry spaces (fitted with lining).

6.1.10 The intensity of illumination of rooms and spaces shall be in accordance with the requirements of the relevant illumination standard.

6.2 Socket Outlets and Plugs

6.2.1 Socket outlets for portable lighting fixtures shall be installed at least:
- **.1** on deck near the windlass;
- **.2** in machinery spaces;
- **.3** in the steering gear compartment;
- **.4** on the navigation bridge;
- **.5** in the radio room.

6.2.2 Socket outlets installed in circuits with different voltages shall 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, shall be adapted for insertion of the plug from the underside.

6.3 Navigation Lights

6.3.1 The navigation lights switchboard shall supply, by separate feeders, the masthead lights, side lights and the stern lights; in tugs, fishing and hydrographic vessels and other similar purpose ships, the navigation lights switchboard shall also supply permanently mounted lights specified in the *COLREG Convention* (the relevant requirements are also given in Table 2.4.1, *Part III – Signal Means* of the *Rules for Statutory Survey of Sea-going Ships*).

6.3.2 The navigation lights switchboard shall be supplied by two feeders:
- **.1** one feeder from the main switchboard,
- **.2** the second feeder from the section switchboard or separate circuits of the ship's lighting system.

The navigation lights switchboard installed in the ship control and monitoring console may be supplied directly from the console, provided it is supplied in accordance 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 lights may be supplied directly from the switchboard.

6.3.3 Navigation lights switchboard shall be provided with visual and audible signals indicating failure of any navigation light with the switch in the "on" position.

6.3.4 Navigation lights shall be connected to the network by flexible cables and plug connectors.

6.3.5 Each navigation light non-safety voltage feeding circuit shall be of two-wire type with a double-pole switch installed in the navigation lights switchboard.

6.3.6 Each navigation light non-safety voltage feeding circuit shall be provided with protection in both wires and with visual signal of proper functioning of each navigation light.

6.3.7 If navigation lights are positioned within the helmsman's sight distance, the visual signal of proper functioning of navigation lights need not be installed.

6.3.8 The visual signal shall be designed and installed in such a manner that its damage does not cause the disconnection of the navigation light.

A voltage drop on the supply switchboard of navigation lights, including the signalling system of functioning of the light, shall not exceed 5 per cent at the rated voltage up to 30 V and 3 per cent at the voltage over 30 V.

6.3.9 The lamp holders and lamps used in navigation lights shall comply with the requirements of the *COLREG Convention* (the relevant requirements are also given in *Part III – Signal Means* of the *Rules for Statutory Survey of Sea-going Ships*, sub-chapter 3.1.7).

7 INTERNAL COMMUNICATION AND SIGNALLING

7.1 Electric Engine-Room Telegraphs

7.1.1 The electric engine-room telegraphs shall comply with the applicable requirements specified in *Part VI – Machinery and Piping Systems*.

7.1.2 The engine-room telegraphs shall be power supplied from the main switchboard or from the ship's control and monitoring console.

7.1.3 The electric engine-room telegraphs shall be provided with a visual signal of the presence of voltage in the power supply circuit.

7.1.4 Each engine-room telegraph shall be provided with an audible signal on the navigation bridge 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 shall remain operating.

7.1.5 The engine-rooms telegraphs installed on the navigation bridge shall be provided with scale lighting permitting adjustment of illumination intensity.

7.2 Internal Service Communication

7.2.1 Where other types of communication facilities are not available, an independent service communication system shall be provided between the navigation bridge and control stands of main engines, as well as between the navigation bridge and the steering gear compartment, which could be:
– telephone communication system,
– loud master communicator.

7.2.2 The communication means shall be provided with the appropriate sources of power, capable of ensuring telephone operation even in the absence of voltage from the main generators. Non-battery telephone sets are recommended for use in telephone communication systems.

7.3 General Alarm System

7.3.1 Ships in which an alarm given by human voice or by any other means will not be heard simultaneously in all locations where people may be present shall be fitted with general emergency alarm system that will ensure good signal audibility in all such places.

7.3.2 Signalling devices shall be installed in the following places:
– in machinery spaces,
– in corridors of accommodation, service and public spaces,
– on open decks.

7.3.3 The general alarm system shall be power supplied continuously in normal operating conditions, as well as in case of main generators failure. It is recommended that a signal lamp indicating power supply "on" should be provided in the general alarm control station.

7.3.4 The general alarm signal shall be activated from the navigation bridge. Alarm signal shall be activated manually by push-button or automatically by alarm generator.

In the case of automatic activation, the alarm shall continue to operate until it is manually turned off or overridden by the public address system broadcast.

7.4 Fire Detection System

7.4.1 Fire detection system shall comply with the applicable requirements specified in *Part V - Fire Protection* and sub-chapter 7.5, *Part VIII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Sea-going Ships.*

7.4.2 The installation of elements of the fire detection system in explosion hazardous spaces or located in the stream of air sucked from these spaces shall comply with the requirements of 2.7.2.

7.4.3 A warning alarm signal to indicate starting of fire-extinguishing system, where fitted, shall be supplied from an accumulator battery.

If provision has been made for fire detection system, the warning alarm signal shall be supplied from an accumulator battery of the fire detection system.

8 PROTECTIVE DEVICES

8.1 General Requirements

8.1.1 Outgoing circuits of switchboards shall be protected against short-circuits and overloads by means of suitable devices installed at the beginning of each circuit.

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

8.1.3 Overload protection shall 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.

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

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

8.2 Protection of Electric Circuits

8.2.1 Generators not intended for parallel operation shall 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 shall 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.

8.2.3 The protective devices used for generator overload protection shall not prevent the possibility of re-starting the generator immediately.

8.2.4 Outgoing feeders from switchboards supplying electric motors rated at over 0.5 kW shall 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.

8.2.5 Where fuses are used for protection of electric motor circuits, disconnect switches shall also be provided for these circuits.

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

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

8.2.8 Electric motors and control systems of electric and electro-hydraulic steering gear shall be provided with short-circuit protection only.

Where fuses are used for protection of steering gear motors, the rated current of the fuse elements shall be chosen by one degree higher than that resulting from the choice made on the basis of the starting current of the electric motor.

Visual and audible alarms warning of motor overload and voltage failure in any of the phases shall be provided.

8.2.9 Power supply circuits of general alarm system shall be provided with short-circuit protection only.

8.2.10 Short-circuit and overload protective devices shall 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 agreement with PRS.

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

8.2.11 Storage batteries, other than those designed to start up internal combustion engines, shall be provided with means of protection against any short-circuit currents.

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

9 ELECTRIC MACHINES AND TRANSFORMERS

9.1 General Requirements

9.1.1 Electric machines installed on board ships shall comply with the requirements of binding standards for marine type products. The use of not type approved electric machines is subject to special consideration of PRS in each particular case.

9.1.2 Rotors of alternating and direct-current machines shall be capable of withstanding, for 2 minutes, without damage and permanent deformations, the increased speed of rotation up to 120 per cent of the rated speed.

9.1.3 Where a machine is so designed that upon installation on board its lower part is situated below the floor level, ventilating air intake shall not be made in the bottom part of the machine.

9.1.4 Alternators, starter motors and electrical equipment mounted on internal combustible engines shall be so arranged as to be located above bilge level and remote from fuel installation.

9.1.5 A flexible copper wire shall be used for drawing current from brushes. Brush holder springs shall not be used for this purpose.

9.1.6 The position of brushes in direct-current machines shall be clearly and indelibly marked.

9.1.7 Commutator type machines shall be capable of operating practically without sparking at any load from zero to the rated value.

9.1.8 The bearings of generators driven by the main propulsion plant by means of belts or chains shall be designed with the transverse pull taken into account.

9.2 Alternating-Current Generators

9.2.1 Each alternating-current generator shall have a separate independent system for automatic voltage regulation.

9.2.2 Damage to automatic voltage regulation of generators shall not result in inadmissible high voltages at the generator terminals.

9.2.3 Alternating-current generators rated at 50 kW (kVA) and over, together with their excitation and voltage regulation systems shall be so designed as to be capable of withstanding, at short-circuits, the effects of the three-fold rated current within 2 s.

9.2.4 Alternating-current generators shall have voltage regulation system so adjusted to the regulation characteristics of the prime movers that the rated voltage will be maintained within ± 5 per cent at load changes from no-load to the rated load at rated power factor.

9.2.5 A sudden change in the balanced load of a generator running at rated speed and rated voltage, under given current and power factor conditions, shall not cause a fall of voltage below 85 per cent or a rise above 120 per cent of the rated value. Following such a change, the generator voltage shall be restored within not more than 1.5 seconds to the rated value with a tolerance of ± 5 per cent.

9.3 Direct-Current Generators

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

9.3.2 Voltage regulators of compound-wound generators shall 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.

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

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

9.3.5 Direct-current sets comprising compound-wound generators shall have such external characteristics that voltage of a hot generator adjusted to the rated value within ± 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 shall not exceed the following limits:

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

9.3.6 Direct-current sets comprising shunt-wound generators shall have such external generator characteristics and such automatic voltage regulators that voltage is maintained within ± 2.5 per cent of the rated value at all load variations from zero to the rated load.

9.4 Transformers

9.4.1 Dry transformers cooled by air shall be used in ships. The use of transformers of other design (e.g. liquid-cooled) is subject to special consideration of PRS.

9.4.2 Transformers shall have electrically separated windings for primary and secondary voltages.

9.4.3 Transformers shall be capable of withstanding 10 per cent overloads for 1 hour and 50 per cent overloads for 5 minutes.

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

10 STORAGE BATTERIES

10.1 General Requirements

10.1.1 Storage batteries shall be so constructed that the loss of capacity of a fully charged battery due to self-discharge after 28 days out of operation at a 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.

10.1.2 Battery containers and closures for holes shall 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.

Closures shall be made of a durable material resistant to electrolyte. The closure design shall be such as to avoid the building up of excess gas pressure inside the battery.

10.1.3 The mastics used shall not change their properties or deteriorate at the ambient temperature changes within – 30°C to +60°C.

10.1.4 Materials used for fabrication of crates to house battery cells shall be resistant to electrolyte. Individual cells arranged within the crates shall be so secured as to preclude their relative movement.

10.1.5 The use of non-service accumulators is subject to special consideration of PRS.

10.2 Arrangement of Accumulator Batteries

10.2.1 Batteries having voltage exceeding the safe voltage, as well as batteries having a capacity of over 2 kW (computed from the maximum charging current and the rated voltage) shall be located in special battery compartments accessible from the deck or in appropriate boxes installed on the open deck. Batteries having a capacity of 0.2 kW up to 2 kW may be installed in boxes or cabinets located inside the ship's hull.

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

Batteries having a capacity of less than 0.2 kW are allowed to be installed in any space, except accommodation spaces, provided they are protected from the action of water and mechanical damage and do not have harmful effect on the surrounding equipment.

10.2.2 The acid and alkaline batteries shall not be placed in one compartment or in one box.

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

10.2.3 The inside part of battery compartment or box, as well as structural parts which may be subjected to harmful effect of electrolyte or gas shall be suitably protected.

10.2.4 The accumulator batteries, as well as the individual accumulator cells shall be properly secured in position.

10.2.5 When installing the accumulator batteries or the individual accumulator cells, fitting linings and distance pieces between them shall be provided to ensure a clearance for circulation of air of not less than 15 mm.

10.2.6 Warning notices indicating the danger of explosion hazard shall be provided on or at the doors leading to the battery compartment, as well as on the boxes containing accumulators.

10.3 Ventilation

10.3.1 The battery compartments and boxes shall have sufficient ventilation that will prevent possible formation and accumulation of explosive mixtures.

The ventilation system shall comply with the requirements set forth in sub-chapter 9.4, *Part VI – Machinery and Piping Systems*.

10.3.2 The battery compartments fitted with mechanical ventilation shall be provided with devices that will prevent possible charging of accumulator batteries before ventilation has been switched on. The charging cycle shall be automatically discontinued if the ventilators stop.

10.4 Charging the Accumulator Batteries

10.4.1 Charging facilities shall be provided for charging accumulator batteries supplying essential services. These facilities shall 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 exceed 8 hours.

10.4.2 The charging facilities shall have means for measuring the voltage across battery terminals and charging current.

10.5 Installation of Electrical Equipment in Battery Compartments

10.5.1 Except for explosion-proof lighting fixtures and cables led to accumulators and lighting fixtures, no other electrical equipment shall be installed in battery compartments.

10.5.2 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 is effectively earthed on both ends.

10.6 Electric Starters for Internal Combustion Engines

10.6.1 In a ship fitted with electrically-started internal combustion engines, irrespective of the number of such engines, a starter battery shall be installed for starting each engine.

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

10.6.3 The capacity of each battery shall be sufficient for six starts 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.

10.6.4 When calculating battery capacity, the duration of each start shall be considered to be at least 5 sec.

10.6.5 A starter battery charging facility shall be supplied by a separate feeder from the main switchboard even if battery charging is possible by a generator mounted on internal combustion engine.

10.6.6 In ships with the electrical installation rated below 10 kW, the starter batteries may be charged from generators mounted on the i.c. engines only.

10.6.7 Starter battery meeting the requirements of 10.6.3 may be used for supplying the ship's lighting installation, provided that the capacity of the battery is adequately increased above the value required in 10.6.3.

10.6.8 Starter batteries shall be located as close as possible to the starter.

10.6.9 Safety disconnectors capable of switching off starting current shall be installed in starting batteries circuits.

11 ELECTRICAL APPARATUS AND ACCESSORIES

11.1 Electrical Apparatus

11.1.1 The design of switchgear with renewable contacts shall be such that renewal of contacts is possible with the use of standard tools, without the need to dismantle the switchgear or its basic components.

11.1.2 All non-manoeuvring switches, except for cabin switches, shall be provided with mechanical or electrical contact position indicators.

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

11.1.4 Machine control gear, except that used for continuous regulation, shall 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.

11.1.5 The direction of movement of manual operating controls of switchgear and machine control gear shall be such that clockwise rotation of a handle (hand wheel) 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 (hand wheel) or shifting of a handle (lever) towards the operator shall correspond to lifting movement, and counter-clockwise rotation or shifting away from the operator – to lowering movement.

11.1.6 Motor-operated apparatus shall operate correctly at control voltage varying within 85 to 110 per cent of the rated value an at rated frequency, in the case of alternating current. A fall of control voltage down to 70 per cent of the rated value shall not cause opening of movable elements.

11.1.7 Switchgear push buttons shall be so designed that they cannot be actuated accidentally.

11.1.8 Fuse elements shall 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.

11.1.9 Fuse elements shall be made of non-combustible and non-hygroscopic insulating material.

11.2 Installation Fittings

11.2.1 Enclosures of accessories and fittings shall be constructed of material resistant to corrosion or suitably protected against corrosion, fire-resistant and having adequate mechanical strength. The enclosures of accessories and fittings designed for installation on weather decks, in refrigerated cargo spaces, fish processing shops or other humid areas shall be made of brass, bronze or equivalent materials, or of suitable quality plastics.

If steel or aluminium alloys are used, adequate anticorrosive protection shall be provided. Threaded and fitted joints shall not be made in aluminium alloys.

11.2.2 The lighting fitting intended to be mounted on or close to combustible materials shall be so constructed as not to get heated over 90°C.

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

11.2.4 No switches are allowed to be fitted in lampholders.

11.2.5 Each lampholder shall be marked with the rated voltage, as well as the permissible current or the lamp power.

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

11.2.7 The use of plugs with slotted pins is not permitted. The pins of plugs designed for currents in excess of 10 A shall be cylindrically shaped, solid or hollow, as the case may be.

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

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

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

11.2.11 Where socket outlets are not interlocked, the clearances between contacts in the air or across the insulation surface shall 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.

11.2.12 Socket outlets and plugs shall be so designed as to make it impossible to insert only one live contact pin into the socket outlet or to insert a live contact pin into the earthing contact. Furthermore, the design of the outlets intended for connecting motors (or gear), the direction of rotation (or operation) of which depends on the sequence of phases or poles connected, shall preclude change of this sequence. When the plug is inserted into the socket outlet, the earthing part of the plug shall make contact with the earthing part of the socket outlet before connecting the live pins.

11.2.13 No fuses shall be fitted in socket outlets, plugs or tapping boxes.

12 HEATING APPLIANCES

12.1 General Requirements

12.1.1 Only heating appliances of stationary type shall be used.

12.1.2 Heating appliances shall be supplied from the main switchboard or section switchboard adopted for this purpose, or from the lighting switchboard.

12.1.3 The supporting structural parts of heating appliances, as well as the internal surfaces of enclosures shall be made entirely of non-combustible materials.

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

12.1.5 Heating appliances shall be so designed that the temperature of their components which are to be handled by the personnel or which can be touched accidentally will not exceed the values indicated in Table 12.1.5.

Table 12.1.5

Item	Specification		Permissible temperature [°C]
1	Control handles and other parts to be handled during substantial periods of time	metallic	55
		non-metallic	65
2	The same, but where short-time contact is possible	metallic	60
		non-metallic	70
3	Enclosures of electric space heating appliances at 20°C ambient temperature		80
4	Air coming out from space heaters		110

12.2 Space Heating Appliances

12.2.1 Electric heaters intended for space heating shall be of stationary type.

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

12.2.2 The space heaters shall be installed in compliance with the requirements of paragraph 2.5.1, *Part V – Fire Protection*.

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

12.2.4 The enclosures of electric heaters shall be so constructed as to make it difficult to place any objects thereon.

12.2.5 Stationary space heating appliances rated at 400 V and admitted for use in accordance with Table 4.2.3 shall be protected against access to live parts, except with the aid of special tools. The enclosures shall be provided with notices stating the voltage value.

12.3 Cooking Appliances

12.3.1 Heating appliances forming part of galley equipment shall be so constructed that cooking utensils cannot come into contact with live parts and that liquid spilling or leakage cannot cause short-circuits or damage to insulation.

12.4 Oil and Fuel Heating Appliances

12.4.1 The electrical heating appliances may be used for heating oil and fuel having a flash point of vapour above 60°C.

12.4.2 The heating appliances of the oil and fuel pipelines shall 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.

12.4.3 The heating appliances for oil and fuel tanks shall 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 shall be provided with visual signal on operation conditions and with audible and visual signals indicating a failure in the system.

12.4.4 The oil and fuel heating appliances shall be fitted with a device controlling the temperature of the heated agent. Irrespective of this device, a safety cut-out switch with manual re-set shall be provided for disconnecting the supply voltage when the temperature of the heated agent reaches 220°C.

13 CABLES AND CONDUCTORS

13.1 General Requirements

13.1.1 Cables and conductors allowed for use in ships shall be non-combustible or flame-retardant type marine cables and conductors, which have been tested in accordance with IEC Publication 60332-1 or an equivalent test procedure – meeting the requirements of the present Chapter of the *Rules* or the relevant national and international standards agreed with PRS, including IEC 60092-3, 60092-350 and 60092-376.

The use of other types of cables is subject to special consideration of PRS in each particular case.

13.1.2 The requirements of the present Chapter do not apply to concentric and telephone cables.

13.2 Conductors

13.2.1 Cable conductors intended for supplying essential services shall be of multi-wire type. Table 13.2.1 specifies the number of wires per conductor.

Table 13.2.1

Item	Nominal cross-sectional area of conductor [mm^2]	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

Note:
The ratio of nominal diameters of any two wires of mechanically compacted conductors shall not exceed the value of 1:1.3 and that of shaped non-compacted conductors – 1:1.8.

13.2.2 Separate wires in multi-wire conductors shall be spliced in a reliable manner so as not to impair the mechanical or electrical properties of the wire and not to change the cross-section of the wire or that of the whole conductor. Splice-to-splice distances in separate wires along the length of conductor shall not be less than 500 mm.

13.2.3 Separate wires of rubber-insulated copper conductors shall 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 has taken measures to guarantee that the rubber insulation will not affect adversely the metal of the conductor. No tinning is required for conductors provided with other types of insulation.

13.3 Insulating Materials

13.3.1 The types of insulation that may be used for insulating current-carrying conductors in cables are given in Table 13.3.1. The use of other types of insulation is subject to special consideration of PRS in each particular case.

Table 13.3.1

Designation of insulation	Standard types of insulating materials	Permissible working temperature[1)] [°C]
PVC/A	Polyvinyl chloride compound – general purpose	60
V 75 PVC/D	Polyvinyl chloride compound – heat resisting quality	75
EPR	Ethylene-propylene rubber compound	85
XLPE	Cross-linked polyethylene compound	85
S 95	Silicone rubber compound	95
HF EPR	Halogen free ethylene propylene rubber	85
HF XLPE	Halogen free cross-linked polyethylene	85
HF S95	Halogen free silicon rubber	95
HF 85	Halogen free cross-linked polyolefin material	85

1) Temperature of the conductor assumed for the calculation of current rating in continuous service of cables.

13.4 Cable Sheaths

13.4.1 Cable and conductor sheaths may be made of materials given in Table 13.4.1.

The use of other materials for cable sheaths is subject of consideration of PRS in each particular case.

Table 13.4.1

Designation	Type of tight non-metallic cable sheath	Maximum working temperature of cable in sheath, [°C]
ST1	Polyvinyl chloride compound – general purpose	60
ST2	Polyvinyl chloride compound – heat resisting quality	85
SE1	Polychloroprene rubber compound	85
SH	Chlorosulfonized polyethylene compound	85
SHF1	Halogen free thermoplastics material	85
SHF2	Halogen free thermosetting material	85

13.4.2 Sheaths shall be of uniform thickness, within permissible limits, throughout the manufacturing length of cable and shall envelope the cable cores concentrically.

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

13.5 Protective Coverings

13.5.1 Metal screening braid shall be made of tinned copper wire. If plain copper wire is used, shall be protected by suitable sheaths. Non-screening braids may be of galvanized steel wires. The braid shall be uniform and its density shall be such that its weight is at least equal to 90 per cent of the weight of the tube of an equal diameter, made of the same material, and with a wall thickness equal to the braiding wire diameter.

13.5.2 Metal armour shall be made of annealed steel wire or tape, galvanized and wound helically, with a suitable pitch, over the cable sheath or an intermediate bedding over the sheath in such a way that a continuous cylindrical layer is formed to assure adequate protection and flexibility of the finished cable. At a special request, the armour may be made of non-magnetic metals, using the techniques described above.

13.5.3 Cable armour or braid made of steel tape or wire shall be painted for corrosion prevention.

13.5.4 Armour bedding shall be made of moisture resistant materials.

13.6 Marking

13.6.1 Rubber- or polyvinyl-chloride-insulated cables having a limiting temperature at core over 60°C shall be marked in such a manner that would permit their identification.

13.6.2 Cable conductors shall be marked in a way that would ensure durability of marking.

In multi-core cables, the cores of which are arranged in several concentric layers, at least two adjacent cores in each layer shall be marked with different colours.

13.7 Wiring

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

13.7.2 Non-insulated wires and busbars are permitted for use only for internal wiring of electrical devices.

13.8 Cabling

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

.1 1.0 mm^2 – for power, control and signalling circuits supplying the essential equipment and for power circuits supplying other equipment;

.2 0.75 mm^2 – for control and signalling circuits supplying non-essential equipment;

.3 0.5 mm^2 – for monitoring and indicating circuits and the circuits serving internal communication, with not less than 4 conductors in the cable.

In the case of circuits supplying non-essential equipment, it is permitted to use single-wire core conductors with a cross-sectional area of 1.5 mm^2 or less.

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

13.8.3 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 shall be used.

Cables of other types may be installed in such locations, provided they are laid in metallic pipes (see 13.8.33).

13.8.4 In locations where cables may be subjected to mechanical damage, they shall have an appropriate armour. Unarmoured cables in such locations shall be protected with special reliable covers or shall be installed in metallic pipes (see 13.8.33).

13.8.5 Cables of antenna circuits leading to radio communication and radio navigation equipment, as well as echo sounder cables shall be installed separately from other cables. The above requirement is not obligatory for double screened cables.

13.8.6 Permissible continuous loads on single-core cables and on conductors insulated by various materials shall comply with the values given in Table 13.8.6 (see also 13.8.9).

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.

The values of the permissible current ratings for the relevant cross-sectional areas specified in the Table shall be reduced by 15% (factor 0.85) in the case where more than 6 cables installed in one bunch may be simultaneously loaded by the rated current or where there is lack of clearance for the cooling air circulation.

Table 13.8.6
Permissible current ratings in continuous service of single-core cables and conductors with various insulation at the ambient temperature of 45°C

Nominal cross-sectional area of conductor [mm^2]	Permissible current rating in continuous service [A]				
	Polyvinyl chloride	Polyvinyl chloride heat resisting quality	Butyl rubber	Ethylene-propylene rubber, cross-linked polyethylene	Silicon rubber and mineral insulation
	+ 60*	+75*	+80*	+85*	+95*
1	8	13	15	16	20
1.5	12	17	19	20	24
2.5	17	24	26	28	32
4	22	32	35	38	42
6	29	41	45	48	55
10	40	57	63	67	75
16	54	76	84	90	100
25	71	100	110	120	135
35	87	125	140	145	165
50	105	150	165	180	200
70	135	190	215	225	255
95	165	230	260	275	310
120	190	270	300	320	360

* Maximum permissible temperature of conductor [°C].

13.8.7 Permissible current ratings for two-, three- or four-core cables shall be reduced in relation to the values given in Table 13.8.6, using the following correction factors:
0.85 – for two-core cables;
0.70 – for three- and four-core cables.

13.8.8 Permissible current ratings for cables and conductors, installed in circuits with intermittent or short-time service, shall be determined by multiplying the value of current rating in continuous service of these cables, calculated in accordance with Table 13.8.6 or according to 13.8.7, by the correction factor taken from Table 13.8.8.

Table 13.8.8
Values of correction factors in relation to load

Nominal cross-sectional area of conductor [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

13.8.9 Permissible current ratings for cables and conductors in relation to different maximum insulation temperatures and different ambient temperatures in continuous, short- time and intermittent services may be selected according to PRS *Publication No. 15/P – Current Rating Tables for Cables, Wires and Busbars in Marine Installations*.

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

13.8.11 Cables installed in parallel for the same polarity or phase shall be of the same type, shall be run as close as possible to each other and shall have the same cross-sectional area of at least 10 mm² and the same length.

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

13.8.13 In normal operating conditions, the voltage drop on the cables between the busbars of the main switchboard and any electric consumers shall not exceed 6 per cent of the rated voltage. For the consumers supplied from accumulator batteries of the voltage not exceeding 50 V, the value may be increased to 10 per cent.

The voltage on terminals of the navigation lights shall not be lower than 95 per cent of the rated voltage for the light.

At short-time service, e.g. at starting the electric motors, a greater voltage drop is permissible if it does not adversely affect the work of the remaining electric consumers, not exceeding, however, 25 per cent of the rated voltage.

13.8.14 Cable runs shall be, as far as possible, straight and accessible and shall 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 shall be installed not closer than 100 mm to the sources of heat.

13.8.15 In spaces subject to increased fire hazard no through runs of cables shall be provided.

Where running of cables in such locations is necessary, an adequate protection of the cables, agreed with PRS, shall be provided.

13.8.16 Cables of intrinsically safe circuits shall be used for one device only and are to be separated from other cables.

13.8.17 No cables shall 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 and gastight bulkheads and decks shall be not less than 20 mm.

13.8.18 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.

13.8.19 Cables installed in fishing vessels and factory ships at locations subjected to the action of salt shall be suitably protected with covers or shall be provided with salt-resistant sheathing.

13.8.20 It is not recommended to install cables under the flooring of machinery spaces. If such an installation is necessary, cables shall be installed in metallic pipes or in closed ducts (see 13.8.33).

13.8.21 When equipment is supplied by two separate feeders, these feeders shall be installed in different runs as far apart as possible from one another, both in horizontal and in vertical direction.

13.8.22 Cables shall not be embedded in thermal or acoustic insulation if it is made of combustible materials. Cables shall be separated from such insulation with plating of non-combustible material or shall be located at a distance not less than 20 mm from the insulation.

Where cables are installed in thermal or acoustic insulation made of non-combustible materials, they shall be calculated with the corresponding load reduction.

13.8.23 The minimum internal bending radii of the cables shall be not less than those specified in Table 13.8.23.

Table 13.8.23

Item	Type of cable		External diameter of cable d [mm]	Minimum bending radius
	Type of insulation	Type of protective covering		
1	Rubber or polyvinyl chloride	Armoured with metal tape or wire	Any	10d
		Protected with braid of metal wires	Any	6d
		Lead alloy and armour	Any	6d
		Other sheathing	up to 9.5	3d
			9.5 to 25.4	4d
			over 25.4	6d
2	Varnished cambric	any	Any	8d
3	Mineral insulation	metal	up to 7	2d
			7 to 12.7	3d
			over 12.7	4d

Item	Type of cable		External diameter of cable *d* [mm]	Minimum bending radius
	Type of insulation	Type of protective covering		
4	Ethylene-propylene rubber compound or cross-linked polyethylene compound	Semiconducting or metallic	25 and over	10*d*

13.8.24 Where cables are installed in ducts and other structures made of combustible materials, the materials shall be protected against fire by suitable fire protection means, such as surface plating, coating or impregnation.

13.8.25 Cables shall be suitably fastened in position by means of clips, holders, hangers, etc. made of metal or other non-combustible or fire-resistant material.

The fastener surface shall be sufficiently wide and is to have no sharp edges.

The fasteners shall be selected in such a manner that the cables are fastened in position securely but without damage to their protective coverings.

Cables shall not be fastened directly to hull construction.

13.8.26 Distances between the cable fastening points in the case of horizontal installation shall not exceed the values given in Table 13.8.26. For vertical runs of cables, these distances may be increased by 25 per cent.

Table 13.8.26

External diameter of cable [mm]		Distance between fastening points for cables [mm]		
Over	Up to	Without armour	With armour	With mineral insulation
–	8	200	250	300
8	13	250	300	370
13	20	300	350	450
20	30	350	400	450
30	–	400	450	450

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

13.8.28 Penetration of watertight bulkheads and decks shall be made tight.

The bulkheads and decks cable penetration packing shall be such as not to impair the watertight integrity of the bulkhead or deck.

13.8.29 Where cables pass 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 shall 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 shall be rounded off.

13.8.30 Cables passing through decks shall be protected against 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 shall be filled with cable compound. For single cables, the use of glands is permitted instead of filling with compound.

13.8.31 Cables shall be fastened in such a manner that mechanical strains in cables are eliminated.

13.8.32 Cables placed in locations subject to heavy vibrations (running to devices placed on shock absorbers) shall be of flexible type, suitable for operating conditions and mounted in such manner as to protect against the effect of vibrations.

13.8.33 Installation of cables in pipes shall be avoided. When required, the use of pipes as mechanical protection shall be made under the following conditions:
- the cross-sectional area of all cables as measured on their outside diameters shall not exceed 40 per cent of the inside cross-sectional area of the pipe (it does not apply to installation of single cable),
- the accumulation of water inside a pipe shall be precluded; when required, ventilation holes shall be provided in the pipes,
- the inside surface of pipes shall be even, smooth and protected against corrosion,
- for voltages over 50 V, pipes shall be effectively earthed.

13.8.34 To fill the cable boxes in watertight bulkheads and decks, the use shall be made of packing compounds that have good adhesion to the inside surfaces of cable boxes and cable sheathing, are resistant to the action of water and oil products and maintain tightness in continuous service.

13.8.35 Ends of rubber-insulated cables, mineral-insulated cables and cables with metallic coating shall be so packed as to prevent the entry of moisture inside the cable.

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

13.8.37 If, during installation of cables, it is found necessary to make additional connections, they shall be effected in suitable junction boxes provided with clamps. The joint as a whole shall be protected against the influence of environmental conditions. Permission for the use of cable connection and the application of cable connection method other than that mentioned above will be specially considered by PRS.

14 AUTOMATION AND REMOTE CONTROL SYSTEMS

14.1 Application

The requirements of the present Chapter apply to all control systems covered by PRS' survey, regardless of the scope of the ship's automation.

14.2 Design Requirements

14.2.1 General Requirements

14.2.1.1 Automated machinery provided with automatic or remote control system, as well as, to a necessary degree, with monitoring systems, shall additionally be provided with means of local manual control.

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

14.2.1.2 Where machinery or installation is remotely controlled, it shall 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.

14.2.1.3 Control systems with global asymptotical stability features are recommended.

14.2.2 Requirements for Components and Units of Automatic Systems

14.2.2.1 Components and units used in automatic systems shall additionally comply with the requirements of the relevant Parts of the *Rules*.

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

14.2.2.3 Damping arrangements (shock absorbers), which are used to protect components and units against the effect of shocks and vibrations, shall be provided with stops to protect them against damage in case of excessive rolling amplitudes.

14.2.2.4 Control elements intended for fixing the settings shall be secured against unintentional change of the position. Provision is to be made for their repeated securing in case of readjustment.

14.2.2.5 Conducting surfaces of plug-in connections shall be of such design as to prevent the increase of contact resistance limiting the correct operation of the equipment.

14.2.2.6 At the terminals of cables and bunches of conductors to components, as well as at the connections to moving parts, means shall be provided to relieve the components from the effect of tension of cables and conductors.

14.2.2.7 Replaceable blocks (printed cards) with plug-in connections shall 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.

Where necessary, due to design or functional features of the component or unit, the permanent marking of correct mounting position shall be provided or the component or unit itself shall be so designed as to preclude mounting in the wrong position.

14.2.2.8 Printed circuit cards shall be covered with electroinsulating varnish on the side on which current lines are located.

14.2.2.9 Final control elements (servo-motors, controllers, etc.) shall be so designed that no uncontrollable movement of their working parts is possible.

14.2.2.10 Pneumatic and hydraulic components and units shall withstand, without damage, short-time overloads caused by an increase of the working medium pressure equal to 1.5 times the rated value.

14.2.2.11 Pressure sensors shall be connected to the piping installation by means of 3-way cocks in order to supply the testing pressure, de-aeration of the piping and disconnecting of the damaged sensor.

14.2.2.12 Pneumatic and hydraulic components and units shall maintain their performance characteristics under the deviation of supply pressure from the rated value within ± 20%.

14.2.3 Requirements for Automatic Systems

14.2.3.1 All control systems essential for the operation of the ship propulsion, machinery control and safety shall operate independently or shall be so designed that a failure in one of those systems will not interfere with the operation of the other systems.

14.2.3.2 Computerised automatic systems shall comply with the requirements specified in *Publication No. 9/P – Requirements for Computer Based Systems.*

14.2.3.3 Electric and electronic circuits of automatic systems shall be provided with means of protection capable of selective disconnecting the damaged parts of the system.

14.2.3.4 Each automatic system shall be so designed that failure in one circuit of lamps, sirens and similar signalling devices will not interfere with the operation of other circuits.

14.2.3.5 Failure of power supply to automatic or remote control systems shall not to result in dangerous conditions.

14.2.3.6 Automatic systems shall 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.

14.2.3.7 Automatic systems shall 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.

14.2.3.8 Automatic systems shall be so designed that typical failures of such systems will not result in hazardous conditions and will not lead to the secondary failures in the system itself and in automated machinery concerned.

14.2.3.9 Each automatic or remote control system shall prevent the automatic restart of controlled machinery after its stopping by the safety system. Restart shall be possible after manual reset (e.g. by control lever being brought to start position).

14.2.3.10 Replaceable and controllable components, as well as the test points shall be so arranged as to provide permanent and easy access.

14.2.3.11 Components or units of automatic systems shall be so designed as to ensure the possibility of their checking and calibration during operation.

14.2.3.12 Measuring range of analogue sensors shall be at least 20% greater than the expected deviation of the input signal value (measured parameter).

14.2.3.13 Pneumatic systems shall be fitted with effective means for ensuring the required degree of purity and dryness of air supplied.

14.2.3.14 Drying and filtering equipment used in automatic systems of main propulsion and electric generating sets shall, as a rule, 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.

14.2.3.15 In supply piping of pneumatic systems, safety valves shall be provided to prevent an increase of pressure by more than 0.1 per cent of the working pressure.

14.2.3.16 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 shall be also taken to enable components or units to operate in case of contamination by the cooling air.

14.2.3.17 Elements intended for control shall be so arranged as to provide easy access, shall be marked in accordance with their designation and shall be secured against self-acting change of position.

14.2.3.18 Where provision has not been made for the machinery space to be continuously attended, the scope of the necessary remote or automatic control is subject to special consideration of PRS, having regard to the location of control station, machinery supervision procedure and machinery service characteristics.

14.3 Power Supply of Automatic Systems

14.3.1 Control system of the main propulsion shall be supplied through two independent feeders. One of these feeders shall be supplied from the main switchboard (directly or through a transformer) and the second may be supplied from the nearest section switchboard supplying essential consumers. Switching on the second power source shall be effected automatically.

14.3.2 Where control systems of auxiliary machinery are supplied from the circuit supplying the prime mover of the machinery, starting of the stand-by units shall be possible also in case of voltage failure in the supply circuit of the machinery actually in operation.

14.3.3 Automatic systems or their hydraulic and pneumatic parts shall be supplied by means of two compressors or two pumps.

14.3.4 Power supply to control system of generating sets, their safety system and safety system of the main engines shall be so arranged that the systems are capable of operating, irrespective of the voltage on the main switchboard.

14.3.5 Alarm system shall be always supplied from two independent power sources. The switching on of the stand-by power source shall be effected automatically.

14.4 Monitoring Systems

14.4.1 Alarm System

14.4.1.1 Depending on the extent of machinery automation, as well as supervision procedure adopted for the machinery, the alarm system shall 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 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 shall be indicated in the relevant control stations. The arrangement of the alarm display shall assist in identifying the particular fault condition and its location within the machinery space.

14.4.1.2 The alarm system shall 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, limited to the source of alarm only, is subject to special consideration of PRS.

14.4.1.3 Alarm system shall have such self-monitoring properties that alarm signal will be given in the case of a broken circuit or other typical failures.

14.4.1.4 The alarm system shall operate simultaneously both visual and audible signals.

14.4.1.5 Visual signal shall be given by intermittent light and shall indicate the reasons of the alarm. Cancelling the visual signal shall be possible only after the reasons of its operation have been eliminated. Acknowledgement of visual signal shall be clearly indicated by the change of its form (i.e. change from intermittent light to steady light or change in flickering frequency).

14.4.1.6 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 shall be maintained until the reason of the previous signal has been eliminated.

Audible signals for machinery shall be clearly distinguished from surrounding sounds and other audible signals, e.g. fire, general alarm system, etc. The local switching off the audible signal on the navigation bridge and in the accommodation area, if provided, shall not stop the audible signal in the machinery space.

14.4.1.7 For easy identification of transitory alarm conditions which are automatically eliminated, the alarm system shall have memory features so that the transitory alarm conditions can be maintained until they are acknowledged.

14.4.1.8 Disconnection or omission of any part of the alarm system shall be clearly indicated.

14.4.1.9 The alarm system shall be capable of being tested during normal machinery operation. Where practicable, means shall be provided at convenient and accessible locations to permit the sensors to be tested without affecting the operation of the machinery.

14.4.1.10 A short-time interruption of power supply to the alarm system shall not cause a loss of information on alarm conditions prior to the interruption.

14.4.1.11 Where visual signals are given by means of lamps, the colour of a visual signal shall be adequate to the character of this signal and the size of the system in accordance with 4.5.1.10.

14.4.2 Safety System

14.4.2.1 The safety system of particular units of automated machinery plant shall operate automatically after exceeding limit values of the given parameters causing a failure and shall 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, 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.

14.4.2.2 Means shall be provided to trace the cause of the safety system action.

14.4.2.3 The safety system intended for the functions specified in 14.4.2.1.3 shall be independent of all other control and alarm systems so that failure or malfunction in these systems will not prevent the safety system from operating.

For the safety system intended for functions required by 14.4.2.1.1 and 14.4.2.1.2, complete independence from other control and alarm systems is not required.

The safety system of internal combustion engines operating due to lubricating oil pressure drop shall be independent of alarm and control systems, including the sensors.

14.4.2.4 The safety system shall have such self-monitoring properties that, with the requirements of 14.4.2.7 satisfied, alarm signal will be given at least in the event of short circuit, earth fault, broken fuse or broken circuit.

14.4.2.5 Safety systems for different units of the machinery plant shall be independent. Failure in the safety system of one part of the plant shall not interfere with the operation of the safety system in another part of the plant.

14.4.2.6 The safety system shall intervene after operation of the alarm system in the relevant sequence of functions.

14.4.2.7 The safety system shall be so designed that failure in the system does not cause hazardous conditions. This feature shall be maintained, not only with regard to the safety of the system itself and associated machinery, but also with regard to the safety of the whole machinery installation and the ship.

14.4.2.8 When the safety system has stopped a unit, the unit shall not be restarted automatically, but only after a manual reset has been carried out (see also 14.2.2.9).

14.4.2.9 When the switching-off facilities in the safety system of the main propulsion are provided, the switching-off device shall be of such design as to preclude the possibility of its unintended use, and in the case of the safety system being switched off, its position shall be indicated by means of a special signal.

14.4.3 Indicating and Recording Systems

14.4.3.1 Indicating and recording systems shall be independent of other systems and shall be so designed that their failures will not affect the other systems.

14.4.3.2 A failure in recording system shall be indicated by an audible and visual signal.

14.4.3.3 Means shall be provided to ensure accurate reading of indication on indicating instruments, having regard to lighting conditions at the point of their installation.

14.4.3.4 Indicating instruments shall be so designed that the operator will receive all necessary information directly, without the necessity of calculations in the units normally used for the measured variable.

14.5 Main Propulsion Control Systems

14.5.1 Main propulsion remote control system is to ensure the control within the whole scope under all operation conditions, including manoeuvres, number of revolutions of the propulsion engine, direction of the propeller thrust forces and the pitch of the propeller, if controllable pitch propeller is used.

14.5.2 Each remote or automation control station of the main propulsion system shall be equipped with the following instruments and devices:

.1 indicators of number of revolutions and direction of rotation of the propeller shaft;

.2 indicators of number of revolutions and direction of rotation of the main engine with the rated power 75 kW and above, when clutch coupling is used;
.3 alarm system annunciators and in particular, indicators informing about the conditions affecting the ship's manoeuvrability;
.4 indicators informing which station is in charge of control;
.5 switching-off device of the main engine safety system (if provided);
.6 indicators of starting air pressure;
.7 emergency shut-down device of the main engine, independent of the remote control system.

14.5.3 Where the main propulsion system incorporates a controllable pitch propeller, then, in addition to instruments and devices specified in 14.5.2, control station shall be provided with pitch position indicator.

14.5.4 The remote control system, whose operation is based on electric or electronic principle, shall be so designed as to give alarm in case of its failure.

14.5.5 Where several control stations of the main propulsion are provided, means shall be taken to prevent simultaneous control from more than one station. One of such control stations shall be superior with respect to other control stations. As a rule, the superior control station shall be located in the machinery space or in its vicinity.

14.5.6 The superior control station shall be capable of taking over the control at any time, as well as monitoring all important parameters of the propulsion system and associated installations, irrespective of which control station is actually in charge. The overtaking of control by the superior control station shall be indicated at least at the station previously in charge.

14.5.7 Transfer of control from one station to another shall be accompanied by audible and visual signals at both stations. Control from another control station shall be possible only after it has been acknowledged in a suitable form that the control was taken over.

14.5.8 It is recommended that the time of change-over from one control station to another, including local control station should not exceed 10 sec.

14.5.9 Transfer of control from one station to another shall be possible without the need to stop the main engine.

14.5.10 Where the main propulsion is controlled from the navigation bridge, control functions shall be limited to simple operations and control command shall generally be given by means of a single control element (lever, wheel, etc.). In the main propulsion systems with controllable pitch propeller or with reversing gear, arrangement with two control elements may be used, provided control system is so designed that an erroneous manoeuvre does not result in stopping the engine. Control of the main propulsion shall be separate for each propeller, with automatic performance of all auxiliary operations, including , where necessary, the protection against an overload of the main engine.

14.5.11 Where a programmed control system is used for starting (reversing) main propulsion, the sequence of operations shall not be time dependent only and the program shall also take into account, to the necessary degree, the operational parameters of the main engine auxiliary installations and the characteristics of the engine. Stoppage in the program performance shall be alarmed. A simultaneous indication of the place of interruption is recommended.

14.5.12 The automatic or remote control system shall be so designed that in the case of rapid change of commands following each other, the last command is always performed. The process of executing the command shall not depend on the speed with which the control element has been moved.

14.5.13 The automatic or remote control system of the main internal combustion engine shall so limit the number of the repeated automatic starting (reversing) attempts in the case of faulty first start (reverse) that the remaining quantity of starting energy (compressed air or electrical energy left in the battery) is sufficient to perform at least three starts of the engine from the local control station.

14.5.14 Failure to start the main internal combustion engine after the repeated automatic starting attempts shall be signalled at the control station.

14.5.15 Where the main internal combustion engine or its control system are not provided with means for limiting the developed torque, an alarm signal shall operate at each control station if the rated value of the torque has been exceeded.

14.5.16 It is recommended that the automatic or remote control system of the main internal combustion engine should be so designed as to preclude continuous operation of the engine within the barred speed range, if such necessity arises, e.g. due to torsional vibrations.

14.5.17 In multi-engine propulsion system, each propulsion engine (or a group of such engines) driving one propeller shall be provided with an independent remote control system.

14.5.18 It is recommended that the remote control system of two or more main propulsion engines driving one propeller should be so designed that the load equalisation of operating engines is automatic.

14.6 Electrical Power Supply and Distribution Control System

14.6.1 Where automatic control system of generating sets is fitted in which the stand-by power unit is started upon voltage decay or drop on the main switchboard busbars, the interruption in power supply shall not exceed 45 seconds. In such case the restarting of the essential machinery necessary to manoeuvre the ship shall be performed automatically and in a sequential order.

14.6.2 The automatic control system of generating sets shall be provided with an interlocking arrangement preventing the generating set from being automatically connected to the mains in the event of short-circuits on the main switchboard busbars.

14.6.3 Where there is no possibility of manual starting of internal combustion engines driving generating sets, the control system shall, in the case of failure of the first automatic or remote starting, so 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 receivers 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.

14.6.4 Failure to start the set shall be signalled by the alarm system.

14.7 Control Systems of Piping Installations

14.7.1 Power operated valves of piping systems controlled automatically or remotely shall be also provided with means for local manual control.

14.7.2 The valves, referred to in 14.7.1, shall be situated in places readily accessible for manual operation under all normal service conditions.

14.7.3 The control system of piping systems intended to be alternately used for different purposes (e.g. for ballast or fuel transfer) shall be fitted with such interlocking and protection arrangements as to comply with the relevant requirements for interconnection of such piping systems, set forth in *Part VI – Machinery and Piping Systems*.

14.7.4 Where the outlet valves from daily service fuel oil tanks are controlled by means of auxiliary power (pneumatic, electric, etc.), the valves shall be of such design as to remain open in case of power supply failure and be capable of being remotely closed from a position outside the machinery space by means of arrangements normally provided for this purpose.

15 ADDITIONAL REQUIREMENTS RELATING TO THE SCOPE OF AUTOMATION

15.1 General Requirements

15.1.1 The requirements of the present Chapter are based on the assumption that small sea-going ships are generally operated with machinery space not permanently attended and that the presence of personnel in such space is necessitated by periodical servicing, adjustments and minor repairs.

15.1.2 The scope of automation resulting from the provisions of the present Chapter is recommended for the form of machinery operation supervision specified in 15.1.1; however, the scope of the provisions application is not considered in the ship's symbol of class.

15.1.3 Where the provisions of the present Chapter are applied, the following shall be taken into account:

.1 the expected ship navigation area;
.2 the ship's size and main propulsion power;
.3 ship's designation;
.4 the number of the ship's crew and organization of work on board the ship.

15.2 Monitoring Systems

15.2.1 It is recommended that the scope and operation principles of monitoring systems should be in accordance with Table 15.2.1.

The use of automatic change-over of stand-by machinery, as required by Table 15.2.1, is advisable when the maintenance of the ship's manoeuvrability depends on the operation of that machinery.

15.2.2 The alarm system annunciators shall be so located that information about events of machinery faults can be permanently given at the navigation bridge control station. The requirements of the present paragraph may be complied with through:

.1 arranging group alarms on the navigation bridge and alarm annunciators giving detailed information in the machinery space;
.2 arranging all alarm annunciators giving detailed information about the cause of action on the navigation bridge.

15.2.3 Where group alarms are used to indicate alarm conditions on the navigation bridge according to 15.2.2.1, the alarm system on the bridge shall cover the following alarm groups, as applicable:

.1 alarm requesting to stop the main engine;

.2 alarm requesting the load reduction of the main engine;
.3 alarm to indicate that the safety system stopping the main engine has operated;
.4 alarm to indicate that the safety system reducing the main engine load has operated;
.5 alarm to indicate failure of the steering gear;
.6 alarm to indicate failure of automatic systems;
.7 alarm to indicate the excessive bilge water level in the machinery space;
.8 group covering all other alarms.

Table 15.2.1

Item	Machinery, installation or equipment	Parameters	Alarm system (monitored value of parameter)	Safety system	Remarks
1	**MAIN PROPULSION**				
1.1	Main internal combustion engine				
1.1.1	Lubricating oil installation	– lubricating oil pressure at inlet to engine (after filter)	minimum	first stage: start of stand-by pump; second stage: stop of engine	
		– lubricating oil 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 of cooling water at inlet	minimum	start of stand-by pump	for fresh and sea water
		– cooling water level in compensating tanks	minimum	–	
1.1.3	Fuel installation	– fuel level in service tanks	minimum	–	
1.1.4	Exhaust system	– temperature of exhaust gases	maximum	load reduction[1)]	on exhaust manifold after cylinders
1.2	Main gear	– lubricating oil pressure at inlet	minimum	start of stand-by pump	
		– temperature of lubricating oil at inlet	maximum	–	
1.3	Shaft line	– temperature of thrust bearing	maximum	–	
		– oil pressure in hydraulic coupling	minimum	–	only in the case of separate oil system
		– level in gravity tank of stern tube lubrication	minimum	–	

Item	Machinery, installation or equipment	Parameters	Alarm system (monitored value of parameter)	Safety system	Remarks
2	**ELECTRICAL INSTALLATION**				
2.1	Main switchboard	– voltage	minimum maximum	–	recommended
		– frequency	minimum maximum	–	recommended
2.2	Internal combustion engines driving electrical generators		engine failure	stop of engine	group alarm signal from safety system
2.3	Automation system		system failure	–	group alarm signal
3	**PIPING SYSTEMS**				
3.1	Bilge system	– level in bilge wells of machinery space	maximum	–	separate alarm signal on the bridge

1) The function of the safety system may be performed by the operator according to the alarm signal or need not be required if the exceeding of parameter does not cause critical condition for the engine.

15.2.4 Where the distance between the navigation bridge and accommodation spaces of the personnel responsible for machinery operation does not afford the reliable voice communication, other quick and efficient means of communication between the bridge and the spaces shall be provided.

15.2.5 Where provision has been made for periodic disconnection of alarm systems in the engine room, such state shall be indicated on the navigation bridge.

15.2.6 Where provision has been made for location of the repeaters of alarm system annunciators within accommodation spaces, it is recommended that the arrangement be such that switching-off the alarm signal (alarm acknowledgement) in the accommodation spaces will be also indicated on the navigation bridge.

15.3 Control Systems

15.3.1 It is recommended that automatic systems of temperature control should be used in the following installations:
– main engine lubricating oil,
– main engine cooling water,
– main gear lubricating oil.

The temperature control system shall be so chosen as to maintain the medium temperature within the required limits also during manoeuvring.

15.3.2 When using compressed air to start the main engine, it is recommended that automatic control system of compressors, capable of maintaining the necessary pressure in the receivers, should be provided.

16.3.2 Cables and conductors shall comply with the requirements of sub-chapter 16.1, *Part VIII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Sea-going Ships*.

16.3.3 The main switchboard shall be located in accordance with the requirements of paragraph 4.5.6.6, *Part VIII – Electrical Installations and Control Systems* of the *Rules for the Classification and Construction of Sea-going Ships*.

16.3.4 Passenger ships constructed or modified before 31 December 2005 engaged only on short domestic day trips are exempt from the requirement specified in paragraph 22.1.5.4 .1 in *Part VIII – Electric Installations and Control Systems*, of the *Rules for Classification and Construction of Sea-going Ships* where the orders and communications are possible to be delivered by voice or by VHF walkie-talkie.

16.4 Passenger Ships with Additional Mark "pas D"

16.4.1 Passenger ships to be assigned additional mark **pas D** in the symbol of class, in addition to compliance with the requirements of the present Part, shall comply with the below requirements:

.1 the ship shall be provided with the emergency source of electric power capable of supplying, for a period of 3 hours, the following consumers:
- emergency lighting;
- navigation lights;
- general alarm system;
- a loud master communicator and public address system (where more than 36 passengers are carried;
- fire detection system;
- the ship's daylight signalling lamp (applies to ships of 150 gross tonnage and upwards);
- the emergency bilge pump and fire pump – if provided;

.2 the capacity of the emergency source of electric power shall be sufficient to supply power to all consumers, whose simultaneous operation is necessary to ensure safety in case of emergency;

.3 the emergency lighting fixtures shall be installed in all places, where passengers and crew may assemble, at all passageways and communication routes, at the ship's control station, engine room, as well as at lifeboats and life rafts stations;

.4 the emergency source of electric power shall comply with the requirements specified in 16.4.2 – 16.4.4.

16.4.2 Where the emergency source of electric power is an accumulator battery, it shall:

.1 be capable of automatically connecting to the emergency switchboard busbars in the event of loss of voltage in the main network;

.2 operate without recharging and the voltage changes at its terminals within ± 12 per cent of the rated voltage throughout the discharge period

.3 be located in a room other than that in which the emergency switchboard is situated.

16.4.3 Where the emergency source of electric power is a generator with an independent prime motor, it shall be:

.1 driven by internal combustion engine equipped with its own fuel and cooling installations;

.2 capable of automatically starting in the event of loss of voltage in the main network and automatically connecting to the emergency switchboard busbars; the total time of starting and taking over the required load by the generator cannot exceed 30 seconds.

16.4.4 The emergency source of electric power and the emergency switchboard shall be situated behind the collision bulkhead, above the continuous deck and outside machinery spaces.

16.4.5 The emergency switchboard shall be installed as near as practicable to the emergency source of electric power.

16.4.6 Two separate general alarm systems shall be provided: for passengers and the crew. In well-justified cases PRS may give consent to installation of one common general alarm system.

16.4.7 The main switchboard shall be located in the same fire division in which generators are situated.

16.4.8 Marine type, non–combustible or fire–resistant cables and conductors shall be used.

16.4.9 Cables of the main and emergency lighting, as well as signalling installations shall not run through machinery spaces, galleys and other enclosed high risk spaces, except cases when other cable location is not possible.

16.4.10 Where electric power is necessary to restore propulsion from a dead ship condition, the emergency source of electric power shall have such capacity that the necessary propulsion starting energy is available within 30 min of blackout.

16.4.11 Passenger ships carrying passengers on open decks only may be assigned additional mark **pas D** in the symbol of class, having regard to service restrictions specified in *Certificate of Class* and subject to compliance with the following requirements:

.1 the emergency source of electric power shall supply through the emergency switchboard the following consumers:
- emergency lighting;
- navigation lights;
- general alarm system;
- public address system (where more than 36 passengers are carried);
- the ship's daylight signalling lamp (applies to ships of 150 gross tonnage and upwards);
- emergency bilge pump and fire pump – if installed;

.2 in the event of loss of emergency power supply to emergency lighting and navigation lights, the ship's sailing shall be limited to daytime;

.3 the emergency source of electric power shall be capable of supplying the consumers specified in 16.4.11.1, for a period of 1 hour;

.4 where the emergency source of electric power is an accumulator battery, it shall comply with the requirements of paragraph 16.4.2;

.5 the emergency source of electric power and the emergency switchboard shall be located behind the collision bulkhead, above the continuous deck and outside machinery spaces;

.6 where the emergency source of electric power is a generating set, the requirements for the generating set and its setting shall be agreed with PRS in each particular case;

.7 where the main lighting is supplied from accumulator batteries and the batteries are installed above the continuous deck, PRS may dispense with the emergency source of electric power.

17 ADDITIONAL REQUIREMENTS FOR SHIPS WITH NON-METALLIC HULL

17.1 In ships with non-metallic hull, electric power distribution system, referred to in 4.1.1.2.2, shall not be used.

17.2 Installation fittings in non-metallic enclosures shall be mounted on base plates made of non-combustible material.

17.3 Places, in which cables are installed, shall be protected against fire by suitable surface lining, coating or impregnation.

17.4 In ships with non-metallic hull, a metal plate with an area not less than 0.2 m^2 and the thickness not less than 2 mm shall be used as earthing. The plate shall be attached to the outer shell plating in a place ensuring its immersion in water under all sailing conditions.

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

17.6 In ships made of glass-reinforcement polyester (GRP) laminate, the application of the requirements regarding running and fastening of cables, as well as cables penetrations and compounds other than those stated in Chapter 13 is permitted if it results from the technology of hull construction, materials, etc. In each such case, the change in the requirements scope shall be agreed with PRS.

17.7 In ships with non-metallic hull, lightning conductors shall be run separately over the whole length. They shall not be connected to busbars and terminals of protective and system earthing.

17.8 In ships with non-metallic hull in which radio equipment is required, all cables within a radius of 9 m from antennas shall be screened or shall be otherwise protected from electromagnetic interferences.

18 ECOLOGICAL SHIPS – MARK: ECO AIR

18.1 Technical requirements for shore power supply systems are given in PRS Rule *Publication 106/P*.

19 INSULATION RESISTANCE OF CABLE NETWORK

19.1 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 shall not be less than that given in Table 19.1.

Table 19.1

Item	Circuit designation	Minimum insulation resistance [MΩ]	
		up to 24 V	24 to 500 V
1	Supply to lighting, communication and signalling installations	0.3	1.0
2	Supply to power consumers	1.0	1.0

19.2 During test, each circuit can be divided into any number of individual sections by means of switches installed in it, by withdrawing the fuses or by disconnecting the consumers.

20 TESTS

Prior to delivery/installation of the ship's new or reconstructed electrical installation, the appropriate tests shall be performed in accordance with the test programme agreed with PRS.

List of amendments effective as of 1 July 2023

Item	*Title/Subject*	*Source*
Page 2	Reference to Publication 100/P, added	PRS
16.1	Amendments related to the issuance of the new Publication 100/P	PRS
