Polski Rejestr Statków

RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

PART VIII

ELECTRICAL INSTALLATIONS AND CONTROL SYSTEMS

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GDAŃSK

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF 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 Subdivision
Part V – Fire Protection
Part VI – Machinery Installations and Refrigerating Plants
Part VII – Machinery, Boilers and Pressure Vessels
Part VIII – Electrical Installations and Control Systems
Part IX – Materials and Welding.

Part VIII – Electrical Installations and Control Systems, January 2015 was approved by the PRS Board on 24 November 2014 and enters into force on 1 January 2015.

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

For existing ships, the requirements of *Part VIII – Electrical Installations and Control Systems* are applicable within the scope specified in *Part I – Classification Regulations.*

The requirements of *Part VIII – Electrical Installations and Control Systems* are extended by the below-listed Publications:

Publication No. 9/P – Requirements for Computer Systems,
Publication No. 11/P – Environmental Tests on Marine Equipment,
Publication No. 15/P – Current Rating Tables for Cables, Wires and Busbars in Marine Installations,
Publication No. 35/P – One Man Bridge Operation (OMBO) Ships,
Publication No. 42/P – Testing of Electric Machines.
Publication No. 25/P – Technical Requirements for Shipboard Power Electronic Systems,
Publication No. 79/P – Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment,
Publication No. 106/P – ECO Class Rules
Publikacja Nr 5/I – Wytyczne do przeprowadzania okresowych przeglądów klasyfikacyjnych elektrycznych urządzeń przeciwwybuchowych na statkach w eksploatacji (available in Polish only),
Publikacja Nr 9/I – Materiały elektroizolacyjne (available in Polish only).

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1 GENERAL

1.1 Application

1.1.1 *Part VIII – Electrical Installations and Control Systems* applies to electrical installations and automatic systems in sea-going ships subject to PRS' survey, as well as to particular types of equipment, systems and their components in accordance with 1.3.

1.1.2 It is recommended that the relevant requirements of *Part VIII* should also cover electrical equipment installed on ships, not specified in 1.3.2 and 1.3.3.

1.1.3 In addition to the requirements of the present Part of the *Rules*, the electrical equipment is to comply with the requirements of the national or international standards indicated by PRS.

1.1.4 In reasonably justified cases, the requirements of the present Part of the *Rules* may be waived or extended by PRS, e.g.: in the case of innovatory solutions implementation.

1.2 Definitions

Definitions and explanations relating to the general terminology of the *Rules for the Classification and Construction of Sea-going Ships* (hereinafter referred to as the *Rules*) are given in *Part I – Classification Regulations.* Wherever, in *Part VIII*, definitions given in other Parts of the *Rules* are used, reference to these Parts is made.

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

Additional source of electric power – a source of electric power intended to supply the electrical equipment for domestic, living and technological applications only. Additional source of electric power with its distribution system and consumers is to be totally separated from all other ship's electric power systems.

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.

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

Dead ship condition – a condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power. The absence of power means the starting battery discharge, the absence of starting air needed for restoring the operation of the main propulsion plant, boilers and auxiliaries.

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

Emergency condition – a condition under which any services needed for normal operational and habitable conditions are not in working order due to failure of the main source of electric power.

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

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.

Emergency switchboard – a switchboard which, in the case of the loss of voltage in the main switchboard busbars, is directly supplied from emergency source of electric power or from transitional source of emergency electric power and is intended to distribute power to consumers which are necessary for maintain safety of the ship during emergency.

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

Fire-retardant insulating material – material satisfying the requirements specified in *Publication No. 11/P – Environmental Tests on Marine Equipment*.

Hazardous area – an area in which an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

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.

Low-rated electrical installation – a shipboard electrical installation with the total output of sources of electric power not exceeding 50 kW (kVA).

Machinery space – see sub-paragraph 1.2, *Part V – Fire Protection.*

Main generating station – a space where the main source of electrical power is situated.

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 – general term for alarm, safety and indicating systems.

Normal operational and habitable condition – a condition under which the ship as a whole, the machinery, services, means and aids ensuring propulsion, ability to steer, safe navigation, fire and flooding safety, internal and external communications and signals, means of escape, and emergency boat winches, as well as the designed comfortable conditions of habitability are in working order and functioning normally.

Passive-EM equipment – electrical equipment which, when used as intended, does not create or produce any switching or oscillation of current or voltage and is not affected by electromagnetic disturbances, e.g. cables, cables accessories; equipment containing only resistive loads without any automatic switching device; batteries and accumulators.

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 the machinery controlled 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.

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

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

Transitional source of emergency electric power – a source of electric power intended to supply all the essential consumers from the moment the loss of voltage occurs in the main switchboard busbars until the emergency generating set picks-up the load.

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

Uninterruptible Power System (UPS) – combination of converters, switches and energy storage means, e.g. batteries, constituting a power system for maintaining continuity of load power in case of input power failure.

Zones – hazardous areas are classified into zones based upon frequency of the occurrence and duration of an explosive atmosphere, as follows:

Zone 0 – a hazardous area in which an explosive gas atmosphere is present continuously or is present for long periods. In Zone 0, only the following explosion-proof electrical equipment may be installed:
- intrinsically safe apparatus (Exia);
- simple electrical apparatus (thermocouples, photocells, strain gauges, junction boxes, switching devices), not capable of storing or generating electrical power;
- electrical apparatus certified for use in Zone 0;
- submersible electrically-driven pumps, having at least two independent methods of shutting down automatically in the event of low liquid level.

Zone 1 – an area, in which an explosive gas atmosphere is likely to occur in normal operation. In Zone 1, the following explosion-proof electrical equipment may be installed:
- electrical equipment that may be considered for Zone 0;
- intrinsically safe apparatus (Exib), flameproof (Exd), pressurized (Exp), increased safety type (Exe), encapsulated (Exm), sand filled (Exq), oil-immersed apparatus (Exo), certified specially (Exs);
- hull fittings containing the terminals for anodes or electrodes of an impressed current cathodic protection or transducers (such as those for depth-sounding or log systems), provided that such fittings are of gastight construction or are housed within a gas tight enclosure and are not located adjacent to a cargo tank bulkhead;
- through runs of cables.

Zone 2 – an area in which an explosive gas atmosphere is not likely to occur in normal operation and if it does occur, it is likely to do so infrequently and will exist for a short period of time. In Zone 2, the following explosion-proof electrical equipment may be installed:
- any electrical equipment that may be considered for Zone 1;
- tested specially for Zone 2 (Exn);
- pressurized, accepted by PRS;
- having an enclosure filled with a liquid dielectric or encapsulated, accepted by PRS;
- the type which ensures the absence of sparks and arcs and of “hot spots” during its normal operation.

1.3 Scope of Survey

1.3.1 General

The general provisions relating to the classification procedure, survey during ship construction, manufacture of equipment and to surveys are given in *Part I – Classification 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 electrical propulsion plant;

.2 main and emergency, including transitional, sources of electric power;

.3 power and lighting transformers and electric power converters used in equipment listed in 1.3.2.1;
.4 distribution gear and control and monitoring panels;
.5 electric drives for:
- machinery essential for the operation of propulsion engines,
- steering gear and all devices for active steering of the ship,
- controllable pitch propellers,
- windlasses, mooring and towing winches,
- boat winches,
- starting air compressors and air compressors for sound signals,
- bilge and ballast pumps as well as cargo pumps on tankers;
- watertight doors and fire doors,
- pumps and compressors of the smothering system,
- ventilating fans in machinery spaces, cofferdams, cargo holds and hazardous rooms and spaces;

.6 main and emergency lighting of spaces and locations of essential machinery and means of escape;
.7 navigation lights and signalling lamps;
.8 electric engine-room telegraphs;
.9 internal service communication;
.10 general alarm system;
.11 fire detection signalling and warning system indicating the release of the fire extinguishing medium;
.12 watertight door and fire door signals;
.13 electrical equipment in hazardous rooms and spaces;
.14 cabling;
.15 earthing devices on oil tankers;
.16 lightning conductors;
.17 electric drives of classified refrigerating machinery;
.18 electrical heaters of fuel and lubricating oil;
.19 heating appliances and space heaters;
.20 main propulsion control system;
.21 main propulsion safety system;
.22 generating sets automatic control system;
.23 safety system of engines driving generating sets;
.24 automatic system of pumps and air compressors;
.25 automatic system of oil and fuel separators;
.26 remote or automatic control system of bilge, ballast, and fuel transfer installations;
.27 machinery alarm system;
.28 control system of steam boilers;
.29 system regulating temperature, pressure and viscosity;
.30 other machinery and facilities not listed above, as required by PRS.

1.3.2.2 PRS' classification survey on board the ship covers also all automatic systems which control or monitor machinery, equipment or installations subject to PRS' survey in accordance with the provisions of the present Part of the *Rules*.

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

1.3.3 Survey of Electrical Equipment Manufacture

1.3.3.1 The following items of electrical equipment intended for systems and devices, specified in 1.3.2.1, are subject to PRS' survey during manufacture:

.1 generating sets;
.2 generators and electric motors of rating 50 kW (kVA) and above;
.3 transformers above 20 kVA rating;
.4 switchboards;
.5 control and monitoring panels;
.6 electric couplings and brakes;
.7 switchgear, protection and control devices;
.8 apparatus and devices of internal communication and signalling;
.9 rotary converters and power-electronic equipment;
.10 fuel and oil heaters;
.11 accumulators;
.12 cables;
.13 heating appliances and space heaters;
.14 photoluminescent materials and electrically powered lights of low-location lighting;
.15 lamps of additional emergency lighting;
.16 automatic pilots;
.17 public address system and general alarm systems;
.18 computers and programmable logic controllers;
.19 sensors and transducers;
.20 automation system controllers;
.21 power operated valves;
.22 servo-motors;
.23 electric, hydraulic and pneumatic relays;
.24 data loggers (if they perform functions covered by the *Rules*);
.25 uninterruptible power system (UPS) units of 3 kVA and above;
.26 other items of electrical equipment not listed above, as required by PRS.

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

1.3.3.3 Test programme for electrical equipment will be specially considered by PRS in each particular case and the values of the relevant test parameters are given in Appendix 2.

1.4 Technical Documentation of a Ship

1.4.1 Classification Documentation of a Ship under Construction

1.4.1.1 Prior to the commencement of ship construction, documentation listed in 1.4.1.2 to 1.4.1.4, is to be submitted to the PRS Head Office for consideration and approval.

1.4.1.2 Classification documentation of electrical equipment:

.1 principle diagrams of power generation and distribution circuits of the main and emergency electric power sources: power circuits, lighting circuits (up to branch circuit board) and navigation light circuits;
.2 specification of data on the circuits with indication of current values, the applied protective devices, as well as the types and cross-sectional areas of cables;
.3 principle diagrams and a general view of the main and emergency switchboards, ship's navigation control and monitoring console and other devices of non-standard design;
.4 calculation results of electric power plant output necessary to provide operation of the ship in conditions specified in 3.1.6, as well as the basis for the choice of the number and output of generators and the calculation of power of electric power emergency sources;

.5 principle or detailed diagrams of main, excitation, control, monitoring, signalization, protection and interlocking circuits of the ship's electric propulsion plant machines;
.6 calculation results of the ship's electric propulsion plant generators output necessary to provide operation in all conditions;
.7 calculation results of short-circuit currents on the main switchboard busbars and in the other points of electric network – as the basis for the choice of switching and protecting apparatus of generators and consumers, as well as for checking electrodynamic and thermal loads to which apparatus, wiring and busbars of main switchboard and other distribution equipment are to correspond – together with the selection of protective devices;
.8 results of calculation of illumination intensity for important compartments and open locations for information;
.9 diagrams of internal communication and signalling;
.10 principle diagrams of essential electric drives according to 1.3.2.1.5;
.11 diagram of lubricating and air cooling systems of main propulsion el. motors;
.12 diagrams of protective earthing, drawings and if necessary, calculation of lightning conductors for tankers, gas carriers and combined ships;
.13 principle diagram of cable passages with indication of compartments through which they pass;
.14 results of capacity calculations of accumulator batteries supplying emergency lighting, navigation lights, general alarm and fire detection systems;
.15 data on electrical equipment in spaces where explosion hazard exists;
.16 diagrams of remote switching-off ventilation, fuel pumps and lubricating pumps;
.17 arrangement plans of main and emergency generators, main and emergency switchboards, accumulator batteries, equipment of explosion-proof execution.

1.4.1.3 When classed refrigerating installation is foreseen, documentation listed in 1.4.1.2 is to include data concerning electrical equipment of refrigerating installation.

1.4.1.4 Classification documentation of shipboard automated machinery:
.1 technical description including: specification of parameters covered by alarm, safety and automatic control systems, information concerning continuity of lubrication of cylinders and machinery of main engine, supply of fuel, steam, etc. and other means necessary for execution of unattended operation, as well as accepted method of repair and maintenance of particular units or elements of automatic systems, data concerning reliability of particular systems or their units;
.2 functional diagrams of particular automatic systems with regard to the respective equipment, machinery and installations, giving information concerning: method of supply, functional features, structure, eventual 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 such as desks, consoles, showing their elevation and arrangement of internal components, as well as their location on board the ship;
.4 in the case of applying computer systems for control or checking the machinery and installations, the above documentation is to be supplemented according to para. 1.4, *Publication No. 9/P – Requirements for Computer Systems*.

1.4.2 Workshop Documentation of a Ship under Construction

In the case of approval of the classification documentation listed in 1.4.1, the following workshop documentation is to be submitted to the relevant PRS Branch Office or Survey Station for agreement:
.1 drawings of cabling and cable fastening;
.2 diagrams of final circuits of emergency switchboard and emergency lighting;
.3 diagrams of final circuits of lighting switchboards;
.4 test programme for ship's electrical equipment and automated machinery carried out alongside the quay and at sea.

1.4.3 Classification Documentation of a Ship under Alteration or Reconstruction

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

1.4.3.2 Where new machinery or arrangements, covered by the requirements of the *Rules*, are installed, or machinery installed differs substantially from those initially fitted, additional documentation, within the scope required for a new ship, is to be submitted to the PRS Head Office (see 1.4.1).

1.5 Technical Documentation of Equipment

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

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

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

2 GENERAL REQUIREMENTS

2.1 Operating Conditions

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

2.1.1 Climatic Hazards

2.1.1.1 The temperature values, specified in Table 2.1.1.1, are to be taken as the rated ambient air and cooling water temperatures for electrical equipment. The use of electrical equipment for other temperature ranges is subject to special consideration by PRS in each particular case.

Table 2.1.1.1

Item	Location in the ship	Ambient air and cooling water temperature, [°C]			
		Unrestricted service		Service outside the tropic	
		Air	Water	Air	Water
1	Machinery spaces, special electrical spaces, galleys	from 0 to 45	30	from 0 to 40	25
2	Open decks and spaces	from –25 to 45	–	from –25 to 40	–
3	Other spaces	from 0 to 40	–	from 0 to 40	–

Notes:

1) For electrical machines located in machinery space, maximum air temperature equal to +50 °C is to be taken.
2) Electronic equipment and components intended to be installed in switchboards, desks and enclosures are to 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 is to 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 are to be made of materials resistant to sea air or reliably protected against its effects.

2.1.2 Mechanical Hazards

2.1.2.1 Electrical equipment is to be capable of correct operation at vibrations with a frequency of 2 Hz to 100 Hz, as follows:

– at a frequency from 2 Hz to 13.2 Hz with displacement amplitude ± 1.0 mm;
– at a frequency from 13.2 Hz to 100 Hz with acceleration amplitude ± 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 is to be capable of correct operation at vibrations with a frequency of 2 Hz to 100 Hz, as follows:

– at a frequency from 2 Hz to 25 Hz with displacement amplitude ± 1.6 mm;
– at a frequency from 25 Hz to 100 Hz with acceleration amplitude ± 4.0 g.

2.1.2.2 Electrical equipment is to 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 sec. or pitching up to 10°.

Emergency equipment is also to be capable of functioning reliably with the ship continuously inclined up to 22.5° transversely or up to 10° of trimming, or within the same limits both transversely and longitudinally.

2.1.2.3 Electrical equipment is to have adequate mechanical strength and is to be so located that it is not exposed to a risk of mechanical damage (see also 2.6.4).

2.1.3 Power Supply Parameters

2.1.3.1 Electrical equipment is to be so designed that it remains operative under steady conditions in all cases, at all deviations from the rated values of voltage and frequency specified in the Tables: Table 2.1.3.1-1 – for a.c. distribution systems, Table 2.1.3.1-2 – for d.c. distribution systems, Table 2.1.3.1-3 – for battery systems (see also 14.1.3.2 to 14.1.3.5).

Table 2.1.3.1-1

Voltage and frequency variations for a.c. distribution systems			
Parameters	Deviations from rated values		
	Prolonged	Transient	
		Value	Time
Voltage	+6%, –10%	±20%	1.5 sec
Frequency	±5%	±10%	5 sec

Table 2.1.3.1-2

Voltage variations for d.c. distribution systems	
Parameters	Variations
Voltage tolerance (continuous)	±10%
Voltage cyclic variation deviation	5%
Voltage ripple (a.c.r.m.s. over steady d.c. voltage)	10%

Table 2.1.3.1-3

Voltage variations for battery systems	
Systems	Variations
Components connected to the battery during charging (see Note)	+30%, –25%
Components not connected to the battery during charging	+20%, –25%
Note: Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.	

2.1.3.2 Where loads are supplied from a battery via an electronic converter or inverter, the maximum permitted d.c. voltage variations are to be taken as those on the load side of the converter or inverter. Where the d.c. is converted into a.c., the maximum variations are not to exceed those given in Table 2.1.3.1-1.

2.1.4 Electromagnetic Interference

2.1.4.1 Electrical and electronic shipborne equipment is to be resistant to the following interference:

.1 electrostatic discharge;
.2 radiated electromagnetic field;
.3 fast transient interference;
.4 conducted radio frequency interference;
.5 surge voltage immunity;
.6 conducted audio frequency interference.

The test parameters are specified in *Publication No. 11/P – Environmental Tests on Marine Equipment* and in IEC 60092-504.

2.1.4.2 Ship's electrical and electronic equipment is not to emit excessive electromagnetic, radiated and conducted interferences.

The test parameters are specified in *Publication No. 11/P – Environmental Tests on Marine Equipment* and in IEC 60092-504.

2.1.4.3 For the purpose of protecting the radio receiving equipment from electrical interference, the requirements given in the *SOLAS Convention* are to be satisfied (these requirements are also given in Chapter 4, *Part IV – Radio Equipment* of the *Rules for Statutory Survey of Sea-going Ships*).

2.1.4.4 Screens of power cables, metal coating and armouring of cables are to be earthed as often 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.

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

2.1.4.6 In all cases, the electrical continuity of all cable sheaths is to be provided, i.e. in cable junction and connecting boxes, as well as at the point of cable penetration 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 ship's metallic hull.

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

2.1.4.9 The screens and enclosures of electrical equipment placed on the navigation bridge are to be earthed.

The screens of cables and flexible cords are to be earthed in accordance with 2.4.3.5.

The screens and enclosures of passive-EM 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 It is recommended to use screened cables with pair or multipair twisted wires to increase their resistance to electromagnetic interference.

2.1.4.11 When installing electrical equipment and cables in the vicinity of magnetic compasses, the requirements given in the SOLAS Convention are to be satisfied (these requirements are also given in sub-chapter 4.2, *Part V – Navigational Equipment* of the *Rules for Statutory Survey of Sea-going Ships*).

2.1.4.12 Telephone cables and cables of other internal communication systems, except for the cables connecting separate telephone sets, as well as cables of electrical medical equipment capable of generating radio interference, are to be screened.

2.1.4.13 In ships constructed of non-current-carrying materials where radio equipment installation is required, all cables installed within the radius of 9 m from antenna are to be screened or are to be protected against interference by other means.

2.2 Materials

2.2.1 Construction Materials

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

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

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

.1 rheostat elements which are to 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 special consideration by PRS in each particular case.

2.2.2 Insulating Materials

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

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

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

2.2.2.3 The insulating materials to be used for winding insulation in machines, apparatus and other equipment for essential services are to be those specified in Table 3.1, Appendix 2. The use of insulating materials of at least Class E is recommended.

2.2.2.4 Conductors used in electrical devices for internal connections are to have insulation made of materials rated at least as hardly combustible. For apparatus with increased heating, as well as those specified in Chapter 15 – of incombustible materials.

2.2.2.5 Insulating materials used for manufacturing cables are to comply with the requirements given in 16.3.

2.2.3 Usage of materials that contain asbestos in installations (e.g. thermal insulating materials, electrical cable materials, cable penetration sealing, brake linings, circuit breakers arc chutes), including spare parts, is prohibited for all ships according to *SOLAS* Regulation II-1/3-5, IACS UI SC 249 as well as MSC.1/Circ.1374 and MSC.1/Circ.1379.

2.3 Design Requirements and Degrees of Enclosures Protection

2.3.1 General Requirements

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

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

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

Gaskets are to be secured to the covers or casings.

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

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

2.3.1.6 When oil, steam or water are led to the measuring instruments used in the control desk or in the switchboard, it is necessary to undertake the preventive measures in order 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, are to be in accordance with the operating voltage and operating conditions of the installation, the properties of the insulating materials used being taken into account.

2.3.3 Internal Connections

2.3.3.1 Stranded conductors are to be used for all the internal wiring in electrical equipment. The use of single-wire conductors is subject to special consideration by PRS in each particular case.

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

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

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

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

2.3.3.5 Insulated conductors are to be laid out and secured in such a manner that the method used for their attachment and arrangement does not lead to reduced insulation resistance and that they are not exposed to damage due to 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 is to be so effected that, under rated operating conditions, the insulation of conductors is not exposed to overheating.

2.3.4 Degrees of Enclosures Protection

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

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

Table 2.3.4.2

Item	Electrical equipment location (examples)	Conditions in equipment location	Design according to degree of protection
1	2	3	4
1 2 3 4 5 6 7	Ammonia plant rooms (refrigerating machinery) Accumulator battery rooms Lamp rooms Paint rooms Stores for welding-gas bottles Holds classified as explosion-hazardous Tunnels for pipes containing oil with a flash-point of 60 °C or below	Danger of explosion	Certified safe-type (see 2.8)
8 9	Dry accommodation spaces Dry control rooms	Danger of touching live parts only	IP20
10 11 12 13 14 15 16 17	Rooms on the bridge Engine and boiler rooms above floor Steering gear rooms Refrigerating machinery rooms (excluding ammonia plant) Emergency machinery rooms General store-rooms Pantries Provision rooms	Danger of dripping liquid and/or moderate mechanical damage	IP22
18	Bathrooms and showers	Increased danger of liquid occurrence and/or mechanical damage	IP34
19 20 21 22 23 24 25	Engine and boiler rooms below floor Closed fuel oil separator rooms Closed lubricating oil separator rooms Ballast pump-rooms Refrigerated rooms Galleys and laundries Machinery space area protected by local water-spraying fire-extinguishing system covering the areas A and B according to Fig. 2.3.4.2.	Increased danger of liquid occurrence and mechanical damage	IP44
26 27 28	Rooms intended for fish processing Shaft or pipe tunnels in double bottom Holds	Danger of liquid spraying, cargo dust presence, serious mechanical damage, aggressive fumes	IP55
29	Open decks	Danger of occurrence of liquids in large quantities	IP56

Notes:

1) Where the protection is not achieved by the equipment enclosure itself, other means or the location where it is installed shall ensure the degree of protection required in the Table.
2) For crude oil tankers, combined ships, ships intended or adapted for operation in the area of oil spillage – see 22.5.4.
3) The area protected by local water-spraying fire-extinguishing system is shown in Fig. 2.3.4.2.

A – a protected area – an area which is required to be protected by local water-spraying fire-extinguishing system

B – an area adjacent to a protected area, exposed to direct spray

C – an adjacent area, other than A and B areas, where water may extend.

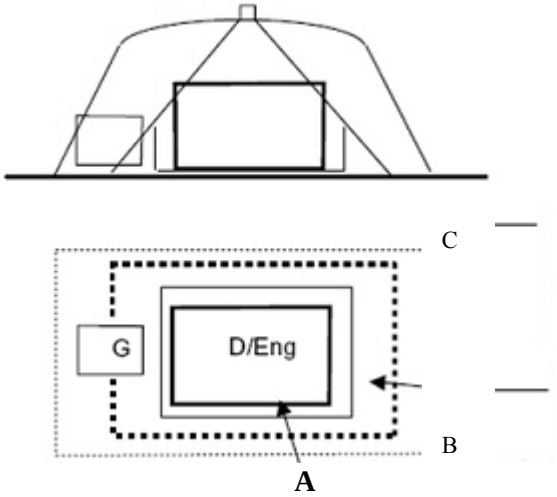


Fig. 2.3.4.2

4) In area C, according to Fig. 2.3.4.2, the electrical and electronic equipment may have a lower degree of protection than IP44, provided evidence of suitability for use in these areas is submitted, taking into account the design and equipment layout, e.g. the position of inlet ventilation openings. The cooling airflow for the equipment is to be ensured.

2.4 Earthing of Non-current-carrying Metal Parts

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

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

2.4.1 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) are to 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 safety voltage;

.2 electrical equipment provided with double or reinforced insulation;

.3 metal parts of electrical equipment fastened in an insulating material or passing through it 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 cages of specially insulated bearings;

.5 lamp bases, lamp holders and fasteners for luminescent lamps, lamp shades and reflectors, covers fastened to lamp holders or to lighting fixtures made of an insulating material or screwed into such a material;

.6 cable hangers and brackets;

.7 single sets of 250 V supplied by a separating transformer.

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

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

2.4.2 Earthing of Aluminium Superstructures in Steel Ships

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

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

2.4.3 Earthing Terminals and Earthing Wires

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

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

2.4.3.2 Fixed electrical equipment is to be earthed by means of external earthing wires or an earthing conductor in the feeding cable. If earthing is made by means of one of the cores of the feeding cable, the core is to be connected to the earthed part of the equipment inside its enclosure. Special earthing need not be provided if the fastening of equipment ensures reliable electrical contact between the equipment enclosure and the ship's hull under all operating conditions.

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

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

Table 2.4.3.2

Cross-section of cable connected to appliance, [mm^2]	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 is to be equal to the nominal section of the feeding cable core for cables up to 16 mm^2 and is to 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 is to be effected through the earthed jack of a socket outlet or other earthed connecting elements and through the earthed copper core of the feeding cable. Cross-section of the earthing core is not to be less than the nominal cross-section of the core in the flexible feeding cable for cables up to 16 mm^2 and at least half the cross-section of the core in the flexible feeding cable, but not less than 16 mm^2 for cables over 16 mm^2.

2.4.3.4 Earthing wires or earthing conductors of cables in fixed equipment are not to be disconnected.

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

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

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

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

The earthing is to be effected at both ends of a cable, except cables in final sub-circuits which are permitted to be earthed on the supply end only. Where the methods specified above cause failures in the

equipment operation, the screens, metal sheaths and armour of cables may be earthed by other approved means.

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

2.4.3.7 Cargo tanks and their process plant, including piping systems, are to have relevant connection with hull of the ship. Resistance between them and hull of the ship is not to be greater than 1 MΩ. In the case of lack of stable connection with the hull, bonding straps are to be used.

2.4.3.8 In the case of application of bonding straps, they are to be:
– clearly visible (in order to immediate verification of their failures);
– designed and installed in such way that they are protected against possible mechanical failures and corrosive atmosphere/products;
– easy for installation and replacement.

2.5 Lightning Protection

2.5.1 General Requirements

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

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

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

2.5.2 Spike

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

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

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

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

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

2.5.3 Lightning Conductor

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

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

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

2.5.4 Earthing

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

2.5.4.2 Provision is to be made for earthing the 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 are to be welded, clamped, riveted or bolted with clamps.

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

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

2.5.6 Earthing Installation

2.5.6.1 Separate metal structures, movable joints, pipelines, screens of the cable network, as well as their inlets to the explosion-hazardous spaces are to be earthed.

2.5.6.2 Pipelines for crude oil products, as well as other pipelines related to the explosion-hazardous spaces and located on open decks or in spaces without electromagnetic shielding are to be earthed to the hull at distances not more than 10 m.

Pipelines located on the deck on which explosive gases may occur, but not related to the explosion-hazardous spaces, may be earthed to the ship's hull at every 30 m.

2.5.6.3 Metal parts located near the lightning conductors are to be earthed if they are not fixed on the earthed structures or if they are not metallically connected in any other way to the ship's hull.

Devices or metal parts located at a distance not more than 200 mm from the earthing conductors are to be connected to the latter in such a way as to preclude the possibility of secondary sparking.

2.5.6.4 All connections in the earthing installation are to be accessible for control and protected against mechanical damages.

2.6 Arrangement of Equipment

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

2.6.2 The horizontal-shaft electric machines are to be so installed that the shaft is situated parallel to the fore-and-aft plane of the ship. Placing 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 is to be so located that cooling air is not drawn in from bilges or other spaces in which the air may be contaminated with substances having a harmful effect on insulation.

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

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

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

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

2.7 Special Electrical Spaces

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

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

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

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

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

2.8 Electrical Equipment in Hazardous Spaces

2.8.1 The requirements of the present sub-chapter apply to electrical equipment installed on all ships where in enclosed and semi-enclosed rooms and spaces explosive mixtures of vapour, gases and dust with air may accumulate – specified in items 1 to 7 of Table 2.3.4.2.

Additional requirements for the installation of electrical equipment in crude oil tankers, combined ships, ships intended or adapted for operation in the area of oil spillage are given in 22.5, whereas the requirements for the installation of electrical equipment in ships having holds and other spaces for carrying vehicles with fuel in their tanks, as well as tank cars and tank trucks carrying cargoes subject to explosion hazards are given in 22.3.

2.8.2 The electrical installations in hazardous spaces and rooms are to be made in accordance with IEC Publication 60092-506.

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

The installation of electrical equipment in paint stores and spaces leading to paint stores is to comply with the requirements given in 2.8.3 to 2.8.5.

The installation of electrical equipment in accumulator battery rooms is to comply with the requirements given in 13.6.

The installation of echo depth sounder oscillators and their cables is to comply with the requirements given in the SOLAS Convention (these requirements are also given in 4.2.4, *Part V – Navigational Equipment* of the *Rules for Statutory Survey of Sea-going Ships*).

2.8.3 Electrical equipment may be installed in paint stores and their ventilation ducts in such case only when it is essential for operational services.

Only the following explosion-proof electrical equipment is allowed to be installed: intrinsically safe type (Exi), with flameproof enclosure (Exd), with pressurized enclosure (Exp), increased safety type (Exe), with special enclosure (Exs).

This equipment is to be intended for the ignition group of mixtures of at least II B and temperature class of at least T3.

Switchgear, protective and control devices for electrical equipment installed in paint stores are to switch off all poles and phases. Such devices are recommended to be installed in non-hazardous spaces.

2.8.4 In spaces on open deck at the distance up to 1 m from input openings of paint stores ventilation ducts or to 3 m from output openings of mechanical ventilation, the following electrical equipment is allowed to be installed:
– electrical equipment of explosion-proof construction allowed for paint stores (see 2.8.3),
– equipment with enclosure Exn,
– equipment which does not generate arc during operation and whose surface does not reach unacceptably high temperature,
– equipment with simplified pressurized enclosure or enclosure resistant to vapour (degree of enclosure protection at least IP55) which surface does not reach unacceptably high temperature,
– cables.

2.8.5 Adjacent spaces having exit to paint stores may be considered as non-hazardous spaces, provided that:
doors to the paint stores are gastight, self-closing type without holders,
– in the paint stores an independent, natural ventilation system from non-hazardous space is provided,
– at the entrance to the paint stores a warning inscription is placed indicating that there are flammable liquids in the store.

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

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

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

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

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

2.8.9 Fastening of electrical equipment to the walls of tanks intended for flammable liquids is not permitted. The distance between electrical equipment and the tank walls is in no case to be less than 75 mm.

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

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

.1 interruption in operation of a ventilation system gives an alarm signal (audible and visual) and switches off the power supply to electrical equipment (with a time delay, if necessary);

.2 interlocking device is provided to ensure that electrical equipment cannot be switched on until the room is ventilated enough (air in the room is to be changed at least 10 times).

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

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

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

Cables passing through the above-mentioned rooms and spaces may be installed, provided the requirements given in 2.8.13 to 2.8.17 are met.

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

.1 metal armour or braid with non-metallic covering; or

.2 lead sheath plus further mechanical protection; or

.3 copper or stainless steel sheath (for mineral insulated cables only).

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

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

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

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

3 MAIN SOURCE OF ELECTRIC POWER

3.1 General Requirements

3.1.1 Each ship is to be provided with main source of electric power of sufficient capacity to supply all essential services of the ship in conditions specified in 3.1.6. The main source of electric power is to consist of at least two generators with an independent prime mover.

In ships of 300 tons gross tonnage and downward (except passenger ships), accumulator battery may be used as main source of power.

The main generating station is to be situated within the machinery space, i.e. within the extreme main transverse watertight bulkheads. Any bulkhead between the extreme main transverse watertight bulkheads is not regarded as separating the equipment in the main generating station, provided there is access between the spaces.

3.1.2 The number and the capacity of the generating sets and power converters composing the main source of electric power are to be such that in the event of any one generating set or power converter being stopped, it will still be possible to:

.1 supply the essential services, mentioned in 3.1.6, maintaining the minimum comfortable conditions of habitability;

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

.3 supply the electrical services necessary to start the main propulsion plant.

3.1.3 The emergency source of electric power may be used for starting the engine-room machinery operation from a dead ship condition if its capability either alone or combined with that of any other source of electric power is sufficient to provide at the same time the services required in 9.3.1 to 9.3.3 or 22.1.2.1 to 22.1.2.3 (see also para. 1.8.4, *Part VI – Machinery Installations and Refrigerating Plants*).

3.1.4 If only electric power is used for starting the main propulsion plant operation from a dead ship condition and if emergency source of electric power cannot be used for this purpose, then the generating set used for starting the main propulsion plant from a dead ship condition is to be provided with starting arrangements at least equivalent to those required for starting the emergency generating set.

3.1.5 Shaft generator may be used instead of one of the generating sets mentioned in 3.1.1, provided it complies with the requirements of 3.2.3.1 and additionally:

.1 the shaft generator runs with a constant rotary speed at variable rotational speed of the main engine or propeller shaft;

.2 there is a possibility of starting the ship's main engine in the event of failure of any of the generating sets;

.3 there is a possibility of the shaft generator operating even when the vessel is stopped.

The use of shaft generators, running with a variable rotary speed depending on the ship's main engine or propeller shaft, which constitute the main source of electric power, will be specially considered by PRS.

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

.1 running conditions;

.2 manoeuvring;

.3 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 assignment.

3.1.7 Each hull of the catamaran is to be provided with at least one generating set.

3.1.8 If the main source of electric power are accumulator batteries, their capacity is to be sufficient to satisfy the requirements given in 3.1.2.1 for 8 hours without recharging.

3.1.9 In ships of restricted service **III** (except passenger ships) with a low-rated electrical installation, one generating set or accumulator batteries may be used as the main source of electric power.

3.1.10 Relevant parameters of sources and consumers of electrical power are to be presented in order to make necessary calculations for preparation of *Ship Energy Efficiency Management Plan* (SEEMP).

3.2 Electric Generating Sets

3.2.1 General Requirements

3.2.1.1 Engines designed for use as generator prime movers are to comply with the requirements given in Chapter 2, *Part VII – Machinery, Boilers and Pressure Vessels* and additionally with the requirements of the present sub-chapter.

3.2.1.2 Generating sets are to be designed for continuous duty, taking into account the power drop of the prime movers during the operation of the ship under the conditions specified in 2.1.1.1.

3.2.1.3 In the event of short-circuit in the ship's network, the generators are to be capable of maintaining the design short-circuit current of the value sufficient for the operation of protective devices.

3.2.1.4 Generators of the generating sets are to be provided with voltage regulation within the limits specified in 10.6 and 10.7, as well as with frequency regulation within the limits specified in 2.1.3.1.

3.2.1.5 For alternating current generators, the difference between the actual value of voltage curve and the corresponding value of the 1st harmonic is not to exceed 5 per cent of the 1st harmonic peak value.

3.2.2 Load Sharing between Generating Sets Running in Parallel

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

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

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

3.2.2.3 Where alternating-current generators are run in parallel at 20 to 100 per cent of rated load, the admissible current variations are to be within ± 15 per cent of the rated current value of the largest generator.

3.2.2.4 The speed governor characteristics of prime movers used to drive direct-current generators are to be such that in parallel operation the load on individual generators is shared, as far as possible, in proportion to the output of each generator.

At loads within 20 to 100 per cent of the rated value, the load on individual generators is not to differ from the proportional output of a particular generator by more than 12 per cent of the output of the largest, or by more than 20 per cent of the smallest of the generators run in parallel. For generators of equal size, the load on any generator is not to vary from the value proportional to their output by more than 10 per cent of rated output.

3.2.3 Shaft Generators

3.2.3.1 Shaft generators used as main source of electric power for shipboard electrical network are to be provided with devices for voltage regulation within the limits specified in 10.6 and 10.7 and for frequency regulation within the limits specified in 2.1.3.1.

In the event of the network frequency drop below the permissible value, provision is to be made for automatic switching on one or more generators with an independent drive, or actuation of alarm system in the engine room or central control platform.

3.2.3.2 The use of shaft generators designed to supply individual consumers with voltage and frequency parameters different from those specified in 3.2.3.1 will be specially considered by PRS in each particular case.

3.2.3.3 Shaft generators with semiconductor converters directly supplying the shipboard network are to be so designed that they cannot be damaged in case of a short-circuit on the main switchboard busbars. The determined value of the short-circuit current is to be sufficient for actuation of automatic protective devices.

3.2.3.4 Shaft generators are to be designed for at least short-time operation in parallel with generating sets with an independent drive for the purpose of manual or automatic picking-up of load.

3.2.3.5 For alternating-current shaft generators, automatic devices preventing current overloads of elements of the generator excitation systems operating with a speed less than 95 per cent of the rated speed, are to be provided. It is permitted that the voltage of the shaft generator terminals be suitably reduced.

3.2.3.6 The main switchboard is to be provided with de-exciters assigned for each shaft generator, as well as with measuring instruments according to 4.5.4.3 or 4.5.4.4.

3.2.3.7 When shaft generators connect to the ship's network, visual signalling is to automatically switch on warning on the navigation bridge that a change of the rotational speed of the main propulsion may result in a change of the ship's network parameters exceeding the limits specified in 10.6, 10.7 and 2.1.3.1.

3.2.3.8 In systems with shaft generators with semiconductor converters, generators with an independent drive may be used as reactive load compensators.

3.2.3.9 Generators and generator systems, having the ship's propulsion machinery as their prime mover, but not forming part of the ship's main source of electrical power, may be used whilst the ship is at sea to supply electrical services required for normal operational and habitable conditions, provided that:

- **.1** there are fitted sufficient and adequately rated additional generators which constitute the main source of electrical power, meeting the requirements specified in 3.1.1;
- **.2** within the declared operating range of the generators and/or generator systems, voltage and frequency variations meet the requirements of 10.6.2 and 2.1.3.1, respectively;
- **.3** arrangements are fitted to automatically start one or more of the generators, constituting the main source of electrical power in the event of power drop and also upon the frequency variations exceeding by ± 10% the limits specified in 2;
- **.4** the short-circuit current of the generator and/or generator system is sufficient to trip the generator / generator system circuit-breaker taking into account the selectivity of the distribution system protective devices;
- **.5** where considered appropriate, load shedding arrangements are fitted to meet the requirements specified in 8.2.3;
- **.6** on ships having remote control of the ship's propulsion machinery from the navigation bridge means are provided, or procedures are in place, so as to ensure that supplies to the essential services are maintained during manoeuvring conditions in order to avoid a blackout situation.

3.3 Number and Power of Transformers

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

Where sectionalised busbars are used in the main switchboard, the transformers are to be connected to different sections of the busbars.

In ships of restricted service **III** and in ships of restricted service **II** with a low-rated electrical installation (other than passenger ships), only one transformer may be provided.

3.4 Power Supply from an External Source of Electric Power

3.4.1 If provision has been made for the ship's network to be supplied from an external source of electric power, a terminal for power supply from an external source of electric power is to be installed in the ship. The circuit supplied by an external electric power source is to comply with the requirements specified in 4.5.4.7.

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

In ships with a low-rated 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.

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

- **.1** suitable clamps to connect flexible cables;
- **.2** switchgear and protective devices for connection and protection of the cable supplying the main switchboard; where the length of the cable between the main switchboard and the terminal is less than 10 m, the terminal need not be provided with protection;
- **.3** a voltmeter or signal lamps to show the presence of voltage on terminals;
- **.4** a device or a possibility of connecting a device for checking the polarity and the phase sequence;
- **.5** clamps for earthing the neutral run from the external source;
- **.6** a plate indicating voltage level, kind of current and frequency;
- **.7** at the external supply terminal or nearby, a device for mechanical fastening of the flexible cable led to the terminal and cable hangers are to be provided.

3.5 Connection of Supply Sources

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

3.5.2 Compound-wound generators designed for parallel operation are to have equalizing connections.

3.5.3 Where alternating-current generators are intended to operate in parallel, a synchronizer is to be installed in the main switchboard.

Where synchronizing is arranged to operate automatically, a stand-by manual synchronizer is to be provided.

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

3.5.4 Where several direct-current generators are installed, a field initiating device is to be installed in the main switchboard. Such a device is also to be used in the case of a.c. synchronous generators if it is necessary for field initiation.

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

3.5.6 Where the main source of electrical power is necessary for propulsion of the ship or where the total output of generators running in parallel is over 1000 kW (kVA), the main switchboard busbars are to be subdivided into at least two parts, which should normally be connected by circuit breakers, switches, isolating switches or other means approved by PRS.

As far as practicable, generators and electrical power consumers which are duplicated are to be equally divided between the parts.

3.5.7 Sectionalisation of the main switchboard busbars for supplying the electrical equipment in each hull of the catamaran is to be provided.

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 1000 V alternating current:
.1.1 three-phase three-wire insulated system;
.1.2 three-phase three-wire system with neutral earthed;
.2 in addition, for voltages up to 500 V alternating current:
.2.1 three-phase four-wire system with neutral earthed but without hull return;
.2.2 single-phase two-wire insulated system;
.2.3 single-phase two-wire system with one wire earthed;
.3 for direct current:
.3.1 two-wire insulated system;
.3.2 single-wire system with hull return, for voltages of up to 50 V only, under the following conditions:
- in ships of gross tonnage less than 1600 (RT),
- in ships of gross tonnage 1600 (RT) and above in restricted and locally earthed systems (e.g. in the starting system of internal combustion engines);

.3.3 two-wire system with one pole earthed;
.3.4 three-wire system with neutral earthed.

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

4.2 Permissible Voltages

4.2.1 The voltages across the terminals of the sources of electric power, at the frequency of 50 Hz and 60 Hz, depending on the applied distribution systems, are given in 4.1.1.

Additional requirements for electrical equipment with the rated voltage higher than 1000 V are specified in Chapter 18.

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

4.2.3 The rated voltages across the terminals of direct current-consuming appliances are not to exceed the values given in Table 4.2.3.

Table 4.2.2

Item	Type of consumers	Permissible voltage, [V]
1	Stationary power consumers, heating, cooking and space heating appliances permanently installed in spaces other than those specified in item 2	1000
2	Portable socket-outlet supplying power consumers, fixed permanently when used; control circuits, heating and space heating appliances in cabins and passenger spaces (see 15.2.5)	500
3	Lighting, signalling and internal communication, socket-outlets for supplying portable equipment with reinforced or double insulation, or separated by means of selective transformer	250
4	Socket-outlets installed in spaces with increased humidity or in extra humid spaces intended for supplying equipment without reinforced or double insulation	50

Table 4.2.3

Item	Type of consumers	Permissible voltage [V]
1	Power consumers	500
2	Cooking, heating appliances, etc.	250
3	Lighting, socket-outlets[1]	250

[*] Inscriptions indicating the necessity of using the appliances only with double or reinforced insulation or appliances separated from the voltage exceeding the safety voltage are to be provided near socket-outlets for a voltage exceeding the safety voltage, installed in spaces with increased humidity or in extra humid spaces.

4.3 Power Supply to Essential Services

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

.1 steering gear electric drives (see also 5.5.2);
.2 electric drives of main propulsion plant excitation units;
.3 electric drives of machinery ensuring the operation of the main propulsion;
.4 electric drives of machinery ensuring the operation of the generating sets constituting the main source of electric power;
.5 electric drives of machinery ensuring the operation of the controllable pitch propellers;
.6 switchboards of the ship's control and monitoring desk (see also 4.4);
.7 windlass electric drives (see also 4.3.3);
.8 fire pump electric drives;
.9 bilge pump electric drives;
.10 gyrocompasses;
.11 electric drives of compressors and sprinkler system pumps;
.12 switchboard of cargo hold refrigerating installations;
.13 section switchboards of the main lighting;
.14 switchboards of radio communication equipment;
.15 navigational equipment switchboards;
.16 switchboards of navigation lights;
.17 section switchboards of other essential services concentrated in accordance with similar function performed;
.18 switchboards of automatic gear of fire detection alarm system;
.19 switchboards for supplying the mooring equipment, cargo handling gear, boat winches, ventilation and heating appliances;
.20 chargers of starting batteries and of batteries supplying essential services;
.21 switchboards supplying electric drives of watertight door closing appliances and of appliances keeping the fire doors open, as well as switchboards of signals indicating the position and closing of watertight and fire doors;
.22 switchboards of cargo refrigerating installation of low pressure carbon dioxide fire-extinguishing system;
.23 switchboards for lighting the air-sheds and those of the signalling lights for helicopter landing fields;
.24 other consumers which will be specially considered by PRS in each particular case.

The consumers specified in .3, .5, .9, .10, .14, .15, .16, .18, .21 may be supplied from switchboards specified in .6 and .17 by separate circuits equipped with switchgear and protective devices.

4.3.2 When two or more devices of the same purpose as that of electric drives specified in 4.3.1 are fitted, except those indicated in 4.3.1.1, 4.3.1.2 and 4.3.1.11, at least one of the drives of these devices is to be supplied by a separate feeder from the main switchboard. The electric drives of other devices of this kind may be supplied from section switchboards or special switchboards intended for supplying essential services.

4.3.3 When the main switchboards busbars are sectionalized and provided with means for isolating the sections, then the electric drives, section switchboards, special distribution boards or panels, if they are doubled or supplied by two feeders, are to be connected to two different main switchboard busbar sections.

4.3.4 In cargo ships of restricted service **II** and **III** and in some cases, upon special agreement with PRS, in cargo ships of other areas of navigation, the windlass may be supplied from the cargo winch switchboard or any other switchboard, provided its power supply is taken directly from the main switchboard and a suitable protection is fitted.

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

4.3.6 Power supply to automation systems is to comply with the requirements given in 20.3.

4.3.7 Where the main source of electrical power is necessary for propulsion and steering of the ship, the system is to be so arranged that the electrical power supply to the equipment necessary for propulsion and steering and to ensure safety of the ship will be maintained or immediately restored in the case of loss of any one of the generators in service.

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 is to be supplied by separate feeders.

4.4.2 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 4.4.3 to 4.4.7 are met (see also 9.4.3).

4.4.3 The switchboards of control and monitoring console are to be supplied from the main switchboard directly or through a transformer by two independent feeders connected to different sections of the main switchboard busbars (where sectionalized busbars are used) or are to be supplied by one feeder from the main switchboard and by one feeder from the emergency switchboard if the generating set is the emergency source of energy.

4.4.4 In addition, the switchboards of control and monitoring console are to be independently supplied by a separate feeder from other source or sources of power, if necessary, basing on the requirements for the equipment fed from these switchboards or on any other technical reasons.

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

4.4.6 Each consumer specified in 4.3.1, supplied from the switchboard of control and monitoring console, is to be supplied by a separate feeder (see also 9.4.3).

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

4.4.8 The ship' navigation control and monitoring consoles are to be provided with a means to check the functioning of test lamps, e.g. "lamp test" button.

4.5 Distribution Switchboards

4.5.1 Switchboard Constructions

4.5.1.1 The frames, front panels and casings of switchboards are to be made of metal or some other incombustible material. The generator panels of the main switchboards are to be separated by barriers made of incombustible materials.

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

4.5.1.3 Switchboards are to be at least protected from drip. This protection is not required if the switchboards are to be located in spaces where the conditions are such that no vertically falling drops of liquid can get into the switchboard (see 4.5.6.2).

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

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

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

4.5.1.6 Main, emergency and section switchboards and control desks are to be provided with handrails fitted on their front side. Switchboards accessible from the rear are to be provided with horizontal handrails fitted at the back.

The handrails may be made of insulating material, wood or earthed metal covered with a suitable insulating material.

Near the main and emergency switchboards of rating 50 V and above, floors are to be covered with non-conducting mats or gratings at the front and rear of the switchboards.

4.5.1.7 The generator panels of main switchboards are to be provided with lighting fittings supplied on the side of the generator, but before its main circuit-breaker or from at least two different sections of busbars through selector switch where sectionalised busbars are used in accordance with 3.5.6.

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

4.5.1.9 The design of wall switchboards is to be such as to provide access to parts which require attendance. The switchboard doors are to be locked in the open position.

It is recommended that withdrawable blocks and panels with apparatus were provided with mechanical devices setting their position during operation, during testing (control circuit connected), as well as when disconnected (main circuits and control circuits disconnected). Drawing-out or drawing-in of block or panel from operating position is to be possible only when switching device is open.

4.5.2 Busbars and Bare Conductors

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

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

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

4.5.2.4 Busbars and bare conductors in switchboard are to have adequate electrodynamic and thermal strength to withstand the passage of short-circuit currents occurring at relevant points in the circuit.

Such electrodynamic loads as occur in busbars and bare conductors due to short-circuit are to be determined in accordance with the relevant standards.

4.5.2.5 Insulators and other insulating elements designed to support busbars and bare conductors are to be capable of withstanding the loads caused by short-circuits.

4.5.2.6 The natural frequency of copper busbars is to be outside the ranges of 40 to 60 Hz and 90 to 110 Hz when the rated frequency is 50 Hz and outside the ranges of 50 to 70 Hz and 110 to 130 Hz when the rated frequency is 60 Hz.

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

.1 red for the positive pole;

.2 blue for the negative pole;

.3 black or yellow and green transverse bands for earth connections;
.4 light-blue for the middle wire.

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

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

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

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

4.5.3 Selection of Apparatus and Short-circuit Currents Calculation

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

Short-circuit protective equipment is to conform to specific conditions of the ship's electrical network and in particular:

– power factor at short-circuit in alternating current networks,
– sub-transient and transient components of short-circuit current.

The following cases of the short-circuits are to be taken into consideration:

– on the generator side,
– on the busbars of the main switchboard,
– on the busbars of the emergency switchboard,
– on the consumers and switchboards supplied directly from the main switchboard.

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

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

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

4.5.3.4 The rated electrodynamic strength of an electrical apparatus not intended for breaking the short-circuit currents is not to be less than the prospective peak short-circuit current at the point of its installation.

4.5.3.5 The rated thermal strength of an apparatus is to be in accordance with the prospective short-circuit current at the point of its installation, as well as with the prospective duration of short-circuits based on the discriminative action of the protection.

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

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

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

4.5.3.9 When calculating the anticipated short-circuit current, the equivalent impedance of the arrangement on the damage side is to be taken into account. The source of current is to include all the generators which may be connected in parallel and all the motors running simultaneously. Currents induced by generators and motors are to be calculated according to IEC 61363-1 standard.

According to the above mentioned standard for alternating-current motors, the following effective values are to be taken:

– big motors (power above 100 kW):

$I''_M = 6.25\ I_{rM}$

$I_{acM} = 4I_{rM}$, t = T/2

$I_{pM} = 10I_{rM,}$

– small motors:

$I''_M = 5I_{rM}$

$I_{acM} = 3.2I_{rM}$, t = T/2

$I_{pM} = 8I_{rM}$

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

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

4.5.4 Arrangement of Apparatuses and Measuring Instruments

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

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

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

The above-mentioned requirements do not refer to the case when switchgear and measuring instruments for several generators are grouped in the central control console of main switchboard or in the central control desk.

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

4.5.4.4 The following instruments are to be installed on the main switchboard for each alternator and on the emergency switchboard for the emergency set:

.1 an ammeter with a selector switch for current measurements in each phase;

.2 a voltmeter with a selector switch for measuring phase or line voltages;

.3 a frequency indicator (as regards generators operating in parallel, a twin frequency indicator with a selector switch for each generator may be used);

.4 a wattmeter (for outputs in excess of 50 kVA).

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

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

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

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

.1 a switchgear and a protective device;

.2 a voltmeter or indicating lamps.

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

Earth current flowing to the ship's hull, induced by insulation resistance measuring device is not to exceed in any conditions 30 mA. Visual and audible alarms are to be provided to indicate an inadmissible insulation resistance drop in the ship's electrical network.

In ships with unattended machinery space, such signals are to be provided also in the central control station.

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

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

.1 for voltmeters – 120 per cent of the rated voltage;

.2 for ammeters associated with generators not operated in parallel and with current consumers – 130 per cent of the rated current;

.3 for ammeters associated with parallel-operated generators – 130 per cent of the rated current for load-current scale and 15 per cent of the rated current for reverse-current scale; (the last requirement applies to d.c. generators only);

.4 for wattmeters associated with generators not operated in parallel – 130 per cent of the rated output;

.5 for wattmeters associated with generators operated in parallel – 130 per cent for power scale and 15 per cent for reverse power scale;

.6 for frequency indicators – ± 10 per cent of the rated frequency.

The above given scale limits may be changed upon agreement with PRS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.5.5 Visual Signals

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

Table 4.5.5.1

Item	Colour	Meaning	Type of signal	Equipment usage
1	Red	Danger	Blinking	Alarm in dangerous situations calling for immediate intervention
			Permanent	General alarm in dangerous situations, as well as in dangerous situations detected but not yet eliminated
2	Yellow	Attention	Blinking	Abnormal situations, but not requiring immediate intervention
			Permanent	Situations intermediate between abnormal and safe. Abnormal situations detected, but not yet eliminated
3	Green	Safety	Blinking	Indication that a stand-by unit is put into service
			Permanent	Normal operating conditions, normal functioning
4	Blue	Instructions and information	Permanent	Units and devices ready to be started. Circuit energized. All in order
5	White	General information	Permanent	Signals used when required. Notations relating to automatic action. Other additional signals

4.5.5.2 The use of visual signals other than those specified in Table 4.5.5.1 (for example, letter codes) will be specially considered by PRS in each particular case.

4.5.6 Arrangement of Switchboards

4.5.6.1 The main switchboards and section boards having open live parts on the rear side, installed along the ship's side below the load waterline, are to be protected from water with special metal shields or by means of any other equivalent measures.

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

4.5.6.3 If switchboards with the degree of protection IP10 and lower are located in a special space, cabinet or recess, such spaces are to be made of non-combustible material or are to have a lining of such material. If the switchboards are located in a space having a deck area of less than 4 m^2, such space is treated as space of category (5) – see sub-chapter 2.2.2, *Part V – Fire Protection.*

4.5.6.4 The arrangement of pipelines and tanks near the electrical equipment is to conform to the requirements given in paras. 1.16.11.11, 1.16.11.14, 1.16.11.16 and 1.16.11.17, *Part VI – Machinery Installations and Refrigerating Plants.*

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

4.5.6.6 The main switchboard is to be located as close as practicable to the main generating station, within the same machinery space and the same vertical and horizontal fire boundaries. Where essential services for steering and propulsion are supplied from section boards, these and any transformers, converters and similar appliances constituting an essential part of electrical supply system are also to satisfy the above requirement.

4.5.6.7 In catamarans, the main switchboard is to be installed in each hull.

It is permitted to install one main switchboard provided that it is situated above bulkhead deck.

4.5.7 Access to Switchboards

4.5.7.1 In front of the switchboard, a passageway is to be provided not less than 800 mm wide for switchboards up to 3 m long and not less than 1000 mm wide for longer switchboards.

In ships of less than 500 tons gross tonnage, the width of the passageway may be reduced to 600 mm.

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

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

4.5.7.3 The space behind the free standing switchboards with open live parts is to be enclosed and fitted with doors in accordance with 2.7.1.

4.5.7.4 The space behind the free standing switchboards, specified in 4.5.7.3, of more than 3 m in length is to have at least two exits located at the opposite ends of the switchboards and leading to the space where the switchboard is installed. One of the doors may lead to the adjacent space provided with at least one more exit.

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

5 ELECTRIC DRIVES FOR MACHINERY AND EQUIPMENT

5.1 General Requirements

5.1.1 The control stations and automatic features of the drives are to comply with the relevant requirements given in 20.1, while the power supply of electrical automation systems is to meet the requirements given in 20.3.

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

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

5.2 Interlocking of Machinery Operation

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

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

5.2.3 A device may be installed that will switch off the interlocking on condition that this device is protected from accidental switching off the interlocking. An informative inscription is to be placed in close proximity to this device indicating its application and forbidding using it by unauthorized personnel. Such device is not to be used for machinery specified in 5.2.1.

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

5.3 Safety Devices

5.3.1 The control systems of electric drives, whose operation under certain conditions may endanger the human safety, are to be provided with safety switches that will ensure the disconnecting of the power supply from the electric drive.

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

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

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

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

5.4 Switchgear and Machine Control Gear

5.4.1 The switchgear which is not designed to break short-circuit currents is to withstand such maximum prospective short-circuit current that may flow at the point of its installation during the time required for operation of protection devices.

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

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

5.4.4 Only such alternating-current electric motors that meet the requirements of 3.1.2.2 and 16.8.3.3 may be directly connected to the network.

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

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

.1 a device interlocking the switch on the switchboard in the ”off” position; or

.2 an additional disconnecting switch near the electric motor; or

.3 fuses in each pole or phase arranged in such a manner that they can be readily removed or replaced by the personnel.

5.5 Electric Drives for Steering Gear

5.5.1 In addition to the requirements given in sub-chapter 6.2, *Part VII – Machinery, Boilers and Pressure Vessels* and in sub-chapter 2.6, *Part III – Hull Equipment*, steering gear is to comply with the requirements of the present sub-chapter.

5.5.2 Each electric or electrohydraulic drive of the main steering gear comprising one or more power units is to be supplied directly from the main switchboard by two separate circuits laid on separate routes (see also 16.8.4.13).

Where sectionalised busbars are used in the main switchboard, each circuit is to be connected to a different section of the busbars. It is recommended that one of the circuits be supplied through the emergency switchboard.

Electric or electrohydraulic drive of the auxiliary steering gear required by sub-chapter 2.6, *Part III – Hull Equipment* may be supplied from one of the circuits supplying the main steering gear.

5.5.3 Each circuit is to have sufficient loads for supplying all the electric motors which are normally connected to it and may run simultaneously.

5.5.4 If a change-over arrangement is provided to supply any electric motor or a combination of motors from one or the other feeder, such feeders are to be designed for operation under the most severe loads and the change-over arrangement is to be installed in the steering gear compartment.

5.5.5 In case of failure in the steering gear power unit operation, the other unit required by sub-chapter 2.6, *Part III – Hull Equipment* is to be capable of being started automatically or by manual means located on the navigation bridge.

5.5.6 In all ships provided with steering gears in accordance with sub-chapter 2.6, *Part III – Hull Equipment* when the main source of power supplying the steering gear drive is out of service, the supply from the emergency source of power or any other independent one located in the steering gear compartment and designed only for this purpose, is to be switched on automatically within 45 seconds.

For ships of 10 000 tons gross tonnage and upwards, this source of power is to have a capacity sufficient for at least half an hour of continuous operation of the steering gear drive, as well as its associated control system and the rudder angle indicator; for all other ships – for at least 10 minutes.

5.5.7 The operating conditions of the electric drive of active means of steering the ship are to conform to the operating conditions of the whole system and the electric motors are to be calculated at least for a short-time duty of 30 minutes.

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

.1 putting the rudder over from one side to the other side within the time and angle stated in sub-chapter 6.2.1, *Part VII – Machinery, Boilers and Pressure Vessels*;

.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 to provide a possibility of putting the rudder over at the average speed astern.

5.5.9 Starting and stopping of the steering gear electric motors other than the electric motors of rudders with direct electric drive are to be effected from the steering gear room and from the navigation bridge.

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

5.5.11 Visual and audible signals are to be provided on the navigation bridge and at the main engine control station to indicate:
.1 the loss of voltage, the absence of phase and the overload in the supply circuit of any energetic set;
.2 the loss of voltage in the control system supply circuit;
.3 loop failure in closed loop systems due to short circuit, broken connection, earth fault;
.4 if programmable electronic systems are used – data communication errors, computer hardware and software failures;
.5 the low level of oil in any service fuel tank;
.6 hydraulic locking considering order given by steering wheel or lever.

Moreover, an indicator is to be provided to indicate that the electric motors of the steering gear power units are running.

Alternatively to signals, required in **.3** and **.4,** depending on rudder characteristic, critical deviations between rudder order or response are to be indicated visually and audibly as steering failure alarm on the navigation bridge. In the deviation analysis, the following parameters are to be considered: delay – the rudder actual position reaches set position within acceptable time limits and accuracy – the end actual position of the rudder shall correspond to the set value within the design offset tolerances.

The most probable failures, e.g. loss of power or loop failure are to result in the least critical of any new possible conditions.

5.5.12 The control systems of the steering gear electric drive, required by sub-chapter 2.6, *Part III – Hull Equipment*, are to be supplied from the steering gear power circuit in the steering gear compartment or directly from the main switchboard busbars supplying the steering gear power circuits.

5.5.13 Means are to be provided in the steering gear compartment for disconnecting from the steering gear any control system operable from the navigation bridge.

5.5.14 Steering gear control is to be provided:
.1 for the main steering gear – on the navigation bridge and in the steering gear compartment;
.2 where the main steering gear is arranged in accordance with the requirements of paragraph 6.2.1.5, *Part VII – Machinery, Boilers and Pressure Vessels* – by two independent control systems, both operable from the navigation bridge. This does not require duplication of the steering wheel or steering lever. Where the control system consists of a hydraulic telemotor, a second independent system need not be fitted, except in a tanker, chemical tanker or gas carrier of 10,000 gross tonnage and upwards;
.3 for power-operated auxiliary steering gear – in the steering gear compartment and on the navigation bridge; it is to be independent of the control system for the main steering gear.

5.5.15 It is permitted to use a steering wheel, a handle or push-buttons as manual controlling means on the control desk.

The direction of rotation of the rudder wheel or the direction of the movement of the control gear handle is to agree with the direction of putting the rudder over.

In the push-button control system, the push-buttons are to be arranged in such a manner that the push-button located on the right side causes the rudder blade to move rightward, while the button on the left side – leftward.

5.5.16 It is permitted to install in ships automatic pilots controlling the ship's steering gear by means of their own transmission gear or by means of the ordinary manual control system.

5.5.17 Under no-disturbance conditions, the heading control system is to keep the heading with accuracy ±1% and with maximum single amplitude 1.5°.

Heading control systems are to comply with the requirements of ISO 11674:2000. The use of other solutions is subject to special consideration by PRS in each particular case.

5.5.18 If the heading control system is connected to two independent heading sources, an alarm, both audible (with mute function) and visual, is to be provided to signal when the heading information deviates from the second heading source beyond preset limit. The preset limit is to be set within a minimum range of 5º to 15º. Clear indication of the heading source in use is to be provided, too. The heading data supplied to the heading control system are not to deviate from the compass heading by more than 0.5º.

5.5.19 A device is to be provided for manual adjustment of the rudder putting-over sensitivity of the automatic pilot depending on voyage conditions, as well as a possibility of automatic pilot adjustment according to the ship's characteristics determined during its construction.

5.5.20 Automatic pilot is to be fitted with a device capable of restricting the putting-over of the rudder within the limits not exceeding 35° to each side.

5.5.21 Indicators are to be provided to inform of determining or obtaining maximum rudder putting at automatic steering.

5.5.22 Adequate visual signalling system indicating both power supply "ON" mode and the control type being used is to be provided. The control mode is to be situated near the control mode change-over switch. The heading control system is to be provided with the alarm system giving the following visual and audible alarms indicating:

.1 failure or impermissible reduction in the power supply to the heading control system or heading monitor (alarm signalling facilities are not required to be integrated into the heading control system);

.2 malfunction of the heading control system;

.3 off-heading – when the actual heading information deviates from the preset heading beyond the preset limit. The preset limit is to be within a minimum range of 5º to 15º;

.4 signal absence or an error in the data received from the external sensors used for the ship control.

The alarm and signalling facilities are to be fitted near the conning position and are to be easily accessible. Audible signalling is to be provided with the mute function specified in 20.4.1.7. Visual signalling of the heading control system is to comply with the requirements specified in 20.4.1.6 and 20.4.1.13.

5.5.23 Automatic pilot control system is to be of a completely self-synchronized type and is not to require any regulation during switching over from one kind of operation to another.

5.5.24 The control desk of the automatic pilot is to be provided with a device for manual control of the steering gear.

5.5.25 Manual control of the steering gear is to be simple and reliable and is to be capable of efficient operating, without complex elements used in automatic control systems.

5.5.26 Change-over from automatic to manual control, and vice versa, is to be possible at any position of the rudder, and it is to be activated by one manual control easily accessible to the officer of the watch within 3 seconds.

5.5.27 The arrangement and construction of the automatic pilot are to ensure the possibility for manual control of the rudder from any of the steering stations available on board the ship in the event of any damage to the automatic control system.

5.5.28 The following instruments and devices are to be mounted on the control desk of the automatic pilot: repeater of gyrocompass or repeater of magnetic compass, true and intended rudder position display, devices switching on the power supply to the whole system of control and electric motors of the steering gear, change-over switches of sensitivity and various kinds of control, signal lamps as required in 5.5.18, 5.5.21 and 5.5.22 and other means of operational control and adjustment.

5.5.29 Repeater, true and intended rudder position display, switching and operation control means of electric motors of the steering gear need not be installed on the control desk, provided the executive mechanism of the automatic pilot is built in the control desk or is installed as a separate device directly connected to the ordinary manual steering control station.

5.5.30 The control desk is to be provided with fuses or circuit-breakers capable of protecting all essential circuits against short-circuit.

5.5.31 The control desk is to be provided with the light regulation of the repeater of the compass rose and steering gear position indicator.

5.5.32 The automatic pilot is to be provided with a device capable of changing the predetermined ship's course to any other course by manual operation within the limits of at least ±15° under automatic control without switching over to manual control specified in 5.5.25.

5.5.33 It is recommended to provide the set of the automatic pilot with two additional remote control stations for manual control capable of ensuring rapid manual changing of the ship's course when proceeding under automatic steering control.

The value of the rapid change of the ship's course should be possible up to the complete circulation. The remote control stations intended for manual control are to be so arranged as to ensure the return of the ship to the predetermined course and further functioning of the automatic control system after the control handle (push-button) of the station is set in neutral position.

5.5.34 Adaptive automatic pilot is to meet the following requirements:

.1 to ensure, without the services of a helmsman, optimum operation of the rudder in various ship's navigation conditions and under the change in the distribution of cargo, ship's speed and trimming;

.2 to enable simultaneous and parallel operation of two steering gear motors in difficult navigation and weather conditions.

5.5.35 Where remote control stations of the heading control system are provided, facilities for control transfer to the remote station and unconditional return of control are to be incorporated in the master station.

5.6 Electric Drives for Anchor and Mooring Machinery

5.6.1 In addition to the requirements given in sub-chapters 6.3 and 6.4, *Part VII – Machinery, Boilers and Pressure Vessels*, the drives of windlasses, anchor and mooring capstans and mooring winches are to comply with the requirements of the present sub-chapter.

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

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

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

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

5.6.4 The power supply of windlass electric drives is to comply with the requirements of paras. 4.3.1 and 4.3.3.

5.7 Electric Drives for Pumps

5.7.1 The electric motors of fuel and lubricating oil transfer pumps, as well as of oil separators are to 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.

5.7.2 The electric motors of the pumps transferring the liquids outboard through the drain holes above the lightest waterline at locations where lifeboats or liferafts are lowered, are to be provided with non-manoeuvering switching devices located near the control stations of the driving machinery for lowering the relevant boats or rafts.

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

5.7.4 The remote switching devices, referred to in 5.7.1 and 5.7.2, are to be located in conspicuous places under glass covers and are to be provided with informative notices.

In catamarans, these devices are to be grouped separately for each hull.

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

5.8 Electric Drives for Fans

5.8.1 The electric motors for ventilation fans in machinery spaces are to be provided with at least two remote switching devices, one of which is to be located outside these spaces and their casings but in direct vicinity to the entries to these spaces.

It is recommended to install such switching devices in one place, together with the switching devices, mentioned in 5.7.1.

5.8.2 The electric motors for ventilation fans serving cargo holds and galley fans are to be provided with switching devices at locations readily accessible from the main deck, but outside the machinery casings.

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

5.8.3 The electric motors for general shipboard ventilation are to have at least two devices for their remote switching off from the navigation bridge and from the watchman special compartment (when the ship is not underway). Where provision has not been made for a watchman compartment, a second switching-off device is to be fitted in a place easily accessible from the main deck.

In ships with a low-rated electrical installation (other than passenger ships), only one remote disconnecting switch may be used, located on the navigation bridge or in a place easily accessible from the main deck.

5.8.4 The supply and exhaust ventilation in spaces protected by a smothering system is to stop automatically when such a system is being put into operation.

5.8.5 The remote switching devices of electric motors for ventilation fans, specified in 5.8.1 ÷ 5.8.3, are to be grouped on board the ship so that all the electric motors may be remotely switched off from not more than three places.

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

5.9 Electric Drives for Boat Winches

5.9.1 The electric drives of boat winches are to comply with the requirements given in the SOLAS Convention (these requirements are also given in *Part II – Life-Saving Appliances* of the *Rules for Statutory Survey of Sea-going Ships*, sub-chapter 2.9).

5.9.2 The controls of the boat winch electric drives are to be provided with self-return to the ”Stop” position.

5.9.3 A switch in the main current of electric motors is to be installed near the boat winch control station.

5.10 Electric Drives for Watertight and Fireproof Doors

5.10.1 The electric drives of watertight doors are to comply with the requirements of Chapter 21, *Part III – Hull Equipment* and the requirements of the present sub-chapter.

5.10.2 Power supply of electric drives, alarm, control and indication circuits of the watertight doors is to be separately distributed from the main switchboard through the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically switched to the transitional source of electric power in the event of failure of either the main or emergency source of electric power, in accordance with the requirements given in 4.3.1.21, 22.1.2.4 and 22.1.2.8.

5.10.3 The electric drives of the devices keeping the fire doors in the open position are to comply with the following:

- **.1** they are to be supplied by main and emergency sources of electric power;
- **.2** they are to be provided with remote control from the navigation bridge ensuring the release of each of the doors separately, in groups or all of them at the same time;
- **.3** they are to release automatically all the fire doors at the same time in the event of loss of voltage supply;
- **.4** they are to be so designed that any failure of the release mechanism of a particular door does not stop the operation and control of other doors.

6 LIGHTING

6.1 General Requirements

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

The list of rooms, spaces and locations in which, in addition to the main lighting, fixtures of emergency lighting are to be installed, is given in 9.3.1.1 and 22.1.2.1.1.

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

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

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

6.1.5 External lighting fixtures are to be installed in such a manner as not to dazzle the person running the ship.

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

6.1.7 Battery compartments and other explosion-hazardous spaces are to be illuminated with lighting fixtures located in adjacent safe spaces through gastight windows or with explosion-proof lighting fixtures installed inside such spaces (see also 2.8).

6.1.8 Ergonomic Considerations

6.1.8.1 Lighting in all spaces and compartments shall be so designed and arranged and so operate as to provide adequate illumination for the safety, well-being, capabilities and task performance as well as means of access and egress and also their capability of detecting potential hazards to themselves.

6.1.8.2 Detailed recommendations in this respect are contained in IACS Recommendation No 132, *Human Element Recommendations for Structural Design of Lighting, Ventilation, Vibration, Noise, Access & Egress Arrangements*.

6.2 Supply to the Lighting Circuits

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

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

6.2.2 The protections of the lighting final circuits of spaces are to be designed for the rated current not exceeding 16 A and the total circuit current is not to exceed 80 per cent of the rated current of the applied protection.

The number of lighting fixtures supplied from the lighting final circuits is not to exceed that specified in Table 6.2.2.

Table 6.2.2

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.

6.2.3 Lighting of corridors, stairways, machinery spaces, propeller shaft tunnels, boiler water-level indicators is to be supplied by not less than two independent feeders. The lighting fixtures are to be arranged in such a manner that in the event of failure of either feeder uniformity of lighting will be ensured. These feeders are to be supplied from different distribution boards which, in the case of application of sectionalised busbars in the main switchboard, are to be connected to different sections of the busbars.

In ships with a low-rated electrical installation, the lighting circuits in the above-mentioned spaces, except machinery spaces, may be supplied by one feeder from the section switchboard or directly from the main switchboard.

6.2.4 Local lighting fixtures in accommodation spaces, as well as socket-outlets are to take power from the lighting switchboard by a separate feeder other than that intended for supplying the common lighting fixtures.

6.2.5 If the ship is divided into main fire zones, lighting of each zone is to be supplied by two feeders which are separated from the feeders supplying the lighting circuits in other fire zones.

As far as possible, the lighting feeders are to be installed in such a manner that a fire in one zone cannot damage the feeders supplying the lighting circuits in other zones.

Where sectionalised busbars are used in the main switchboard, such feeders are to be connected to different sections of the busbars.

6.2.6 The main lighting system is to be so designed that a fire or other failure in the spaces containing the main source of electric power and/or the main lighting transformers does not cause the disconnection of the emergency lighting.

6.2.7 Permanently-installed lighting fixtures in holds are to take their power supply from a special switchboard. Apart from the fuses and switches, this switchboard is to be provided with visual signals to indicate the presence of voltage in individual lighting circuits.

In ships with a low-rated electrical installation, lighting fixtures in holds may be supplied from the switchboard located on the navigation bridge. The switchboard is to be provided with visual signals indicating the presence of voltage in cargo hold lighting circuits.

6.3 Emergency Lighting

6.3.1 The intensity of emergency lighting in particular spaces, locations and areas, mentioned in 9.3.1.1 and 22.1.2.1.1, is to be equal to at least 10 per cent of the general lighting intensity (see 6.7).

Emergency lighting intensity in the engine room may be equal to only 5 per cent of the general lighting intensity if socket outlets, supplied from the emergency lighting system, are provided in this space.

This lighting is to ensure easy identification of the escape routes (or ensure the intensity of light of at least 0.5 lux).

6.3.2 For the purpose of achieving the intensity of lighting required by 6.3.1, incandescent lamps, together with gas discharge lamps, may be applied (see also 6.1.6).

6.3.3 The main lighting lamps may be used as the lamps of the emergency lighting, provided that they are supplied from the emergency source of electric power.

6.3.4 The emergency lighting system is to be so designed that a fire or other casualty in the spaces containing the emergency source of electric power and/or emergency lighting transformers will not disconnect the main lighting system.

6.3.5 Permanently fixed, independent, automatically switched on lamps with built-in accumulator batteries and automatically recharged from the main lighting circuits may be used for the emergency lighting.

6.3.6 Each emergency lighting fixture is to be painted red. This requirement concerns also lighting fixtures mentioned in 6.3.3.

6.4 Switches in Lighting Circuits

6.4.1 Two-pole switches are to be used in lighting circuits. In dry accommodation and service spaces except navigation bridge, single-pole switches may be used in circuits of individual and group lighting fixtures with a total power consumption of not more than 6 A, as well as in safety-voltage lighting fixtures.

6.4.2 Permanently installed ship's external lighting fixtures are to be provided with central switches located on the navigation bridge or in any other permanently attended place situated on upper deck.

6.4.3 The switches of lighting circuits of fire-extinguishing stations are to be located outside these spaces.

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

6.4.5 In the emergency lighting circuits, as a rule, no switches are to be fitted for the local disconnecting of fixtures. These switches may be used only in such circuits of the emergency lighting lamps which, under normal conditions, are the lamps of the main lighting.

Emergency lighting lamps of places near lifeboats and liferafts, as well as outboard spaces, which in normal conditions are main lighting lamps, are to switch on automatically at the black-out.

It is permitted to switch them on by central switches located on the navigation bridge, provided that these lamps switch on automatically after black-out.

The emergency lighting circuits of the navigation bridge are to be provided with switches.

6.5 Fluorescent and Gas Discharge Lamps

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

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

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

6.5.4 Gas discharge lamps supplied by a voltage exceeding 250 V are to be provided with warning notices stating the voltage rating. All live parts of such lamps are to be suitably protected.

6.6 Socket Outlets and Plugs

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

.1 on deck near the windlass;
.2 in the gyrocompass room;
.3 in the radio equipment converter room;
.4 in the steering gear compartment;

.5 in the emergency generator set compartment;
.6 in the machinery spaces;
.7 behind the main switchboard;
.8 in special enclosed electrical spaces;
.9 in the propeller shaft tunnel;
.10 on the navigation bridge;
.11 in the radio room;
.12 in the vicinity of cargo winches;
.13 in the vicinity of the log trunk and echo sounder;
.14 in spaces where centralized ventilation and air conditioning installations are located.

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

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

6.6.4 Socket outlets cannot be installed in machinery spaces below the floor, in the enclosed spaces of fuel or lubricating oil separators or in places where the explosion-proof type equipment is required.

6.7 Illumination Intensity

6.7.1 The intensity of illumination of rooms and spaces is not to be below that specified in Table 6.7.1. These requirements are not applicable to ships provided with lighting circuits supplied at a voltage below 30 V.

The general illumination standards, stated in Table 6.7.1, refer to the level of 800 mm above the compartment floor, while the general illumination standards, plus local ones, refer to the level of the working areas.

Table 6.7.1

Item	Spaces and surfaces		Illumination intensity, lux			
			Lighting other than incandescent		Incandescent lighting	
			general + local	general	General + local	general
1	2		3	4	5	6
1	Radio room	At level of 0.8 m above floor	–	–	–	100
		Operation tables in radio room	–	–	200	–
2	Chart room	At level of 0.8 m above floor	–	100	–	50
		Chart tables	150	–	150	–
3	Navigation bridge	At level of 0.8 m above floor	–	75	–	50
4	Engine rooms, spaces for switchboards, manoeuvring and control stations, spaces for automation facilities and gyrocompasses	At level of 0.8 m above floor	–	75	–	75
		Surfaces of switchboards and control and monitoring desks	200	100	150	75
		Main engine controls stand	150	100	150	75
		Passageways between boilers, machinery, engines, stairs	–	75	–	30
		In front of boilers	100	75	75	75
5	Battery compartments	At level of 0.8 m above floor	–	75	–	50
6	Propellers shaft tunnels, log and echo sounder trunk or recess, chain lockers	At level of 0.8 m above floor	–	50	–	20
		Surfaces of shaft bearings and connection flanges, etc.	75	–	50	–
7	Passageways on decks, gangway bridges and lifeboat and liferaft positions	At level of 0.8 m above deck	–	50	–	20
8	Overside spaces in way of lifeboat and liferaft lowering	Near the load waterline	–	–	–	5

6.8 Navigation Lights

6.8.1 Navigation Light Controller (hereinafter referred to as NLC) is to be located on the bridge. The NLC is to supply only navigation lights and special signal lights, such as lights required by canal Authorities. Navigation lights defined in the *COLREG Convention* (specified also in the *Rules for Statutory Survey of Sea-going Ships*, *Part III – Signal Means*, Table 2.4.1) are to be supplied by separate circuits.

6.8.2 The NLC is to be supplied by two circuits:

.1 one circuit from the emergency switchboard, which is supplied in accordance with paragraph 9.4.1;

.2 the second circuit from the section switchboard, which is not supplied from the emergency switchboard only.

The NLC installed in the ship's navigation control and monitoring console may be supplied directly from the console, provided it is supplied in compliance with paragraph 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.

Automatic switch over to the alternative source of power is permitted.

6.8.3 Navigation lights are to be connected to the network by flexible cables and plug connectors.

6.8.4 Each feeding circuit of navigation lights is to be of two-wire type with a double-pole switch with visual indication of "ON/OFF" status, installed in the NLC.

6.8.5 Each navigation light feeding circuit is to be provided with protection in both wires and with visual signal of proper functioning of each navigation light.

The visual indicator is to be designed and installed in such a manner that its damage will not cause the disconnection of the navigation light. A voltage drop on the NCL, including the signalling system of functioning of the lights, is not to exceed 5 per cent at the rated voltage up to 30 V and 3 per cent at the rated voltage over 30 V.

6.8.6 Irrespective of the signals, required in 6.8.5, provision is to be made for visual and audible signals functioning in the case of failure of power supply to navigation lights and failure of any navigation light, with the switch in the "on" position.

The power supply of signals is to be taken:

– from a circuit or a source other than used for the power supply of the NLC, or
– from an accumulator battery.

6.8.7 Provision is to be made for adjustment of the NLC indicators illumination intensity so arranged that the total extinguishing of illumination should not be possible.

6.8.8 The NLC is to enable the use of a bi-directional communication interface complying with the requirements of IEC Publication 61162.

6.8.9 The lamp holders and lamps used in navigation lights are to comply with the requirements of the COLREG Convention (these 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 General Requirements

7.1.1 In addition to compliance with the applicable requirements of the present Chapter, signalling and internal communication systems are to comply, within the scope agreed with PRS, with the provisions of the *Code on Alerts and Indicators, 2009*, adopted by IMO Resolution A.1021(26).

7.1.2 With the exception of bells, audible signals are to have a signal frequency between 200 Hz and 2,500 Hz.

7.2 Electric Engine-room Telegraphs

7.2.1 In addition to compliance with the requirements of the present sub-chapter, the electric engine-room telegraphs are to meet the requirements given in para. 1.14.1, *Part VI – Machinery Installations and Refrigerating Plants.*

7.2.2 The engine-room telegraphs are to be provided with a visual signal of the presence of voltage in the power supply circuit supplying the engine-room telegraphs and an audible signal of the supply voltage loss.

7.2.3 The engine-room telegraphs installed on the navigation bridge are to be provided with scale lighting permitting adjustment of illumination intensity so arranged that the total extinguishing of illumination should not be possible.

7.2.4 The engine-room telegraphs are to take their power supply from the main switchboard or from the navigation equipment switchboard. If the ship is provided with a ship's navigation control and monitoring console, the engine-room telegraph may take its power supply from this control console.

7.2.5 The engine-room telegraph transmitter on the navigation bridge is to be installed in such a way that in the case of transmitting commands concerning the running of the ship, the handle of the transmitter is set in accordance with the direction of the ship's running. The vertical position of the handle is to correspond to the command "Stop".

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

7.2.7 Where two and more engine-room telegraphs are located in close proximity to one another (on one deck), they are to ensure the transmission of commands from any telegraph and the reception of reply by all of them simultaneously, without any additional switching.

The change-over to telegraphs located on another deck or in another part of the ships is to be performed by switches fitted on the navigation bridge.

7.2.8 Each engine-room telegraph is to 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 should remain operating.

7.3 Internal Service Communication

7.3.1 Internal Telephone Communication

7.3.1.1 Where other types of communication facilities are not available, an independent telephone communication is to be provided between the navigation bridge and control stands of machinery and main engines, and engineer officers' accommodation spaces. In the case of enclosed or not enclosed central control stand, independent telephone communication is to be provided between this stand and the navigation bridge and between the navigation bridge and a local main machinery and propellers control stands.

These requirements are considered fulfilled if the apparatus located at local control stands are connected in parallel to the apparatus of the independent telephone communication between the navigation bridge and the enclosed central control stand.

7.3.1.2 In addition to the means of communication specified in 7.3.1.1, telephone communication is to be provided between the navigation bridge and the following main service spaces and stands: forecastle, poop, watch stand on the mast, steering gear compartment and each emergency steering position (if provided), space of emergency switchboard, gyrocompass room, fire-extinguishing station, space of electrical machinery for main propulsion, accommodation spaces of engineers or other spaces where the equipment ensuring the safety of ship's navigation has been installed.

Instead of telephones, loud master communicators may be used.

In the case of two-way communication between the navigation bridge and the above-mentioned spaces, no additional means of communication are required.

7.3.1.3 Service communication systems are to enable calling the subscriber and the clear voice communication in the conditions of specific noise in places where communication means are installed.

Where service telephone sets are located in spaces with a high noise level, noise suppressors are to be used or the sets are to be provided with additional headphones.

7.3.1.4 The communication means specified in 7.3.1.1 and 7.3.1.2 are to be provided with suitable sources of power, capable of ensuring the telephone operation even in the absence of power supply from the main sources of power.

7.3.1.5 A damage or disconnection of any telephone set is not to affect the working ability of the other sets.

7.3.1.6 The telephones prescribed by 7.3.1 for two-way telephone communication between the navigation bridge and closed central control stand or between the navigation bridge and main engine and machinery local control stand are to be provided with audible and visual calling signalisation both in the closed central control stand and in the machinery space.

7.3.1.7 A loud master communicator may be independent or common with the public address system described in 7.3.2.

7.3.2 Public Address System

7.3.2.1 Every passenger ship and every cargo ship of 300 gross tonnage and upwards are to be fitted with public address system or other suitable means of communication between all accommodation and service spaces, control stations and open decks.

7.3.2.2 Public address system is to be one complete system consisting of a loudspeaker installation which enables simultaneous broadcast of messages from command microphone posts to all accommodation, service and public spaces, as well as to open decks. The public address system may not be required in such spaces as under-deck passageway, bosun's locker, hospital, pump-room. The public address system may be used for broadcasting radio programmes and sound recordings, provided they can be overridden by service orders and information.

7.3.2.3 The public address system is to have one main command microphone post, installed on the navigation bridge and at least one more command microphone post, e.g. installed in the compartment intended for the watch when the ship is in port or provided at the accommodation ladder.

7.3.2.4 The main command microphone post is to be provided with means for control of the quality of broadcasts in each broadcasting line, by e.g. audio control.

7.3.2.5 The public address system is to be capable of being connected to at least two broadcasting lines:

.1 deck broadcasting line, intended for connecting loudspeakers installed on open decks;

.2 service broadcasting line, intended for connecting loudspeakers installed in service, accommodation and public spaces (cabins, messrooms, smoking rooms, libraries, reading rooms, etc., including the adjacent corridors and landings).

7.3.2.6 For the purpose of broadcasting commands and emergency messages, the control of the public address system (switching on, changeover of broadcasting lines, disconnection of any broadcast and switching on forced broadcasting system) is to be carried out directly from the main command microphone post, irrespective of the position of controls in all other command microphone posts and loudspeakers.

7.3.2.7 Loudspeakers installed in accommodation spaces are to be fitted with volume controllers or switches. Plugs are not to be used.

7.3.2.8 Every command microphone post is to be fitted with light signalling which is to operate after the activation of the public address system.

7.3.2.9 The public address system, on full load and maximum amplification, is to ensure broadcasting service orders and emergency messages from command microphone posts to all accommodation, service and public spaces, at the sound pressure level:
– 75 dB(A) and at least 20 dB(A) above the ambient noise level, in interior spaces;
– 80 dB(A) and at least 15 dB(A) above the ambient noise level, in exterior spaces.

7.3.2.10 The public address system is to be so arranged as to prevent feedback or other interference in broadcasting lines, e.g. in the case of short-circuit in loudspeakers' down-leads.

7.3.2.11 The public address system is to be supplied from the main source of electrical power, the emergency source of electrical power and transitional source of electrical power, if required by Chapter 9 or 22.

7.3.2.12 Administration may accept the use of public address system for the general alarm and the fire alarm, provided that:

.1 all requirements for those alerts specified in the *LSA Code*, *FSS Code* and the *SOLAS Convention*, as amended, are complied with;

.2 all the relevant requirements for alerts, specified in the *Code on Alerts and Indicators, 2009* are complied with*;*

.3 the public address system automatically overrides: any other input system when an emergency alarm is required and any volume controls provided to give the required output for the emergency mode when an emergency alarm is required;

.4 the public address system is arranged to prevent feedback or other interference; and

.5 the public address system is arranged to minimize the effect of a single failure.

7.4 General Alarm System

7.4.1 Every cargo ship of 300 gross tonnage and upwards and every passenger ship are to be provided with a general alarm system. The system shall be capable of sounding the general alarm signal consisting of seven short blasts followed by one long blast on the ship's whistle or siren and additionally on other signalling devices.

The minimum sound pressure level for the alarm tone in open spaces is to be at least 80 dB(A) and at least 15 dB(9A) above the ambient noise level. In closed spaces the sound pressure level for the alarm tone is to be at least 75 dB(A) and at least 20 dB(A) above the ambient noise level. In no case shall the sound pressure level exceed 120 dB(A). In cabins without a loudspeaker installation, a buzzer or a similar sound device is to be installed.

In cargo ships of less than 300 gross tonnage, an alarm given by human voice or by any other means is permitted, provided it is heard simultaneously in all locations where people may be present.

7.4.2 Signalling devices are to be installed in the following places:

.1 in machinery spaces;

.2 in public spaces if their floor area is more than 150 m^2;

.3 in corridors of accommodation, service and public spaces;
.4 on open decks;
.5 in processing spaces.

7.4.3 The general alarm system is to be supplied from the ship's network and from the emergency switchboard busbars in accordance with the requirements of paras. 9.3.1.3 or 22.1.2.1.4.

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

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

7.4.5 When general alarm system is provided with its own accumulator battery, this battery may also be used for supplying other internal communication appliances, provided the battery capacity is sufficient for simultaneous supply of electric power to all appliances for at least 3 hours and these appliances are so designed that a damage to any circuit does not interfere with operation of other circuits and the prospective period of supplying the appliances is not long.

7.4.6 Power supply circuits of general alarm system are to be provided only with short-circuit protection. Protection devices are to be fitted in both wires of supply circuit, as well as in circuits of each signalling device, if the system is not of self-controlled type.

One common protection for several signalling devices may be fitted if, in the space in which signalling devices are installed, good audibility of other signalling devices with independent protection is ensured.

7.4.7 Audible devices of general alarm system are to be so located that a signal is clearly heard against the noise in the given space. Audible devices installed in spaces with high intensity of noise are to be also fitted with visual signals.

The sound of the general alarm system is to be different from the sounds of all other signalling systems.

7.4.8 The general emergency alarm signal is to be activated from the navigation bridge and, except for the ship's whistle, also from the main fire control station or from the cargo central station, if provided, or from the compartment intended for the watch when the ship is in port.

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

7.4.9 No switching devices are to be incorporated into the circuits of the general alarm system other than the switch specified in 7.4.8. However, if it is necessary to install switches in the general alarm system switchboards, they are to be interlocked in the closed position or are to be otherwise protected from access thereto by unauthorized persons.

Intermediate contactors connected by means of a switch may be used; however, not more than one contactor in each branch is to be fitted.

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

7.4.11 Audible devices of general alarm system are to be divided at least in two circuits connected by one switch and so located that in large spaces (machinery spaces, boiler spaces, processing and other special spaces) audible devices supplied from different circuits are installed.

7.4.12 Activation of general alarm system is to override all communication systems other than service broadcasting systems.

7.5 Fire Detection System

7.5.1 General Requirements

7.5.1.1 In addition to the requirements of the present sub-chapter, fire detection system is to comply with the requirements given in Chapter 4, *Part V – Fire Protection*.

7.5.1.2 Fire detection system may be used for fire detection and alarm, general alarm system and control of:

.1 public address system;
.2 stopping fans;
.3 closing fire doors;
.4 closing fire dampers;
.5 sprinkler system;
.6 additional low-location lighting;
.7 smoke extraction system.

7.5.1.3 Fire detection control panels (see 7.5.2 and 7.5.3) are to be located on the navigation bridge, in the main fire control station or another accessible place, where the fire detection alarm will result in undertaking proper action by the crew.

7.5.1.4 Fire detection system is to be of self-controlled type and is to give visual and audible alarm signal in an emergency, e.g. switching over to emergency power supply or power decay. Signalling of the system emergency conditions is to be different than fire alarm signal.

7.5.1.5 Detection of high temperature, smoke or other combustion products is to actuate visual and audible alarm in the fire detection control panels and on the navigation bridge.

7.5.1.6 Fire detection control panels are to be provided with informative plates identifying section number and spaces or regions covered by the detection system.

7.5.1.7 Cables and conductors of fire detection system are not to run through galleys, machinery spaces of category A and other high fire risk spaces, except supply cables and fire detectors installed in these spaces.

7.5.2 Fire Detection System in Compartments and Engine-rooms

7.5.2.1 Fire detection system is to be installed in the following locations:

.1 accommodation spaces, public spaces, stairways and corridors, control stations,
.2 periodically unattended machinery spaces,
.3 machinery spaces where:
- the installation of automatic and remote control system has been provided in lieu of continuous manning of the space; and
- the main propulsion and associated machinery, including the main source of electric power, are provided with various degrees of automatic or remote control and are under continuous manned supervision from the engine control room.

7.5.2.2 Fire detection and fire alarm system shall be supplied by separate feeders from two inedependent sources of power supply.

If the main source of power supply is the main source of electrical power, then another source of power supply shall be either the emergency power source or accumulator batteries having both the capacity and location in accordance with the requirements specified in 9.3 or 22.1.2.

If the main source of power supply is a set of accumulator batteries, then additional accumulator batteries shall be provided. Each of those batteries shall be in accordance with the requirements specified in 9.3 or 22.1.2.

Power supply changeover to the emergency source shall be automatic with simultaneous activation of the indication mentioned in 7.5.1.4.

The feeders from the main and emergency power sources shall be led directly from the main switchboard and from the emergency switchboard to the automatic changeover switch avoiding section switchboards.

7.5.2.3 Detectors and manually operated call points are to be connected into loops corresponding to sections specified in Chapter 4, *Part V – Fire Protection*. Activation of a detector or a manually operated call point is to result in operation of audible and visual alarm in the fire detection control panel or in the alarm indicating unit, giving the number of activated loop (section of detectors).

7.5.2.4 In the case of fire in machinery spaces the alarm should be immediately audible within accommodation spaces of the responsible engine-room crew.

7.5.2.5 If the alarm signals mentioned in 7.5.2.2 and 7.5.2.3 have not received attention at locations specified in 7.5.1.3 within 2 minutes, audible alarm shall be automatically sounded at control stations, in service spaces and crew accommodation as well as in machinery spaces of category A. This alarm sounder system shall be an integral part of the fire detection and fire alarm system.

If such an alarm system is not an integral part of the fire detection and fire alarm system, it shall be supplied from at least two independent sources of power supply one of which shall be an emergency source. Additionally, the alarm sounder system shall also be supplied from a transitional source of electric power ensuring continuous power supply, e.g. during the time necessary to start the emergency generating set.

7.5.2.6 Indicating units are to identify at least number of loop (section), where a detector or a manually operated call point has been activated.

At least one indicating unit is to be continuously, easily accessible at sea and in port to responsible crew members.

One indicating unit is to be located on the navigation bridge if fire detection control panel is located in the main fire control station.

7.5.2.7 An informative plate, specified in 7.5.1.6, is to be provided near each indicating unit.

7.5.2.8 Fire detection system with a remote detector identification capability is to comply with the following requirements:

- **.1** configuration of the loop (electrical circuit linking detectors of various sections and connected to the control panel) is to preclude its damage in more than one place, which means that data highway is not to run through protected zone more than once, and where it is not possible, e.g. in large general purpose compartments, the loop parts running through again are to be installed as far as practicable;
- **.2** any fault occurring in the loop, e.g. power decay, short-circuit, earth is not to cause the whole loop ineffective, but only a part of it, of the size equal to the size of fire detection system loop without capability of identifying detectors;
- **.3** arrangements are to be provided to ensure restoration of the initial configuration of the system after repair/elimination of failure;
- **.4** the first indicated fire alarm shall not prevent any other detector from initiating further fire alarms.

7.5.2.9 Detectors are to be operated by heat, smoke or other combustion products, flame or any combination of these factors. Flame detectors may only be used in addition to smoke or heat detectors. Installation of other detectors will be separately considered by PRS in each particular case, provided that they are as sensitive to the initial stage of fire as the detectors specified above.

7.5.2.10 Smoke detectors required in stairways, corridors and escape routes within accommodation spaces are to be certified to operate before the smoke density exceeds 12,5% obscuration per metre, but

not until the smoke density exceeds 2% obscuration per metre. Sensitivity limits for smoke detectors intended for other spaces are subject to special consideration by PRS in each particular case.

7.5.2.11 Heat detectors are to be certified to operate before the temperature exceeds 78°C, but not until the temperature exceeds 54°C, when the temperature rises to these limits at a rate less than 1°C per minute. Sensitivity limits of heat detectors for other temperature rises are subject to special consideration by PRS in each particular case.

7.5.2.12 In spaces of a normal high ambient temperature, the permissible operation temperature of heat detectors may be increased to 30°C above the maximum deckhead temperature. Operation temperature of heat detectors in drying rooms and similar spaces may be up to 130°C, and up to 140°C in sauna.

7.5.2.13 All detectors are to be of such a type that they can be tested for correct operation and restored to normal surveillance without the necessity of the renewal of any component.

7.5.2.14 Where fire detectors are provided with the means to adjust their sensitivity, necessary arrangements are to be ensured to fix and identify the set point.

7.5.2.15 Where there is a possibility of temporary switching off a particular loop or detector, it is to be clearly indicated at a fire detection control panel and reactivation is to be performed automatically after the preset time.

7.5.2.16 It is recommended to provide each detector with visual indicator to enable confirmation of its operation.

7.5.2.17 The installation of detectors of the fire detection system in explosion- hazardous spaces or located in the stream of air sucked from these spaces is to comply with the requirements of 2.8 and 22.5.4.

7.5.3 Sample Extraction Smoke Detection System in Holds

7.5.3.1 Sample extraction smoke detection system in holds, operating on the principle of the analysis of the air coming from the protected spaces to the analysing unit, is to be supplied, together with the fans, from the main and other independent stand-by source of electric power. Change-over of power supply to stand-by source of electric power is to be performed automatically with simultaneous activation of alarm signal specified in 7.5.1.4.

7.5.3.2 The system is to be capable of continuous operation. Exception is the system operating on sequential scanning principle, in which interval between scanning the same position twice is to depend on number of sampling points and overall response time of the fans.

The interval is to be calculated from:

$$I = 12 \times T \times N \ \text{[s]} \qquad (7.5.3.2)$$

where:

T – response time of air sample extraction, [s];

N – number of air sampling points.

However, maximum permissible interval between two air sample extractions is not to exceed 120 s.

7.5.3.3 The system is to be so designed, constructed and installed as to prevent:

.1 penetration of hold atmosphere into accommodation, service spaces, machinery spaces and control stations;

.2 ignition of flammable mixtures of gas and air.

7.5.3.4 The system is to ensure:

.1 testing correct operation and restoring to normal surveillance without the renewal of any component;

.2 observation of air in each sampling pipe;

.3 extracting, as far as practicable, equal quantity of air through each smoke accumulator.

7.5.3.5 Sample extraction fans are to be duplicated and have sufficient capacity to suck air from the farthest spaces with the mechanical ventilation in these spaces switched on.

The complete time of air sample extraction, depending on fans capacity and pipes length is to be 15 s.

7.5.3.6 The sensing unit is to be certified to operate before the smoke density within the sensing chamber exceeds 6.65% obscuration per metre.

7.6 Warning Signalisation of Fire-extinguishing Systems Operation

7.6.1 In addition to the requirements of the present sub-chapter, warning signalling system indicating that a fire-extinguishing system is put into action, is to meet also the requirements given in Chapter 4, *Part V – Fire Protection*.

7.6.2 Warning signalling system is to be supplied from the ship's main source of electric power and from accumulator battery of the capacity sufficient to provide power supply for 30 minutes. An automatic change-over of its supply to an accumulator battery in the case of voltage decay in the ship's network is to be provided.

7.6.3 Warning signal is to be:

- **.1** activated automatically, e.g. by opening doors of control boxes of manual and remote mechanism activating fire-extinguishing system;
- **.2** activated ahead of activation of fire-extinguishing system operation – see para. 3.6.4.2.1, *Part V – Fire Protection*;
- **.3** audible in spaces with fire-extinguishing system in usual noise conditions;
- **.4** different than any other audible signal;
- **.5** provided with additional visual signal in spaces of excessive noise.

7.7 Indication of Closing Watertight and Fire Doors

The indication of closing watertight doors is to meet the requirements of paras. 7.4.8.4 to 7.4.8.8 and 7.5.6.4 to 7.5.6.8, *Part III – Hull Equipment*, and the indication of the fire doors position is to meet the requirements of para. 6.1.8.4.3, *Part V – Fire Protection*.

7.8 Alarm System in the Accommodation Spaces for Engineering Personnel

An audible engineer's alarm is to be provided to be operated manually from the main engine control station in the engine room or from the central control room, if provided.

7.9 Single Hold Cargo Ships Water Detection System

7.9.1 Ships having a length *L* of less than 80 m and a single cargo hold below the freeboard deck or cargo holds below the freeboard deck which are not separated by at least one bulkhead made watertight up to that deck, are to be fitted in such space or spaces with water level detectors complying with the requirements of paras. 7.9.2 to 7.9.5.

7.9.2 The water level detectors, required by 7.9.1, are to:

- **.1** give an audible and visual alarm at the navigation bridge when the water level above the inner bottom in the cargo hold reaches a height of not less than 0.3 m (prealarm), and another when such level reaches not more than 15% of the mean depth of the cargo hold (main alarm); audible alarms are to clearly discriminate between the two different water levels detected in hold;
- **.2** be fitted at the aft end of the hold or above its lowest part where the inner bottom is not parallel to the designed waterline. Where webs or partial watertight bulkheads are fitted above the inner bottom, PRS may require the fitting of additional detectors.

7.9.3 Electrical equipment of single hold cargo ships water detection system is to comply with the requirements of paras. 22.8.1.4 to 22.8.1.11.

7.9.4 The water level detectors, required by 7.9.1, need not be fitted in ships complying with the requirements of para. 22.8.1. The system need not be also fitted in ships having watertight side compartments, each side of the cargo hold length extending vertically at least from inner bottom to freeboard deck.

7.9.5 Ships of subdivision length $Ls \geq 80$ m for which it will not be revealed that they fulfill regulations regarding subdivision and damage stability (fulfillment of regulations of relevant requirements specified in *Part IV – Stability and Subdivision*) are to meet requirements specified in subchapter 22.8.

7.10 Alert Management System on Navigation Bridge

7.10.1 It is recommended that navigation bridge be provided with an alert management system in accordance with the requirements specified below. The requirements also apply to the existing systems (already installed on board the ship).

7.10.2 Alert management system shall properly classify and deliver alerts so that the bidge crew have full control over safe ship handling taking correct actions in emergencies.

7.10.3 Alert management system shall be divided into the following priorities:
- emergency alarms;
- alarms;
- warnings;
- cautions.

7.10.4 Prioritised groups mentioned in 7.10.3 shall be established according to the following criteria:
a) emergency alarm:
   - alarm indicating immediate danger to human life or to the ship and its machinery exists and that immediate action has to be taken, as specified in the *Code on Alerts and Indicators, 2009* (IMO Res. A.1021(26)).

b) alarm:
   - condition requiring immediate attention and action to maintain the safe navigation and operation of the ship;

c) warning:
   - condition requiring no immediate attention or action; warnings are presented for precautionary reasons to bring awareness of changed conditions which are not immediately hazardous, but may become so if no action is taken;

d) caution:
   - awareness of a condition which requires attention out of the ordinary consideration of the situation or of given information.

7.10.5 Alerts shall be divided into the following three categories:
- category A – additional information related to the given alert is required to be displayed by the system, i.e. detailed case description (serious hazard, e.g. collision, stranding);
- category B – additional information related to the given alert is not required to be displayed;
- category C – alerts which cannot be confirmed in the navigation bridge but they require information on their status (e.g. cancellation), such as alerts related to the machinery installations.

7.10.6 The system shall also present alerts by their status:
- confirmed;
- unconfirmed.

7.10.7 Alert given (unconfirmed) shall:
- give audible signal along with visual indication;
- provide information on the alert reason;

Additionally, it is recommended that voice communication in English be given to describe the particular alert.

7.10.8 Alert signals shall be in accordance with the requirements specified in paragraphs 20.4.1.5 and 20.4.1.6.

7.10.9 Unconfirmed warning shall gradually:
a) be repeated as a warning within 5 minutes;
b) convert into an alarm within further 5 minutes;

7.10.10 Alert management system shall be provided with human-machine interface (HMI).

7.10.11 Alerts of category A shall be indicated in the position directly corresponding to the particular system.

7.10.12 Alerts of categories B and C shall be duplicated in the HMI.

7.10.13 In the HMI it shall be possible to confirm any alarm and warning only separately.

7.10.14 HMI shall provide for simultaneous communication of at least 20 of all recent alerts.

7.10.15 The possibility shall be provided for the screen to return to the display of essential alerts by a single move of the operator.

7.10.16 Clear indication shall be provided on screen for each newly displayed alert in the case of verification of the alerts in the history or in the case of screen selection for setting/analysis of other functions.

7.10.17 Means shall be provided for all the alerts to be recorded in the history and kept for at least 24 hours. Easy access to the alerts for their immediate verification shall possible for the crew for 24 hours a day.

7.10.18 The system including the HMI shall be duplicated and it shall be supplied by separate feeders from two sources of electrical power one of which shall be an emergency source of power of the ship.

7.10.19 In case of failure of the main source of electrical power, the system shall retain all the information and automatically restart on the resumption of power supply from the emergence source.

8 PROTECTIVE DEVICES

8.1 General Requirements

8.1.1 Except the cases, specified in 8.3.3, 8.4.1 and 8.9, outgoing circuits of switchboards are to be protected against short-circuits and overloads by means of suitable devices installed at the beginning of each circuit.

Where circuit overload is not likely to occur, the circuit may be protected against short-circuits only.

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

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

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

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

8.1.4 Overload protection is to be provided in:

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

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

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

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

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

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

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

8.2 Protection of Generators

8.2.1 Generators not intended for parallel operation are to be provided with means of protection against overload and short-circuits. Fuses may be used as protective devices for generators rated under 50 kW (kVA), where installed with switches or contactors operating in all phases simultaneously.

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

.1 against overloads;

.2 against short-circuits;

.3 against reverse current or reverse power;

.4 against under-voltage.

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

For a setting of the protection to operate at 150 per cent of the rated current of generator, the time-lag is not to exceed 2 minutes for a.c. generator and 15 seconds for d.c. generator. At overloads exceeding 150 per cent of the rated current, the disconnection of the generator under such overload is to be instantaneous.

Overload protection setting and time delay values are to be selected to correspond to the overload characteristics of the generator prime mover so that the prime mover is capable of developing the necessary output within the time delay period adopted.

The protective devices used for generator overload protection are not to preclude the possibility of restarting the generator immediately.

8.2.3 Means are to be provided to automatically and selectively disconnect the less essential services in the event of the generator being overloaded. This load shedding may be carried out in one or several stages, depending on the generator overload capacity.

The equipment for which the automatic load shedding is unconditionally allowed includes all services for habitability, e.g.: cooking, heating, domestic refrigeration, mechanical ventilation, air-conditioning, equipment of sanitary systems, etc.

The equipment for which the automatic load shedding is permissible includes the services specified in: 4.3.1.7, 4.3.1.12, 4.3.1.19 and 4.3.1.20. The automatic load shedding of other services is allowed unless their disconnection causes immediate disruption or prevents the systems required for the ship safety from being immediately available when the power supply is restored to normal operation conditions.

The equipment for which the automatic load shedding is not allowed includes at least all services specified in 4.3.1.1 to 4.3.1.6.

The scope of the shed equipment is subject to special consideration by PRS in each particular case.

The above-mentioned requirements may be considered not applicable to ships having low-power electrical installation which requires PRS' consent in each particular case.

8.2.4 Reverse-power protection for generators intended to operate in parallel is to be selected to correspond to the prime mover characteristics. The respective protection settings are to be in accordance with those specified in Table 8.2.4.

Table 8.2.4

Kind of current	Limits of reverse-power protection settings related to generator prime mover	
	Turbine	Internal combustion engine
Alternating current	2-6 per cent of rated output of generator (kW)	8-15 per cent of rated output of generator (kW)
Direct current	2-6 per cent of rated current of generator (A)	8-15 per cent of rated current of generator (A)

Reverse-power and reverse-current protection for direct-current generators is to be installed in the pole opposite to that in which the equalizer is connected. Reverse power or reverse-current protection is still to be capable of operation when the voltage applied is reduced by 50 per cent although reverse current or reverse power may have altered values.

Reverse-power and reverse-current protection is to permit transfer of power led from the ship's network (e.g. from cargo winches).

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

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

8.2.6 Protection against internal faults and damage to connections between the generator and the circuit-breaker, causing de-energizing and immediate switching off the generator, is recommended for generators of rating 1500 kVA and above.

8.2.7 If a turbine-driven d.c. generator is intended for operation in parallel with other generator, a device is to be provided to trip the automatic circuit-breaker of this generator when the emergency governor of the turbine operates.

8.2.8 The short-circuit trips with a time-lag are to be so selected that in each case the expected short-circuit current in a protected circuit, after the lapse of the time-lag, is greater than the minimum return current of the trip.

8.2.9 Fuses may be applied as protection of semiconductors in the generator excitation circuits. Overload protection is to be in accordance with thermal characteristics of semiconductors.

8.2.10 Electronic or computerised protection devices for generators and consumers with load current higher than 30% of the rated current are to be provided with:
– arrangements to readily identify the final settings, if they are adjustable;
– facilities and instructions for testing on board the settings and functions.

8.3 Protection of Electric Motors

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

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

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

It is admissible for motor overload protective devices to be replaced by audible and visual signals subject to special consideration by PRS in each particular case.

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

8.4 Protection of Steering Gear Motors

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

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

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

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

8.4.3 The electric motors of active means of steering the ship are to have short-circuit and overload protection. Overload protection is to give audible and visual signals and is to cause the disconnection of the electric motor within the range required by 8.3.2.

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

8.4.4 Where the steering gear motor circuits are supplied via an electronic converter and are limited to the converter's full load current, the requirement of paragraph 8.4.2 need not be complied with. In such case the required, in 8.4.1, an overload warning is to be set to a value not greater than the normal load of the electronic converter (determined in accordance with the manufacturer's operating instructions).

8.5 Protection of Transformers

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

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

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

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

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

If these transformers are supplied from different sections of the main switchboard, which may be disconnected during service , an interlocking device is to be provided to prevent their parallel operation when one of the sections, from which they are supplied, is disconnected.

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

8.6 Protection of Storage Batteries

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

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

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

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

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

.1 the lamps are supplied through circuits inside the enclosure of the device;

.2 the protection of the device circuit is not exceeding 25 A;

.3 a fault in the lamp circuit is not liable to cause an interruption in the operation of an essential service.

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

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

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

.1 the coils are in the common enclosure of the device, they have common protective devices and they refer to the control system of one device;

.2 the coils are supplied through circuit of the device with protection not exceeding 25 A.

8.8 Protection of Power-electronic Equipment

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

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

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

8.9 Protection of Emergency Circuits

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

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

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

9.1 General Requirements

9.1.1 Each ship with self-propulsion is to be provided with the emergency source of electric power.

Such a source of power is not required in ships where the main source of electric power are accumulator batteries, provided that at least one of the batteries installed meets the capacity and the location requirements for the emergency source of electric power.

The installation of the emergency source of power in ships without self-propulsion is subject to special consideration by PRS in each particular case.

9.1.2 Generators with an independent drive or accumulator batteries may be used as the emergency source of electric power.

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

Where electrical power is necessary to restore propulsion from a dead ship condition, the emergency source of electrical power is to have such capacity that the necessary propulsion starting energy is available within 30 min of blackout. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and other essential auxiliaries (excluding emergency generator).

The dead ship condition is understood to mean a condition under which the main propulsion plant, together with generating sets are not in operation and devices intended for starting the main and auxiliary engines such as starting air vessels or starting batteries are discharged. Emergency generating set is not in operation but it is ready to use.

For steam ships, the 30 min. time limit is to be considered as time from blackout/dead ship condition to light-off of the first boiler.

9.1.4 Means are to be provided to enable the inspection of all emergency electrical installations, including the automatic starting arrangement.

9.1.5 The central control station or the main switchboard are to be provided with a device indicating the discharge of an accumulator battery serving as the emergency or the transitional emergency source of power.

9.2 Spaces of Emergency Sources of Electric Power

9.2.1 The spaces of emergency sources of electric power, associated transforming equipment (if any), the transitional sources of electric power, the emergency switchboard and the emergency lighting switchboard are to be situated above the highest continuous deck, outside machinery casings and aback the collision bulkhead.

The exits from these spaces are to be easily accessible and are to lead directly to the open deck on which the emergency source of electric power is located.

9.2.2 The location of the emergency sources of electric power, associated transforming equipment (if any), the transitional sources of electric power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electric power, associated transforming equipment, and the main switchboard is to be such as to ensure that fire or other casualty in the space containing the main source of electric power, associated transforming equipment, the main switchboard or in any machinery space of Category A will not interfere with the supply, control and distribution of emergency electric power.

9.2.3 The spaces of emergency sources of electric power, associated transforming equipment, the transitional sources of power, the emergency switchboard and the emergency lighting switchboard are not to

be adjoining, as far as practicable, to machinery and boiler compartments of Category A or spaces containing the main source of electric power, associated transforming equipment and the main switchboard.

Where such an arrangement is impracticable, decks and bulkheads separating the spaces are to comply with the requirements concerning control stations, set forth in *Part V – Fire Protection*.

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

9.2.5 Where the emergency source of electric power is a generator with an independent drive, the emergency switchboard is to be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

This space is to contain also all the starting, charging and energy storing devices intended for starting the emergency set.

9.2.6 The space of the emergency generating set is to be provided with heating arrangements to ensure appropriate temperature for ready starting of the set. The space is to be also ventilated in compliance with requirements of para. 11.3.3, *Part VI – Machinery Installations and Refrigerating Plants*.

9.2.7 An accumulator battery which constitutes the emergency or transitional source of electric power, as well as the emergency switchboard are to be installed in separated spaces. The accumulator battery space is to meet the requirements given in 13.2.

9.3 Emergency Sources of Electric Power in Cargo Ships

9.3.1 The emergency sources of electric power in cargo ships of 300 tons gross tonnage and upwards of unrestricted service and the restricted service **I** are to have adequate capacity to supply simultaneously, for a period of 18 hours, electric power to the following consumers:

- **.1** emergency lighting of :
  - **.1** all corridors, stairways and exits leading from accommodation and service spaces, personnel lift cars and their trunks,
  - **.2** the machinery and generating sets spaces,
  - **.3** all control stations, the main and the emergency switchboards,
  - **.4** emergency generating set space,
  - **.5** the navigation bridge,
  - **.6** chart room and radio room,
  - **.7** the stowage positions for emergency and fire equipment, as well as the location of the manually operated call points,
  - **.8** the steering gear compartment,
  - **.9** position at the fire pump, the emergency bilge pump, the sprinkler pump and at the starting positions of their motors,
  - **.10** air-sheds and landing fields for helicopters,
  - **.11** gyrocompass rooms,
  - **.12** medical rooms;
  - **.13** in all cargo-pump rooms of tankers constructed on or after 1 July 2002;
- **.2** navigation lights, ”not under command” lights and other lights required by the *International Regulations for Preventing Collisions at Sea* (the COLREG Convention);
- **.3** internal communication equipment, command broadcast apparatus and general alarm system;
- **.4** navigation and radio equipment in accordance with the requirements of the SOLAS Convention (these requirements are also given in *Part IV and Part V* of the *Rules for Statutory Survey of Seagoing Ships*);
- **.5** fire detection system;
- **.6** the daylight signalling lamp, audible devices (whistles, gongs, etc.), the manually operated calling signalisation and all internal signalling systems required in an emergency;

.7 one of the fire pumps (if supplied by the emergency source of electric power) and the electric installations ensuring the operation of the foam generators specified in para. 3.5.3.5, *Part V – Fire Protection*;

.8 other consumers, whose operation will be regarded by PRS necessary to ensure the safety of the ship and that of the people on board.

The consumers, specified in 9.3.1.3 to 9.3.1.6, may be supplied by their own accumulator batteries installed in accordance with 9.2 and having sufficient capacity to supply the services during 18 hours.

For ships of 300 tons gross tonnage and upwards of restricted service **II** (only for ships engaged on domestic voyages) and of restricted service **III** (for ships engaged on domestic voyages and for ships engaged on international voyages) the required period of 18 hours may, upon the consent of the Administration, be reduced to 12 hours.

For ships of less than 300 tons gross tonnage of unrestricted service and the restricted service **I**, the required period of 18 hours may be reduced to 6 hours; for ships of less than 300 tons gross tonnage of restricted service **II** and **III** – to 3 hours.

9.3.2 The emergency sources of electric power are to supply, for the period of 3 hours, the emergency lighting of places at lifeboats and liferafts, as well as the out-board spaces where the lifeboats and liferafts are brought down on water.

9.3.3 The emergency sources of electric power are to ensure supply to the steering gear.

9.3.4 Where the emergency source of electric power is a generator with an independent prime mover, it is to be:

.1 driven by internal combustion engine (see para. 2.1.6, *Part VII – Machinery, Boilers and Pressure Vessels*) fitted with an alarm and safety system required by 9.3.10;

.2 capable of automatically starting in case of the loss of voltage in the main network and automatically connecting to the emergency switchboard busbars; the services required in 9.3.7 are to be automatically supplied from the emergency generator. The total time of starting and taking over the required load by the generator cannot exceed 45 seconds;

.3 provided with a transitional source of electric power if the time of the generator automatic starting and supplying the load, as required in .2, exceeds 45 seconds.

9.3.5 Where the emergency source of electric power is an accumulator battery, it is to:

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

.2 be capable of automatically connecting to the emergency switchboard busbars in the case of the loss of voltage in the main network and capable of immediately supplying at least those services specified in 9.3.7.

9.3.6 The accumulator battery is to be used as a transitional source of electric power required in 9.3.4.3. The capacity of the battery is to be sufficient to provide power supply without recharging and at the voltage changes at its terminals within ± 12 per cent of the rated value throughout the discharge period.

9.3.7 The capacity of the battery used as a transitional source of electric power is to be such as to ensure, for 30 minutes, power supply to the following consumers:

.1 lighting and navigation lights in accordance with 9.3.1.1, 9.3.1.2 and 9.3.2;

.2 all internal communication equipment and signals required in an emergency;

.3 fire detection and general alarm systems;

.4 the daylight signalling lamp, audible signals (whistles, gongs, etc.).

The consumers specified in .2, .3 and .4 are not required to be supplied by a transitional source of electric power, provided they have their own accumulator batteries of sufficient capacity for the required period of time.

9.3.8 During transition from the main to emergency power supply, services requiring continuous power supply are to be supplied from uninterruptible power system (UPS) complying with the requirements of sub-chapter 9.6.

9.3.9 Uninterruptible power systems used as battery or transitional emergency sources of power supply, required in 9.3.5 and 9.3.4.3, are to additionally comply with the requirements of sub-chapter 9.6.

9.3.10 Internal combustion engines driving emergency generators are to be fitted with an alarm and safety system designed:

.1 so that their parameters comply with the requirements of Chapter 2, *Part VII – Machinery, Boilers and Pressure Vessels*;

.2 to "fail safe". The characteristics of the "fail safe" operation are to be evaluated on the basis of the system topology, its associated machinery, the complete installation and ship;

.3 such that regardless of the engine output, all shutdowns (except overspeed shutdown) are automatically overridden when the engine is in automatic or remote control mode during navigation;

.4 in which the alarm system functions in accordance with the requirements of 20.4.1 and 21.3, with an additional requirement that emergency diesel engine group alarms are to be arranged on the bridge;

.5 with a local means of engine shutdown additional to the fuel oil control from outside the space;

.6 with a local indications of at least those parameters listed in .1 within the same space as the emergency diesel engines and remaining operational in the event of failure of the alarm and safety systems.

9.4 Distribution of Electric Power from Emergency Sources

9.4.1 The emergency switchboard is to be supplied during normal operation from the main switchboard by an interconnector feeder which is to be protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard in case of the loss of voltage in the main source of electric power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

9.4.2 While the ship is at sea, the emergency generating set may be used for short periods only, to supply consumers other than those specified in 9.3.1, 9.3.2, 9.3.3 in the following conditions:

.1 blackout condition;

.2 dead ship condition;

.3 routine use for testing;

.4 short-term parallel operation with the main source of electrical power for the purpose of load transfer.

9.4.3 The emergency generating set may be used, exceptionally and for short periods, during the ship lay time in port for the supply of the consumers not mentioned in 9.3.1, 9.3.2 and 9.3.3, provided the following requirements are complied with:

.1 to prevent the generator or its prime mover from becoming overloaded when used in port, arrangements are to be provided to shed sufficient non-emergency loads to ensure its continued safe operation;

.2 the prime mover is to be fitted with fuel oil and lubrication oil filters, monitoring equipment and protection devices as required for the prime mover for main power generation and for unattended operation;

.3 the fuel oil supply tank is to be provided with a low level alarm, arranged at a level ensuring sufficient fuel oil capacity for the emergency services for the period of time required in 9.3.1 and 22.1.2;

.4 the prime mover is to be designed and built for continuous operation and should be subjected to a planned maintenance scheme ensuring that it is always available and capable of fulfilling its role in the event of an emergency at sea;

.5 fire detectors are to be installed in the locations containing emergency generating set and the emergency switchboard;
.6 means are to be provided to readily change over to emergency operation;
.7 supply, control and monitoring circuits are to be so arranged and protected that any electrical fault will not influence the operation of the main and emergency services.

When necessary for safe operation, the emergency switchboard is to be fitted with switches to isolate the circuits.

9.4.4 Instructions are to be provided on board to ensure that when the ship is under way, all control devices (e.g. valves, switches) are in a correct position for the independent emergency operation of the emergency generating set and emergency switchboard.

These instructions are also to contain information on the required fuel oil tank level, position of harbour/sea mode switch, if fitted, ventilation openings, etc.

9.4.5 The consumers, listed in 9.3.1.1 and 22.1.2.1, are to be supplied with electric power by separate circuits directly from the busbars of the emergency switchboard fitted with suitable protection devices and switches. The consumers, listed in 9.3.1.2 to 9.3.1.6 or in 22.1.2.1.2 to 22.1.2.1.6, may be supplied from the ship's navigation control and monitoring console located on the navigation bridge and supplied in accordance with 4.4.2.

9.4.6 Where a transitional source of electric power is fitted, the consumers listed in 9.3.7 or 22.1.2.7 are to be supplied through a special switchboard. The circuits of the switchboard are not to be fitted with switches.

9.4.7 Cables supplying the emergency consumers are to be so run as to ensure the electric power supply to the remaining emergency consumers in case the emergency consumers located below the bulkhead deck are flooded.

9.4.8 The switchboards of the emergency consumers are to be located above the bulkhead deck, behind the collision bulkhead.

9.5 Starting Arrangements of Emergency Generating Sets

9.5.1 The following devices with a continuously stored energy may be used as the starting arrangements of emergency generating sets:
.1 electrical starting system with its own accumulator battery and the charging system supplied from the emergency switchboard;
.2 hydraulic starting system supplied from the emergency switchboard;
.3 compressed air starting system supplied from the main or auxiliary air receivers through a non-return valve or by emergency air compressor supplied from the emergency switchboard.

9.5.2 Each emergency generating set arranged to be automatically started is to be equipped with a starting device of an approved type having the energy reserve sufficient for performing at least three consecutive starts. A source of the stored energy is to be protected against critical depletion by the automatic starting system, unless a second independent means of starting is provided. In addition, a second source of energy for additional three starts within 30 minutes or a manual starting device are to be provided.

9.5.3 Where automatic starting of the emergency generating set is not required, manual starting initiated by manual cranking, inertial starter, manually charged hydraulic accumulators, powder charge cartridges may be applied, provided it can be demonstrated as being effective.

Where manual starting is not practicable, the starting devices are to comply with the requirements of 9.5.1 and 9.5.2, manual initiation of starting being permitted.

9.5.4 Where the emergency generating set is arranged to be started by means of electric starting system with its own accumulator battery only, a second accumulator battery serving as a reserve source of power with stored energy meeting the requirements of para. 9.5.2 is to be provided.

9.5.5 Emergency generating sets are to be capable of being readily started in their cold condition down to the temperature of 0°C. If this is impracticable or if lower temperatures are likely to occur, heating arrangements are to be provided so that ready starting of the generating sets is ensured.

9.6 Uninterruptible Power System (UPS) Units as Battery or Transitional Emergency Power Systems

9.6.1 Uninterruptible Power System units (hereinafter referred to as UPS units) are to be constructed in accordance with IEC Publication 62040 or the relevant national or international standards agreed with PRS. For the purpose of the present requirement, the following types of the UPS units can be distinguished:

.1 off-line UPS unit – an UPS unit where under normal operation the output load is powered from the bypass line (raw mains) and only transferred to the inverter if the bypass supply fails or goes outside, permitted by the *Rules*, preset limits. Permissible break in the load supply during transfer is to be not longer than 10 ms;

.2 line interactive UPS unit – an off-line UPS unit where the bypass line switches to the inverter when the input power goes outside, required by the *Rules*, voltage and frequency limits;

.3 on-line UPS unit – an UPS unit where under normal operation the output load is powered from the inverter, and will therefore continue to operate without break in the event of the supply input failing or going outside, permitted by the *Rules,* preset limits.

9.6.2 The operation of the UPS unit is not to depend upon external services.

9.6.3 The type of the UPS unit is to be appropriate to the power supply requirements of the connected load equipment.

9.6.4 An external bypass is to be provided.

9.6.5 The UPS unit is to be monitored and audible and visual alarm is to be given in a normally attended location for:

.1 power supply failure (voltage and frequency) to the connected load;

.2 earth fault;

.3 operation of battery protective device;

.4 when the battery is being discharged;

.5 when the battery bypass is in operation (applies to on-line UPS units, see 9.6.1.3).

9.6.6 The UPS unit is to be suitably located for use in an emergency. UPS units utilizing valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC Publication 62040 or the relevant national or international standards agreed with PRS.

9.6.7 The output power is to be maintained for at least the duration required for the connected equipment, as specified in 9.3 or 22.1.2.

9.6.8 No additional services are to be connected to the UPS unit without verification that the UPS unit has adequate capacity. The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in the requirements of the present Part of the *Rules*.

9.6.9 The rating parameters of the UPS charge unit are to be sufficient to recharge the batteries while maintaining the output supply to the UPS unit load equipment.

10 ELECTRIC MACHINES

10.1 General Requirements

10.1.1 Electric propulsion generators and electric propulsion motors or, where justified, also machines of other designation, are to have heating arrangements to maintain their temperature at least 3°C above the ambient air temperature.

10.1.2 Shaft generators are to have a possibility for the stator to be axially shifted in relation to the rotor to ensure an access to the winding. If such shifting is impossible, a split stator and split bearing discs are to be provided.

Such shaft generators are to have an air-gap precluding the possibility of mechanical contact of the stator with the rotor in the most unfavourable service conditions.

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

.1 generators, converters, electric couplings and brakes: 120 per cent of the rated speed, but not less than 3 per cent of the maximum number of revolutions in transient conditions;

.2 series-wound motors: 120 per cent of the permissible speed as indicated on the rating plate, but not less than 150 per cent of the rated speed;

.3 all motors other than those mentioned above: 120 per cent of the maximum no-load speed.

10.1.4 Where a machine is so designed that at the point of installation on board its lower part is situated below the floor level, ventilating air intake is not to be effected through the bottom part of the machine.

10.1.5 The requirements concerning electric machines testing are given in *Publication No. 42/P – Testing of Electric Machines.*

10.2 Rings, Commutators and Brushes

10.2.1 Direct-current machines for driving the propulsion plants and direct-current machines rated at 200 kW and above are to be provided with sight holes to permit observation of the commutator and brushes without removing the lids.

10.2.2 The permissible amount of wear of commutator segments or slip rings is to be indicated on their face side. It is to be taken equal to at least 20 per cent of the commutator segment or ship ring height.

10.2.3 For rotor of a mass of more than 1000 kg, possibility of reconditioning the commutator without removing the rotor from the machine is to be provided.

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

10.2.5 The position of brushes in direct-current machines is to be clearly and indelibly marked.

Direct-current machines are to be so constructed as to be capable of working with fixed brush setting under all conditions.

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

No sparking is to be possible at the specified overloads, reversals or starts, to such an extent as to cause damage to brushes or commutators.

10.3 Bearings

10.3.1 Bearings are to be so designed as to avoid the possibility of oil splashing or leaking along the shaft and coming into contact with the machine windings or live parts.

10.3.2 Sliding bearings are to be fitted with overflow holes enabling outflow of oil excess and an oil level inspection lid. Oil level indicators are to be provided on machines rated at 100 kW (kVA) or more.

10.3.3 Pressure lubrication systems are to incorporate pressure indicators for oil supplied to a bearing.

10.3.4 Where reasonable, measures are to be taken to prevent flow of shaft stray currents through machinery bearings.

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

10.4 Temperature Sensors

10.4.1 Stators of alternating-current machines rated at over 500 kVA or having an axial core length of more than 1000 mm, are to be provided with temperature sensors installed in places where the highest temperatures may be expected.

10.4.2 Embedded temperature sensors are recommended for short-time-rated and intermittent-rated electric motors.

10.4.3 It is recommended that embedded temperature sensors be used for the windlass drive electric motors. The sensors are to be so selected that the protection system disconnects the motor when the temperature rise limit for the insulation employed is exceeded by more than 30 per cent.

The terminals of sensors leads are to be so located as to be easily accessible.

10.5 Overcurrent

10.5.1 Generators are to be so designed that after reaching the steady-state temperature corresponding to the rated load they are capable of sustaining overcurrent such as specified in Table 10.5.1

Table 10.5.1

Item	Type of generator	Overcurrent [%]	Duration of overcurrent [sec.]
1	A.C. generator	50	120
2	D.C. generator	50	15

10.5.2 Electric motors are to be so designed as to be capable of developing, without stopping or sudden speed changes, increased torque such as specified in Table 10.5.2.

Table 10.5.2

Item	Type of motor	Overload by torque [%]	Duration of overload [sec.]	Testing conditions
1	Polyphase synchronous motors, as well as squirrel-cage motors with starting current less than 4.5 times the rated current	50	15	Frequency, voltage and excitation to be maintained at rated levels
2	Polyphase induction motors for continuous and intermittent duties	60	15	Frequency and voltage to be maintained at rated levels
3	Motors as specified in 2, but for short-time and continuous duty with varying load	100	15	As above
4	Direct-current motors	50	15	Voltage to be maintained at rated level

10.6 Alternating-current Generators

10.6.1 General Requirements

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

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

10.6.1.3 Alternating-current generators are to have excitation margin sufficient to maintain for 2 minutes the rated voltage with a tolerance up to 10 per cent, with generator's overload equal to 150 per cent of the rated current and power factor equal to 0.6.

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

10.6.1.5 Peak value of the three-phase short-circuit current of synchronous generators during operation at rated value is not to exceed fifteen-fold peak value of rated current.

10.6.2 Voltage Regulation

10.6.2.1 Alternating-current generators are to have voltage regulation system so adjusted to the regulation characteristics of the prime movers that the rated voltage is maintained within ± 2.5 per cent (up to ± 3.5 per cent for emergency sets) at load changes from no-load to the rated load at rated power factor.

Main generators may have their voltage maintained within ± 3.5 per cent of the rated value at all power factor values from 0.6 to 0.9 except for the rated power factor.

The above requirement applies to a set operating at the rated speed and load of the generator.

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

Following such a change, the generator voltage is to be restored within not more than 1.5 seconds to the rated value with a tolerance of ± 3 per cent. For emergency sets, these values may be increased, respectively, to 5 seconds and ± 4 per cent of rated voltage.

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

10.7 Direct-current Generators

10.7.1 General Requirements

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

10.7.2 Voltage Regulation

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

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

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

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

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

Voltage variations in a compound-wound generator running at 20 to 100 per cent of the rated load are not to 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.

10.7.2.6 Direct-current sets comprising shunt-wound generators are to 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.

10.8 Electromagnetic Brakes

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

10.8.2 A 30 per cent voltage fall below the rated value is not to cause a hot brake to operate.

10.8.3 Electromagnetic brakes are to allow a manual release.

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

10.8.5 The shunt windings of a compound-wound electromagnetic brake are to be capable of holding off the brake even when no current flows through the series winding.

10.8.6 The shunt windings of electromagnetic brakes are to be so constructed or protected that they can be safe from damage at overvoltages such as occur when they are disconnected.

11 TRANSFORMERS

11.1 General Requirements

11.1.1 The requirements of the present sub-chapter apply to power and lighting transformers specified in 3.3.

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

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

11.2 Overloads, Voltage Variations and Parallel Operation

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

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

11.2.3 Parallel-operating transformers are to have compatible vector groups, the same transformation ratios and their short-circuit voltages are to be such that the load on any transformer, at full load, does not depart from the corresponding proportional part of its power output by more than 10 per cent.

11.2.4 Where transformers are arranged to operate in parallel, the rated power output of the smallest transformer is not to be less than half the rated power output of the largest transformer.

12 POWER-ELECTRONIC EQUIPMENT

12.1 General Requirements

12.1.1 Power-electronic equipment is to be provided with silicon semi-conductor elements. The use of other types of elements is subject to special consideration by PRS.

12.1.2 Power-electronic equipment in which the power loss exceeds 500 W is to be provided with heating appliances to maintain the temperature of at least 3°C higher than the ambient temperature.

12.1.3 Power-electronic equipment is to be provided with air-cooling (natural or forced).

The application of liquid-cooling is subject to special consideration by PRS.

12.1.4 In power-electronic equipment with forced ventilation, a protective device is to be provided to ensure reducing or switching off the load when the ventilation is switched off, as well as the actuating of the visual and audible signals when maximal permissible temperature inside equipment is exceeded.

12.1.5 Power-electronic equipment is to be provided with appropriate measuring instruments.

The maximum permissible values of parameters are to be marked on the scales of the measuring instruments. On the scales of the cooling air thermometers, in the case of forced air cooling, the maximum permissible temperature of the cooling air is to be clearly indicated.

12.2 Permissible Parameters of the Voltage Distortions

12.2.1 The voltage distortion factor, K, of the ship's network, caused by the operation of the power-electronic equipment is not to be greater than 10 per cent. The application of the power-electronic equipment causing the voltage distortions, exceeding the given tolerance range, is subject to special consideration by PRS.

The distortion factor is to be derived from the following formula:

$$K = \frac{1}{U_n}\sqrt{\sum_{v=2}^{n} U_v^2} \cdot 100\% \qquad (12.2.1)$$

where:

U_n – effective value of the network voltage;

U_v – effective value of voltage of v-number harmonic;

v – number of higher harmonic.

12.2.2 The factor uw, determining the maximum relative deviation of the voltage instantaneous value from the first harmonic, is not to exceed 30 per cent.

The factor is to be derived from the following formula:

$$u_w = \frac{\Delta U_m}{\sqrt{2}\,U_1} \cdot 100\% \qquad (12.2.2)$$

where:

ΔU_m – the maximum value of the distorted voltage;

U_1 – the first harmonic effective value of voltage.

12.3 Control and Signalling Systems

12.3.1 Power-electronic equipment is to be provided with visual signals indicating the "on" and "off" position of the power and control circuits.

12.3.2 The power circuits are to be electrically separated from the control circuit.

12.3.3 The prolonged difference between currents in parallel branches is not to be more than 10 per cent of the mean current value.

12.3.4 Failure of any of the rectifier valves is not to affect the operation of power-electronic equipment. An automatic control of load is to be provided to avoid exceeding the permissible loads for each of the rectifier valves. Failure of each of the rectifier valves is to be signalled by visual and audible alarms.

12.3.5 The asymmetry of control pulses of the converter control system ($\Delta\alpha$) is to be determined by the formula:

$$\Delta\alpha = \delta_k - \frac{360}{n} \qquad (12.3.5)$$

where:

δ_k – distance between pulses of the adjacent ducts, in electric degrees;

n – number of control channels.

$\Delta\alpha$ is not to exceed ± 3 electric degrees at any point of the control range.

13 STORAGE BATTERIES

13.1 General Requirements

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

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

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

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

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

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

13.1.6 Accumulator batteries connected in series (e.g. two 12 V batteries supplying 24 V installation) are to be of the same type and the same capacity so that voltage drop occurring on each battery will be the same.

13.2 Arrangement of Accumulator Batteries

13.2.1 Batteries having voltage exceeding the safety voltage, as well as batteries having a capacity of over 2 kW (computed from the maximum charging current and the rated voltage) are to be located in special battery compartments accessible from the deck or in appropriate boxes installed on the open deck. These spaces are to be special electrical spaces.

Batteries having capacity of up to 2 kW may be installed in boxes or cabinets located inside the ship's hull.

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

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

Accumulator batteries having a capacity of less than 0.2 kW are allowed to be installed in any space complying with the requirements of sub-chapter 11.8, *Part VI – Machinery Installations and Refrigerating Plants*, except accommodation spaces, provided that they are protected from the action of water and mechanical damage and do not harmfully affect the surrounding equipment.

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

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

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

13.2.4 The accumulator batteries, as well as the individual accumulator cells are to be properly secured in position. When they are placed on a stillage, the distance between the deck and the plugs of the upper tier of cells is not to exceed 1500 mm.

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

13.2.6 Warning notices indicating the danger of explosion are to be provided on the doors leading to the battery compartment or near thereto, as well as on the boxes containing accumulators.

13.2.7 Accumulator batteries shall not be located in accommodation spaces except where the batteries are hermetically sealed. The location of hermetically sealed accumulator batteries in accommodation spaces is to be agreed with PRS in each particular case.

13.3 Heating

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

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

13.3.3 The shipboard air conditioning system is not to be used for heating the battery compartments.

13.4 Ventilation

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

The ventilation system is to meet the requirements given in sub-chapter 11.8, *Part VI – Machinery Installations and Refrigerating Plants*.

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

13.5 Charging the Accumulator Batteries

13.5.1 Charging facilities are to be provided for charging accumulator batteries supplying essential services. These facilities are to be capable of charging a battery within a period of time not exceeding 8 hours.

If an additional battery, which replaces the battery being charged, is available, the charging time may exceed 8 hours.

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

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

13.6 Installation of Electrical Equipment in Battery Compartments

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

Cables leading to accumulators and lighting fixtures may be run without covers, provided that they have a metal armour or braid covered by non-metallic sheath, and that the armour or the braid are effectively earthed on both ends.

13.7 Electric Starters for Internal Combustion Engines

13.7.1 Number of Starter Batteries

13.7.1.1 In a ship equipped with electrically-started internal combustion engines, irrespective of the number of such engines, not less than two starter batteries are to be installed for starting the main and the auxiliary engines, or not less than two common batteries for starting all engines.

Permanent switching of the system is to be provided to ensure the possibility of using any battery for starting any of the engines in the group serviced by this battery. The arrangement is to be such that the batteries cannot be connected in parallel.

Where a single auxiliary engine is fitted, only one battery may be required.

13.7.1.2 The starting batteries are to be used for starting and the engine's own monitoring purposes only. Arrangements are to be provided to maintain continuously the stored energy at all times.

13.7.1.3 In ships of restricted service **III** and ships of restricted service **II** with the low-rated electrical installation (other than passenger ships), only one starter battery may be allowed, provided it is capable of starting any i.c. engine.

13.7.2 Battery Characteristics

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

13.7.2.2 The capacity of each battery is to 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. For main engines, such number of starts is to be ensured within 30 minutes as is required in the case of the starting compressed air system (see sub-chapter 16.1, *Part VI – Machinery Installations and Refrigerating Plants*).

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

13.7.3 Charging Facilities

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

13.7.3.2 In ships of restricted service **III** and in ships of restricted service **II** with the low-rated electrical installation (other than passenger ships), the starting batteries may be charged only from the generator mounted on the i.c. engine.

13.8 Batteries for Essential and Emergency Services

13.8.1 Where batteries to supply essential and emergency services are fitted, a list of such batteries is to be made and kept. The list, which is to be submitted to PRS' Surveyor during inspection, is to include at least the following information regarding the batteries: type and the manufacturer's name; rating voltage and capacity; location; equipment and/or systems served; maintenance/replacement cycle dates; dates of the latest maintenance and/or replacement; for replacement batteries in storage, the date of manufacture and shelf life.

13.8.2 Replaced batteries are to be of an equivalent performance type. To ensure that, appropriate procedures are to be provided.

13.8.3 Where vented batteries replace valve-regulated sealed ones, it is to be ensured that the existing ventilation is adequate to the location and installation of the vented batteries (see Chapter 11, *Part VI – Machinery Installations and Refrigerating Plants*).

14 ELECTRICAL APPARATUS AND ACCESSORIES

14.1 Electrical Apparatus

14.1.1 General Requirements

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

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

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

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

14.1.2 Manually Operated Apparatus

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

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

14.1.2.2 Switchgear push buttons are to be so designed that they cannot be actuated accidentally.

14.1.3 Motor-operated Apparatus

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

14.1.3.2 Electric motor actuators are to ensure correct closing of switchgear at control voltage varying within 85 to 110 per cent of the rated value and at rated frequency, in the case of alternating current.

14.1.3.3 Actuator operation at 110 per cent of the rated control voltage is not to cause mechanical damage to the switchgear or excessive rebounding of contact liable to affect the switching capacity (due to arcing or welding of contacts). As regards electromagnetic contactors, the above requirement is applicable to contactor operation at an ambient temperature of –10°C and with the coil winding cold.

14.1.3.4 At 85 per cent of the rated control voltage, the actuator is to be capable of correctly closing the switchgear at rated making current, at an ambient temperature of + 45°C and with the actuator winding heated to the rated temperature.

14.1.3.5 A fall of control voltage down to 70 per cent of the rated value is not to cause opening or pressure decrease of movable elements below the required minimum, at an ambient temperature of +45°C and with the actuator winding hot.

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

14.1.4 Coils

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

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

14.1.5 Resistance Elements

14.1.5.1 Resistance elements are to be easily replaceable in sections or as a whole.

14.1.5.2 Resistors are to be so located and ventilated that they do not heat other devices beyond the permissible limits.

14.1.5.3 The joints between resistor elements or between the resistor elements and terminals are to be made by welding or by mechanical press-fitting where there is no need to dismantle them. Soldering is allowed where there is no risk of temperature rise at the point of junction above the specified limits for the solder.

14.1.6 Fuses

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

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

14.2 Installation Fittings

14.2.1 General Requirements

14.2.1.1 Enclosures of accessories and fittings are to be constructed of corrosion-resistant or suitably protected from corrosion and at least low flame-spread materials of adequate mechanical strength. The enclosures of accessories and fittings designed for installation on weather decks, in refrigerated cargo spaces, fish processing shops, or other humid areas are to be made of brass, bronze or equivalent materials, or of plastics of suitable quality.

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

Threaded and fitted joints are not to be made in aluminium alloys.

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

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

14.2.2 Lampholders

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

14.2.2.2 No switches are allowed to be fitted in lampholders.

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

14.2.3 Plug and Socket Connectors

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

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

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

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

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

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

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

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

15 HEATING APPLIANCES

15.1 General Requirements

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

15.1.2 Heating appliances are to be supplied from the main switchboard or section switchboard adopted for this purpose, or from the lighting switchboard, with due regard paid to the requirements of para. 6.2.1.

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

15.1.4 The permissible leakage current for hot heating appliances of stationary type is to 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.

15.1.5 Heating appliances are to be so designed that the temperature of their components which are to be handled by the personnel or which can be touched accidentally does not exceed the values stated in Table 15.1.5.

Table 15.1.5

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

15.2 Space Heating Appliances

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

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

15.2.2 The space heaters are to be installed in compliance with the requirements of para. 7.5, *Part V – Fire Protection*.

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

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

15.2.5 Stationary space heating appliances rated at 380 V and admitted for use in accordance with Table 4.2.2 are to be protected against access to live parts except with the aid of special tools. The enclosures are to have notices giving the voltage value.

15.3 Cooking Appliances

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

15.4 Oil and Fuel Heating Appliances

15.4.1 The electrical heating appliances may be used for heating oil and fuel having a flash point of vapour above 60 °C, provided that the requirements given in 15.4.2 and 15.4.3 are complied with.

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

15.4.3 As required in sub-chapter 12.3, *Part VI – Machinery Installations and Refrigerating Plants,* the heating appliances for oil and fuel tanks are to be provided with temperature control devices for the heated medium, temperature indicators for surfaces of heating elements, minimum level sensors, as well as with means for the disconnection of power supply to the heating devices when the maximum permissible parameters have been reached.

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

15.4.4 Where steam or electric heaters are provided in fuel or lubricating oil systems, they are to be fitted with at least high temperature alarm or low flow alarm in addition to a temperature control system. These alarms are not required where the temperature dangerous for ignition of the medium cannot be reached.

The safety switch with manual re-set is to be provided for disconnecting the supply voltage when temperature above 220 °C can be reached by a surface of the heating element. The safety switch is to be independent from the automatic control sensor.

Fuel and lubricating oil heaters are to be installed in accordance with the requirements specified in 12.2, *Part VI – Machinery Installations and Refrigerating Plants*.

16 CABLES AND CONDUCTORS

16.1 General Requirements

16.1.1 Cables and conductors allowed for use in ships are to be at least fire retardant and tested in accordance with IEC Publication 60332-1 or equivalent test procedures, meeting the requirements of the present Chapter or the relevant national and international standards agreed with PRS, including IEC Publications 60092-3, 60092-350, 60092-351, 60092-352, 60092-353, 60092-354, 60092-359, 60092-373, 60092-374, 60092-375 and 60092-376.

16.1.2 The telecommunication, telephone and coaxial cables are to comply with the requirements of IEC Publications: 60092-351, 60092-373, 60092-374, 60092-375, and 60331-23. Optical fibre cables are to comply with the requirements of IEC Publication 60331-25.

16.1.3 Where the use of fire-resistant cables is required, the cables are to comply with the requirements of IEC Publication 60331. Fire resistant cables are to be easily distinguishable.

16.1.4 The possibility of the use of other types of cables and wires is subject to special consideration by PRS in each particular case.

16.1.5 The requirements of the present Chapter do not apply to power cables for the voltage over 1000 V.

16.2 Conductors

16.2.1 Cable conductors intended for supplying essential services are to be of multi-wire type. Table 16.2.1 specifies the number of wires per conductor.

Table 16.2.1

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
7	240 – 300	61	30

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

16.2.2 Separate wires in multi-wire conductors are to 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 are not to be less than 500 mm.

16.2.3 Separate wires of rubber-insulated copper conductors are to be tinned or coated with a suitable alloy.

Tinning or other anticorrosive coating of external wiring or of all wires of a rubber-insulated conductor may be dispensed with if the manufacturer takes measures to guarantee that the rubber insulation does not affect adversely the metal of the conductor.

No tinning is required for conductors provided with other types of insulation.

16.3 Insulating Materials

16.3.1 The types of insulation that may be used for insulating current-carrying conductors in cables are listed in Table 16.3.1. The use of other types of insulation is subject to special consideration by PRS in each particular case.

Table 16.3.1

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 resistance 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 serviceof cables.

16.4 Cable Sheaths

16.4.1 Cable and conductor sheaths may be made of materials given in Table 16.4.1.

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

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

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

Table 16.4.1

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 resistance quality	85
SE1	Polychloroprene rubber compound	85
SH	Chlorosulfonized polyethylene compound	85
SHF1	Halogen free thermoplastics material	85
SHF2	Halogen free thermosettings material	85

16.5 Protective Coverings

16.5.1 Metal screening braid is to be made of tinned copper wire. If plain copper wire is used, it is to be protected by suitable sheaths. Non-screening braids may be of galvanized steel wires. The braid is to be uniform and its density is to 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.

16.5.2 Metal armour is to 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. On special demand, the armour may be made of non-magnetic metals, using the techniques described above.

16.5.3 Cable armour or braid made of steel tape or wire are to be painted for corrosion prevention.

16.5.4 Armour bedding is to be made of moisture resistant materials.

16.6 Marking

16.6.1 Rubber- or polyvinyl-chloride-insulated cables having a limiting temperature at core over 60 °C are to be marked in such a manner as would permit their identification.

16.6.2 Cable conductors are to be marked in a way that would ensure the permanence of marking.

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

16.7 Wiring

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

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

16.8 Cabling

16.8.1 General Requirements

16.8.1.1 There are to 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 (see 1.2), it is permitted to use single-wire core conductors with a cross-sectional area of 1.5 mm^2 or less.

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

16.8.1.3 In locations affected by the action of crude oil products and other aggressive media, the cables having a sheathing that will withstand the action of a given medium are to be used. Cables of other types may be installed in such locations, provided they are laid in metallic pipes (see 16.8.8).

16.8.1.4 In locations where cables may be subjected to mechanical damage, they are to have an appropriate armour, while other types of cables in such locations are to be protected with special reliable covers or are to be installed in metallic pipes (see 16.8.8).

16.8.1.5 Power and control cables for systems required to be operable under fire conditions, specified in 16.8.1.6, are to be fire-resistant if they pass through the casings of machinery spaces of Category A, galleys, drying rooms, boiler rooms and other high fire risk areas, other than those which they serve.

Systems that are self-monitoring, fail safe or duplicated with cable runs as widely separated as practicable may be exempted from this requirement.

On the outer side of the above-mentioned compartments, the cables are to be run at a distance of not less than that specified in 16.8.4.2.

In ships in which, due to their dimensions, the above requirement cannot be satisfied, measures are to be taken to ensure effective protection of the cables running through fire-hazardous spaces.

16.8.1.6 Systems required to be operable under fire conditions include: fire and general alarm system; fire-extinguishing systems and fire-extinguishing medium alarms; fire detection system; control and power systems to power-operated fire doors and status indication for all fire doors, control and power systems to power-operated watertight doors and status indication for all watertight doors, emergency lighting, low location lighting, public address system, remote emergency stop/shutdown systems for devices which may support the propagation of fire and/or explosion; emergency fire pump in accordance with the requirement specified in 3.2.4.2, *Part V – Fire Protection*.

In each particular case, the system means main and emergency power supply circuits, control, signalling circuits, as well as communication-circuits between the devices constituting part of the system.

The signalling and control cables are to be fire-resistant at least from the control/monitoring panel to the local distribution panel nearest to the relevant area or zone served. The power supply cables are to be fire-resistant at least from their distribution point, within the space containing the emergency source of electrical power, to the local distribution panel nearest to the relevant area or zone served.

16.8.2 Selection of Cables and Conductors for Loads Required

16.8.2.1 Permissible continuous loads on single-core cables and on conductors insulated by various materials are to comply with the values given in Table 16.8.2.1 (see also 16.8.2.6).

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 are to 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 16.8.2.1
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
1	2	3	4	5	6
	+ 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
150	220	310	340	365	410
185	250	350	390	415	470
240	290	415	460	490	–
300	335	475	530	560	–

* Maximum permissible temperature of conductor [°C].

16.8.2.2 The values of permissible current ratings, I, for the cross-sectional areas specified in Table 16.8.2.1, as well as for any other cross-sectional areas are to be calculated from the formula:

$$I = \alpha\, S^{0.625} \quad [\text{A}] \qquad (16.8.2.2)$$

where:

α – factor depending on the maximum permissible operating temperature of the conductor, determined from Table 16.8.2.2;

S – nominal cross-section of conductor, [mm^2].

Table 16.8.2.2

Maximum temperature of conductor [°C]		60	65	70	75	80	85	90
Values of factor α for the nominal cross-sectional area of conductor, S	≥ 2.5 mm^2	9.5	11	12	13.5	15	18	18
	< 2.5 mm^2	8	10	11.5	13	15	18	20

16.8.2.3 Permissible current ratings for two-, three- or four-core cables are to be reduced in relation to the values given in Table 16.8.2.1, using the following correction factors:

0.85 – for two-core cables;

0.70 – for three- and four-core cables.

16.8.2.4 Permissible current ratings for cables and conductors, installed in circuits with intermittent or short-time service, are to be determined by multiplying the value of current rating in continuous service of these cables, calculated in accordance with Table 16.8.2.1 or according to 16.8.2.3, by the correction factor taken from Table 16.8.2.4.

Table 16.8.2.4
Values of correction factors in relation to load

Nominal cross-sectional area of conductor [mm^2]	Intermittent service, 40%		Short-time service, 30 min.		Short-time service, 60 min.	
	Cables and conductors					
	with metal coverings	without metal coverings	with metal coverings	without metal coverings	with metal coverings	without metal coverings
1	1.24	1.09	1.06	1.06	1.06	1.06
1.5	1.26	1.09	1.06	1.06	1.06	1.06
2.5	1.27	1.10	1.06	1.06	1.06	1.06
4	1.30	1.14	1.06	1.06	1.06	1.06
6	1.33	1.17	1.06	1.06	1.06	1.06
10	1.36	1.21	1.08	1.06	1.06	1.06
16	1.40	1.26	1.09	1.06	1.06	1.06
25	1.42	1.30	1.12	1.07	1.06	1.06
35	1.44	1.33	1.14	1.07	1.07	1.06
50	1.46	1.37	1.17	1.08	1.08	1.06
70	1.47	1.40	1.21	1.09	1.09	1.06
95	1.49	1.42	1.25	1.12	1.11	1.07
120	1.50	1.44	1.28	1.14	1.12	1.07
150	1.51	1.45	1.32	1.17	1.14	1.08
185	–	–	1.36	1.20	1.16	1.09
240	–	–	1.41	1.24	1.18	1.10
300	–	–	1.46	1.28	1.20	1.12

16.8.2.5 Permissible current ratings specified in Table 16.8.2.1 refer to the ambient temperature of + 45°C. For other ambient temperatures, permissible current ratings of cables and conductors are to be calculated using correction factors given in Table 16.8.2.5.

Table 16.8.2.5
Values of correction factors in relation to the ambient temperature

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

16.8.2.6 Instead of making calculations resulting from 16.8.2.1 to 16.8.2.5, permissible current ratings for cables and conductors in relation to different maximum insulation temperature and different ambient temperatures in continuous, short-time and intermittent services may be selected according to *Publication*
No. 15/P – Current Rating Tables for Cables, Wires and Busbars in Marine Installations.

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

16.8.2.8 Cables are to be so selected as to withstand the maximum short-circuit current. When choosing the cables, time-current characteristics of the applied protections, as well as the peak value of the anticipated short-circuit current in the first alternation, are to be also taken into account.

16.8.2.9 Cables installed in parallel for the same polarity or phase are to be of the same type, are to be run as close as possible to each other and are to have the same cross-sectional area of at least 10 mm^2 and the same length.

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

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

16.8.3.2 In normal operating conditions, the voltage drop on the cables between the busbars of the main or emergency switchboard and any electric consumers is not to 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.

For navigation light circuits, the permissible voltage drop may be limited to smaller values so as to ensure the required lighting characteristics.

At short-time service, e.g. at starting the electric motors, a greater voltage drop is permissible, provided it does not adversely affect the work of the remaining electric consumers.

16.8.3.3 Cables used for supplying the directly-started alternating-current electric motors are to be so calculated that the total drop of voltage on motor terminals at starting does not exceed 25 per cent of the rated voltage.

The possibility of increasing the specified above voltage drop is subject to special consideration by PRS.

16.8.4 Installation of Cables

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

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

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

16.8.4.3 Cables installed in bunches are to be in accordance with the requirements of IEC Publication 332-3[*)] regarding resistance of cable bunches to the spread of flame or the following means preventing the spread of flame are to be provided:

.1 fire stops, at least of B-0 Class (see sub-chapter 1.2, *Part V – Fire Protection*) are to be fitted on the cable bunches at the inlet to the main switchboard, emergency switchboard, switchboard supplying essential auxiliaries, monitoring and control panels and desks for control of machinery and the ship, as well as at each end of totally enclosed cable runs;

.2 in enclosed and semi-enclosed compartments and spaces, cable bunches installed in semi-enclosed and open cable runs are to be provided with:

– fire protection coating applied to the entire length of vertical runs and to the length of 1 m at every 14 m for horizontal runs, or

– fire stops of the B-0 Class, at least at every second deck or at every 6 m for vertical runs and at every 14 m for horizontal runs;

.3 cable bunches installed in holds are to be protected using fire stops of B-0 Class at the boundaries of the holds.

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

16.8.4.5 In holds of dry-cargo ships intended for the carriage of dangerous cargoes, as a rule, no through runs of cables are to be installed.

Admissibility and methods of installation of cables in such holds are to be agreed with PRS.

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

16.8.4.7 No cables are recommended to be installed under the flooring of machinery spaces. If such an installation is required, cables are to be installed in metallic pipes or in closed ducts (see 16.8.8).

16.8.4.8 Cables installed across expansion joints in the hull structure are to be provided with expansion loops having a radius adequate for such a joint. The inside diameter of a loop is to be not less than 12 times the outside diameter of the cable.

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

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

[*)] Item 2.4 of PN-89/E-04160/55 Standard is considered equivalent.

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

16.8.4.12 Conductors in multi-core cables are not to be used for supplying power and control the circuits of essential services not associated with one another.

Multi-core cable is not to be used for both the safe voltage circuits and working voltage circuits greater than the safe voltage.

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

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

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

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

16.8.4.16 Cables installed in refrigerated spaces are to be provided with protective sheathing of neoprene or of any other material resistant to the action of the refrigerant. If cables are provided with an armour, this armour is to be suitably protected against corrosion.

16.8.4.17 Cables in refrigerating spaces are to be installed on perforated panels or bridges and are to be fastened in position in such a manner that a free space is reserved between the cables and the walls of the room.

Panels, bridges and cable clips are to be protected against corrosion.

If cables are to pass through the thermal insulation of a refrigerated space, they are to run at right angles to the insulation surface in an appropriate gland packed on both ends.

16.8.4.18 The minimum internal bending radii of the cables are not to be less than those specified in Table 16.8.4.18.

Table 16.8.4.18

Item	Kind of cable		External diameter of cable *d* [mm]	Minimum bending radius
	Kind of insulation	Kind of protective covering		
1	Rubber or polyvinyl chloride	Armoured with metal tape or wire	Any	10 *d*
		Protected with braid of metal wires	Any	6 *d*
		Lead alloy and armour	Any	6 *d*
		Other sheathing	Up to 9.5	3 *d*
			9.5 to 25.4	4 *d*
			Over 25.4	6 *d*
2	Varnished cambric	Any	Any	8 *d*
3	Mineral insulation	Metal	Up to 7	2 *d*
			7 to 12.7	3 *d*
			Over 12.7	4 *d*
4	Ethylene-propylene rubber compound or cross-linked polyethylene compound	Semiconducting or metallic	25 and over	10 *d*

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

16.8.5 Fastening of Cables

16.8.5.1 Cables are to be suitably fastened in position by means of clips, holders, hangers, etc. made of metal or other incombustible or low flame spread material.

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

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

16.8.5.2 Distances between the cable fastening points in the case of horizontal installation are not to exceed the values given in Table 16.8.5.2. For vertical runs of cables, these distances may be increased by 25 per cent.

Table 16.8.5.2

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

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

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

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

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

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

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

16.8.6.1 Penetration of watertight, gas-tight and fire-resisting bulkheads and decks is to be made tight. Packing where cables penetrate the mentioned bulkheads and decks is not to reduce their tightness or resistance; no force resulting from elastic deformations of the ship's hull is to be transmitted to the cables.

16.8.6.2 When installing the cables through non-watertight bulkheads or elements of the ship's structure not exceeding 6 mm in thickness, lining or bushings that will prevent damage to cables are to be provided.

Where bulkheads or the ship's structures are more than 6 mm thick, no lining or bushings are required, but the edges of the holes are to be rounded off.

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

16.8.7 Cable Compounds and Packing

16.8.7.1 To fill the cable boxes in watertight bulkheads and decks, the use is to be made of packing compounds having good adhesion to the inside surfaces of cable boxes and cable sheathing, that will withstand the action of water and oil products, will not shrink and lose its tightness in continuous service under conditions specified in 2.1.1 and 2.1.2.

16.8.7.2 Packing of cable penetrations through fire-resisting bulkheads is to be so made as to withstand standard fire test required for the given type of bulkhead, specified in sub-chapter 1.2, *Part V – Fire Protection*.

16.8.8 Installation of Cables in Pipes and Conduits

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

Cables with lead sheaths not having any additional protective coating are not to be drawn into pipes.

The application of cable trays and protective casings made of plastic materials is permitted, provided they meet the requirements specified in sub-chapter 16.8.9.

16.8.8.2 Pipe and conduit bending radius is not to be smaller than the permissible radius for cable of the largest diameter installed in this pipe (see 16.8.4.18).

16.8.8.3 The sum of the cross-sectional areas of all cables as measured on their outside diameters is not to exceed 40 per cent of the inside cross-sectional area of the pipe or conduit, in which the cables are put.

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

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

Pipes having open ends (e.g. ventilation and bilge pipes) in a hazardous area are to be regarded as hazardous area. Enclosed spaces containing such pipes are to be regarded as extended hazardous area, unless provided with overpressure ventilation, with air inlets located in non-hazardous areas.

16.8.8.6 Cable pipes and conduits installed alongside the ship's hull, which can be damaged by deformation of the ship's hull, are to be provided with appropriate compensation devices.

16.8.8.7 Cables running in vertical pipes and conduits are to be protected in such a way as not to be damaged due to tension caused by their own mass.

16.8.9 Cable Trays and Protective Casings Made of Plastic Materials

16.8.9.1 Cable trays and protective casings made of plastic materials are to be supplemented by metallic fixing and straps.

When used on open deck, cable trays and protective casings are to be additionally protected against UV light.

16.8.9.2 The support spacing is to be not greater than that specified in the manufacturer's recommendations for the maximum safe working load and is not to exceed 2 meters.

16.8.9.3 The sum of the cross-sectional areas of all cables passing through the protective casing is not to exceed the value specified in 16.8.8.3.

16.8.9.4 The selection and spacing of cable trays and protective casing supports are to take into account: the dimensions of cable trays and casings; mechanical and physical properties of the material; the mass of cable trays and protective casings, loads due to weight of cables, external forces, thrust forces and vibrations; maximum accelerations to which the system may be subjected; combination of loads.

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

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

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

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

16.8.10.3 If single-core cables rated in excess of 250 A are installed parallel to steel structures, the distance between cables and these structures is to be not less than 50 mm.

16.8.10.4 When installing single-core cables with cross-sectional areas of over 185 mm^2, cables are to inter-cross not less than every 15 m. No cable inter-crossing is required in the case of cable length up to 30 m.

16.8.10.5 Multi-core cables with parallel connected cores are to be installed in the same way as single-core cables. For these cables, all requirements for single-core cables are applicable.

16.8.11 Connecting and Tapping of Cables

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

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

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

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

17 SPECIAL ELECTRICAL SYSTEMS IN SHIPS

17.1 Electric Propulsion Plant

17.1.1 General Requirements

17.1.1.1 In addition to compliance with the applicable requirements of particular Chapters of the present Part, the electrical equipment forming part of the electric propulsion plant is to comply with the requirements specified in IEC Publication 60092-501.

17.2 Dynamic Positioning System

17.2.1 General Requirements

17.2.1.1 In addition to compliance with the applicable requirements of particular Chapters of the present Part, dynamic positioning system is to comply with the requirements specified in IMO MSC./Circ.645 – *Guidelines for Vessels with Dynamic Positioning Systems.*

18 ADDITIONAL REQUIREMENTS FOR EQUIPMENT OF ABOVE 1000 V

18.1 General Requirements

18.1.1 The requirements of the present Chapter apply to electrical equipment with rated voltage above 1000 V up to 15 000 V alternating current and are supplementary to those specified in other Chapters of the present Part of the *Rules*.

Distribution systems with rated voltages above 15 000 V are subject to special consideration by PRS in each particular case.

18.1.2 Insulating materials used in electrical equipment of above 1000 V are to ensure, during the continuous service of the ship, the insulation resistance of at least 2000 Ω per V of rated voltage.

18.1.3 Warning notices indicating the value of voltage are to be placed at the entries to special electric spaces and on the enclosures of electric equipment located outside these spaces.

18.1.4 In junction boxes and sockets, as well as terminal boxes of electrical equipment with rated voltage above 1000 V, no joints are to be installed or connection of conductors effected if such joints or conductors are rated for lower voltages.

18.2 Power Distribution

18.2.1 Distribution Systems

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

.1 a three-core insulated system;

.2 a three-core system with the neutral point earthed directly to the ship's hull;

.3 a three-core system with the neutral point earthed to the hull through a low ohm resistance (value of resistance is to be so selected that the short-circuit earth current is within limits 0.2 ÷ 1.0 of the rated load current of the largest generator);

.4 a three-core system with the neutral point earthed to the ship's hull through a high ohm resistance (value of resistance is to be equal to 1/3 value of the capacitive reactance between phase and an earth).

18.2.1.2 The total resistance of the neutral earthing is to be so selected that the short-circuit current passing through the hull is not greater than the rated current of the largest generator but not less than three times the minimum current required to operate any device protecting against short-circuit with the ship's hull.

It is permitted to connect all earthing resistors to a common earth bar which has connection with the hull at least in two places.

18.2.1.3 It is to be possible to split the main switchboard into at least two sections, each supplied by at least one generator, by means of circuit breakers, switches or switch disconnectors. Alternatively, at least two separate interconnected switchboards are to be provided. In that case, interconnecting cable is to be provided with a circuit-breaker at each end of the cable.

Services, which are duplicated, are to be divided between the sections of the main switchboard or between the interconnected switchboards. For the supply of auxiliary circuits, at least one independent source of electrical power for each section is to be provided.

18.2.1.4 The neutrals of generators operating in parallel may be connected in common before the common earthing resistor.

18.2.1.5 Generator neutrals are to be earthed through resistance in the main switchboard or directly on the generator.

18.2.1.6 For the purpose of maintenance or for the resistance measurements, the neutral conductor of each generator is to be provided with an isolating device so that the earthing connection of generator neutral can be isolated.

18.2.1.7 When using system with neutral earthed, measures are to be taken to preclude passage of short-circuit current from equipment or cable to the ship's hull in the hazardous zones.

18.2.2 Permissible Voltages

Rated voltages are not to exceed the values specified in Table 18.2.2.

Table 18.2.2

Inter-phase rated voltage [kV]	Rated frequency [Hz]
3/3.3	50 or 60
6/6.6	50 or 60
10/11	50 or 60

18.2.3 Power Supply from External Source of Electric Power

The power supply of the ship's network from an external source of electric power is permissible only for ships permanently moored such as floating docks, dredgers, drilling units, etc.

Where external source of supply is necessary for auxiliary circuits, at least two external sources of supply are to be provided. Those external sources are to be so arranged that a failure or loss of one of them will not cause the loss of more than one generator set and/or set of the essential services.

Where necessary, one source of supply is to be from the emergency source of electrical power for the start-up from dead ship condition.

18.3 Protective Devices

18.3.1 General Requirements

18.3.1.1 When different voltages are used in one device, precautions are to be taken to prevent the lower voltage systems from being charged by leakage from the higher voltage systems.

18.3.1.2 The overload protection is to be provided in all phases of the alternating-current system. No fuses are to be used in the overload protection.

18.3.1.3 Installations with rated voltage above 1 000 V are to be provided with audible and visual alarm giving a warning of short-circuit with the ship's hull.

18.3.2 Protection of Generators

18.3.2.1 Generators are to be provided with protection against short-circuit with the ship's hull and against phase-to-phase faults in the cable connecting the generator with the main switchboard.

18.3.2.2 The excitation systems of generators are to cause de-energizing of generators when any of the protective devices of the generator operates.

18.3.2.3 Generators are to be provided with protection against internal faults.

18.3.3 Protection of Transformers

18.3.3.1 Transformers are to be provided with overload and short-circuit protection.

18.3.3.2 The low voltage sides of the transformers are to be protected against overvoltages from higher voltage sides, which may be achieved by:

– direct earthing of the lower voltage system,
– appropriate neutral voltage limiters,
– earthed screen between the primary and secondary windings of the transformers.

18.3.3.3 Where transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

18.3.3.4 Voltage transformers are to be provided with overload and short-circuit protection on the secondary side.

18.4 Protective Earthing

18.4.1 Metallic enclosure of switchboards is to be provided with copper conductor situated along its total length, having at least two relevant terminals for connection with the ship's hull. One-second short-circuit earth current density in this conductor is not to exceed 150 A/mm^2, and the cross-section of conductor is not to be less than 30 mm^2. Casings of compartments and fields are to be connected to earthing conductor directly or by means of the metal parts of structure.

Welded and twisted connections assure proper continuity of earthing, but for twisted connections the surface of connection is to be protected against corrosion by usage of adequate anti-corrosion surfaces.

Depending on the method of the network neutral earthing and the time necessary for activation of the protection devices, maximum short-circuit current is to be taken into consideration for earthing connections.

18.4.2 Earthing of metal parts of withdrawable circuit-breakers or movable elements are to be effective in each fixed and intermediate position.

18.4.3 Doors of the high voltage compartments are to be connected to the earthed structure by means of copper conductor with a cross-section not less than 6 mm^2.

18.4.4 Metal enclosures of other high voltage equipment are to be earthed by means of flexible copper conductor of such cross-section that one-second short-circuit earth current density is not to exceed 150 A/mm^2, but not less than 16 mm^2.

18.4.5 The secondary windings of measuring current and voltage transformers are to be earthed by means of copper conductor with cross-section of not less than 4 mm^2.

18.4.6 The earthing conductors are to be suitably marked.

18.5 Arrangement and Protection Degree of Electrical Equipment

18.5.1 The electrical equipment is to be located in special electric spaces; the degree of protection of its enclosures is to be at least IP23 (see also 18.6).

The degree of protection of terminal boxes of electric rotating machines is to be at least IP44. The degree of protection of metal enclosed switchgear, controlgear assemblies and static convertors is to be at least IP32.

In justified cases, such equipment may be placed outside the special electric spaces, provided the protection degree is at least IP4X and access to live parts is possible only when the voltage is off or with the use of special tools.

18.5.2 A easy-to-read diagram of the arrangement and the connections of electrical equipment is to be located in the special electric space.

18.5.3 Where equipment is not contained in an enclosure but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

18.6 Switchboards

18.6.1 The switchboards are to be provided with doors locked with a special key, other than those for switchboards and electrical equipment operating at lower voltages.

Opening of the door is to be possible only when the part of main circuit located in compartment or field of swichboard which becomes accessible is disconnected from supply.

18.6.2 Circuit-breakers used in switchboards are to be of a withdrawable type.

Circuit-breakers or movable elements with apparatus are to have mechanical devices fixing them in the operating position, in the testing position (control circuits are connected), as well as in switching-off position (main circuits are disconnected and furthermore, there is safe, insulating clearance in poles of main circuit).

Automatic shielding is to be provided, by means of insulating barriers, of fixed contacts of plug connections in live condition when circuit-breaker or movable element is withdrawn to the testing position, switched-off position or withdrawn totally from the switchboard.

Pulling out or pulling in of the circuit-breaker or movable element to the operating position is to be possible only when switchgear is in open condition.

If electrical or other energy is required for the operation of circuit breakers and switches, a store supply of such energy is to be provided for at least two operations of all the components.

However, the tripping due to overload, short-circuit or under-voltage is to be independent of any stored electrical energy sources.

18.6.3 For the purpose of short-circuiting the busbars and the outgoing switchboard circuits with each other and with the ship's hull, a device rated for the maximum short-circuit current is to be provided in the switchboard.

The possibility of using a portable short-circuiting device instead of a stationary one is subject to special consideration by PRS.

18.6.4 Along the free-standing switchboards a passageway is to be provided for inspection of the switchboard and the switchgear. The width of the passageway between the switchboard and the wall is not to be less than 800 mm and that between the parallel switchboard sections – not less than 1000 mm.

If such passageways are intended for maintenance of the switchboard, their width is to be increased to 1000 mm and 1200 mm, respectively.

Such passageway widths are required, irrespective of the type of the accidental touch protection applied.

18.6.5 The clearances between the live parts of electrical equipment and the protective barriers and enclosures are not to be less than those given in Table 18.6.5.

Table 18.6.5

Item	Rated voltage [kV]	Minimum height of passageway [mm]	Minimum protective clearances of live parts from barriers and enclosures consisting of:	
			tight doors and barriers [mm]	insulating handrails [mm]
1	3/3.3	2500	70	600
2	6/6.6	2500	100	600
3	10/11	2500	140	700
4	15	2500	180	700

In the case of smaller distances, appropriate voltage impulse test must be applied.

18.6.6 Switchboards are to be provided with devices intended for reduction of overpressure to ensure the mechanical strength of enclosure in case of internal short-circuit arcs.

Devices are to be so located that the influence of hot and ionized gases would not endanger personnel and compartment, in which they are located.

18.6.7 Switchboards are to be provided with devices which respond to the internal overpressure of compartments or radiation of electric arcs and which cause automatic switching-off of faulty circuit during short-circuit arcs.

18.7 Electric Machines

18.7.1 Electric generators and electric motors stator windings are to have all phase ends brought out to a separate terminal box.

18.7.2 Electric machines are to be provided with temperature detectors in their stator windings to actuate a visual and audible alarm in a normally attended position whenever temperature exceeds the permissible limit. If embedded temperature detectors are used, means are to be provided to protect the circuit against overvoltage.

18.7.3 Heating arrangements are to be provided to prevent the accumulation of moisture and condensation within the machines when they are stopped. It is recommended that such means are automatically switched on at stand-still and switched off at starting.

18.7.4 Heat exchangers of rotating machines are to be of the double tube type. In a normally attended position, a visual and audible alarm is to be given to monitor water cooler leakage.

18.7.5 In addition to the tests normally required for rotating machinery, a high frequency high voltage test is to be carried out on the individual coils in order to demonstrate a satisfactory withstand level of the inter-turn insulation to steep fronted switching surge. This test applies to coils for rotating machinery to be used either in earthed or insulated system and is to be considered as acceptance test.

It is recommended that the test be carried out as follows:

a sufficiently high frequency to develop the required voltage across the coil (e.g. by discharging a capacitor across the coil leads) is to be applied to the coil preferably after inserting the coils into the stator core and after bracing and wedging (if necessary with temporary wedges at the end of the core).

The peak value of the test voltage is given by the formula:

$$U_p = 2.45 \cdot U \quad [\text{V}] \qquad (18.7.5)$$

where:

U – nominal voltage of the system.

Each coil is to be subjected to five impulses. If any coil fails during testing, it is to be replaced and the inter-turn test applied to the replaced coil and repeated on those coils disturbed during the replacement.

Alternative tests proposed by the manufacturer will be accepted, subject to PRS' consent.

18.8 Transformers

18.8.1 Dry transformers having earthed screens between the windings of the high and low voltages are to be used.

The use of other types of transformers is to be agreed with PRS in each particular case.

18.8.2 The isolating of the transformer on the high voltage side is to cause the disconnection of the switch on the low voltage side.

18.8.3 If the voltage on the low voltage side of the transformer does not exceed 1000 V and the windings have the neutral insulated, a protective surge arrester is to be connected between the neutral of each transformer and the ship's hull. Such a surge arrester is to be designed for operation at a voltage not exceeding 80% of the minimum proof voltage of the equipment supplied by the transformer in question.

18.8.4 Parallel to the surge arrester, insulation monitoring instruments or an insulation fault indicator in the lower voltage circuit supplied by the transformer in question may be connected. Such devices are not to interfere with the proper operation of the arrester.

18.9 Cabling

18.9.1 For three-phase alternating-current cabling, three-core cables with multi-wire cores are to be used.

18.9.2 The cross-sectional area of power cable conductor is not to be less than 10 mm^2.

18.9.3 Design, type and the permissible loads of the applied cables are subject to special consideration by PRS in each particular case.

18.9.4 The cables of the network of over 1000 V are to be installed separately from the network cables for voltages of up to 1000 V and are to be clearly marked.

18.9.5 When installing the cables, the following conditions are to be satisfied:

.1 the cables intended for distribution of electric power with various voltage values in the network may be installed in a common run, provided the insulation of all cables installed in the common run is rated for the highest voltage occurring in the run in question;

.2 the cables passing through the accommodation spaces are to be run in enclosed cable protective casings or pipes;

.3 the air clearances between high voltage cables of different voltage ratings are to comply with the distances specified in column 4 of Table 18.6.5;

.4 cables installed outside the special electric spaces are to be contained in earthed metallic pipes or ducts or are to be provided with earthed metallic sheaths.

Cables may be installed in the open when they are provided with a continuous metallic screens, sheaths or armour effectively bonded to earth.

18.9.6 It is not permitted to install connecting boxes nor any similar means for clearing the break in cables, damages or for extending the cables.

18.9.7 Rated voltages of cables are not to be less than the rated voltages of circuits, in which they are used.

Rated voltages of cables are not to be less than the rated voltage between phases of circuit. This concerns systems with the earthed neutral point to the ship's hull through high ohm resistance, without automatic switching-off of the circuit with damaged insulation, as well as systems with insulated neutral point.

18.10 Voltage Tests of Main Circuits

18.10.1 Before being put into service, each system is to be tested by performing:

.1 an insulation resistance test,

.2 a direct current (d.c.) voltage-withstand test with the voltage meeting the following conditions:

$$U \geq 1.6\ (2.5\ U_o + 2)\ \text{[kV]} \qquad (18.10.1\text{-}1)$$

for cables of the rated voltage (U_0) up to and including 3.6 kV; or

$$U \geq 4.2\ U_o\ \text{[kV]} \qquad (18.10.1\text{-}2)$$

for cables of higher rated voltages

where:

U_o – rated power-frequency voltage, between the conductor and earth or metallic screen, for which the cable is designed, [kV].

The test voltage is to be maintained for a minimum of 15 minutes. After completion of the test, the conductors are to be connected to earth for a period sufficient to remove any trapped electric charge.

.3 an insulation resistance re-testing (after the voltage test).

Alternatively, an a.c. voltage-withstand test may be carried out upon advice from high voltage cable manufacturer at a voltage not less than normal operating voltage of the cable and it is to be maintained for a minimum of 24 hours.

Tests according to IEC Publication 60502 are also permitted.

Table 18.10

System voltage, [kV]	Testing voltage 1 min *) [kV]		Impulse voltage [kV]	
	to earth and between phases	safe pole clearance	to earth and between phases	safe pole clearance
3/3.3	10	12	40	46
6/6.6	20	23	60	70
10/11	28	32	75	85

*) For systems with insulated neutral point, testing voltage (1 minute) not less than 7.5 times the value of the rated voltage between phase and neutral point, is to be applied.

19 REQUIREMENTS FOR ELECTRICAL EQUIPMENT OF REFRIGERATING INSTALLATIONS

19.1 General Requirements

The requirements of the present Chapter apply to the electrical equipment of classed refrigerating installations.

The requirements given in 19.2.3, 19.2.4, 19.3.1 and 19.4 are also applicable to unclassed refrigerating installations.

19.2 Power Supply

19.2.1 The electric drives of refrigerating installations are to be supplied by separate feeders from the refrigerating plant switchboard. The motors of refrigerating compressors may be supplied directly from the main switchboard. Refrigerating plant fans may be supplied from the refrigerating plant switchboard or from other switchboard supplied directly from the main switchboard.

Irrespective of the kind of power supply, the drives of refrigerating installations are to be the last to be disconnected in case of the generator overload.

The emergency ventilation is to be supplied by a separate feeder from the main switchboard or other switchboard supplied directly from the main switchboard.

19.2.2 Power supply of the electric drives of isothermal container equipment is to comply with the requirements of sub-chapter 22.4.2.

19.2.3 If the refrigerant of Group II is applied (for the definition, see para. 21.2.1, *Part VI – Machinery Installations and Refrigerating Plants*), a device is to be provided for emergency remote disconnection of the refrigerating installation switchboard, operated from the below given places:

.1 from the permanent control post of the refrigerating installations in the refrigerating machinery room;

.2 from a location situated outside the space that may be contaminated with refrigerants of Group II in the case of a breakdown in the refrigerating machinery room;

.3 outside, near every exit from the refrigerating machinery room.

The apparatus for emergency remote disconnection are to be installed in such a manner that they cannot be actuated accidentally.

19.2.4 The device for emergency remote-controlled disconnection of the refrigerating installation switchboard employing the refrigerant of Group II is to disconnect simultaneously the electric drives of refrigerating compressors if they are supplied directly from the main switchboard (see 19.2.1) and simultaneously disconnect the main lighting of refrigerating machinery room, as well as to switch on the emergency ventilation, water screens and emergency lighting.

Additionally, near the devices for emergency remote disconnection of switchboard of such a refrigerating installation, at locations stated in 19.2.3.1 and 19.2.3.2, devices are to be installed for remote starting, in any sequence, of emergency ventilation, water screens and emergency lighting without disconnection of the refrigerating installation switchboard.

19.2.5 It is recommended to apply safe voltage power supply to electric heating appliances for hatches and exits leading from refrigerating and freezing spaces.

19.3 Ventilation

19.3.1 If the refrigerant of Group II is used, the exhaust fan electric motors of the emergency ventilation in the refrigerating machinery rooms, installed in the exhaust ducts, are to be explosion-proof.

19.3.2 The fan electric motors located in the stream of air coming from the refrigerated cargo spaces are to have an enclosure of at least IP55.

19.4 Lighting

19.4.1 If the refrigerant of Group II is used, explosion-proof emergency lighting fittings are to be installed in the refrigerating machinery space in addition to the main lighting fittings. The emergency lighting fittings are to be supplied separately from the electrical equipment and from the main lighting fittings installed in the refrigerating machinery room.

20 AUTOMATION AND REMOTE CONTROL SYSTEMS

20.1 Application

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

20.2 Design Requirements

20.2.1 General Requirements

20.2.1.1 Computerised automatic systems are to meet the requirements given in *Publication No. 9/P – Requirements for Computer Systems*.

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

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

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

20.2.1.4 Where remote control of the main propulsion from the navigation bridge has been applied and the ship machinery space is continuously manned, local control in the event of remote control system failure is to be provided.

Additionally, the possibility of controlling auxiliary machinery, essential for the operation of the main propulsion and ship safety, from a local position is to be ensured.

20.2.1.5 Control systems with global asymptotical stability features are recommended.

20.2.1.6 Where machinery space of the ship is to be continuously attended by one person, the extent of the necessary remote or automatic control is subject to special consideration by PRS, having regard to the location of the control station and surveillance procedure adopted for the machinery, as well as their service requirements.

20.2.2 Requirements for Components and Units of Automatic Systems

20.2.2.1 Components and units used in automatic systems are to additionally comply with the requirements of the relevant Parts of the *Rules*.

20.2.2.2 Individual components and units of systems and their external connections are to be permanently and clearly marked. The marking is to ensure an easy identification with the drawings and, in the case of sensors, is also to indicate their purpose and the set point. Analog indicators are to be marked with rated values using red colour.

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

20.2.2.4 Components and units to be installed in spaces or areas of explosion risk are to be of intrinsically safe or flame-proof type.

20.2.2.5 Control elements intended for fixing the settings are to be secured against unintentional change of the position. Their repeated securing in case of readjustment is to be enabled.

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

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

20.2.2.8 Replaceable blocks (printed cards) with plug-in connections are to be so designed as to preclude the possibility of erroneous replacement. They should also be capable of being effectively and permanently fixed in working position.

When it is necessary, due to design or functional features of the component or unit, the permanent marking of correct mounting position should be provided or the component or unit itself should be so designed that mounting in other than correct position is impossible.

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

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

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

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

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

20.2.2.14 Temperature sensors installed on the distribution piping for flammable liquids are to be fitted in pockets.

20.2.3 Requirements for Automatic Systems

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

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

20.2.3.3 Each automatic system is to be so designed that the failure in one circuit of lamps, sirens and similar signalling devices does not interfere with the operation of other circuits.

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

20.2.3.5 Automatic systems are to be built of such components and units that their replacement with the other ones of the same type does not affect the operation of the system. If readjustment is necessary, it should be possible by simple means.

20.2.3.6 Automatic systems are to be protected against malfunctions as a result of short time deviations of parameters due to rolling and pitching, starting or stopping of the machinery or due to other similar, normal fluctuation of parameters.

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

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

20.2.3.9 Replaceable and controllable components, as well as the test points are to be arranged with permanent and easy access.

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

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

20.2.3.12 Pneumatic systems are to be fitted with effective means for ensuring the required degree of purity and dryness of air supplied.

20.2.3.13 Drying and filtering equipment used in automatic systems of main propulsion and electric generating sets are, as a rule, to be doubled and so arranged as to ensure the operation of one of them when the other is out of action. Double drying and filtering equipment need not be used, provided it is of self-cleaning type or of such design that quick replacement of contaminated inserts is possible without stopping the air supply.

20.2.3.14 In supply piping of pneumatic systems, safety valves are to be provided to prevent an increase of pressure by more than 10 per cent of the working pressure.

20.2.3.15 Where hydraulic, pneumatic, electric and electronic components are situated in common desks, consoles and other similar units, they are to be so separated from each other that possible leakage of working medium does not affect the electric, electronic or pneumatic components.

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

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

20.2.3.17 Elements intended for control are to be arranged with easy access, and are to be marked appropriately to their assignment, as well as are to be secured against self-acting change of the position.

20.3 Power Supply of Automatic Systems

20.3.1 Where power supply to electrically driven essential machinery is required both from the main and emergency sources, electric and electronic control systems of such machinery are also to be supplied from two independent sources.

20.3.2 Control system of the main propulsion is to be supplied through two independent feeders. One of these feeders is to 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 of the second power source is to be effected automatically.

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

20.3.4 Automatic systems or their hydraulic and pneumatic parts are to be supplied by means of two compressors or two pumps.

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

20.3.6 Alarm system is to be always supplied from two independent power sources. Switching on of the stand-by power source is to be effected automatically.

Where the stand-by power source of the alarm system is an automatically started emergency generating set, the alarm system circuits monitoring the conditions affecting the ship's manoeuvrability and parameters of generating sets prime movers are to be additionally supplied from an accumulator battery of a capacity sufficient for 30 minute operation of that part of the system.

20.3.7 Supply of automatic equipment essential for starting and operation of the emergency generating set is to be taken from starting accumulator batteries or from separate battery located in the emergency generating set compartment.

20.4 Monitoring Systems

20.4.1 Alarm System

20.4.1.1 In addition to compliance with the applicable requirements of the present Chapter, alarm signalling is to comply, within the scope agreed with PRS, with the requirements of the *Code on Alerts and Indicators, 2009.*

20.4.1.2 Depending on the extent of machinery automation, the alarm system is to give the following types of alarms:

.1 alarm to indicate that limit values of parameters have been exceeded;

.2 alarm to indicate that safety system has operated;

.3 alarm to indicate the failure of power supply to particular automatic system or that the stand-by power supply has been switched on;

.4 alarm to indicate that other values or conditions resulting from the detailed requirements of the present Part of the *Rules* have been changed.

Alarm conditions of machinery are to be indicated in the relevant control stations. The arrangement of the alarm display is to assist in identifying the particular fault condition and its location within the machinery space.

20.4.1.3 Alarm system is to function independently of control and safety systems so that a failure or malfunction in these systems will not prevent the alarm system from operating. Possible interconnection of these systems, restricted to the source of alarm only, is subject to special consideration by PRS.

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

20.4.1.5 The alarm system is to operate simultaneously both visual and audible signals.

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

20.4.1.7 Audible signal may be common for all types of alarms. If the possibility of switching off the audible signal is provided the readiness of actuating new alarms from other parameters is to be maintained until the reason of previous signal has been eliminated.

In ships of 500 tons gross tonnage and upwards, switching off audible signals is not to extinguish visual signals.

Audible signals for machinery are to be clearly distinguished from surrounding sounds and other audible signals, e.g. fire, CO_2 releasing, etc. The local switching off the audible signal on the navigation

bridge and in the accommodation area, if provided, is not to stop the audible signal in the machinery space.

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

20.4.1.9 Disconnection or omission of any part of the alarm system is to be clearly indicated.

20.4.1.10 Alarm system is to be capable of being tested during normal machinery operation. Where practicable, means are to be provided at convenient and accessible locations to permit the sensors to be tested without affecting the operation of the machinery.

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

20.4.1.12 When visual signals are given by means of lamps, the colour of a visual signal is to be adequate to the character of this signal and the size of the system in accordance with 4.5.5.

20.4.1.13 Where it is intended to provide a dimming arrangement for alarm system annunciators on the navigation bridge, the arrangement is to be such that the total extinguishing of annunciators luminescence is impossible.

20.4.2 Safety System

20.4.2.1 Safety system of particular units of automated machinery plant is to operate automatically after exceeding limit values of the given parameters causing a failure and is to cover all foreseeable fault conditions assumed with regard to operational properties and characteristics of the machinery concerned so that:

- **.1** normal operating conditions are restored, or
- **.2** the machinery operation is temporarily adjusted to the prevailing conditions (by reducing the load of machinery), or
- **.3** machinery and boilers are protected from failure by stopping (in the case of machinery) or by shutting off the fuel (in the case of boilers).

20.4.2.2 Means are to be provided to trace the cause of the safety system action.

20.4.2.3 The safety system is to operate in the event of lack or wrong reaction of the crew which may result in machinery failure.

20.4.2.4 The safety system intended for the functions specified in 20.4.2.1.3, is to 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 listed in 20.4.2.1.1 and 20.4.2.1.2, complete independence of other control and alarm systems is not required.

20.4.2.5 Safety system is to have such self-monitoring properties that, with the requirements of para. 20.4.2.7 satisfied, alarm signal will be given at least in the case of short circuit, earth fault, broken fuse or broken circuit.

20.4.2.6 Safety systems of different units of the machinery plant are to be independent. Failure in the safety system of one part of the plant is not to interfere with the operation of the safety system in another part of the plant.

20.4.2.7 Safety system is to intervene after operation of the alarm system in the relevant sequence of functions.

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

20.4.2.9 When the safety system has stopped an unit, the unit is not to be restarted automatically, but only after a manual reset has been carried out (see also 20.2.3.8).

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

20.4.3 Indicating and Recording Systems

20.4.3.1 Indicating and recording systems are to be independent of other systems and so designed that their failures do not affect the other systems.

20.4.3.2 A failure in recording system is to be indicated by an audible and visual signal.

20.4.3.3 Means are to be provided to ensure accurate reading of indication on indicating instruments taking into account lighting conditions at the point of their installation.

20.4.3.4 Indicating instruments are to 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.

20.5 Main Propulsion Control Systems

20.5.1 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 controllable pitch propeller, if any.

20.5.2 The remote control from the bridge is to be limited to a single control element (lever, wheel, etc.) separate for each propeller, and all the auxiliary control functions are to be performed automatically. The protection against overloading of the propulsion and against the continuous operation of the propulsion within the forbidden speed range is to be actuated by the remote control, where necessary. Where several propellers constituting one propulsion system are provided to operate simultaneously, they may be additionally controlled by one control element.

In ships of less than 500 tons gross tonnage, whose propulsion system consists of non-reversible engine operating through a reversing gear or controllable pitch propeller, the arrangement with two control elements may be used, provided that the control system is so designed that an erroneous manoeuvre does not result in stopping the engine.

20.5.3 The remote control system is to be independent of engine room telegraph or any other means of communication used for giving the manoeuvre commands. It is permitted to use one lever for both systems.

20.5.4 Auxiliary control operations performed by the remote control system after any setting of the control system, including emergency reversing from ”full ahead”, are to proceed in the programmed sequence with the time intervals required by the main engine being respected.

The programme is not to be time-dependent only, but it is to take account of the operational parameters of the main engine auxiliary installations and signals acknowledging the performance of the sequence of actions according to the programme.

Stoppage in the programme performance is to be alarmed. A simultaneous indication of the place of interruption is recommended.

Where the main turbines are used, the control system is to be so designed that when maintaining the necessary manoeuvrability of the propulsion system, the changes of controlled parameters of the turbine

set do not cause hazardous disturbances in the operation of auxiliary machinery and installations, such as boilers, condenser installations, etc.

20.5.5 The remote control station on the navigation bridge is to be equipped with the device for stopping the main engine in case of emergency independently of the remote control system.

Such device is to be so designed that the requirements given in 20.4.2.9 and 20.2.3.8 are satisfied.

20.5.6 Automatic interlocking of the remote starting of the main engine is to be provided, e.g. when the crankshaft turning gear is under operation or in case of lack of lubricating oil pressure.

20.5.7 In the case of the turbine main propulsion, a device for the slow turning of rotor is to be provided. It is to start automatically when the turbine stops for a longer period of time than permitted by the manufacturer . The possibility of switching off this device from the navigation bridge is to be provided. In ships with permanently attended machinery spaces, automatic starting of the turning device need not be applied.

20.5.8 The remote control system is to be so designed as to give alarm in case of failure, and the number of revolutions, as well as the direction of power screw thrust be maintained till the local station takes over the control. It especially refers to the power supply decay (electric, pneumatic and hydraulic). The decay is not to cause a serious and abrupt change in the power of the main propulsion being developed and in the direction of the propeller revolutions.

20.5.9 The number of the repeated starting (reversing) attempts in the case of faulty starts (reverses) is to be limited in order to preserve enough starting energy to perform manual startings. The alarm is to be given at the starting energy drop to the level indispensable to manual startings.

The minimum level of the starting energy at which the alarm starts to operate is to be such that:

.1 for starting by means of compressed air, six starts of reversible engine from the local control station and three starts of non-reversible engine could be performed;

.2 for electrical starting – three starts of non-reversible engine could be performed.

20.5.10 Simultaneous control of the main propulsion from more than one station should be excluded. The control from several conjugated control units is allowed from one control station.

20.5.11 The remote control system is to be so designed that the transfer of control from one station to another will not cause any essential change in thrust of a screw or in rotations of the main engine.

20.5.12 Each control station is to be equipped with the indicator informing which station is in charge of control.

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

20.5.13 The number, type and arrangement of the main propulsion remote control stations are to be adapted to the type of supervision over the machinery. One of such stations is to be superior with regard to others. The superior control station is to be located in the machinery space. Only the superior control station may overtake the control from the station on the navigation bridge or from other remote control stations. The superior control station is to have monitoring facilities of all important parameters of the propulsion system and associated installations, irrespective of which control station is actually in charge.

Instructions: The adequate hardware of the remote control stations is to be provided so that the operator will have a possibility of supervising the performance of commands and controlling the parameters of the main engine operation within the range appropriate for a given station.

The control stations are to be equipped with:

– indicators of number of revolutions and direction of rotation of the propeller shaft;
– indicators of number of revolutions and direction of rotation of the main engine when clutch coupling is used;
– indicators of propeller speed and direction of rotation in the case of fixed pitch propellers, if such propeller has been installed;
– indicators of propeller speed and pitch position in the case of controllable pitch propeller, if such propeller has been installed;

- alarm system annunciators and in particular, indicators informing about the conditions affecting the ship's manoeuvrability (see also 20.5.9);
- indicators informing which station is in charge of control;
- emergency shut-down device of the main engine;
- device for switching off the slow turning of the main turbine rotor (see 20.5.7);
- switching-off device of the main engine safety system (see 20.4.2.10).

Where several conjugated control units are used at one control station, only one of them may be provided with the above-mentioned indicators of the alarm system. In the vicinity of the remaining control units, only an indicator informing about the alarm signal may be used.

20.5.14 The remote control system is to be so designed that in the case of rapid commands following each other, the last one is always performed. The of executing the commands is not to depend on the speed with which the control element has been moved.

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

20.5.16 Remote control system of two or more main propulsion engines driving one propeller is to be capable of automatic equilizing the load of operating engines.

20.5.17 Automation systems of the main propulsion remote control from the bridge are to be designed in a manner which ensures that threshold warning of the impending or imminent slowdown or shutdown of the propulsion system is given to the watch officer on the bridge, even when the machinery spaces are attended. The warning is to be given in time to assess navigational circumstances in an emergency. In particular, the systems are to control, monitor, report, alert and take safety action to slow down or stop the propulsion while providing the officer in charge of the navigational watch with an opportunity to manually intervene, except for those cases where manual intervention will result in total failure of the engine and/or propulsion equipment within a short time, for example in the case of overspeed.

20.6 Electrical Power Supply and Distribution Control System

20.6.1 The arrangement of the ship's electric generating plant is to ensure the continuity of electric power supply in accordance with the following requirements:

.1 For ships having electric power demand normally supplied by one generator, there are to be adequate provisions in case of its failure for automatic starting and connecting to the main switchboard a stand-by generator of sufficient capacity to permit propulsion and steering and to ensure the safety of the ship with automatic restarting of the essential auxiliaries, including, where necessary, sequential operations. This stand-by electric power is to be available to take over the load preferably within 30 seconds but in any case not more than 45 seconds, after loss of power. The time of taking over the load by a stand-by generator is to be short enough to delay the starting of the emergency source of electric power.

.2 For ships having electric power demand normally supplied by two or more generating sets operating in parallel, arrangements are to be provided (e.g. load shedding of less essential consumers for which the load shedding is unconditionally allowed and, where necessary, also the consumers for which the load shedding is allowed – see 8.2.3) to ensure that in the case of failure of one of these units, the remaining ones are kept in operation without overload, to permit propulsion and steering and to ensure the safety of the ship.

When the arrangement, specified in .1, is to be applied in ships where the main generating set is driven by a steam turbine, the prime mover of stand-by power supply unit is to be an internal combustion engine.

20.6.2 The control system of generating set prime movers should, in case of failure of 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 having the highest output.

20.6.3 Failure to start the set is to be signalled by the alarm system.

20.6.4 The automatic control system of generating sets is to be provided with interlocking arrangement preventing the generating set from being automatically connected when a short-circuit occurs on the busbars of the main switchboard.

20.6.5 The alarms specified in item 2.3, Table 21.3.1-1 are to be indicated in the engine control room as individual alarms; where the alarm panel with individual alarms is installed on the engine or in the vicinity, common alarm in the engine control room is required.

20.7 Control Systems of Steam Boilers

20.7.1 Control characteristics of different automatic control systems of operation of steam boilers are to be so selected as to maintain the water level, steam pressure and other controlled parameters within the predetermined limits over the entire load range of the boiler, and to ensure rapid changes of boiler load in accordance with boiler characteristics.

20.7.2 The automatic control system of boiler firing installation is to be so designed that starting of a cold boiler is only possible from the local control station.

20.7.3 The automatic control system of boiler firing installation is to be so designed that fuel supply is only possible when, additionally to the conditions specified in para. 11.2.1, *Part VII – Machinery, Boilers and Pressure Vessels*, the following conditions are fulfilled:

.1 water level is normal;
.2 viscosity and temperature of fuel oil are sufficient for its proper atomisation;
.3 prepurging of the combustion chamber has been effected during at least 30 sec., and the dampers in the air ducts are fully opened;
.4 fuel supply to the burners is set for the minimum value.

20.7.4 The automatic control system of boiler firing installation is to be so designed that purging of combustion chamber always takes place after the fuel supply has been cut off, whether manually or automatically.

For the boiler fired by more than one burner, purging of the combustion chamber is to take place after switching off of the last burner.

20.7.5 Where the boiler is fired by more than one burner, the control systems of burners are to be independent of each other as far as practicable.

In any case, failure of pilot burner control system is not to disturb the operation of the main burners.

20.7.6 The automatic boiler firing installation is to be provided with safety system shutting off the fuel oil supply as specified in para. 11.2.2, *Part VII – Machinery, Boilers and Pressure Vessels*, and also when the following failures occur:

.1 the ignition of the fuel fails within 5 sec. from the beginning of fuel admission;
.2 the viscosity or the temperature of fuel oil is too low;
.3 the values of parameters of atomising steam or air intended for fuel atomising fall;
.4 the water level in the boiler is below the permissible value.

20.7.7 The restarting of firing installation after the elimination of defects is to be possible from the local control station only.

The automatic control system of boiler firing installation is to be so designed that the ignition device is switched on after a certain time of purging the combustion chamber in accordance with the manufacturer's requirements.

20.8 Control Systems of Piping Installations

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

20.8.2 The valves, specified in 20.8.1, are to be situated in places readily accessible for manual operation under all normal service conditions.

20.8.3 All components of valve control system fitted inside the double bottom are to be so designed as to be capable of normal operation when completely flooded under the water head resulting from the maximum draught of the ship.

20.8.4 Where piping systems are intended to be alternately used for different purposes (e.g. for ballast or fuel transfer), their control system is to be provided with such interlocking and protection arrangements as to meet the relevant requirements for interconnection of such piping systems given in *Part VI – Machinery Installations and Refrigerating Plants*.

21 UNATTENDED OPERATION OF MACHINERY SPACE AND ONE MAN BRIDGE OPERATION – MARKS: AUT, NAV1

21.1 Application

21.1.1 The requirements of the present Chapter apply to ships which are to be assigned additional mark **AUT** or **NAV1** in the symbol of class. Automation systems of these ships are to comply also with the requirements given in other Chapters of the present Part of the *Rules*.

21.1.2 To be assigned mark **AUT**, which means the ship's ability for unattended operation of the machinery space, the requirements given in 21.2 to 21.4 are to be complied with. These requirements have been set out under the assumption that the number of engineering staff on board is sufficient to maintain seaworthiness of the ship in case of failure of automatic systems, as well as to carry out routine adjustment and inspection of the operation of such systems.

21.1.3 To be assigned mark NAV1, which means that the ship is adapted for one man bridge operation, the requirements specified in *Publication No. 35/P – One Man Bridge Operated (OMBO) Ships* are to be complied with.

21.2 General Requirements

21.2.1 The extent of machinery automation is to be such that the operation of machinery periodically unattended is possible during a period of 8 hours. This applies to the following machinery and equipment:

.1 the main propulsion, together with auxiliary machinery and controllable pitch propeller;
.2 electric power supply and distribution;
.3 steam boilers and exhaust gas boilers;
.4 air compressors;
.5 fuel and lubricating oil separators;
.6 inert gas generators;
.7 other machinery and equipment covered by the *Rules*.

The automatic control systems maintaining working parameters (temperature, pressure, viscosity, etc.) are to be provided. These systems are to be capable of maintaining the working parameters under all normal service conditions, including manoeuvring, within the limits appropriate for the considered machinery, equipment and installations.

21.2.2 Upon separate agreement with PRS, the extent of automation of some simple and daily irregular operations may be limited to remote control from the ship's navigation bridge.

21.2.3 The local manual control may be applied as the only means of control to perform:

.1 operations carried out at regular intervals, if, due to the character of these operations or the arrangement of the plant, the intervals are greater than the assumed unmanned period;
.2 operations carried out irregularly and not requiring quick response to alternations of the conditions (e.g. blowing-off sea valves or chests with the exception of the case specified in 21.2.5, change-over to filling, emptying, cleaning or heating the tanks, etc.);
.3 operations associated with starting the installations.

21.2.4 The power units developing the auxiliary energy (pneumatic or hydraulic) used in automatic systems are to start automatically so that the continuity of power supply is maintained in all service conditions.

21.2.5 In ships with ice strengthening L1A and L1, arrangements for cleaning sea valves and chests are to be remotely controlled from the navigation bridge.

21.2.6 Where on board ship with the mark for unattended machinery space added to the class symbol, refrigerating plant classed with PRS is fitted, the extent of automation of such plant, its monitoring sys-

tems and the arrangement of indicators of such systems are subject to special consideration by PRS in each particular case.

21.2.7 Means are to be provided for detecting a rise of water in the machinery space bilges or bilge wells. For this purpose, the following requirements are to be complied with:

.1 bilge wells are to be large enough to accommodate normal drainage during the unattended period. The arrangement of these wells and level sensors is to be such that accumulation of liquids may be detected at all normal angles of heel and trim as specified in sub-chapter 1.6, *Part VI – Machinery Installations and Refrigerating Plants;*

.2 in the case where bilge pumps start automatically to drain machinery space, means are to be provided to indicate that the influx of liquid is greater than the pump capacity or that the pump is operating more frequently than would normally be expected.

Instructions: In order to meet the above requirements, the following measures may be taken:
- smaller bilge wells to cover a reasonable period of time for accommodating normal drainage,
- alarms of bilge pump operating for more than 15 minutes,
- alarm of high water level in bilge wells operating prior to automatic starting of the pump.

Where automatically controlled bilge pumps are provided, special attention is to be given to oil pollution prevention requirements.

.3 alarms of high water level in bilges and those resulting from the requirements of sub-paragraph .2 are to be given in the space specified in 21.3.6, at the engineers' accommodation area and on the navigation bridge.

21.2.8 The requirements for fire detection systems in machinery space are given in Chapter 4, *Part V – Fire Protection*.

21.3 Monitoring Systems

21.3.1 The extent and operation principles of monitoring systems are to comply with:
- Table 21.3.1-1 for ships of 500 tons gross tonnage and above;
- Table 21.3.1-2 for ships above 24 m in length and of less than 500 tons gross tonnage.

Where the extent of monitored parameters differs from that specified in the Table or where it is proposed to install the systems based on different operation principles, special consideration will be given by PRS in each particular case.

Automatic change-over of stand-by machinery in auxiliary systems of the main internal combustion engine, as required by Tables 21.3.1-1 and 21.3.1-2, need not be applied if at least two main engines are provided for ship propulsion, each having independent auxiliary systems, as well as independent safety system which will stop one of the engines, when necessary, and will simultaneously disconnect that engine from the propulsion system.

21.3.2 The alarm system is to cover all automated machinery, as well as all types of alarms specified in 20.4.1.2.

21.3.3 Where the concentration of alarms is necessary in the engine room alarm panel, only such individual alarms may be concentrated which are related to parameters which cannot be exceeded simultaneously, as well as such which are associated with the same machinery, provided that individual alarms are indicated at the location of this machinery.

Group alarms are to comply with all requirements for alarm system specified in 20.4.1.

21.3.4 The alarm system annunciators are to be so located that during the unmanned period of machinery, the engineering personnel on duty is made aware that a machinery fault has occurred.

If the bridge navigating officer of the watch is the sole watch-keeper, then, in the event a machinery fault being monitored at the control location for machinery, the alarm system is to be such that this watch-keeper is made aware when:

.1 a machinery fault has occurred;

.2 the machinery fault is being attended to;

.3 the machinery fault has been rectified.

For carrying out the function mentioned in sub-paragraph .3, means of communication between the navigation bridge, accommodation spaces for engineering personnel and the machinery spaces may be used.

Instructions: The requirements of the present paragraph may be complied with, inter alia, through:
- arranging group alarms on the navigation bridge and accommodation spaces for the engineering personnel responsible for the operation of the machinery and alarm annunciators giving detailed information in the space where the superior control station is located, or
- arranging all alarm annunciators giving detailed information on the navigation bridge and group alarms in the accommodation spaces of engineering personnel responsible for the operation of the machinery.

In any case, the acknowledgment of alarms in the machinery space and in the accommodation spaces for engineering personnel is to be indicated on the navigation bridge.

21.3.5 When group alarms are used to indicate alarm conditions on the navigation bridge, the alarm system on the bridge is to 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 safety system stopping the main engine has operated;
.4 alarm to indicate that safety system reducing the main engine load has operated;
.5 alarm to indicate that starting (reversing) of the main engine has failed;
.6 alarm to indicate failure of the steering gear;
.7 alarm to indicate failure of the power supply to automatic systems;
.8 alarm to indicate the excessive bilge water level in machinery space;
.9 group covering all other alarms as specified in 21.3.1;
.10 alarm to indicate that alarm system of the internal combustion engine driving emergency generator has operated;
.11 alarm to indicate that safety system of the internal combustion engine driving emergency generator has operated.

Alarms indicating such states of machinery which have direct influence on ship's manoeuvrability are to operate on the navigation bridge, no matter which station is actually responsible for the control of machinery.

Switching over of alarm system from the machinery space to the bridge or v.v. is to be accompanied by visual and audible signal given in accordance with 20.4.1.5, 20.4.1.6 and 20.4.1.7.

21.3.6 All annunciators of alarm system, and to the necessary extent, the displaying instruments of indicating system, are to be concentrated in the space in which the superior control station is situated.

Where in parallel to the control station on the navigation bridge which is equipped with group alarms, only local control stations in the machinery space are provided, all indicators of indicating system are to be situated on engines, turbines and machinery only, and all annunciators of alarm system giving detailed information are to be concentrated in one place in the machinery space or in an adjacent space having door communication with the machinery space.

21.3.7 Where the repeaters of alarm system annunciators are located within the accommodation spaces, the switching off of the alarm signal (alarm acknowledgment) in the accommodation spaces is also to be indicated on the navigation bridge.

Where the repeaters of alarm system annunciators are not provided within accommodation spaces, other reliable and efficient means of communication between the bridge and the accommodation of the personnel responsible for machinery operation are to be fitted. Such means of communication are also recommended in the case where the repeaters of alarm system annunciators are provided.

21.4 Control Systems

21.4.1 Main Propulsion Control System

21.4.1.1 In addition to indicators and devices specified in 20.5.13, the main propulsion control station on the bridge is to be equipped with an arrangement for immediate stopping of the main engine or turbine.

This arrangement is to be independent of the control system and is to be so designed that the requirements, specified in 20.2.3.8 and 20.4.2.10, are complied with.

21.4.1.2 Means are to be provided to keep the starting air pressure at the required level where diesel engines are used for the main propulsion.

21.4.2 Electric Power Supply and Distribution Control Systems

Automatic control of effective reserve output of actually running generating sets is to be provided and the arrangement is to be such that automatic start of large power consuming machinery is only possible when the reserve output of generating sets is sufficient to cover starting and operational power demand of such machinery. In certain circumstances it may be necessary that stand-by generating set be started prior to start of the machinery in question.

21.5 Personnel Alarm

21.5.1 The personnel alarm is to automatically set off an alarm on the navigation bridge or in the officers' quarters, as appropriate, if it is not reset from the machinery space, in a period not exceeding 30 minutes.

21.5.2 A pre-warning signal is to be provided in the machinery space which operates 3 min before the alarm, referred to in 21.5.1, is given.

21.5.3 The alarm system is to be put into operation:

.1 automatically when the engineer on duty has to attend the machinery space in case of a machinery alarm;

.2 manually by the engineer on duty when attending the machinery space on routine checks.

21.5.4 The alarm system is to be disconnected by the engineer on duty after leaving the machinery space. When the system is brought into operation automatically in accordance with 21.5.3.1, its disconnection should not be possible before the engineer acknowledged the alarm in the machinery space.

21.5.5 Personnel alarm is to automatically operate the engineers' alarm, required in 21.6.

21.6 Engineers' Alarm

In addition to manual operation from the machinery space, the engineers' alarm on ships with periodically unattended machinery spaces is to operate when the machinery alarm is not acknowledged in the machinery space or ECR in a specified limited period of time, depending on the size of the ship but not exceeding 5 min.

Table 21.3.1-1

Item	Machinery, system or equipment	Parameters[1)]	Alarm system: alarm condition / monitored value of parameter	Safety system	Remarks
1	2	3	4	5	6
1	**Main propulsion**				
1.1	Main internal combustion engine (cross-head)				
1.1.1	Fuel system	– pressure of fuel at outlet from filter (at inlet to engine)	– minimum	start of stand-by pump	remote measurement
		– viscosity or temperature of fuel before injection pumps	– maximum and minimum	–	
	–	– fuel leakage from high pressure pipes	– alarm signal	–	
		– level in service tank	– minimum	–	high level alarm signal is required in case of lack of overflow installation
		– common rail fuel oil pressure	– minimum		
1.1.2.	Lubricating oil system	– pressure of lubricating oil at inlet to main and thrust bearings	– minimum	first stage: start of stand-by pump; second stage: load reduction[2)]; third stage: stop of engine	remote measurement
		– pressure of lubricating oil at inlet to crosshead bearings	– minimum	first stage: start of stand-by pump; second stage: load reduction[2)]; third stage: stop of engine	remote measurement when separate lubricating oil systems are foreseen
		– pressure of lubricating oil at inlet to camshaft	– minimum	first stage: start of stand-by pump; second stage: stop of engine	when separate lubricating oil systems are foreseen
		– temperature of lubricating oil at inlet to camshaft	– maximum	–	when separate lubricating oil systems are foreseen
		– temperature of lubricating oil at inlet to ME	– maximum	–	
		– temperature of thrust bearing or temperature at bearing outlet	– maximum	first stage: load reduction; second stage: stop of engine	

1	2	3	4	5	6
		– oil temperature at outlet from main, crank, crosshead bearings or	– maximum	load reduction	for engines of more than 2250 kW output or diameter of cylinder of above 300 mm
		– oil mist concentration in crankcase [8)]	– dangerous	load reduction[3)]	for engines of more than 2250 kW output or diameter of cylinder of above 300 mm
		– flow of oil lubrication of cylinders; on each cylinder	– no flow	load reduction	
		– level in lubricating oil tanks	– minimum	–	for each tank separate alarm signal is required, if separate lubricating oil systems (e.g. camshaft, valve arm etc.) are provided
		– common rail servo oil pressure	– minimum		
1.1.3	Turboblowers system	– turboblower lubricating oil inlet pressure	– minimum	–	if independent lubricating oil system, integrated with the turboblower, is not provided
		– temperature of lubricating oil of each bearing at outlet from turboblower	– maximum*	-	
		– speed of turboblower	–	–	remote measurement
1.1.4	Piston cooling system	– pressure of cooling medium at inlet	– minimum	first stage: start of stand-by pump[4)]; second stage: load reduction[2)];	load reduction is not required if the cooling oil is taken from the main system of the engine
		– temperature of cooling medium at outlet from each cylinder	– maximum	load reduction[2)]	
		– flow of piston cooling medium at outlet from each cylinder [7)]	– no flow	load reduction[2)]	
		– level in piston cooling medium expansion tank	– minimum	–	
1.1.5	Sea cooling water system	– pressure of sea water	– minimum	start of stand-by pump	

* Where, due to the turboblower design**,** the alarm function "maximum lubricating oil temperature" of each bearing cannot be realized, alternative arrangements are to be provided, e.g. continuous monitoring of inlet oil pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turboblower manufacturer's instructions.

1	2	3	4	5	6
1.1.6	Cylinder fresh cooling water system	– pressure of cylinder cooling water at inlet	– minimum	first stage: start of stand-by pump[4]; second stage: load reduction[2];	
		– temperature of cylinder cooling water (after each cylinder) or	– maximum	load reduction[2]	where one common cooling space without individual stop valves is employed for all cylinder jackets
		– temperature of cylinder cooling water at outlet	– maximum	load reduction[2]	where one common cooling space without individual stop valves is employed for all cylinder jackets
		– presence of oil in engine cooling installation	– alarm signal	–	if engine cooling water is used in fuel and lubricating oil heat exchanger
		– level in cylinder cooling water expansion tank	– minimum	–	
1.1.7	Starting and control air system	– pressure of starting air before main shut-off valve	– minimum	–	remote measurement
		– pressure of control air	– minimum	–	
		– pressure of safety system air	– minimum	–	
1.1.8	Scavenging air system	– pressure in scavenging air collector	–	–	remote measurement
		– temperature of scavenging air in underpiston space (fire)	– maximum	load reduction[3]	
		– level of water in scavenging air tank	– maximum	–	
1.1.9	Exhaust system	– temperature of exhaust gases after each cylinder	– maximum	load reduction[2]	remote measurement
		temperature of exhaust gases after each cylinder. Deviation from mean value	– maximum	–	
		– temperature of exhaust gases before each turboblower	– maximum	–	remote measurement
		– temperature of exhaust gases after each turboblower	– maximum	–	remote measurement
1.1.10	Fuel valves cooling medium system	– pressure of fuel valves cooling medium	– minimum	start of stand-by pump	
		– temperature of fuel valves cooling medium	– maximum	–	

1	2	3	4	5	6
		– medium level in fuel valves cooling medium expansion tank	– minimum	–	
1.1.11	Engine speed/direction of rotation	–	–	–	remote measurement
1	2	3	4	5	6
		– wrong way	– alarm signal	–	
1.1.12	Overspeed		– alarm signal	stop of engine	
1.1.13	Supply failure of control, safety and alarm systems		– alarm signal	–	
1.2	Main internal combustion engine (trunk-piston)				
1.2.1	Fuel system	– pressure of fuel at outlet from filter (at inlet to engine)	– minimum	start of stand-by pump	remote measurement
		– viscosity or temperature of fuel before injection pumps	– maximum and minimum	–	only in the case when engine operates on heavy fuel oil
		– fuel leakage from high pressure pipes	– alarm signal	–	
		– level in fuel service tank	– minimum	–	high level alarm signal is required in case of lack of overflow installation
		– common rail fuel oil pressure	minimum		
1.2.2	Lubricating oil system	– pressure of lubricating oil at inlet to main and thrust bearings	– minimum	first stage: start of stand-by pump; second stage: stop of engine	remote measurement
		– pressure difference on lubricating oil filter	– maximum	start of stand-by pump, if fitted	remote measurement
		– temperature of lubricating oil at inlet to ME	– maximum	–	remote measurement
		– oil mist concentration in crankcase [8)]	– dangerous	stop of engine	only for medium speed engines of more than 2250 kW output or diameter of cylinder of above 300 mm [5)]
		– flow of cylinder lubricating oil; on each cylinder	– no flow	load reduction	
		– common rail servo oil pressure	minimum		

1	2	3	4	5	6
1.2.3	Turboblowers system	– pressure of lubricating oil at inlet to turboblowers	– minimum	–	remote measurement
		– temperature of lubricating oil of each bearing at outlet from turboblowers	maximum*		if independent oil lubricating system, integrated with the turboblower, is not provided.
1.2.4	Sea cooling water	– pressure of sea water	– minimum	start of stand-by pump	remote measurement
1.2.5	Cylinder fresh cooling water system	– pressure or flow of cooling water at inlet to cylinders	– minimum	first stage: start of stand-by pump; second stage: load reduction	remote measurement
		– temperature of cooling water at outlet from cylinders	– maximum	load reduction[6)]	remote measurement
		– level in compensating tank of cylinders cooling water	– minimum	–	
1.2.6	Starting and control air system	– pressure of starting air before main shut-off valve	– minimum	–	remote measurement
		– pressure of control air	– minimum	–	remote measurement
1.2.7	Scavenging air system	– temperature of scavenging air in tank	– maximum	–	
1.2.8	Exhaust system	– temperature of exhaust gases after each cylinder	– maximum	load reduction	remote measurement concerns engines of output of over 500 kW/cylinder
		– temperature of exhaust gases after each cylinder. Deviation from mean value	– maximum	–	for engines of output of over 500 kW/ /cylinder
1.2.9	Number of engine revolutions	–	–	–	remote measurement
1.2.10	Overspeed	–	– alarm signal	stop of engine	
1.2.11	Supply failure of control, safety and alarm systems	–	– alarm signal	–	
1.3	Main steam turbine				
1.3.1	Lubricating oil system	– oil pressure before turbine	– minimum	first stage: start of stand-by pump; second stage: shutdown of steam supply to turbine	

1	2	3	4	5	6
		– lubricating oil temperature	– maximum	–	
		– oil level in gravity tank	– minimum	–	
1.3.2	Condensating and cooling water system	– vacuum in condenser	– minimum	stop of turbine	
		– level in condenser	– maximum – minimum	stop of turbine	
		– level in hot-well	– maximum – minimum	–	
		– level in de-aerator	– maximum – minimum	–	
		– pressure in de-aerator	– minimum	–	
		– pressure or flow of condenser cooling water (after the condenser)	– minimum	start of stand-by pump	
		– pressure of condensate after pump	– minimum	start of stand-by pump	
1.3.3	Steam system	– pressure at inlet to turbine	– maximum – minimum	–	
		– pressure of gland sealing steam	– maximum – minimum	–	for each turbine casing separately
1.3.4	Miscellaneous	– turning gear	– engaged	–	
		– temperature of journal and thrust bearings	– maximum	–	
		– axial rotor displacement	– maximum	stop of turbine	
		– transverse rotor displacement	– maximum	stop of turbine	
		– vibration of turbine casing	– dangerous	stop of turbine	
		– excessive speed of turbine	–	stop of turbine	
1.4	Main gear	– pressure of lubricating oil at inlet	– minimum	first stage: start of stand-by pump[4)]; second stage: stop of main engine	
		– temperature of lubricating oil at inlet	– maximum	–	
		– pressure difference on lubricating oil filter	– maximum	–	
		– temperature of main bearings	– maximum	–	

1	2	3	4	5	6
1.5	Shaft line	– temperature of thrust, intermediate and stern tube bearings	– maximum	–	
		– oil pressure in hydraulic coupling	– minimum	–	only in the case of separate oil system
		– level in gravity tank of stern tube lubrication	– minimum	–	
		– oil pressure in servo-system of c.p. propeller	– minimum	start of stand-by pump	
		oil temperature in servo-system of c.p. propeller at outlet	– maximum	–	
1.6	Compressors	– pressure of compressor lubricating oil	– minimum	stop of compressor	
		– flow of compressor cooling water	– no flow	stop of compressor	
		– temperature of compressor cooling water at outlet	– maximum	–	
2	**Electric installation**				
2.1	Main switchboards	– insulation resistance	– minimum	functional features of safety system with regard to item 2.1 and 2.2 will be separately considered depending on the arrangement	
		– voltage	– maximum – minimum		
		– frequency	– maximum – minimum		
2.2	Main generators	– load current	– maximum		
		– short-circuit current	– minimum		
		– reverse power	– maximum		
2.3	Internal combustion engines driving main generators (trunk-piston)	– pressure of lubricating oil at inlet	– minimum	stop of engine	
		– flow or pressure of cooling water			
		– temperature of lubricating oil at inlet	– no flow	–	
			– minimum		
			– maximum	–	

1	2	3	4	5	6
		– oil mist concentration in crankcase	– maximum	stop of engine	for engines having power of more than 2250 kW or a cylinder bore of more than 300 mm
		– engine overspeed			
		– level in cooling medium expansion tank, if not connected to the main system	alarm signal – minimum	stop of engine	
		– temperature of cooling water or air at outlet	– maximum	–	
		– fuel leakage from high pressure pipes	– physical value agreed with PRS depending on design	–	
		– level in fuel oil service tank	– minimum	–	
		– pressure of starting air before engine or in receiver	– minimum	–	before engine – only in the case of remote starting of stand-by generating set from the bridge
		– viscosity or temperature of fuel before injection pumps	– minimum and maximum		for heavy fuel oil engines
		– temperature of exhaust gases after each cylinder	– maximum		for engines of output of over 500 kW/cylinder
		– common rail fuel oil pressure	minimum		
		– common rail servo oil pressure	minimum		
2.4	Internal combustion engines driving emergency generators	– fuel oil leakage from pressure pipes	alarm signal		
		– lubricating oil temperature	maximum		for engines having a power output ≥ 220 kW
		– lubricating oil pressure	minimum		
		– oil mist concentration in crankcase [8)]	maximum		for engines having a power output of more than 2250 kW or having a cylinder bore more than 300 mm

1	2	3	4	5	6
		– pressure or flow of cooling medium	minimum		for engines having a power output ≥ 220 kW
		– temperature of cooling medium	maximum		
		– engine overspeed	alarm signal	stop of engine	for engines having a power output ≥ 220 kW
2.5	Steam turbines driving generators	– pressure of lubricating oil at inlet	– maximum	stop of turbine	
		– temperature of lubricating oil at inlet	– maximum	–	
		– pressure in condenser	– maximum and minimum	stop of turbine	with regard to counter-pressure or vacuum
		– level in condenser	– maximum	–	
		– axial rotor displacement	– maximum	stop of turbine	
2.6	Steering gear with electric or electrohydraulic propulsion	– supply voltage	– minimum	switching on of second feeder or second power supply unit	
		– load current	– maximum	depending on the arrangement	
		– short-circuit current	– minimum	disconnection of drive	
2.7	Electrical drives of other essential machinery	– load current	– maximum	depending on the arrangement	
		– short-circuit current	– minimum	disconnection of drive	
3	**Piping system**				
3.1	Bilge system	– vacuum on suction side of the pump	– minimum	–	
		– level in bilge wells of machinery space	– maximum	–	separate alarm signal on the bridge (see also 21.2.8) is recommended
3.2	Fuel oil treatment system	– level in fuel settling tank	– minimum	–	
		– water seal of fuel purifier	– loss of water	–	only in the case when purifier is to be in operation during unmanned period
		– fuel temperature at purifier inlet	– maximum	–	
			– minimum		
3.3	Sludge systems	– level in purifier wastes tank	– maximum	–	
		– level in sludge tanks	– maximum	–	
4	**Steam boilers and associated systems**				
4.1	Boiler	– pressure of steam	– maximum	–	
		– water level	– maximum	shutdown of fuel oil	
			– minimum	supply at minimum level	

1	2	3	4	5	6
		– temperature of superheated steam	– maximum	–	for main boilers only
		– temperature of saturated steam	– maximum	–	for main boilers only
4.2	Circulating pump	– water flow through pump	– no flow	depending on arrangement of system and type of boiler	
4.3	Feed water system	– pressure on delivery side of feed water pump	– minimum	start of stand-by pump	
		– pressure of lubricating oil at inlet to the turbine driving feed water pump	– minimum	stop of turbine and start of stand-by pump	for main boilers only
4.4	Firing system	– pressure of fuel oil before burner	– minimum	–	
		– flame extinguishing	–	shutdown of fuel oil supply	
		– pressure of combustion air	– minimum	shutdown of fuel oil supply	
		– temperature of fuel oil before burner	– maximum – minimum	shutdown of fuel oil supply at minimum temperature	
		– level in daily service tank	– minimum	–	for auxiliary boilers only in the case when boiler is necessary for the operation of main engine
		– rotary air heater	– stopping	shutdown of fuel oil supply	for main boilers only
		– pressure of atomising steam	– minimum	shutdown of fuel oil supply	for main boilers only
5	**Classified refrigerating plant**	–	– malfunction	–	group alarm signal
		–	– failure	–	group alarm signal of operation of safety system

1) Parameters covered by safety and alarm systems, with the exception of levels and flow, are also to be covered by indicating system.

2) The function of safety system may be performed by the operator upon the relevant alarm signal, or need not be required if the exceeding of parameter does not cause a critical condition for the engine acc. to manufacturer's statement.

3) If the load reduction does not provide for the sufficient protection for the engine, automatic stoppage of the engine may be required by PRS.

4) The stand-by pump may also be started by the "no flow" signal.

5) One oil mist detector for each engine, having two independent outputs for initiating the alarm and shut-down, would satisfy the requirement for independence between alarm and shut-down system.

6) Two separate sensors are required for alarm and load reduction.

7) Where outlet flow cannot be monitored due to engine design, alternative arrangements may be accepted by PRS.

8) Equipment for crankcase oil mist detection and alarm (separate for each engine) or alternatively, the engine bearing temperature monitoring system, or other equivalent devices are to be of the type approved by PRS. The procedure for type testing of equipment for crankcase oil mist detection and alarm is specified in *Publication 79/P – Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment*.

Table 21.3.1-2

Item	Machinery, system or equipment	Parameters[1)]	Alarm system: alarm state / monitored value of parameter	Safety system	Remarks
1	2	3	4	5	6
1	**Main propulsion**				
1.1	Main internal combustion engine				
1.1.1	Lubricating oil system	– pressure at inlet to engine (after filter)	– minimum	first stage: start of stand-by pump[3)]; second stage: stop of engine load reduction[2)]	
		– temperature at inlet to engine	– maximum		
		– level in circulating oil tank	– minimum	–	
1.1.2.	Cooling system	– temperature of cooling water at outlet from engine	– maximum	–	on outlet manifold after cylinders
		– pressure or cooling water flow at inlet	– minimum	first stage: start of stand-by pump[3)]; second stage: load reduction[2)]	for fresh and sea water
		– level in compensating tanks	– minimum	–	
1.1.3	Fuel system	– level in service tanks	– minimum	–	
1.1.4	Exhaust system	– temperature of exhaust gases	– maximum	load reduction[2)]	on exhaust manifold after cylinders
1.1.5	Engine overspeed	–	alarm signal	stop of engine	
1.2	Main gear	– pressure of lubricating oil at inlet	– minimum	first stage: start of stand-by pump[3)]; second stage: stop of main engine	
		– 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	–	
		– oil pressure in servo-system of c.p. propeller	– minimum	start of stand-by pump	

1	2	3	4	5	6
2	**Electrical installation**				
2.1	Main switchboards	– insulation resistance	– minimum	–	recommended
		– voltage	– maximum – minimum	–	recommended
		– frequency	– maximum – minimum	–	recommended
2.2	Internal combustion engines driving electrical generators	– pressure of lubricating oil at inlet	– minimum	stop of engine	
		– temperature of lubricating oil at inlet	– maximum	–	
		– temperature of cooling water or air at outlet	– maximum	–	
		– starting air pressure	– minimum		
		– engine overspeed	– alarm signal	stop of engine	
3	**Piping system**				
3.1	Bilge system	– level in bilge wells of machinery space	– maximum	–	separate alarm signal on the bridge (see also 21.2.7)
4	**Steam boilers and associated systems**				
4.1	Boiler	– steam pressure	– maximum	–	
		– water level	– maximum – minimum	shutdown of fuel oil supply at minimum level	
1	2	3	4	5	6
4.2	Circulating system	– water flow through circulating installation	– no flow	depending on arrangement of system and type of boiler	
4.3	Feed water system	– delivery pressure of feed water pump	– minimum	start of stand-by pump	
4.4	Firing system	– failure of burner	–	emergency shutdown of fuel oil supply	

[1] Parameters covered by safety and alarm systems, with the exception of levels and flow, are also to be covered by indicating system.

[2] The function of 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 according to the engine manufacturer's statement.

[3] The stand-by pump may also be started by the "no flow" signal.

22 REQUIREMENTS FOR ASSIGNMENT OF ADDITIONAL MARK IN THE SYMBOL OF CLASS *)

22.1 Passenger Ships – Mark: PASSENGER SHIP

22.1.1 Power Supply and Signalling System

22.1.1.1 The power supply for pumps, air compressors and control and monitoring system of the sprinkler system is to be taken directly from the main and emergency switchboards by separate feeders. Such feeders are to run to an automatic change-over switch which in its normal position is to be connected to the feeder from the main switchboard and in the event of voltage decay automatically will change over to the feeder from the emergency switchboard. The switches of these feeders in the main and emergency switchboard are to be clearly marked and provided with a notice that they must be permanently set in the connected position. No other switches are to be installed in these feeders.

22.1.1.2 Cables supplying the sprinkler system machinery (pump, air compressor, control and monitoring system) are not to be run through the machinery spaces, galleys and other enclosed fire-hazardous spaces, except where the said machinery is installed in these spaces.

22.1.1.3 The lighting of saloons, ladders, stairs and passageways leading to the boat deck is to be supplied by not less than two independent feeders.

The lighting fixtures are to be arranged in such a manner that in the event of failure of either feeder uniformity of lighting will be ensured. These feeders are to be supplied from different distribution boards which, in the case of application of sectionalised lighting busbars in the main switchboard, are to be connected to different sections of the busbars.

22.1.1.4 Feeders of essential services are to be so arranged that the fire in any main fire zone will not damage such feeders in other fire zone. This requirement is considered to be satisfied when the cables of the main and emergency supply passing through any main fire zone are run as far apart as possible from one another both in horizontal and vertical direction.

22.1.1.5 The general alarm system is to be composed of two independent groups: one for the passengers and one for the crew.

In passenger ships with low-rated electrical installations, only one group of the general alarm system may be used.

22.1.1.6 In addition to the requirements, specified in 16.8.1.5 and 16.8.1.6, cables for services required to be operable under fire conditions are to be fire-resistant where they pass through the main vertical fire zones, other than those which they serve.

22.1.1.7 In addition to locations specified in paragraph 7.5.2.1, fire detection system is to be installed on cabin balconies where fitted with furniture and furnishings other than the furniture and furnishings of restricted fire risk defined in SOLAS II-2, regulation 3, paragraphs 40.1, 40.2, 40.3, 40.6 and 40.7.

22.1.2 Power Supply from the Emergency Source of Electric Power

22.1.2.1 Emergency sources of electric power in passenger ships, except those of restricted service **II** and **III**, are to have adequate capacity to supply power simultaneously to the following consumers for 36 hours:

.1 emergency lighting of:

– places of embarkation and lowering of lifeboats and liferafts, as well as outboard spaces where the lifeboats and liferafts are launched, in accordance with the requirements of the

*) The requirements of the present Chapter are supplementary to those given in other Chapters of the present Part of the *Rules* for the purpose of assigning additional marks in the symbol of class.
For the definition of particular marks – see *Part I – Classification Regulations.*

SOLAS Convention (these requirements are also given in *Part II – Life-Saving Appliances* of the *Rules for Statutory Survey of Sea-going Ships*),
- indicators to exits to the boat deck, as well as informative plates near the life-saving appliances,
- exits from the spaces where a large number of passengers, crew or special personnel may gather simultaneously,
- corridors and stairways leading to accommodation and service spaces, exits to open deck and the passenger lift cars,
- machinery and generator spaces, together with their local control station,
- all control stations, as well as the main and emergency switchboards,
- emergency source of electric power space,
- the navigation bridge,
- chart room and radio room,
- the stowage positions for emergency and fire equipment, as well as the location of the manually operated call points of fire signalisation,
- steering gear compartment,
- positions at the fire pumps, the emergency bilge pump, the sprinkler pump and at the starting positions of their motors,
- air sheds and landing fields for helicopters,
- gyrocompass room,
- medical rooms;

.2 navigation lights, "no under command" lights, as well as other lights required by the *International Regulations for Preventing Collisions at Sea*;

.3 navigation and radio equipment, in accordance with the requirements of the *SOLAS Convention* (these requirements are also given in *Part IV – Radio Equipment* and *Part V – Navigation Equipment* of the *Rules for Statutory Survey of Sea-Going Ships)*;

.4 internal communication equipment, command broadcast apparatus and general alarm system;

.5 fire detection system, the fire door holding and release system, specified in para. 6.1.8.3, *Part V – Fire Protection*;

.6 audible signalling devices (whistles, gongs, etc.), daylight signalling lamp, manually operating calling system and all other internal signalling systems required in an emergency;

.7 one of fire pumps, the automatic sprinkler pump and electrical equipment ensuring the operation of foam generators specified in para. 3.5.3.5, *Part V – Fire Protection*;

.8 the emergency bilge pump and remote control system of bilge valve installation;

.9 other consumers, provided that their operation is considered by PRS necessary to ensure the safety of the ship and that of the people on board.

The consumers, listed in sub-paragraphs .1 to .6 , may be supplied by their own accumulator batteries, installed in accordance with 9.2, of sufficient capacity to supply the services during 36 hours.

For ships of restricted service, the required time of 36 hours may, subject to the consent of the Administration, be shortened to 18 hours for ships of restricted service **II,** engaged on domestic voyages only and to 12 hours – for ships of restricted service **III,** engaged on domestic and international voyages.

22.1.2.2 Emergency source of electric power is to supply power to additional low-location lighting specified in 22.1.4 within at least 60 minutes from the moment of switching on the system in an emergency.

22.1.2.3 Emergency source of electric power is to supply power to the steering gear in accordance with the requirements of 5.5.6.

22.1.2.4 Emergency source of electric power is to have adequate capacity to supply power to the below-mentioned consumers for 30 minutes:

.1 electric drives of watertight doors, their indicators and warning signals; sequential operation of the doors may be permitted, provided that all doors are closed in 60 seconds;

.2 emergency electric drive of passenger lifts; the passenger lifts may be brought to deck level sequentially.

.3 in ships constructed on or after 1 July 2010 **–** supplementary lighting is to be provided in all cabins to clearly indicate the exit so that occupants will be able to find their way to the door. Such lighting may have a self-contained source of electric power**.**

22.1.2.5 Where the emergency source of electric power is a generator with an independent drive, it is to be:

.1 driven by diesel engine (see para. 2.1.7, *Part VII – Machinery, Boilers and Pressure Vessels*);

.2 capable of automatically starting in case of loss of voltage in the main network and automatically connecting to the emergency switchboard busbars; the services required in 22.1.2.8 are to be automatically supplied from the emergency generator. The total time of starting and taking over the required load by the generator cannot exceed 45 seconds;

.3 provided with a transitional source of electric power connecting automatically at the loss of voltage.

22.1.2.6 Where the emergency source of electric power is an accumulator battery, it is to:

.1 operate without recharging and with the voltage change at its terminal within ± 12 per cent of the rated value throughout the discharge period;

.2 be capable of automatically connecting to the emergency switchboard busbars in case of the loss of voltage in the main network and capable of supplying at least those services mentioned in 22.1.2.8.

22.1.2.7 The accumulator battery is to be used as a transitional source of electric power required in 22.1.2.5.3. The capacity of the battery is to be sufficient to provide power supply without recharging and with the voltage change at its terminals within ± 12 per cent of the rated value throughout the discharge period.

22.1.2.8 The capacity of the accumulator battery used as a transitional source of electric power is to be sufficient to provide power supply for 30 minutes to the below-mentioned consumers:

.1 lighting and navigation lanterns in accordance with 22.1.2.1.1 and 22.1.2.1.2;

.2 all signalling and internal communication equipment required in an emergency;

.3 the general alarm and fire detection systems;

.4 daylight signalling lamp, audible signalling devices (whistles, gongs, etc.), the fire door holding and release systems, as well as fire door position indicators, specified in para. 6.1.8.3, *Part V – Fire Protection*;

.5 drives of watertight doors, their position indicators and warning signals. Sequential operation of the doors may be permitted.

The consumers, specified in .2, .3 and .4, need not be supplied from a transitional source of electric power, provided they are fitted with their own accumulator batteries of sufficient capacity to supply the services for the required period of time.

22.1.3 Electrical Equipment of Watertight Doors

22.1.3.1 Electrical equipment of watertight doors as well as its associated elements are to be, as far as practicable, located above the bulkhead deck, outside dangerous rooms and spaces.

22.1.3.2 Where the location of electrical equipment below the bulkhead deck cannot be avoided, the following degrees of enclosure protection are to be ensured:

.1 electric motors, their associated circuits and control elements – IPX 7;

.2 watertight door position sensors and their associated circuit elements –IPX 8;

.3 elements of warning signals of the door movement – IPX 6.

22.1.3.3 Electric power, control, indication and alarm circuits are to be so protected against fault that a failure in one door circuit will not cause a failure in any other door circuit.

Short circuits or other faults in the alarm or indication circuits of a door are not to result in a failure of the supply and control circuits.

Arrangements are to be such that leakage of water into elements of electrical equipment located below the bulkhead deck will not cause the door to open.

22.1.3.4 A single failure of the supply or control circuit of the watertight sliding doors is not to result in the opening of the closed doors.

The power supply to electric motors mechanically driving doors of type 3 (specified in sub-chapter 21.2.1, *Part III – Hull Equipment*) is to be continuously monitored in a direct vicinity of each of the electric motors.

The power supply decay in the supply and control circuits is to activate visual and audible signals on the central stand on the navigation bridge.

A single failure in the electric or hydraulic power-operated systems of watertight doors, excluding the hydraulic actuator is not to prevent the hand operation of any door.

22.1.3.5 Watertight doors which also serve as fire doors are not to be closed automatically in case of fire detection by the fire detection system.

22.1.4 Additional Low-location Lighting

22.1.4.1 Additional low-location lighting (required in para. 6.1.6.10.5, *Part V – Fire Protection*) is to be made of:

– photoluminescent materials having properties of storing lighting energy when the ambient light source is less effective; or
– light sources supplied by electric power such as incandescent bulbs, light emitting diodes, electroluminescent lamps, electrofluorescent lamps, etc.

Additional low-location lighting products are not to contain radioactive or toxic materials.

22.1.4.2 Additional low-location lighting system is to operate for at least 60 minutes.

The system is to be capable of being activated directly from the continuously manned central control station. It may, additionally, be continuously operating or be switched on automatically, e.g. by the presence of smoke within the spaces served.

22.1.4.3 In all passageways, the additional low-location lighting is to be continuous except as interrupted by corridors and cabin doors, however, the interruption is not to exceed 2 metres.

The additional low-location lighting is to be installed at least on one side of the corridor, either on the bulkhead within 300 mm from the deck, or on the deck within 150 mm from the bulkhead.

In corridors of more than 2 metres wide, additional low-location lighting is to be installed on both sides.

In stairways the additional low-location lighting is to be installed within 300 mm above the steps such that each step may be readily identified from either above or below that step.

In dead-end corridors, additional low-location lighting is to have arrows placed at intervals of no more than 1 metre, or equivalent direction indicators, pointing away from the dead-end.

22.1.4.4 Additional low-location lighting is to lead to the exit door handle. No other doors are to be similarly marked. Sliding fire doors and watertight doors are to be marked with an additional low-location lighting sign showing how the door opens.

22.1.4.5 Photoluminescent strips are not to be less than 75 mm wide. Photoluminescent strips having a width less than that stated herein are to be used only if their luminance is properly increased.

Photoluminescent materials are to ensure luminance equal at least 15 mcd/m^2 measured 10 minutes after the removal of all external lighting sources and greater than 2 mcd/m^2 for 60 minutes. Photoluminescent installation materials are to be provided with sufficient external light necessary to charge the photoluminescent materials to meet luminance requirements.

22.1.4.6 Additional low-location lighting supplied by electric power is to be connected to the emergency switchboard so as to be powered by the main source of electric power under normal service conditions and by the emergency power source in emergency conditions (see also 22.1.2.2).

For existing ships, additional low-location lighting may be connected to the main lighting system, provided that independent battery charged from the main lighting system, ensuring supply of low-location lighting for at least 60 minutes, is fitted.

Additional low-location lighting supplied from battery is to comply with the requirements given in 22.1.4.7 ÷ 22.1.4.10.

22.1.4.7 Additional low-location lighting supplied with electric power is to fulfil the following requirements:

.1 the planar sources of light are to have minimum luminance of 10 cd/m^2 from the active parts in a continuous line of 15 mm minimum width;

.2 the point sources of miniature lamps are to provide not less than 150 mcd mean spherical intensity with a spacing of not more than 100 mm between lamps;

.3 the point of source of light emitting diode systems are to have a minimum peak intensity of 35 mcd. The angle of half intensity cone is to be appropriate to the likely track directions of approach and viewing. Spacing between lamps is to be of no more than 300 mm;

.4 electroluminescent lamps are to function for 60 minutes from the moment of removing the main power supply specified in 22.1.4.6.

The typical track directions of approach and viewing are to be considered:

a) for sources which are required to be viewed from a horizontal position, within a 60° cone having its centre located 30° from the horizontal mounting surface of the point source and in line with the track direction,

b) for sources which are required to be viewed vertically, within a 60° cone having its centre located perpendicular to the mounting service of the point source.

22.1.4.8 The power supply arrangements to the additional low-location lighting are to be so arranged that a single fault does not result in the complete loss of the lighting in any fire zone and such that a fire in any fire zone or on any deck does not result in loss of the lighting in any other fire zone or deck. This requirement may be satisfied by the power supply circuit configuration, use of fire resistant cables complying with IEC Publication 60331 or the provision of suitably located power supply units having integral batteries adequately rated to supply the lighting for a minimum period of 60 minutes.

22.1.4.9 Single lights and lighting assemblies of additional low-location lighting are to be designed or arranged so that any single fault or failure in a light or lighting assembly, other than a short-circuit, will not result in a break in visible delineation exceeding 1 metre.

22.1.4.10 Lighting fixtures and assemblies are to be flame retardant, have an ingress protection of at least IP55 and are to comply with the tests requirements specified in *Publication No. 11/P – Environmental Tests on Marine Equipment*.

22.1.4.11 Additional emergency lighting on passenger ferries, executed according to 22.2.2, may by used partly or totally as low-location lighting, provided that conditions, specified in 22.1.4.1 ÷ 22.1.4.10, are complied with.

22.1.5 Additional Requirements for Public Address System

22.1.5.1 In passenger ship, the public address system is to be capable of being connected to three broadcasting lines:

– deck broadcasting line, specified in 7.3.2.5.1;
– service broadcasting line, specified in 7.3.2.5.2;
– passenger broadcasting line, intended for connecting loudspeakers installed in passenger accommodation and public spaces (cabins, messrooms, libraries, verandas, cafeterias, bars, etc., including the adjacent corridors and landings).

22.1.5.2 Provision is to be made for disconnecting passenger broadcasting line from service and deck broadcasting lines when addressing crew accommodation and work spaces.

22.1.5.3 The public address system is to be protected against an unauthorized use. It is to be provided with an override function controlled from the main command microphone post located on the navigation bridge so that all emergency messages will be broadcast even if any loudspeaker has been switched off, its volume has been turned down or the public address system is used for other purposes.

22.1.5.4 The public address system is to comply with the following requirements:

.1 each of the broadcasting lines, specified in 22.1.5.1, is to have at least two loops of flame retardant cable, which should be sufficiently separated throughout their length and have two separate and independent amplifiers. Amplifiers cabling is to be run in segregated cable routes;

.2 each loudspeaker is to be individually protected against short-circuit;

.3 each command microphone post is to be provided with emergency function control, which should:

- be clearly indicated as the emergency function;
- be protected against unauthorized use;
- automatically disconnect any other input system or programme;
- automatically override all volume controls and on/off controls in the public address system so that the required emergency mode volume specified in 7.3.2.9 is achieved in all spaces.

22.1.5.5 Cables and wiring serving internal communications or signals are to be, as far as practicable, routed clear of galleys, laundries, machinery spaces of category A and their casings and other high fire risk areas. Where practicable, all such cables are to be run in such a manner so as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space.

22.1.6 Passenger Ships Engaged on Domestic Voyages

The requirements for a ship to be assigned an additional mark **Class A**, **Class B**, **Class C** or **Class D** in the symbol of class are specified separately by PRS in each particular case. PRS may also exempt a ship from certain requirements of the present Part or change the scope of these requirements. Any exemptions/changes may be granted within the scope permitted by the *Council Directive 98/18/EC of 17 March 1998 on Safety Rules and Standards for Passenger Ships*, as amended.

22.2 Roll on – Roll off Passenger Ships and Passenger Ferries – Marks: RO-RO/ PASSENGER SHIP, FERRY/ PASSENGER SHIP

22.2.1 Installation of Electrical Equipment in Special Category Spaces

22.2.1.1 The requirements of sub-chapter 22.2.1 apply to special category spaces defined in *Part V – Fire Protection.*

22.2.1.2 On the car deck or platform above the bulkhead deck in a zone over a height of 450 mm above the deck or platform preventing the free passage of gas downwards, electrical equipment of an enclosure protection of not less than IP55 is allowed to be installed, provided that the ventilation system ensures at least 10 air changes per hour. Electrical equipment suitable for use in Zone 2 may be also installed in the above locations.

22.2.1.3 In holds and compartments above the bulkhead deck in a zone below a height of 450 mm above the deck or platform preventing the free passage of gas downwards, as well as in exhaust ventilation ducts, electrical equipment of explosion-proof construction, suitable for Zone 1, is to be installed.

22.2.1.4 In the whole volume of holds and compartments below the bulkhead deck, electrical equipment of explosion-proof construction – suitable for Zone 1, is to be installed.

22.2.1.5 Electrical installations of securing and locking devices of bow doors and inner doors on passenger ferries and roll on – roll off passenger ships are to comply with the requirements of paras. 7.4.8.4 to

7.4.8.9, *Part III – Hull Equipment*; electrical installations of securing and locking devices of shell doors and stern doors are to comply with the requirements of paras. 7.5.6.4 to 7.5.6.8, *Part III – Hull Equipment.*

22.2.1.6 In ro-ro passenger ships, cabling for general alarm and public address systems is subject to PRS' approval.

22.2.2 Supplementary Emergency Lighting

22.2.2.1 In addition to the emergency lighting required by 22.1.2.1.1, on passenger ships with ro-ro cargo spaces or special category spaces, all passenger public spaces and alleyways are to be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electric power have failed and under any condition of heel. The illumination provided is to be such that the approach to the means of escape can be readily seen (or to ensure the lighting intensity of 0.5 lux).

The supplementary lighting is to be such that any failure of the lamp will be immediately apparent.

22.2.2.2 The source of power for the supplementary lighting is to consist of accumulator batteries located within the lighting units. Accumulator batteries provided are to be continuously charged from the emergency switchboard and are to be replaced at intervals having regard to service life specified by the manufacturer in the ambient conditions to which they are subject in service.

22.2.2.3 Portable rechargeable battery operated lamps are to be provided in every crew space alleyway, crew recreational space and every working space which is normally occupied, unless supplementary emergency lighting, as required by 22.2.2.1 and 22.2.2.2, is fitted.

22.3 Roll on – Roll off Ships and Ferries – Marks: RO-RO SHIP, FERRY

22.3.1 Installation of Electrical Equipment in Ro-Ro Cargo Spaces

22.3.1.1 Ro-ro cargo spaces (see the definition given *Part V – Fire Protection*) are to be regarded as hazardous areas.

22.3.1.2 The electrical equipment in ro-ro cargo spaces is to comply with the requirements of subchapter 22.2.1.

22.3.1.3 Cables are to be protected against mechanical damage. Cables installed horizontally are to be laid at least 450 mm above the continuous deck or platform preventing the free passage of gas downwards.

Cable passages through decks and bulkheads are to be gastight.

22.3.1.4 Electrical devices installed in exhaust ventilation ducts, such as the fan motors are to be of explosion-proof construction, i.e. of increased safety type (Exe) or with flameproof enclosures (Exd).

22.3.1.5 Lighting installed in ro-ro cargo spaces is to be divided into at least two groups; each of the groups is to be supplied by a separate circuit.

22.3.2 Installation of Electrical Equipment in Holds and Compartments other than Ro-Ro Cargo Spaces, Intended for the Carriage of Vehicles with Fuel in their Tanks

22.3.2.1 In holds and compartments in a zone above a height of 450 mm above the continuous deck or platform preventing the free passage of gas downwards, electrical equipment of an enclosure protection not less than IP55 may be installed, provided that the ventilation system ensures at least 10 air changes per hour. Electrical equipment suitable for use in Zone 2 may be also installed in the above locations.

22.3.2.2 In holds and compartments in a zone below a height of 450 mm above the continuous deck or platform preventing the free passage of gas downwards, as well as in exhaust ventilation ducts, electrical equipment of explosion-proof construction, suitable for Zone 1, is to be installed.

22.4 Container Ships and Ships Intended for the Carriage of Containers – Marks: CONTAINER SHIP, ACC (…)

22.4.1 Application

The requirements of sub-chapter 22.4 are applicable to electrical equipment of container ships and ships intended for carrying isothermal containers.

22.4.2 Supply and Distribution of Electric Power

22.4.2.1 In addition to compliance with the requirements given in 3.1.2, the output of the main sources of electric power and of power converters is to provide the supply to all isothermal containers to be carried.

In order to ensure the supply to isothermal containers during loading operations on board the ship, all main sources of electric power and all power converters, including the reserve ones, may be used.

As the power value of electrical equipment of isothermal containers, their installed power is to be assumed. The power consumption of electrical equipment of thermal containers under rated operating conditions is not to exceed 15 kW (18.75 kVA).

The application of diversity and load factors is subject to special consideration by PRS in each particular case.

22.4.2.2 The means of overload protection of electric power sources, specified in 8.2.3, are to provide for the feeder of the thermal container switchboard to be the last to be disconnected from the main switchboard (see also 19.2.1).

22.4.2.3 Electrical network supplying the electrical equipment of isothermal container equipment is to be separated from the ship's network by means of separating transformers supplied from the main switchboard.

22.4.2.4 The electrical equipment of isothermal containers is to be supplied from special switchboards supplied by separate feeders.

22.4.2.5 The socket outlets installed in holds or on weather decks in places where isothermal containers are located are to be supplied by separate feeders from special switchboards specified in 22.4.2.4 and 22.4.3.

22.4.2.6 Electrical network of socket outlets intended to supply electrical equipment of isothermal containers is to have the rated voltage of 220 V or 380 V of 3-phase alternating current of a frequency of 50 Hz or 240 V or 440 V of 3-phase alternating current of a frequency of 60 Hz.

22.4.3 Distribution Switchboards and Transformers

22.4.3.1 The switchboards of isothermal containers, electric converters (if any) and separating transformers are to be located in special electrical spaces.

22.4.3.2 The secondary windings of separating transformers are to have the neutral point insulated.

22.4.3.3 Each switchboard is to be fitted with apparatus providing for:

.1 visual signals to indicate that the switchboard is in live condition;
.2 switching on and off each feeder of socket outlets;
.3 protection of feeders supplying socket outlets against short-circuit;
.4 measuring of insulation resistance.

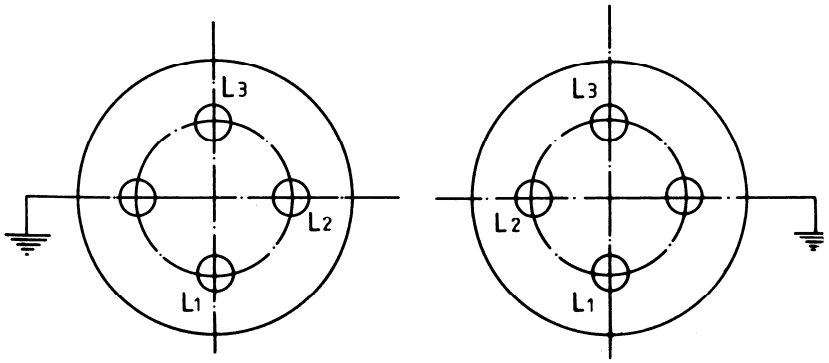
22.4.4 Socket Outlets

22.4.4.1 In holds intended for carrying isothermal containers, only the socket outlets to supply containers may be installed. The socket outlets installed in the hold are to have a protection degree of at least IP55 and those installed on the weather deck – at least IP56.

Where electrical system of remote monitoring of temperature, humidity, ventilation and other parameters of isothermal containers in holds and on decks is employed, additional socket outlets may be installed in holds and on decks to connect such a monitoring system.

22.4.4.2 Irrespective of the requirements, given in 14.2.3, socket outlets supplying electrical equipment of isothermal containers are to be fitted with a switch interlocked so that the plug cannot be inserted or withdrawn while the switch is in the "on" position. They are also to be provided with informative plates indicating their voltage value.

22.4.4.3 The electrical equipment of isothermal containers is to be supplied from the ship's network through socket outlets with the direction of phase rotation in the sequence L1, L2, L3 as shown in the diagram presented in Fig. 22.4.4.3.



The front view of plug The front view of socket outlet

Fig. 22.4.4.3. Sequence of phase connections of plug and socket outlet

22.4.4.4 Socket outlets intended to supply electrical equipment of isothermal containers are to be designed for the following rated currents:
– 60 A for voltages 220 V, 50 Hz or 240 V, 60 Hz,
– 32 A for voltages 380 V, 50 Hz or 440 V, 60 Hz.

22.4.4.5 The design and dimensions of contacting parts of plugs are to be such as to exclude the possibility of connecting the plugs rated for one voltage with the socket outlet rated for another voltage.

22.4.4.6 The design and dimensions of contacting parts of the socket outlets and plugs are to comply with the international standards.

22.4.5 Protective Earthing

The socket outlet intended to connect the earthing conductor of the flexible cable of an isothermal container is to be earthed by means of an earthing conductor in the supplying feeder. The earthing conductor in the supply cable is to be earthed in the location of the switchboard supplying socket outlets of isothermal containers.

22.5 Crude Oil Tankers, Product Carriers, Gas Tankers, Chemical Tankers, Ships Intended for Operation in Oil Spillage Area – Marks: CRUDE OIL TANKER, PRODUCT CARRIER A, LIQUEFIED GAS TANKER, CHEMICAL TANKER, OIL RECOVERY VESSEL

22.5.1 Application

22.5.1.1 The requirements of sub-chapter 22.5 apply to electrical equipment in ships intended for the carriage of liquid cargoes having a flashpoint 60°C and below, as well as to ships intended or adapted for operation in the oil spillage area.

22.5.1.2 The equipment installed in hazardous spaces of the above-specified ships is to be suitable for explosive mixtures specified in 2.8.4, with the exception of the following explosive mixtures:
– hydrogen and acetylene of explosion group IIC;

– acetaldehyde and ethylether of temperature class T4;
– carbon disulphide of temperature class T6 and explosion group IIC.

22.5.2 Power Distribution Systems

22.5.2.1 Only the following systems may be used for the distribution of electric power:
- **.1** two-wire insulated system for direct current;
- **.2** two-wire insulated system for single-phase alternating current;
- **.3** three-wire insulated system for three-phase alternating current (also for a voltage of 1000 V ÷ 11 000 V alternating current);
- **.4** three-wire system with the earthed neutral point by a high ohm resistance for a voltage of 1000 V ÷ 11 000 V alternating current (see also 18.2.1).

22.5.2.2 The earthed systems of electric power distribution may be used only for the supply of the following consumers, provided they are used outside the hazardous rooms and spaces:
- **.1** system of the outer hull cathode current protection against corrosion;
- **.2** system of monitoring and measuring the insulation resistance (see 4.5.4.8);
- **.3** electrical system for the starting of diesel engines.

22.5.3 Hazardous Rooms and Spaces

22.5.3.1 The following rooms and spaces are considered as hazardous:
- **.1** inner spaces of cargo compartments and cargo tanks, cargo pipelines and the cargo pumping systems;
- **.2** open spaces up to a height of 1 m above the water surface covered by oil (for ships operating directly in the oil spillage area);
- **.3** cofferdams and other spaces adjoining cargo compartments and cargo tanks;
- **.4** enclosed or semi-enclosed spaces containing cargo pumps, enclosed or semi-enclosed spaces, not completely welded, containing cargo pipelines;
- **.5** enclosed or semi-enclosed spaces situated above the cargo compartments and cargo tanks, as well as spaces having bulkheads above or on the level of the cargo compartment bulkheads and the cargo tank bulkheads;
- **.6** enclosed or semi-enclosed spaces situated directly above the pump rooms, as well as above the vertical cofferdams adjacent to cargo compartments and cargo tanks, provided they are not divided by the gas-tight decks and do not have power ventilation;
- **.7** spaces and rooms other than cofferdams, adjoining and situated below the upper part of cargo compartments and cargo tanks;
- **.8** spaces and semi-enclosed rooms on the open deck within a radius of 3 m from manholes, hatches and other openings not intended for ventilation of cargo compartments and cargo tanks, as well as the ends of cargo pipelines;
- **.9** spaces on the open deck above cargo compartments and cargo tanks (as well as above the ballast tanks used as cargo tanks) over the full width of the ship and additionally 3 m fore and aft up to a height 2.4 m above the deck. For ships operating directly in the oil spillage area, the space specified above extends over the full length of the ship;
- **.10** compartments for oil hoses and oil recovery equipment;
- **.11** enclosed and semi-enclosed spaces having direct exits or other openings leading to one of the above-mentioned rooms or spaces;
- **.12** rooms and spaces above cofferdams adjacent to the compartments of cargo tanks, not separated by oil-tight and gas-tight bulkheads or decks, lacking proper ventilation and having entrances from the deck above;
- **.13** rooms situated above the pump rooms, where the electric motors of cargo and stripping pumps are installed.

22.5.3.2 Where the deck of a cargo tank extends to the bulkhead of accommodation spaces, the rooms mentioned in 22.5.3.1.9 are to be defined assuming that the height of the wash barrier is at least equal to the height of the side which restricts the flowing of the liquid cargoes from the ship's deck. In this case, the hazardous area extends 3 m beyond the wash barrier.

22.5.3.3 Spaces situated below the level of the main deck and having direct exits or other openings leading to spaces on the main deck, specified in 22.5.3.1.9, are not considered as hazardous on condition that suitable, double, self-closing gas-tight doors forming an air-lock, as well as the additional power ventilation with an air inlet beyond the hazardous area are provided.

22.5.3.4 For ships adapted for operation in the oil spillage area, entrances, ventilating holes (inlets, outlets) and other openings in non-hazardous spaces, such as accommodation, service and machinery spaces, not provided with gastight closures, are to be situated 6 m above the highest load-line and, in each case, outside the hazardous zone. Entrances to these spaces, situated 6 m below the highest load-line or in the hazardous zone, are to be fitted with air-locks; the remaining openings are to be provided with gastight closures and are to be closed during oil recovery operations.

22.5.4 Electrical Equipment in Hazardous Rooms and Spaces

22.5.4.1 The electrical installations in hazardous spaces and rooms are to be made in accordance with IEC Publication 60092-502.

22.5.4.2 In hazardous rooms and spaces, the installation of electrical equipment is not allowed with the exception of:

- **.1** lighting fixtures and signal lamps having pressurized enclosures (Exp) flameproof enclosures (Exd) or enclosures of increased safety type (Exe);
- **.2** switches of increased safety type (Exe) or with flameproof enclosures (Exd);
- **.3** communication, remote control, monitoring and control equipment of intrinsically safe type (Exi);
- **.4** electric motors of increased safety type (Exe), with flameproof enclosures (Exd) or with pressurized enclosures (Exp).

22.5.4.3 In inner spaces of cargo compartments and cargo tanks, cargo pipelines and cargo pumping systems, electrical equipment and cables are not to be installed, with the exception of installation of intrinsically safe type (Exi).

22.5.4.4 In open spaces up to a height of 1 m above the water surface covered with oil (for ships operating directly in the oil spillage area), electrical equipment and cables are not to be installed with the exception of installations of intrinsically safe type (Exi).

22.5.4.5 In cofferdams and other spaces adjacent to cargo compartments and cargo tanks, the installation of electrical equipment is not allowed with the exception of:

- **.1** equipment of intrinsically safe type (Exi);
- **.2** echo depth sounder oscillators and their cables in accordance with the requirements given in the SOLAS Convention (these requirements are also given in *Part V – Navigational Equipment* of the *Rules for Statutory Survey of Sea-going Ships*, sub-chapter 4.2.4);
- **.3** cables of the outer hull cathode current protection system installed in corrosion-proof steel pipes with gastight joints up to the upper deck.

22.5.4.6 In enclosed and semi-enclosed spaces containing cargo pumps or cargo pipelines, only the following equipment is allowed to be installed:

- **.1** electrical equipment specified in 22.5.4.5.1 to 22.5.4.5.3;
- **.2** lighting supplied by at least two circuits, with fuses and switches on all poles or phases, situated outside the hazardous rooms and spaces, the following constructions are possible:
  - illumination by means of lamps installed outside the hazardous rooms and spaces through side scuttles of fixed type placed in gas-tight bulkheads or decks, provided they do not reduce the strength, gastightness and flameproofness of those bulkheads and decks;
  - lighting fixtures of explosion-proof construction with pressurized enclosures (Exp) or with flameproof enclosures (Exd), whose cables are to be protected against mechanical damage by means of metallic protective sheaths;
- **.3** through runs of cables.

Electric motors for driving the devices located in pump-rooms are to be installed in adjacent non-hazardous rooms. Gas-tight stuffing boxes are to be used for the shaft penetrations through bulkheads or decks. Electric motors are to have devices for remote switching off, located outside the rooms in which electric motors are installed and above the tank deck.

22.5.4.7 In enclosed and semi-enclosed spaces above the deck of cargo compartments and cargo tanks, as well as in spaces having bulkheads above or on the level of both the cargo compartment bulkhead and the cargo tank bulkhead, in enclosed and semi-enclosed spaces situated directly above pump-rooms and above vertical cofferdams adjacent to cargo compartments and cargo tanks which are not separated by gas-tight decks and are not provided with power ventilation, in compartments for cargo hoses and oil recovery equipment, only the following are allowed to be installed:

.1 electrical equipment of intrinsically safe type (Exi);

.2 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd); or of increased safety type (Exe); the switches of these fixtures are to be located outside the hazardous rooms and spaces;

.3 through runs of cables.

22.5.4.8 In rooms and spaces other than cofferdams, adjacent to cargo compartments and cargo tanks or situated below their upper parts, only the following equipment is allowed to be installed:

.1 electrical equipment specified in 22.5.4.5;

.2 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd); this lighting is to be made by means of lamps supplied by at least two circuits, with fuses and switches on all poles or phases, situated outside the hazardous rooms and spaces;

.3 through runs of cables.

22.5.4.9 In semi-enclosed spaces and rooms on the open deck within a radius of 3 m from manholes, hatches and other non-ventilated openings of cargo compartments and cargo tanks, only the following equipment is allowed to be installed:

.1 electrical equipment specified in 22.5.4.2;

.2 through runs of cables in ducts or pipes containing cables, except expansion loops.

22.5.4.10 In spaces on the open deck above cargo compartments and cargo tanks (also above the ballast tanks used as cargo tanks) over the full width of the ship and 3 m fore and aft on the open deck up to a height of 2.4 m above the deck, in enclosed or semi-enclosed spaces having direct exits or other openings leading to one of the above rooms and spaces specified in 2.8.11, only the following equipment is allowed to be installed:

.1 electrical equipment specified in 22.5.4.2;

.2 through runs of cables in ducts or pipes containing cables.

22.5.4.11 In rooms and spaces above cofferdams adjacent to cargo tanks which are not separated by oil-tight and gastight bulkheads or decks and do not have suitable ventilation and have entrances from the deck situated above, only the following equipment is allowed to be installed:

.1 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd) or of increased safety type (Exe);

.2 other electrical devices which do not produce electric arcs during normal operation and whose surfaces are not heated to a dangerous temperature;

.3 other electrical devices of increased safety type (Exe), ventilated and having an enclosure protection of minimum IP55, whose surfaces are not heated to a dangerous temperature.

22.5.4.12 In rooms, where there are electric motors of cargo and stripping pumps, situated above pump-rooms, the following equipment is allowed to be installed:

.1 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd) or of increased safety type (Exe);

.2 other electrical devices which do not produce electric arcs during normal operation and whose surfaces are not heated to a dangerous temperature;

.3 other electrical devices of increased safety type (Exe), ventilated and having an enclosure protection of minimum IP55 whose surfaces are not heated to dangerous temperature.

Where the room's location and arrangement indicate that the explosive mixtures of gases, vapours or dust with air may accumulate, suitable ventilation is to be ensured. Also interlocking between the starting device for an electric motor of the cargo pump and the electric drive for the ventilation system of this compartment is to be provided. This interlocking is to permit the pump electric motor to be started only after the compartment has been sufficiently ventilated.

22.5.4.13 The possibility of occurrence of explosive mixtures of gas with air during cargo pumping, ballasting and gas-freeing by mechanical means outside the spaces and rooms specified in 22.5.3.1 is to be taken into account. Areas on open deck or semi-enclosed spaces on open deck, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet which permits the flow of large volumes of vapour, gas mixtures during loading/discharging/ballasting are defined as Zone 1, as specified by IEC 60092-502, para. 4.2.2.8.

Areas within 4 m beyond the zone specified above are defined as Zone 2, as specified by IEC 60092-502, para. 4.2.3.2.

Electrical equipment or cables shall normally not be installed in the areas, referred to above. Where essential for operational purposes, electrical equipment may be installed in these areas in accordance with the requirements of IEC 60092-502.

22.5.4.14 Areas on open deck or semi-enclosed spaces on open deck, within 3 m of cargo tank ventilation outlets are defined as Zone 1, as specified by IEC 60092-502, para. 4.2.2.7.

Areas within 2 m beyond the zone specified above are to be considered Zone 2 (as opposed to 1.5 m specified by IEC 60092-502, para. 4.2.3.1).

Electrical equipment or cables shall normally not be installed in the areas, referred to above. Where essential for operational purposes, electrical equipment may be installed in these areas in accordance with the requirements of IEC 60092-502.

22.5.5 Portable Electrical Equipment Intended for Oil Recovery from Sea Surface

22.5.5.1 Portable electrical equipment is to be of explosion-proof construction.

22.5.5.2 Panels or sockets used for supplying portable electrical equipment are to be fitted with interlocking preventing the connection of live portable electrical equipment, as well as with protective devices against short-circuit and overload in any phase.

Such panels or sockets are to be so installed that a cable used for supplying portable electrical equipment does not run through door openings or any other openings capable of being closed, enclosing hazardous rooms and spaces.

22.5.5.3 Flexible cables used for supplying portable electrical equipment are to have a metal shield covered with a tight non-metallic sheathing resistant to kerosine products.

22.5.6 Installation of Cables

22.5.6.1 In crude oil tankers and ships intended or adapted for operation in the oil spillage area, cables installed on gangways are to be laid in appropriate conduits or pipes (see 16.8.8).

Where gangways are provided in the spaces mentioned in 22.5.3.1.9, the cables laid on them are to comply with the requirements of para. 2.8.15.

22.5.6.2 For systems operating at the voltage specified in 22.5.2.1.4, only cables having copper sheaths plus additional isolating coating on those sheaths are to be used. The cross-sectional area of the sheaths is to be not less than the cross-sectional area of the core. The design of such cables is subject to special consideration by PRS.

22.5.7 Additional Means for Prevention against Explosion in Cargo Pump Spaces

22.5.7.1 Cargo, ballast and stripping pumps installed in cargo pump spaces and driven through shafts penetrating through bulkheads of those spaces are to be equipped with temperature measuring systems of bulkhead shaft sealing, bearings and pump casings. The alarm signal is to be given in cargo central station or on pump control stand and it is to be continuous, audible and visual.

22.5.7.2 To discourage personnel from entering the cargo pump-room when the ventilation system is not in operation, one of the following means is to be applied:

.1 interlocking of lighting in the cargo pump-room with the ventilation system is to be provided such that the ventilation is to be in operation to energize the lighting. Failure of the ventilation system should not cause the lighting to go out. Emergency lighting is not to be interlocked;.

.2 warning alarms are to be provided at the door to the cargo pump- room:

- visual alarm warning that the cargo pump-room ventilation system is not in operation, that the pump-room atmosphere may therefore be hazardous, and that the pump-room is not to be entered until verified safe;
- visual and audible alarms indicating that pump-room door was opened, although the pump-room ventilation system is not in operation. The alarms are to also operate on the navigation bridge. Reset of the alarm is to be provided from the navigation bridge only.

22.5.7.3 A system for continuous monitoring of the concentration of hydrocarbon gases is to be provided. Sampling points or measuring detector heads are to be located in suitable positions in order that potentially dangerous leakages are easily detected. Sequential sampling is acceptable as long as it is dedicated for the pump-room only, including exhaust ducts, and the sampling time is reasonably short. Suitable positions may be the exhaust ventilation duct, lower parts of the pump-room above floor plates or other areas where air circulation is reduced. The system is to cause activation of alarm signal when gas concentration exceeds 10% of the lower flammable limit.

Alarm signal (visual and audible) is to be given in the pump-room, engine control room, cargo central station and on the navigation bridge. The requirements for gas analysing units are given in 22.5.8.

22.5.7.4 All cargo pump-rooms are to be equipped with the bilge well monitoring system with properly arranged signalling system.

22.5.8 Location of Units for Continuous Analysis of Flammable Vapours and Gas

22.5.8.1 Gas analysing units with non-explosion proof measuring equipment may be located in areas outside cargo areas, e.g. in cargo central station, on the navigation bridge or in the engine room when mounted on the forward bulkhead, provided that the requirements, given in 22.5.8.2 to 22.5.8.6, are fulfilled.

22.5.8.2 The gas sampling pipes are not to run through hazardous spaces, except where permitted by 22.5.8.6.

22.5.8.3 The gas sampling pipes are to be equipped with flame arresters. Sample gas is to be led to the atmosphere through outlets arranged in a safe location.

22.5.8.4 Bulkhead penetrations of sample pipes between safe and hazardous areas are to be of approved type and have the same fire integrity as the division penetrated. A manual isolating valve is to be fitted in each of the sampling pipes at the bulkhead on the gas safe side.

22.5.8.5 The gas detection equipment, including sample piping, pumps, solenoids, analysing units, etc. is to be located in a reasonably gastight steel cabinet (e.g. a fully enclosed steel cabinet with a gasketed door), which is to be monitored by its own sampling point. At gas concentrations above 30% of the lower flammable limit inside the steel cabinet, the entire gas analysing unit is to be automatically shut down.

22.5.8.6 Where the cabinet cannot be arranged directly on the bulkhead, sample pipes are to be of steel or other equivalent material and without detachable connections, except for the connection points for isolating valves at the bulkhead and analysing units, and are to be routed on their shortest ways.

22.5.9 Integrated Cargo and Ballast Systems on Tankers

22.5.9.1 The requirements of the present sub-chapter are applicable to tankers contracted for construction on or after 1 January 2004.

22.5.9.2 Integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps.

22.5.9.3 A single failure in the integrated cargo and ballast system – including its control and safety systems – is not to make the integrated cargo and ballast pumps inoperable simultaneously.

22.5.9.4 The emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems and a single failure in the control system circuits or the emergency stop circuits is not to cause disconnection of power supply and in consequence stopping the ballast pumps.

22.5.9.5 Manual emergency stops of the cargo pumps are not to make the ballast pumps inoperable.

22.5.9.6 The control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

22.5.9.7 In the event of failure of the automatic or remote control systems, secondary means of control are to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

22.6 Special Purpose Ships – Marks: RESEARCH SHIP, TRAINING SHIP

22.6.1 Power Supply of Essential Services

In special purpose ships carrying more than 50 special personnel, the circuits supplying the essential services are to be made in accordance with 22.1.1.4.

22.6.2 Emergency Sources of Electric Power

22.6.2.1 In special purpose ships carrying not more than 50 special personnel, the emergency source of electric power is to fulfil the requirements specified in 9.3.

Special purpose ships of more than 50 m in length are to additionally fulfil the requirements specified in 22.1.2.4.1.

22.6.2.2 In special purpose ships carrying more than 50 special personnel, the emergency source of electric power is to fulfil the requirements specified in 22.1.2.

22.6.3 Electrical Equipment in Store-rooms for Explosives

22.6.3.1 In store-rooms for explosives electrical equipment is not to be installed, except lighting fixtures with globes and guards. Cable runs passing through these store-rooms are to be installed in watertight pipes.

22.6.3.2 The switches of lighting circuits are to be installed outside these store-rooms. Visual signals indicating the presence of voltage in the circuit are to be provided at the switch location.

22.6.3.3 Terminals for connecting portable magazines for explosives to the ship's network are to have an enclosure protection of at least IP56 and are to be fitted with supply rating plates.

22.7 Floating Cranes – Mark: FLOATING CRANE

22.7.1 For floating cranes and crane ships in which driving systems similar to those described in Chapter 17 are used for hoisting gears, the requirements of that Chapter may be applied to the electrical drives of hoisting gears within the scope agreed with PRS in each particular case.

22.7.2 For floating cranes having their own propulsion, the output of the main sources of electric power is to be sufficient for ensuring the operation of the crane under one of the conditions: when travelling or during loading operations.

22.7.3 The rooms and lockers intended for the location of accumulator batteries, as well as the rooms of emergency sources of electric power are allowed to be situated below the main deck, provided all other requirements specified in Chapter 13 and sub-chapter 9.2 are complied with.

22.7.4 Floating cranes are to be provided with an audible signalling system operated from the operator cabin to give audible signals during loading operations.

22.7.5 Telephone communication between the navigation bridge and the operator cabin is to be provided.

22.8 Bulk Carriers – Mark: BULK CARRIER

22.8.1 Detection system of water ingress into cargo holds, ballast tanks and dry spaces of bulk carriers

22.8.1.1 Bulk carriers are to be fitted with the below-mentioned water level detectors and indicators:

- **.1** in each cargo hold giving audible and visual alarms, one when the water level above the inner bottom reaches the height of 0.5 m (the pre-alarm) and another at the height not less than 15% of the depth of the cargo hold but not more than 2 m (the main alarm). The visual alarms are to clearly discriminate between the two different water levels detected in each hold. On the existing bulk carriers fitted with the pre-alarm system (0.5 m water level indication), detectors with only the latter alarm (i.e. the main alarm) need be installed;
- **.2** in any ballast tank forward of the collision bulkhead giving an audible and visual alarm when the liquid in the tank reaches the level not exceeding 10% of the tank capacity;
- **.3** in any dry or void space other than a chain cable locker any part of which extends forward of the foremost cargo hold giving an audible and visual alarm at the water level of 0.1m above the deck.

Such alarms need not be provided in enclosed spaces, the volume of which does not exceed 0.1% of the ship's maximum displacement volume.

22.8.1.2 The visual and audible characteristics of the alarms, specified in 22.8.1.1.2 and 22.8.1.1.3, are to be the same as those of the main alarm described in 22.8.1.1.1.

22.8.1.3 The alarm systems, described in 22.8.1.1.1 and 22.8.1.1.2, may be equipped with an alarm overriding devices activated when the holds or tanks are used for the carriage of water ballast.

Hold/tank, where the override device is activated, is to be clearly identifiable on the signalling panel.

Cancellation of the override condition and reactivation of the water detection alarm system is to be automatic, when the hold or tank has been de-ballasted to a level below the lowest alarm indicator level.

22.8.1.4 Electrical equipment of the water ingress detection system is to comply with the following requirements:

- **.1** the water ingress detection system, including its essential equipment, is to be of a type approved by PRS;
- **.2** the water level detectors in holds are to be fitted in aft part of each hold either as close to the centreline as practicable or within a distance less or equal to B/6 from the centerline. Where not practicable, they are to be located at both the port and starboard sides of the cargo hold. The sensors installed in the spaces other than cargo holds are to be located in the lowest part of those spaces;
- **.3** detection equipment is to be suitably corrosion resistant for all intended cargoes;
- **.4** the detector indicating the water level is to be capable of activating with the accuracy of ± 100 mm;
- **.5** the part of the system which has its circuitry in the cargo area is to be intrinsically safe;
- **.6** the degree of protection of electrical equipment installed in the cargo holds, ballast tanks and dry spaces is to be at least IP68. Where necessary, the electrical equipment (including the cables)

is to be protected against mechanical damage by cargoes or mechanical handling equipment. The degree of protection of electrical equipment installed above the cargo and ballast spaces is to be at least IP56;

.7 time delays are to be incorporated into the alarm system to prevent spurious alarms.

22.8.1.5 The alarm system is to have such self-monitoring properties that audible and visual alarm signal will be given in the case of broken circuit or other typical failure.

22.8.1.6 The water ingress detection system is to be supplied from two independent electrical power supply sources – the primary electrical power supply and the emergency source of power supply. A dedicated accumulator battery may be used as the emergency source of power supply, provided the capacity of the battery is equivalent to that of the emergency source, specified in 9.3. Failure of the primary electrical power supply is to be indicated by visual and audible alarm. Where batteries are used as the emergency source of power supply, failure alarms for both power supplies are to be provided.

22.8.1.7 All the above-mentioned alarms are to be indicated at least on the navigation bridge.

22.8.1.8 The alarm panel is to be suitable for location on the navigation bridge. Dimmer is to be provided for visual indication on the bridge. The audible indication is to be capable of being muted by the operator.

Audible and visual signalling is to comply with the requirements specified in 20.4.1.1, 20.4.1.6, 20.4.1.7 and 20.4.1.8.

22.8.1.9 The alarm panel is to be provided with a push-button for testing visual and audible indication and returning to the off position when not operated.

22.8.1.10 The water ingress detection system is to be capable of continuous operation while the ship is at sea.

22.8.1.11 The detector installation is not to inhibit the use of any sounding pipe or other level gauging device for cargo holds or other spaces.

22.9 Additional Requirements for Energy Efficient Ships

22.9.1 Application

The requirements specified in this Chapter apply to new ships or ships who have undergone substantial modification of gross tonnage 400 and above engaged on international voyages specified in Regulation 21 of Annex VI to *MARPOL*, in accordance with definitions contained in Regulations 2.23 and 2.24 of Annex VI to *MARPOL*.

22.9.2 Documents to be Submitted

The documents to be submitted at each stage of design are specified in the *Guidelines on Survey and Certification of EEDI* and the *Industry Guidelines on Calculation and Verification of EEDI* contained in *Publication 103/P – Guidelines for Energy Efficiency of Ships*.

Prior to commencement and during the ship construction or modification the documentation required at each stage of design, including the documentation prepared after the sea trials conducted shall be submitted to PRS Head Office for consideration and approval.

22.9.3 Additional Mark EF in the Symbol of Class

Ships whose attained energy efficiency design index (*EEDI*) does not exceed the required value of *EEDI* (determined for the specific period) may be assigned additional mark **EF** in the symbol of class.

22.10 Ecological Ships – Mark: ECO AIR

22.10.1 Technical requirements for shore power supply systems are given in PRS Rule Publication No. 106/P.

23 SPARE PARTS

23.1 General Requirements

23.1.1 The number, kind and location of spare parts on board the ship are left to the shipowner's decision. The construction of electrical and automation equipment, the manufacturer's recommendations, intended service conditions, as well as the necessity of compliance with the requirements of the Flag State Administration are to be taken into account.

Furthermore, for remote control systems and automation, the exchange of total elements or units (blocks, cassettes, etc.) and not the exchange of their particular components should be a rule.

23.1.2 Spare parts, together with the appropriate tools, materials and instruments are to be located in an easily accessible place protected against corrosion.

23.2 List of Spare Parts for Ship's Electrical Equipment

The number and kind of spare parts, given in Table 23.2, are to be regarded as general recommendations.

Table 23.2
Spare parts for ship's electrical equipment

Item	Equipment	Spare parts		Number of spare parts	Remarks
1	2	3		4	5
1	Generators and rotating exciters	Brushes		1 set	Of each type per 3 identical machines
		Brush-holders		1pc	
		Bearings		1 set	
2	Static exciters	Thyristors and diodes of the power circuits		1 pc of each type	For 3 static exciters of the same type
		Resistors and condensers of the power circuits inductance		1 pc of each type	
3	Electric motors	Brushes		1 set	Per 6 motors of each type
		Brush-holders		1 pc	
		Bearings		1 set	
4	Steering gear	Brushes		1 set	For each motor
		Brush-holders		1 pc	
		Bearings		1 set	
		Rotors with shaft and the half of coupling		1 unit	Additional spare parts only for D.C. steering gear with one motor
		Exciter coils of each type		1 pc	
		Complete electric motor		1 unit	Only for A.C. steering gear with one motor
5	V-belt drives	V-belts		1 set	For each drive
6	Main, emergency and auxiliary switchboards, control desks, etc. (quantity of spare parts for the whole ship)	Knife switches, rotary switches, etc. Automatic circuit-breakers for current up to 63 A		2 pc	Of each type if there are more than 10 switches, and 1 pc – if there are less than 10
		Automatic circuit breakers for the current over 63 A	Replaceable contacts	1 set	Of each type
			Voltage coils	1 pc	
			Arc chutes	1 pc	
		Fuses	Complete fuses	2 pcs	Of each type
7	Starting and control apparatus and contactors	Replaceable contacts		1 set	Of each type per 6 identical devices
		Voltage coils		1 pc	
8	Emergency lighting	Incandescent lamps		1 set	If lighting supply voltage differs from ship's network voltage

1	2	3	4	5
9	Navigation lanterns	Incandescent lamps	2 pcs for each lantern	
10	Switchboard of navigation lanterns	Relay	2 pcs	
		Pilot lamps	1 set	
11	Portable measuring instruments	Insulation resistance measuring instrument	1 unit	A multi-purpose multi-range instrument recommended
		Ammeter	1 unit	
		Voltmeter	1 unit	
		Ohmmeter	1 unit	
12	Fans for refrigerated spaces of classed refrigerating installations	Complete rotor	1 unit	Per 6 D.C. motors of the same type where no spare motors are available
		Exciter winding coils	1 set	
		Complete stator	1 unit	Per 6 A.C. motors of the same type where no spare motors are available

Appendix 1

INSULATION RESISTANCE OF CABLE NETWORK

1 The insulation resistance to hull of electrical circuits of the cable network measured during trials on completion of the ship construction or during surveys of ships in service is not to be less than that given in Table 1.

Table 1

Item	Designation of circuit	Minimum insulation resistance, [MΩ]		
		up to 125 V	125 to 500 V	over 500 V
1	Supply to lighting installations	0.3	1.0	–
2	Supply to power consumers	–	1.0	2000 Ω per volt of the rated voltage
3	Communication installation (unless otherwise specified)	0.3	1.0	–

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

Appendix 2

VALUES OF MECHANICAL AND ELECTRICAL PARAMETERS TO BE CHECKED IN COURSE OF TESTING TYPE OF EQUIPMENT AND THE SHIP'S ELECTRICAL INSTALLATIONS

1 Insulation Resistance

1.1 The value of insulation resistance of the new electrical equipment measured at the manufacturer's or research laboratory is to meet the requirements of the relevant national standards but is not to be less than:

– 10 MΩ in cold condition, 1 MΩ in hot condition – for equipment of rated voltage up to 65 V,
– 100 MΩ in cold condition, 10 MΩ in hot condition – for equipment of rated voltage over 65 V.

For electric machines, at the insulation resistance measurements after the electric strength test, the value of insulation resistance in hot condition equal to 1 MΩ is permitted (see also *Publication No. 42/P – Testing of Electric Machines*).

1.2 The value of insulation resistance to hull, as well as between phases (poles) of electrical equipment measured during testing after completion of the ship construction is not to be less than the values indicated in Table 1.2.

The insulation resistance of the equipment measured during surveys of ships in service may be less than the values indicated in Table 1.2, but is not to be below 2000 Ω per volt of the rated consumer voltage.

The insulation resistance values indicated in Table 1.2 are applicable to electrical equipment having a voltage up to 1000 V.

The minimum values of insulation resistance of electrical equipment having a voltage of over 1000 V are to comply with the requirements of 18.1.2 and for electric machines rated at over 1000 kW (kVA), irrespective of the voltage value, will be specially considered by PRS in each particular case.

Insulation resistance readings are to be taken one minute after the application of the test voltage.

Table 1.2

Item	Type of electrical equipment	Minimum insulation resistance at 20 ± 5°C ambient temperature and normal humidity [MΩ]	
		in cold condition	in hot condition
1	Electric machines	1	1
2	Transformers	5	2
3	Switchboards	1	–
4	Machine control gear	5	–

2 Dielectric Strength of Insulation

2.1 General Requirements

The dielectric strength of insulation in electrical installations, with the exception of that pertaining to individual types described under 2.2 of the present Appendix, is to be tested by applying, for 1 minute, an alternating sinusoidal test voltage having a frequency of 50 Hz and the r.m.s. value as shown in Table 2.1.

Table 2.1

Rated voltage U_n [V]	Test voltage U_p [V]
up to 65	$2\,U_n + 500$
66 to 250	1500
251 to 500	2000
501 to 1000	$2\,U_n + 1000$
over 1000	$3U_n$

Table 2.1 is not applicable to communication appliances and electrical devices incorporating semiconductor elements for which the test voltage value will be specially considered by PRS in each particular case.

2.2 Machines, Transformers and Apparatus

2.2.1 The insulation of electric machine windings is to withstand for 1 minute, without breakdown and sparking, an alternating practically sinusoidal test voltage having a frequency of 50 Hz and the r.m.s. value as shown in Table 2.2.1.

Table 2.2.1
Test voltage at the test of dielectric strength of insulation

Item	Electric machine or part thereof		Test voltage r.m.s. value, U_p, [V]
1	Insulated parts of machines rated at	less than 1 kW (kVA)	$2\,U_n + 500$
		from 1 kW (kVA) to 10 000 kW (kVA)	$2\,U_n + 1000$ but not less than 1500
2	Field windings of direct-current machines supplied from external source		$2\,U_w + 1000$ but not less than 1500
3	Field windings of synchronous generators		$10\,U_w$ but not less than 1500 and not more than 3500
4	Field windings of synchronous motors, when:	starting with the field winding short-circuited or connected directly to the rotor, or starting with the a.c. winding idle	$2\,U_w + 1000$ but not less than 1500
		starting either with the field winding closed through, connected in series, resistance, or with the field winding open, regardless of whether it is sectionalized or not	$2\,U_m + 1000$ but not less than 1500
5	Rotor windings of slip-ring induction motors or of synchronous induction motors if not permanently short-circuited (e.g. if intended for resistor starting):	for non-reversing motors or motors reversible from standstill only	$2\,U_r + 1000$ but not less than 1500
		for reversible motors, as well as those braked by counter-current	$4\,U_r + 1000$ but not less than 1500
6	Rotor windings of direct-current reversible crane motors		$3\,U_n + 1000$ but not less than 1500
7	Exciters, except those mentioned in items 2 and 8		As for the field windings they are intended to supply
8	Exciters of synchronous motors or synchronous induction motors if they are disconnected from the motor during starting, or if one of the poles is connected to earth		$2\,U_n + 1000$ but not less than 1500

U_n – rated voltage [V];
U_w – maximum value of rated excitation voltage [V];
U_m – maximum value of voltage which may occur under starting conditions between the terminals of the field winding, or, in the case of a sectionalized field winding, between branch terminals [V];
U_r – voltage between the slip rings or terminals of the rotor at standstill, with rated voltage applied to the stator terminals [V];
f_n – rated frequency of the transformer [Hz];
f_{pr} – frequency of the test voltage [Hz].

2.2.2 In addition to the tests specified in Table 2.2.1, the electric machines are to withstand for 3 minutes, without damage, an elevated interturn test voltage equal to 1.3 times the rated voltage value. Machines operating within a certain voltage range are to withstand an interturn insulation test voltage equal to 1.3 times the highest voltage level.

2.2.3 While tested at the manufacturer's works, the transformers are to withstand, for 1 minute, a test for dielectric strength of insulation by application of test voltage equal to twice the rated voltage between phases plus 1000 V, but not lower than 2500 V. An alternating current test voltage of the above value at any frequency between 25 and 100 Hz is to be applied in turn between each winding and the remaining windings connected to frame and earthed cores.

This test is to be carried out after the temperature rise test, if any.

The interturn insulation is to withstand a test voltage equal to twice the voltage which occurs between turns, coils and coil terminals when the rated voltage is applied to the transformer terminals. The duration of the test is not to be less than that obtained from formula 2.2.3, but not less than 15 sec.

$$t = \frac{2 f_n}{f_{pr}} \qquad (2.2.3)$$

t – duration of the test, min.

2.2.4 The insulation of electric apparatus is to withstand, for 1 minute, without breakdown or sparking, a practically sinusoidal a.c. test voltage having a frequency of 50 Hz and r.m.s. value as indicated in Table 2.2.4.

Table 2.2.4

Rated voltage [V]	Test voltage [V]
up to 65	1000
66 to 250	2000
251 to 660	2500
661 to 800	3000
801 to 1200	3500
1201 to 7500	$3U_n$

2.2.5 The test voltage for fuses rated at up to 500 V is to be 3000 V.

2.2.6 The insulation of windings of electromagnetic tripping device is to withstand, for 1 minute, without a breakdown or sparking, a practically sinusoidal test voltage having a frequency of 50 Hz and r.m.s. value of 2000 V.

3 Temperature Rise Limits

3.1 The temperature rise limits for insulation material under continuous duty conditions are listed in Table 3.1.

Where the insulation is composed of different materials, the temperature that each of the materials is allowed to reach is not to be higher than the temperature rise limit for a given material.

Table 3.1

Class of insulation	Temperature rise limit [°C]
A	105
E	120
B	130
F	155
H	180
200, 220, 250	over 180

Where the insulation consists of several layers of different materials and it is not possible to measure the temperature reached by particular materials, the temperature rise limit for the composite is to be assumed to be that applicable to the lowest class of the material used.

A material used solely for mechanical protection or for separating shims may be of a lower class of insulation.

3.2 The temperature rise limits for electric machines are given in Table 3.2. They are based on the cooling air temperature of 45°C. Where the coolant temperature is lower than the said values, the temperature rise limits may be increased accordingly, but not more than by 10°C.

Where the coolant temperature is higher than the above values, the temperature rise limits are to be reduced accordingly.

Table 3.2
Temperature rise limits for electric machines at 45°C cooling-air temperature

Item	Electrical parts	Classes of insulating material														
		A			E			B			F			H		
		Method of measurement [°C]														
		Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	A.C. windings of synchronous and asynchronous machines rated at 5000 kVA and higher, or having a core length of 1 m and over	–	55	55	–	65	65	–	75	75	–	95	95	–	120	120
2	Windings of A.C. machines rated at under 5000 kVA and having a core length of less than 1 m. Field windings of D.C. and A.C. machines, D.C. excited, except such as are listed under 3, 4 and 5. Windings of rotors connected with commutator	45	55	–	60	70	–	65	75	–	80	95	–	100	120	–
3	Field windings of D.C. excited non-salient-pole machines	–	60	–	–	75	–	–	85	–	–	105	–	–	120	–
4	Single-layer field windings with exposed surface	60	60	–	75	75	–	85	85	–	105	105	–	130	130	–
5	Low resistance field windings with more than one layer, as well as compensating windings	55	55	–	70	70	–	75	75	–	95	95	–	120	120	–
6	Permanently short-circuited windings, insulated	55	–	–	70	–	–	75	–	–	95	–	–	120	–	–
7	Permanently short-circuited windings, uninsulated	The temperature rise of such parts is not to be so high as to constitute risk of damage to insulating and other adjacent materials														
8	Steel cores and other parts out of contact with windings															
9	Steel cores and other parts in contact with windings	55	–	–	70	–	–	75	–	–	95	–	–	120	–	–
10	Commutators and ship rings open and enclosed	55	–	–	65	–	–	75	–	–	85	–	–	95	–	–

3.3 The temperature rise for transformers operating at the rated load and at an ambient temperature of 45°C is not to exceed the values given in Table 3.3.

Table 3.3

Item	Transformer parts	Method of measurement	Temperature rise limits for insulation classes [°C]				
			A	E	B	F	H
1	Windings	Resistance	55	65	75	95	120
2	Cores and other parts	Thermometer	The temperature rise is not to be higher than that allowed for adjacent materials				

3.4 The temperature rise limits for various parts of equipment (apparatus) at the ambient temperature of +45°C are not to be higher than the values given in Table 3.4.

Table 3.4

Item	Equipment (apparatus) parts			Temperature rise limits [°C]
1	Massive spring contacts	Copper	continuous duty	35
			eight-hour continuous duty, intermittent duty, short-time duty	55
		silver or with silver inserts		*
		other metals or sintered cermets		depending on quality of metal or sintered cermet
2	Brush contacts			25
3	Busbar connections	no protection against oxidation at point of contact		45
		protected against oxidation at point contact by:	tin or cadmium plating, silver plating	55 75
		soldered or welded connections		75
4	Magnets, magnet cores, and similar parts			the same as for insulation in contact with the said parts
5	Manual controls	metallic		10
		insulant		20
6	Enclosures, shields or parts accessible to accidental touch			35
7	Enclosures of rheostats suitably guarded against accidental touch			200
8	Cooling air from rheostats when taking measurements at a distance of 25 mm			175

* The temperature rise is admissible only up to a level at which a hot part does not cause heating of the adjacent parts above their temperature rise limit.

4 Cyclic Irregularity of Electric Generating Sets

Cyclic irregularity, per revolution, of electric generating sets using piston engines as prime movers is not to exceed the values given in Table 4.

Cyclic irregularity, per revolution, for all loads, inclusive of rated load, at rated speed, is determined from the formula:

$$S = \frac{\omega_{\max} - \omega_{\min}}{\omega_{av}} \tag{4}$$

ω_{max} – maximum angular velocity;
ω_{min} – minimum angular velocity;
ω_{av} – average angular velocity.

Table 4

Number of engine impulses per second	Cyclic irregularity	
	one- or two-cylinder engines	engines with more than two cylinders
under 10	1/75	1/150
10 to 20	1/75	number of impulses per second/1500
over 20	1/75	1/75

5 Vibration Resistance

The requirements are specified in *Publication No. 11/P – Environmental Tests on Marine Equipment*.

6 Climatic Tests

The requirements are specified in *Publication No. 11/P – Environmental Tests on Marine Equipment*.

7 Inflammability Test of Electro-insulating Materials

The requirements are specified in *Publication No. 11/P – Environmental Tests on Marine Equipment*.

SUPPLEMENT – RETROACTIVE REQUIREMENTS

1 GENERAL PROVISIONS

1.1 The requirements given in the present Supplement apply to existing ships.

1.2 The scope of retroactive requirements is specified separately for each of the requirements given below.

1.3 The scope of technical documentation subject to PRS' consideration and approval is given in the relevant sub-chapters related to particular issues covered by retroactive requirements. The documentation is to be submitted to PRS well in advance of the retroactive requirements implementation date.

1.4 It is the responsibility of the Owner to execute the applicable retroactive requirements according to the implementation schedule. Retroactive requirements execution is confirmed by PRS' Surveyor in the report on the nearest Periodical Survey.

2 REQUIREMENTS

2.1 Additional Low-Location Lighting

2.1.1 Application

The present requirements apply to existing passenger ships carrying more than 36 passengers, constructed before 1 July 1998.

2.1.2 Required Technical Documentation

– LLL arrangement diagram,
– LLL power supply principal diagram (in the case of electrical power supply).

2.1.3 Detailed Requirements

The additional low-location lighting, referred to in sub-chapter 22.1.4, *Part VIII*, is to be also installed in crew accommodation spaces.

2.2 Side Shell Doors and Stern Doors

2.2.1 Application

The present requirements apply to existing passenger ferries and ro-ro passenger ships, constructed before 1 July 1997.

2.2.2 Required Technical Documentation

– signalling supply diagram,
– watertight doors closing signalling diagram,
– water leakage detection signalling diagram,
– assembly drawing of bridge indicators panel.

2.2.3 Detailed Requirements

Electrical installations of the securing and locking arrangements for side shell doors and stern doors are to comply with the requirements given in para. 2.2.3.3 of Supplement to *Part III – Hull Equipment*.

2.3 Signalling of Water Detection in Cargo Holds, Ballast Tanks and Dry Spaces on Bulk Carriers

2.3.1 Bulk carriers constructed before 1 July 2004 are to comply with the requirements specified in 22.8.1 of the present Part not later than the date of the Annual, Intermediate or Class Renewal Survey of the ship to be carried out after 1 July 2004, whichever comes first.

2.3.2 For bulk carriers constructed before 1 July 2004, water level detectors in cargo holds are to be placed within a distance less than or equal to 1 corrugation space or 1 bulkhead vertical stiffener space from the centreline. Where not practicable, the detectors are to be located at both the port and starboard sides of the cargo hold.

2.3.3 Bulk carriers which have been constructed with an insufficient number of transverse watertight bulkheads (and which do not comply with the requirements of the SOLAS Convention XII/9) are to satisfy the requirements specified in para. 2.3.2 of Supplement to *Part II – Hull*.

2.4 Signalling of Water Detection in Cargo Hold on Single Hold Cargo Ships other than Bulk Carriers

2.4.1 Single hold cargo ships other than bulk carriers having a length L of less than 80 m constructed before 1 January 2007 (or 100 m if constructed before 1 July 1998) are to comply with the requirements of sub-chapter 7.9 of the present Part not later than the date of the first Intermediate or Class Renewal Survey of the ship to be carried out after 1 January 2007, whichever comes first.

2.4.2 Existing ships fitted with the hold bilge high water level alarm system are to be upgraded to comply with the requirements of paragraph 7.9, on the date specified in 2.4.1.

2.4.3 Ships of subdivision length $L_s \geq 100$ m constructed on or after 1 February 1992 and ships of subdivision length $L_s \geq 80$ m constructed on or after 1 July 1998 are to meet requirements specified in subchapter 22.8.

Listing of Changes effective on the 1 January 2015

Item	*Title/Subject*	*Source*
1.1	Table 21.3.1-1	IACS UR M35 Rev.6
1.2	Table 21.3.1-1	IACS UR M35 Rev.6
2.3	Table 21.3.1-1	IACS UR M36 Rev.4
22.10	Ecological ships – mark: ECO AIR	–
