PART XI. ELECTRICAL EQUIPMENT

1. GENERAL

1.1 APPLICATION

1.1.1 The requirements of the present Part of the Rules apply to electrical installations in ships subject to the Register survey, as well as to individual types of electrical equipment in accordance with 1.3.

1.1.2 It is recommended that the relevant requirements of the present Part shall be also applied to electrical equipment, which is installed in ships not specified in 1.3.2 and 1.3.3.

1.1.3 Conformity of passenger ships with distinguishing marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** in the ship class symbol by the provisions of the European Parliament and Council Directive 2009/45/EC of May 6, 2009 concerning the rules and standards of safety for passenger ships, which entered into force on July 15, 2009 (revised version as amended by the EU Commission Directive 2010/36/EU of June 1, 2010), hereinafter referred to as the Directive 2009/45/EC, should be implemented according to the requirements of Section 2.6.1 of the General Provisions relating to the technical supervision of the application of these Rules and/or the special requirements of these Rules to the ship depending on the distinguishing mark in the ship class symbol for new or existing (refer to paragraphs 2.6.1.1.4.2 or 2.6.1.1.4.3 of General Provisions relating to the technical supervision, respectively) ships referred to in certain items with (or without) reference to the distinguishing marks in the ship class symbol, namely compliance with the following requirements:

— new ships with distinguishing marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S** — all applicable requirements of this part with regard to references to the distinguishing mark in the ship class symbol subject to availability of specific requirements for these marks in certain items;

— existing ships with marks **B-R3-S**, **B-R3-RS** carrying more than 36 passengers *(as of October 1, 2003)* — paragraphs 19.3.1.4, 19.3.2.1, 19.3.2.2;

— new ships with marks **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** and existing ships with marks **B-R3-S**, **B-R3-RS** — paragraphs 2.1.2.2, 2.2.2.5, 2.3.2.1, 2.3.7, 2.4.4, 2.5.1.1, 2.5.1.2.2, 2.5.1.2.7, 2.5.1.2.8, 2.5.3.5, 3.1.1, 3.1.3, 3.1.4, 4.6.1, 4.6.4.7, 4.6.6.5, 5.5.11, 5.5.11.1, 6.1.1, 6.2.6, 6.3.4, 7.2.1, 7.2.2, 7.8, 8.1, 8.4.1, 8.4.2, 9.1.1, 9. 1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 15.2, 15.3, 19.1.2.1, 19.1.2.1.1, 19.1.2.1.2, 19.1.2.1.6, 19.1.2.1.7, 19.1.2.1.8, 19.1.2.3.1, 19.1.2.4, 19.1.2.4.3, 19.1.2.5, 19.1.2.5.3, 19.1.2.7.3, 19.1.2.7.5, 19.3.3;

— new ships with marks **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** — paragraphs 5.5, 5.5.2, 5.5.9, 5.5.10, 5.5.11, 5.5.11.3, 6.1.3, 7.2.2, 13.2, 13.3, 13.6, 16.8.1, 16.8.1.8, 16.8.4, 16.8.4.13, 16.8.6, 16.8.7, 19.3.1.4, 19.3.2.1, 19.3.2.2;

— new ships with marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**,

B-R3-RS, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** — paragraphs 2.1, 2.2, 2.3;

— new ships with marks **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS**, of a length 24 m and more — paragraphs 5.10, 5.10.8;

— new ships with marks **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS**, built before January 1, 2003, and existing ships with marks **B-R3-S**, **B-R3-RS** — paragraphs 2.1, 7.5.3, 7.5.6, Tables 7.5.6, 7.5.7, 7.5.8, 16.8.1.8;

— new ships with marks B-R3-S**,** B-R3-RS**,** C-R3-S**,** C-R3-RS**,** D-R3-S**,** D-R3-RS**, built on January 1, 2012, or later** — paragraphs **19.1.6.**

1.2 DEFINITIONS AND EXPLANATIONS

Definitions and explanations relating to the general terminology of the Rules are given in General Provisions on Activities within the Framework of Technical Survey and in Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships[1].

For the purpose of the present Part the following definitions and explanations have been adopted:

1.2.1 Emergency source of electrical power is a source of electrical power intended to supply necessary ship's services in case of power failure on the main switchboard.

1.2.2 Emergency lighting is lighting of ship's spaces and zones by means of lighting fixtures fed from the emergency source of power or from the transitional emergency source of power.

1.2.3 Emergency transitional source of electrical power is a source of electrical power intended to supply necessary ship's services from the moment of the power failure on the main switchboard busbars until the emergency generator is switched on to supply the emergency switchboard busbars.

1.2.4 Emergency switchboard is a switchboard intended to be supplied directly from the emergency or emergency transitional source of electrical power in case of failure of the main source of electrical power and to supply the emergency services.

1.2.5 Emergency consumers are consumers which shall be supplied by an emergency source of electrical power if there is a failure of the main electrical power source.

1.2.6 Antistatic earthing is electrical connection to ensure grading of static electricity potentials of the structural parts of equipment and ship's hull due to their direct contact or through antistatic earthing conductors.

The antistatic earthing conductors are:

metal conductors connecting equipment subject to antistatic earthing, cable shields, piping, etc, to one another and/or to ship's hull or other equipment earthed;

layers of conductive substances applied onto equipment surfaces, such as: metal coatings, conductive plastics, compounds, mastics, antistatic paint coatings, etc.

1.2.7 Safety voltage is any voltage not dangerous to the personnel. This condition is considered to be satisfied if the windings of

[1] Hereinafter referred to as Part I "Classification".

transformers, transducers, and other devices to step down voltage are electrically separated and if the value of stepped-down voltage across these devices or sources of electrical power does not exceed:

50 V between poles for direct current;

50 V between phases or between phases and the ship's hull for alternating current.

1.2.8 Lighting divertor is an upper part of a lightning protection device intended to accept atmospheric discharges directly.

1.2.9 Flash-resistant electric insulation material is a material which passes the tests required by the Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

1.2.10 Shaft generators are generators driven by the main machinery and supplying the ship's mains or separate consumers.

1.2.11 Lead wire is a wire providing electrical connection of a lighting divertor and earthing.

1.2.12 Essential services are services normal operation whereof ensures safe navigation, safety of human life and safety of cargo on board ship; essential services are divided into primary and secondary services.

.1 Primary essential services are the services, which need to be in continuous operation to maintain propulsion and steering of the ship. Such services are those listed in 1.3.2.1.

.2 Secondary essential services are the services, which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the ship safety. These services shall be ready for the immediate activation. Such services are those listed in 1.3.2.2.

1.2.13 Galvanic intrinsical safety is a status of ship equipment and systems which excludes the possibility of fire break-out or explosion due to electrical sparking during galvanic contact of the ship with onshore facilities, which is caused by electrochemical effects and stray currents in the surrounding sea water and ground.

1.2.14 Main switchboard is a switchboard designed to take electrical power directly from the main electrical power source and to distribute it among ship consumers.

1.2.15 Uninterruptible power system (UPS) is combination of transducers (rectifier – inverter), switches (bypass) and energy storage means, for example, batteries, constituting a power system for maintaining continuity of load power in case of input power failure.

1.2.16 Electrical mains is a set of all interconnected installations with an equal rated voltage.

1.2.17 Low-power electric installation is an electric installation of a ship with a total capacity of electrical power sources up to 50 kW (50 kV·A).

1.2.18 Electrostatic intrinsical safety is a status of ship equipment and systems which excludes the possibility of fire break-out or explosion due to static discharges.

1.2.19 Earthing is electrical connection of a part of electrical equipment to be earthed to ship's hull.

1.2.20 Lightning protection zone is the area, within the limits of which the ship's space is protected against direct lightning strokes.

1.2.21 Competent body is an organization possessing appropriate knowledge and experience in a specific area, which documents are recognized by the Register.

1.2.22 Ship's hull means all ship's metal parts, which have a reliable electrical connection to the outer metal shell plating.

For ships with nonconducting hull, it is a special copper sheet with the area of not less than 0.5 m^2 and the thickness not less than 2 mm, which is fixed to the outside of the ship's shell plating at a level below the light load waterline and is used for earthing all the equipment installed on board the ship.

1.2.23 Non-essential services are services, the temporary disconnection of which does not impair the safety of navigation, the safety of human life and the safety of cargo on board.

1.2.24 Main electrical power source is a source of electrical power intended to supply all electrical equipment and systems essential for maintaining the ship in normal operational and habitable condition, without resorting to the emergency source of electrical power.

1.2.25 Main electrical power plant is a space where the main source of electrical power is placed.

1.2.26 Special main electrical power plants are spaces or locations intended expressly for electrical equipment and accessible only to operating personnel.

1.3 SCOPE OF SURVEYS

1.3.1 General.

General provisions applicable to the classification procedure, survey during ship's construction and manufacture of the equipment are stated in the General Regulations for the Classification and Other Activity and in Part I "Classification".

1.3.2 Survey of ship's electrical equipment.

Main and emergency sources of electrical power, power and lighting transformers and transducers (both rotating and static), main and other switchboards, cable mains, as well as electrical equipment, systems and arrangements listed in 1.3.2.1 to 1.3.2.4 are subject to survey on board the ship.

1.3.2.1 Primary essential services are:

.1 steering gear;

.2 pumps of hydraulic systems of CP-propellers;

.3 scavenging air blower, fuel oil supply pumps, fuel valve cooling pumps, lubricating oil pumps and cooling water pumps for main and auxiliary engines and turbines necessary for propulsion;

.4 forced draught fans, feed water pumps, water circulating pumps, vacuum pumps and condensate pumps for steam plants on steam turbine ships, and also for auxiliary boilers on ships where steam is used for equipment supplying primary essential services;

.5 oil burning installations for steam plants on steam turbine ships and for auxiliary boilers where steam is used for equipment supplying primary essential services;

.6 electrical equipment for azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps;

.7 electrical equipment for electric propulsion plant and azimuth electric

propulsion plant with lubricating oil pumps, cooling water pumps and forced draught systems;

.8 special electric generators and associated power sources supplying the equipment listed in paragraphs 1.3.2.1.1–1.3.2.1.7;

.9 hydraulic pumps supplying the equipment listed in paragraphs 1.3.2.1.1–1.3.2.1.8;

.10 equipment for fuel treatment, viscosity control equipment for heavy fuel oil;

.11 navigation lights, aids and signals

.12 internal communication devices/systems;

.13 lighting system;

.14 control, monitoring, alarm and safety devices/ systems for equipment to primary essential services;

.15 other primary essential services needed to ensure that the ship is used in compliance with its purpose and Class notation, as required by the Register.

1.3.2.2 Secondary essential services are:

.1 windlasses (anchor and mooring machinery);

.2 fuel oil transfer pumps and fuel oil treatment equipment;

.3 lubrication oil transfer pumps and lubrication oil treatment equipment;

.4 pre-heaters for heavy fuel oil;

.5 starting air and control air compressors;

.6 bilge, ballast and heeling pumps;

.7 fire pumps and other fire extinguishing medium pumps;

.8 ventilating fans for engine and boiler rooms;

.9 services considered necessary to maintain dangerous spaces in a safe condition, including services for hull earthing on oil tankers, lightning protection and services ensuring electrostatic and galvanic intrinsic safety;

.10 fire alarm systems;

.11 electrical equipment for watertight and fire-proof closing appliances;

.12 special electric generators and associated power sources supplying the equipment listed in paragraphs 1.3.2.2.1–1.3.2.2.11;

.13 hydraulic pumps which supply equipment listed in paragraphs 1.3.2.2.1–1.3.2.2.12;

.14 tunnel (in a transverse channel) and azimuth thrusters;

.15 inert gas devices/systems in oil tankers;

.16 .control, monitoring, alarm and safety devices/ systems for cargo ships;

.17 electric drives for refrigerating plants, specified in 1.1, Part XII "Refrigerating Plants"

.18 control, monitoring, alarm and safety devices/ systems for equipment to secondary essential services;

.19 .19 other secondary essential services needed to ensure that the ship is used in compliance with its purpose and Class notation, as required by the Register.

1.3.2.3 Services for habitability are those services, which need to be in operation for maintaining the ship's minimum comfort conditions for the crew and passengers.

.1 cooking;

.2 heating;

.3 .domestic refrigeration;

.4 .domestic ventilation;

.5 sanitary and fresh water;

.6 electric generators and associated power sources supplying equipment specified in 1.3.2.3.1 to 1.3.2.3.5.

1.3.2.4 Other electrical services are:

.1 electrical equipment of processing machinery of ships used for processing the living resources of the sea and not engaged in their catching (refer to 19.4.4.1);

.2 electrical equipment of fishing and processing machinery of fishing vessels (refer to 19.10.1.1);

.3 other machinery and devices not listed above as required by the Register.

1.3.2.5 Electrical equipment of domestic services, as well as the equipment not supplying primary and secondary essential services, shall be subject to survey on board the ship only in respect to the following:

.1 influence exerted by the operation of this equipment on the quality of electrical power produced by the shipboard electrical power plant;

.2 selection of the types and sections of cables and wires, as well as the methods of cable installation;

.3 insulation resistance, earthing and protective devices.

1.3.3 Survey during manufacture of electrical equipment.

1.3.3.1 The following kinds of electrical equipment intended for use in installations and systems listed in 1.3.2 are subject to survey during manufacture:

.1 generating sets;

.2 electric machines;

.3 transformers;

.4 switchboards;

.5 control and monitoring panels;

.6 electric slip couplings and brakes;

.7 apparatus and devices for electrical protection, starting, control and switching;

.8 apparatus and devices of internal communication and signalling;

.9 power semiconductor transducers and other similar power units;

.10 fuel and oil heaters;

.11 accumulator batteries;

.12 cables and wires;

.13 fixed electric measuring instruments;

.14 electrical apparatus and facilities to measure non-electrical values;

.15 space heating and cooking appliances;

.16 mounting fixtures;

.17 stationary lighting fixtures;

.18 control and monitoring devices;

.19 other equipment not listed above as required by the Register.

1.3.3.2 The safe type electrical equipment shall be surveyed (with respect to its safety) by a competent authority whose documents are recognized by the Register, irrespective of whether or not this equipment is subject to survey according to the requirements of 1.3.3.1.

1.3.3.3 Scope of tests of electrical equipment after manufacture and requirements for tests are given in the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

1.4 TECHNICAL DOCUMENTATION

1.4.1 General provisions applicable to the procedure of approval of technical documentation are set forth in the General Regulations for the Classification and Other Activity. The scope of technical documentation on electrical equipment for the entire ship to be submitted to the Register for consideration is stated in 3.2, Part I "Classification".

1.4.2 Prior to starting the survey of the electrical equipment manufacture, the following documentation shall be submitted

to the Register for consideration:

.1 description of the principle of operation and main characteristics;

.2 specification (list of items), which indicates all the components, instruments and materials used and their technical characteristics;

.3 general view drawing with sectional views;

.4 circuit diagram;

.5 programme of tests;

.6 results of rotor shaft (armature) calculation and drawing of fastening of poles, active iron core, commutator, etc., as well as welded joints of the spoke rib and the shaft, for electric machines with rated current in excess of 1000 A;

.7 busbar calculation of electrodynamic and thermal short circuit strength — for switchboards, if rated current of the generators operating separately or total current of the generators operating in parallel exceeds 1000 A;

.8 data concerning immunity to static or dynamic interference or method of electromagnetic compatibility testing;

.9 measures to be taken for interference suppression.

When necessary, the Register may require supplementary technical documentation and data on reliability to be submitted.

2. GENERAL REQUIREMENTS

2.1 OPERATING CONDITIONS

2.1.1 Influence of climatic conditions.

2.1.1.1 The rated ambient air and cooling water temperatures for electrical equipment shall be those specified in Table 2.1.1.1.

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

2.1.1.3 Where electrical equipment is installed within environmentally controlled spaces the ambient temperature, for which the equipment shall be suitable, may be reduced as against the value given in Table 2.1.1.1 and maintained at a value not less than + 35 °C, provided:

.1 the equipment is not for use for emergency services and is located outside the machinery spaces;

.2 temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, the remaining unit is capable of satisfactorily maintaining the design temperature;

.3 the equipment installed in such spaces shall be able to work safely at temperature of +45 °C until the nominal working ambient temperature may be achieved; the cooling equipment shall be rated for + 45 °C ambient temperature;

.4 audible and visual alarms shall be provided at a continually manned control station to indicate any malfunction of the cooling units.

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Table 2.1.1.1

Ser. No.	Equipment location	Temperature of ambient air and cooling water, °C			
		Unrestricted navigation		Navigation beyond tropics	
		Air	Water	Air	Water
1	Machinery rooms and special electrical spaces, galleys	From +45 to 0	+32	From +40 to 0	25
2	Weather decks	From +45 to -25	–	From +40 to -25	–
3	Other rooms	From +40 to 0	–	From +40 to 0	–

Note. Electronic elements and devices designed to be mounted into switchboards, panels or casings, shall provide reliable operation at ambient air temperature up to +55 °C.

Temperatures up to +70 °C shall not cause damage of elements, devices and systems.

2.1.2 Mechanical impacts.

2.1.2.1 Electrical equipment shall be capable of reliable performance at vibrations with frequency of 2 to 80 Hz, i.e. with an amplitude of displacements of +1 mm for frequency range of 2 to 13.2 Hz and an acceleration of ±0.7 g for frequency range of 13.2 to 80 Hz.

Electrical equipment located on the sources of vibrations (diesel engines, compressors, etc.) or in the steering gear room shall be capable of reliable performance at vibrations of 2 to 100 Hz, i.e. with an amplitude of displacement of ±1.6 mm for frequency range of 2 to 25 Hz and an acceleration of ±4.0 g for frequency range of 25 to 100 Hz.

Electrical equipment shall also be capable of reliable performance at shocks having an acceleration of ±5.0 g and at a frequency of 40 to 80 shocks per minute.

2.1.2.2 Electrical equipment shall be capable of reliable performance with the ship having continuous list up to 15° and trim up to 5°, as well as during rolling motion up to 22.5° with a period of 7–9 s and pitching motion with vertical deviation up to 10°.

Emergency equipment shall also be capable of functioning reliably with the ship having continuous list up to 22,5° and trim up to 10°, or within the same limits of simultaneous list and trim and with rolling motion up to 22.5° with a period of 7÷9 s and pitch motion with vertical deviation up to 10°.

In gas carriers and chemical tankers, the emergency electrical power sources shall be capable of reliable performance with the ship having list up to 30°.

2.1.2.3 Electrical equipment shall possess the relevant mechanical strength and shall be so located as to avoid the risk of mechanical damage (refer also to 2.7.4).

2.1. Permissible variations of supply parameters.

2.1.3.1 Electrical equipment shall be so designed that it remains operative in all cases, except as noted in 10.8.2, 14.1.3.2 to 14.1.3.3 at all variations from the supply voltage and frequency as specified in Table 2.1.3.1 (refer also to 3.1.2.2 and 16.8.3.3).

2.1.3.2 In ships of restricted area of navigation **R3** and **R3-IN**, it is allowed to use for machinery and gear of non-essential services the electrical equipment (of general commercial type) not fully complying with the above requirements, which is subject to special consideration by the Register in each case.

Machinery and units on ships with restricted navigation area, except of essential

machinery and units, may employ equipment (of general industrial design), which complies with the specified requirements partially, which is subject to special consideration by the Register in each case.

Table 2.1.3.1

Parameters		Permissible deviations		
		long-term, %	short-term	
			%	time, s
Alternate current	voltage	+6... -10	± 20	1.5
	frequency	± 5	± 10	5
Direct current	voltage	± 10	5	cycle variations
			10	ripples

Note.

When the services are fed from accumulator battery:

long-period voltage variation within + 30 to -25 per cent for the equipment fed from the accumulator battery connected to the charging unit;

long period voltage variation within + 20 to -25 per cent for the equipment, which is not connected to the charging unit.

2.2 ELECTROMAGNETIC COMPATIBILITY

2.2.1 General.

2.2.1.1 The present requirements are applicable to electrical equipment and automation equipment to ensure electromagnetic compatibility on board.

2.2.1.2 Fail safe performance of the equipment shall be ensured under conditions of interference having the following parameters:

.1 static and variable (50 Hz) magnetic field in accordance with Table 2.2.1.2.1.

Installation of equipment is permitted:

class 1 — at a distance of 2 m and more from a powerful field source (busbar, group transformer);

class 2 — at a distance of 1 m and more from a powerful field source;

class 3 — irrespective of the distance from field source of any kind;

Table 2.2.1.2.1

Equipment class	Intensity, A/m	
	Static field	Varying field (50 Hz)
1	100	100
2	400	400
3	1000	1000

.2 .harmonic components of voltage in supply circuits in accordance with the higher harmonics diagram for ship mains to be found in Fig. 2.2.1.2.2 on a logarithmic scale;

.3 electrostatic discharges with a voltage amplitude of 8 kV;

.4 radio frequency electromagnetic fields within a range of 80 MHz — 2 GHz with a root-mean-square value of field intensity of 10 V/m;

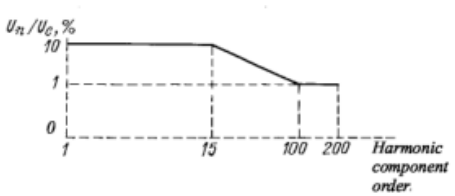


Fig. 2.2.1.2.2. Diagram of higher harmonic components for ship mains

.5 nanosecond voltage pulse with an amplitude of 2 kV for the power supply and of 1 kV for signalling and control cables with a duration of 5/50 ns;

.6 radio frequency interference in conductivity circuits within a range of 150 kHz to 80 MHz with a root-mean-square voltage of 3 V and 80 per cent modulation at a frequency of 1 kHz;

.7 microsecond voltage pulse in supply circuits with an amplitude of 1 kV for symmetrical pulse feed and of 2 kV for non-symmetrical pulse feed with a duration of 1.2/50 ps.

2.2.1.3 The voltage curve harmonic distortion factor shall not exceed 10 per cent and shall be determined by the formula:

$$K_U = \frac{1}{U_c}\sqrt{\sum_{n=2}^{200} U_n^2} \cdot 100\,\%,$$

(paragraph 2.2.1.3)

where Uc = actual circuit voltage;

Un = harmonic component voltage; n = higher harmonic component order.

The value of Ku is specified for the complete electrical power system of a ship.

On special agreement with the Register, busbars with K_U>10 % may be used for power supply to powerful sources of the harmonic components of voltage and to electrical equipment not sensitive to such harmonic components, provided that the busbars are connected to the main busbars through isolating devices (refer to 2.2.2.2).

2.2.1.4 The intensity levels of radio interference from equipment in the power supply circuits shall not exceed the following values within the frequency bands given below:

for the equipment installed on open deck and bridge control station:

10–150 kHz — 96–50 dBpV/m;

150–350 kHz — 60–50 dBpV/m;

350 kHz — 30 MHz — 50 dBpV/m,

for the equipment installed in machinery and other enclosed spaces:

10–150 kHz — 120–69 dBpV/m;

150–500 kHz — 79 dBpV/m;

500 kHz — 30 MHz — 73 dBpV/m.

Artificial mains network and quasi-peak measuring receiver shall be used for measuring the intensity level of radio interference.

The receiver bandwidth when measurements are taken within the frequency band from 10 to 150 kHz shall be 200 Hz and within the frequency band from 150 kHz to 30 MHz — 9 kHz.

2.2.1.5 On ships, for which the level of radio interference from power semiconductor transducers cannot be limited in conformity with 2.2.1.4, the mains of automation, radio and navigational equipment shall be galvanically isolated from the mains of those transducers so that at least 40 dB are damped within the frequency range 0.01 — 30 MHz.

The power supply cables of equipment having the radio interference levels in excess of those stipulated by 2.2.1.4 shall be laid at least 0.2 m away from the cables of other equipment groups where the common cable run is longer than 1 m (refer to 2.2.2.8).

2.2.1.6 The levels of the radio interference electromagnetic field induced at a distance of 3 m from the equipment shall not exceed the following values within the frequency bands given below:

for the equipment installed on open deck and bridge control station:

150–300 kHz — 80–52 dB pV/m;

300 kHz — 30 MHz — 52–34 dB pV/m;

30 — 2000 MHz - 54 dBpV/m, except for the band 156 — 165 MHz where the level shall be equal to 24 dBpV/m.

for the equipment installed in machinery and other enclosed spaces:

150 kHz — 30 MHz — 80–50 dB pV/m;

30–100 MHz — 60–54 dB pV/m;

100–2000 MHz — 54 dB, except of the range 156–165 MHz, where it shall be equal to 24 dB.

Quasi-peak measuring receiver shall be used to take measurements.

The receiver bandwidth within the frequency band from 150 kHz to 30 MHz and from 156 to 165 MHz shall be 9 kHz and within the frequency band from 30 to 156 MHz and from 165 MHz to 1 GHz - 120 kHz.

2.2.2 Measures to ensure electromagnetic compatibility.

2.2.2.1 To ensure protection of radio equipment against electromagnetic interference, the requirements of Part TV "Radio Equipment" of the Rules for the Equipment of Sea-Going Ships shall be considered.

2.2.2.2 For the purpose of dividing the power supply of the ship, rotary transducers, special transformers and filters shall be used.

2.2.2.3 Power cable screens or metal armour shall be connected to the metal casing of relevant equipment and shall be earthed as frequently as possible, at each end as a minimum.

2.2.2.4 The screens of signal cables shall be earthed at one point on the side of the initial signal processing block. The cable shall have an external insulating sheath.

2.2.2.5 Continuous screening shall be ensured, and for this purpose cable screens shall be connected to equipment casings, and it shall also be ensured in cable branch boxes and cable distribution boxes, and in way of cable penetrations through bulkheads.

2.2.2.6 The earthing installed for the purpose of interference protection shall have an electric resistance not greater than 0.02 Ohm, minimum length possible, shall be resistant to vibration and corrosion, and shall be readily accessible for inspection.

2.2.2.7 Cable shields shall not be used as return conductors.

2.2.2.8 By the type of signals conveyed, ship cables are subdivided in groups as follows:

.1 coaxial cables of radio receivers and conveying video signals with the level of signals 0.1 mcV to 500 mcV;

.2 screened or coaxial cables conveying analogue or digital signals with a level 0.1 to 115 V;

.3 screened cables of telephone and radio broadcasting apparatus, control and signalling network with the level of signals 0.1 to 115 V;

.4 unscreened and located below the deck or screened and located above the deck cables of power and lighting network with the level of signals 10 to 1000 V;

.5 coaxial or screened cables of the transmitting aerials of radio transmitters, radar installations and echo sounders, power semiconductor transducers with the level of signals 10 to 1000 V.

2.2.2.9 Cable of the same group may be laid in the same cable run provided interference-sensitive equipment is not influenced by the difference in the levels of signals conveyed.

Where cable lengths laid in parallel are in excess of 1 m, the cables (cable runs) of different groups shall be laid at least 0,1 m apart and their intersections shall be effected at right angles.

The radar installation and echo sounder cables mentioned in 2.2.2.8.5 shall either be double-screened or, if they are coaxial, laid inside a metal pipe. The outer screen shall be earthed, as well as the principal screen of the cable.

2.2.2.10 When electrical equipment is installed or cables are laid in the vicinity of magnetic compasses and to ensure protection against interference from other navigational equipment, the requirements of Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships shall be considered.

2.2.2.11 On all ships constructed from non-conductive materials, for which radio equipment is required by the Rules, all cables located within 9 m from the aerials shall be shielded or otherwise protected from radio interference, and all the equipment on board those ships shall be fitted with devices for radio interference suppression.

2.3 MATERIALS

2.3.1 Structural materials.

2.3.1.1 The structural parts of electrical equipment shall be fabricated of durable materials, rated at least as having low flame-spread characteristics, resistant to sea air, oil and fuel vapour effects, or reliably protected against such effects.

For equipment installed or intended for use in dangerous spaces and zones, the structural parts of electrical equipment shall be fabricated of materials ensuring electrostatic and galvanic intrinsic safety.

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

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

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

.2 short-circuit rotor windings of asynchronous and synchronous motors, which may be made of aluminium or its alloys resistant to sea conditions;

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

.4 parts of electrical equipment directly connected to the ship's hull in case of hull-return single-wire system.

2.3.2 Insulation materials.

2.3.2.1 Insulating materials of live parts shall not contain asbestos and shall have adequate dielectric strength and resistance to creepage currents, moisture and oil, as well as sufficient mechanical strength, or else be suitably protected.

The heating temperature of current-carrying parts and their connections shall not exceed the permissible heating temperature of the insulating materials at the rated load.

2.3.2.2 Non-flammable liquids may be used for cooling uninsulated parts of electrical equipment.

The use of flammable oils for this purpose is subject to special consideration by the Register in each case.

2.3.2.3 The insulating materials used for winding insulation in machines, apparatus and other equipment for essential services shall comply with the agreed standards.

The use of insulating materials not inferior to Class E is recommended.

2.3.2.4 Conductors used in electrical devices for internal connections shall have

insulation made of materials rated at least as having low flame-spread characteristics and for apparatus with increased heating and also indicated in Section 15 — of non-combustible materials.

2.3.2.5 For insulation materials used for the manufacture of cables, refer to 16.3.

2.4 STRUCTURAL REQUIREMENTS AND PROTECTION OF ELECTRICAL EQUIPMENT

2.4.1 General.

2.4.1.1 Such parts as require replacement while in service shall be easily dismountable.

2.4.1.2 Where screw fastenings are employed, provision shall be made of exclude self-loosening of screws and nuts or, where dismantling and opening are a frequent occurrence, loss of same.

2.4.1.3 Gaskets used in components of electrical equipment (such as doors, covers, sight holes, packing glands, etc.) shall ensure adequate protection when in service.

The gaskets shall be secured to the covers or casings.

2.4.1.4 If the casings, panels and covers of electrical equipment, installed where unspecialized personnel has access to it, render lived parts inaccessible, they shall be opened with tools only.

2.4.1.5 Suitable water drainage arrangements shall be provided in electrical equipment where condensation is likely to occur. Channels shall be fitted inside the equipment to provide for condensate drainage from all equipment components.

The windings and live parts shall be so arranged or protected that they are not exposed to the effects of such condensate as may accumulate inside the equipment.

2.4.1.6 Electrical equipment with forced ventilation, designed for installation in bottom parts of damp spaces, shall be provided with a ventilation system so as to avoid, as far as possible, suction of moisture and oil vapours inside the equipment.

2.4.1.7 Where measuring instruments with oil, steam or water supply are fitted in the control panel or desk, measures shall be taken to prevent these agents from making contact with the live parts in case of damage to the instruments or pipelines.

2.4.2 Insulation clearances.

Clearances between live parts at different potentials, or between live parts and earthed metal parts or outer enclosure, both in air and across the insulant surface shall be in conformity with the operating voltage and operating conditions of the installation, with the properties of the insulating materials used duly taken into account.

2.4.3 Internal wiring.

2.4.3.1 Stranded wires shall be used for internal wiring of electrical equipment throughout.

The use of solid wires is subject, in each case, to special consideration by the Register.

2.4.3.2 For internal wiring of switchboards, control desks, other distribution and switching arrangements, etc., wires of not less than 1 mm^2 in cross-sectional area shall be used.

For systems of control, protection, measurement of different parameters, signalling and internal communication the use of wires having a cross-sectional area not less than 0.5 mm^2 is permitted.

For electronic and electrical devices for transformation and transmission of low-power signals wires not less than 0.2 mm^2 in cross-sectional area may be used.

2.4.3.3 Current-carrying parts shall be so attached that they will not have to sustain any additional mechanical stresses; such parts shall not be attached by screws fitted directly into insulating materials.

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

2.4.3.5 Insulated wires shall be laid up 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 electrodynamic loads, vibrations or shocks.

2.4.3.6 Arrangements shall be made to ensure that the temperatures allowed for insulated wires under normal service conditions or for the duration of short-circuit current breaking are not exceeded.

2.4.3.7 Insulated wires shall be so connected to terminals or busbars that the wire insulation shall not be exposed to the overheating temperature under rated operating conditions.

2.4.4 Protection of electric equipment.

2.4.4.1 Depending on location, the use shall be made of electrical equipment in appropriate protective enclosure, or other suitable measures shall be taken to protect the equipment from harmful effect of the environment and to protect the personnel from electric shock hazards.

2.4.4.2 The minimal degree of protection of electrical equipment installed in ship's spaces and zones shall be chosen from Table 2.4.4.2.

2.5 PROTECTIVE EARTHING OF METAL PARTS WHICH DO NOT CARRY CURRENT

Metal enclosures of electrical equipment operated at a voltage exceeding the safety level or having no double or reinforced insulation shall be fitted with an earth terminal marked with the symbol ⏚.

Provision shall be made for earthing inside and outside of the electrical equipment enclosure dependent on its purpose.

2.5.1 Parts to be earthed.

2.5.1.1 Metal parts of electrical equipment, which are likely to be touched under service conditions and which may become five in the event of damage to the insulation (except for those mentioned under 2.5.1.2), shall have a reliable electric contact with a component fitted with an earth terminal (refer also to 2.5.3).

2.5.1.2 Protection earthing 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 non-conducting material or passing therethrough and separated from the earthed and live parts in such a manner that under normal operating conditions these parts cannot become live or come in contact with earthed parts;

.4 bearing housings isolated to guard against circulating currents;

Table 2.4.4.2

Spaces, in which electrical equipment is installed		Type of electrical equipment				
		Electric machines, transformers	Switchboards, control gear, starters	Communication and signalling equipment, automation equipment, accessories (switchers, sockets, junction boxes)	Space heating and cooking appliances	Lighting
Spaces and zones, in which explosive mixtures of vapours, gases or dust with air are likely to occur		*Ex* (refer to paragraphs 2.9, 19.2.4)	–	*Ex* (refer to paragraphs 2.9, 19.2.4)	–	*Ex* (refer to paragraphs 2.9, 19.2.4)
Dry spaces, dry accommodation spaces		IP20	IP20	IP20	IP20	IP20
Bridge control station, radioroom		IP22	IP22	IP22	IP22	IP22
Service spaces, steering gear rooms, refrigerating plant rooms (except for ammonia equipment), emergency diesel generator rooms, general purpose stores. . Pantries, provision stores		IP22	IP22	IP22	IP22	IP22
Engine and boiler rooms	Above plating	IP22	IP22	IP44	IP22	IP22
	Below plating	IP44	–	IP44	IP44	IP44
	Control stations (dry)	IP22	IP22	IP22	IP22	IP22
	Enclosed separator rooms	IP44	IP44	IP44	IP44	IP44
Refrigerated spaces, galleys, laundries, bathrooms and showers		IP44	IP44	IP55	IP44	IP44
Catch processing spaces[1], shafting tunnels, cargo holds		IP55	IP55	IP55	IP55	IP55
Open decks		IP56	IP56	IP56	IP56	IP56
Machinery and boiler room protected by the fixed local application fire extinguishing systems s[2]		IP44	IP44	IP44	IP44	IP44

[1] For the electrical equipment installed in the catch processing spaces an additional protection is recommended to enable sanitarization of the equipment with sea water.

[2] The electrical equipment within adjacent areas not exposed to direct spray (see paragraph 3.12 of Part VI "Fire Protection"), upon agreement with the Register may have a lower degree of protection provided relevant measures of the electrical equipment protection are taken (e.g. installation of extra inlet ventilation openings, filters,

baffles, etc).

Note. Where the enclosure of equipment does not guarantee the necessary protection, alternative methods of protection or alternative arrangement of equipment shall be applied to ensure the degree of protection stipulated by the Table.

.5 lampholder caps and fastening elements of luminescent lamps, lampshades and reflectors, housings, which are attached to holder caps or lamps, are made of insulation material or screwed into such a material;

.6 fastening elements of cables;

.7 a single consumer with voltage under 250 V, which is powered by a disconnecting transformer.

.8 equipment supplied with direct current at a voltage up to 50 V, or with alternate current at mean square conductor-to-conductor voltage up to 50 V, while auto-transformers shall not be used to achieve this voltage.

2.5.1.3 Screens and metal armour of cables must be connected to earth.

2.5.1.4 The secondary windings of all instrument transformers for current and voltage shall be earthed.

2.5.2 Earthing of aluminium structures in steel ships.

Superstructures of aluminium alloys fastened to the ship steel hull but insulated therefrom shall be earthed by at least two special wires, which will not start electrolytic corrosion at the points of their contact with the superstructure and the hull.

The conductivity of each wire shall not be lower than the equivalent conductivity of a copper wire having a cross-sectional area of 16 mm^2.

Such earthing connections shall be provided at different locations around superstructure perimeter, shall be accessible for inspection and protected from damage.

2.5.3 Earth terminals and conductors.

2.5.3.1 Bolts for fastening the earthing conductor to the ship's hull shall have a diameter not less than 6 mm. For cables and wires having a cross-sectional area of 2.5 mm^2 and 4 mm^2 it is permitted to use bolts (screws) 4 mm and 5 mm in diameter, respectively. Such bolts shall not be used for other purposes.

The bolts screwed into material (without nuts) shall be manufactured of brass or other corrosion- resistant material.

Ship's hull in places of earthing conductor connections shall be cleaned to metal and properly protected against corrosion.

2.5.3.2 Fixed electrical equipment shall be earthed by means of external earthing conductors or an earthing core in the feeding cable.

When earthing is effected with a special core of the feeding cable, it shall be connected to the earthing device inside the enclosure of the electrical equipment.

Such earthing effected with external earthing conductors need not be provided in case the arrangement of equipment ensures a reliable electrical contact between the equipment enclosure and the metal ship's hull under all operating conditions.

For earthing effected with an external earthing conductors, the use shall be made of copper conductors, as well as conductors of any other corrosion-resistant metal provided the resistance of these conductors does not exceed that of the required copper conductor. The cross-sectional area of copper earthing conductor shall not be less

than that specified in Table 2.5.3.2.

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

2.5.3.3 Earthing of movable, loose and portable consumers shall be effected through and earthed jack in the socket outlet or other earthed contact device and a copper earthing core of the feeding flexible cable.

The cross-sectional area of the earthing core shall not be less than the nominal cross-sectional area of the feeding flexible cable core for cables up to 16 mm^2 and at least half the cross-sectional area of the feeding flexible cable core, but not less than 16 mm^2, for cables over 16 mm^2.

Table 2.5.3.2

Section area of cable core which is connected to a consumer, mm^2	Section area of an earthing core of fixed equipment, mm^2, at minimum	
	solid	strand
Up to 2.5	2.5	1.5
2.5–120	½ of the section area of a connected cable core, but at least 4	
More than 120	70	

2.5.3.4 Earthing of the fixed equipment shall be non-disconnectable.

2.5.3.5 Earthing of shields and metal armour of cables shall be effected in one of the following ways:

.1 using a copper earth wire of a cross-section not less than 1.5 mm^2 for cable conductors with a cross-sectional area up to 25 mm^2 and not less than 4 mm^2 for cable conductors with a cross-sectional area over 25 mm^2;

.2 by adequate attachment of the shields and metal armour to the hull;

.3 by means of cable gland rings provided these are characterized by corrosion resistance, good conductivity and elasticity.

Except for cables of end branches of circuit, which may be earthed at the supply end only, earthing can be effected at both cable ends.

Cable shields and metal armour may be earthed in another approved way, provided these methods do not hamper the operation of equipment.

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

2.6 LIGHTNING PROTECTION

2.6.1 General.

2.6.1.1 In ships provision shall be made for lightning protection devices covering the zone with all the equipment to be protected.

2.6.1.2 In ships, where consequential effects of lightning strokes may cause a fire or explosion, lightning protection earthing devices shall also be fitted to preclude consequential sparking.

2.6.1.3 Lightning protection device shall consist of an air termination, down conductor and earth termination.

On metal masts no special lightning protection device need be fitted if provision is made for reliable electrical connection of the mast to the metal hull or earthing point.

2.6.2 Air termination network.

2.6.2.1 In metal ships the ship's vertical structures (masts, derrick posts, superstructures, etc.) may be used as air termination if provision is made for reliable electrical connection of these structures to

the metal hull.

Additional air terminations shall be used only when ship's structural elements proper do not provide for reliable lightning protection.

2.6.2.2 If electrical equipment is installed on the top of the metal mast, provision shall be made for an air termination network, which is effectively earthed.

2.6.2.3 On each mast or top mast of non-conducting material an effectively earthed air termination shall be provided.

2.6.2.4 The air termination shall be made of a rod at least 12 mm in diameter. The rod may be of copper, copper alloys or steel protected against corrosion. For aluminium masts aluminium rods shall be used.

2.6.2.5 The air termination shall be fitted to the mast in such a manner that it projects at least 300 mm above the top of the mast or above any device fitted on its top.

2.6.3 Down conductor.

2.6.3.1 The down conductor shall be made of a rod, strip or multiwire cable having a cross-sectional area not less than 70 mm^2 for copper or its alloys and not less than 100 mm^2 for steel. Steel down conductors shall be protected against corrosion.

2.6.3.2 Down conductors shall run on the outer side of masts and superstructures with a minimum number of bends, which shall be gradual and have as large radius as possible.

2.6.3.3 Down conductors shall not run through dangerous spaces and zones.

2.6.3.4 In ships with non-metal hull the down conductor of the lightning protection device shall be laid separately throughout its length (including its connection to the earth termination network), without connecting to the busbars of the protective and operation earthing circuits.

2.6.4 Earth termination network.

2.6.4.1 In composite ships the metal stem or other metal structures immersed in water under any navigation condition may be used as earth termination.

2.6.4.2 Means shall be provided on board the ship to allow for connecting the ship's steel hull or the earth termination network to the shore-based lightning protection device earthing when the ship is in a dock or on a slipway.

2.6.4.3 Earthing of ships with non-conducting hulls shall be in accordance with 1.2 (refer to the definition "Ship's hull").

2.6.5 Connections in lightning protection device.

2.6.5.1 Connections between the air termination network, down conductor and earth termination network shall be welded or bolted with clamps.

2.6.5.2 The contacting surface area between the down conductor, air termination network and earth termination network shall not be less than 1000 mm^2.

The connecting clamps and connecting bolts shall be made of copper, copper alloys or steel protected against corrosion.

2.6.6 Lightning protection earthing devices.

2.6.6.1 Lightning protection earthing referred to in 2.6.1.2 shall be provided for isolated metal structures, flexible connections, pipes, screens of power and communication lines, pipeline entries into dangerous spaces.

2.6.6.2 All pipelines conveying petroleum products and other pipelines associated with dangerous spaces and zones and located on open decks or in spaces free from electromagnetic screening shall be earthed to the ship's hull at least at 10 m

intervals throughout their length.

All pipelines, which are located on the upper deck where explosive gases may be present and which are not associated with dangerous spaces and zones, shall be earthed to the ship's hull at least at 30 m intervals throughout their length.

2.6.6.3 Metal parts near down conductors shall be earthed if they are not fixed to earthed structures and have no other metal connection to the ship's hull. In so doing, facilities or metal parts located at a distance of up to 200 mm from the down conductor shall be so connected to the down conductor that consequential sparking is excluded.

2.6.6.4 The joints of earthing elements shall be accessible for inspection and protected from mechanical damage.

2.7 ARRANGEMENT OF ELECTRICAL EQUIPMENT

2.7.1 Electrical equipment shall be installed in such a manner as to provide convenient access to controls and to all parts that require maintenance, inspection and replacement.

2.7.2 The horizontal-shaft electric machines shall be so installed that the shaft is positioned parallel to the centre line of the ship. Installation of machines with the shaft positioned in another direction is permitted only in those cases when the design of the machine ensures its normal operation under conditions specified in 2.1.2.2.

2.7.3 The air-cooled electrical equipment shall be so located that cooling air is not taken from bilges or other spaces wherein the air may be contaminated with substances having a harmful effect on insulation.

2.7.4 The electrical equipment placed in locations subject to vibration and shocks, which are heavier than those specified in 2.1.2.1 and which are impossible to eliminate, shall be so designed as to ensure its normal operation under these conditions or to mounted on relevant shock absorbers.

2.7.5 Electrical equipment shall be fixed in position in such a manner that the strength of decks, bulkheads and skin is not impaired as a result of this.

2.7.6 No electrical equipment shall be located in spaces wherein explosives are stored. Lighting of such spaces shall be provided with lighting fixtures fitted in adjacent flameproof spaces. If this is impracticable, the electrical equipment shall be of the design and type which prevent potential ignition and explosion.

2.7.7 When the enclosures of electrical equipment are made from different material than the structures on which they are installed, care shall be taken, if necessary, to prevent electrolytic corrosion.

2.7.8 When installing equipment within coverage area of the local application fixed fire-fighting system, the requirements of paragraphs 7.13.3 and 7.13.4 shall be met.

2.8 SPECIAL ELECTRICAL SPACES

2.8.1 The doors of special electrical spaces shall be locked. These doors shall open on the outside.

In case the doors face corridors and passageways in accommodation and service spaces, it is permitted that these doors open on the inside on condition that protection guards and stops are provided. A warning notice shall be placed on the door. From the inside of the space the door shall open without a key.

2.8.2 Special electrical spaces shall not be adjacent to the tanks filled with

flammable liquids. If this requirement is not feasible from the structural point of view, measures shall be taken eliminating the possibility of flammable liquid penetration into these spaces.

2.8.3 No exits, side scuttles of the opening type or other openings are permissible from special electrical spaces into dangerous spaces.

2.8.4 Handrails of non-conducting material shall be installed in special electrical spaces, in passage ways and servicing areas when the open-type electrical equipment is used.

2.9 SAFE-TYPE ELECTRICAL EQUIPMENT

2.9.1 The requirements of the paragraph are applicable to all ships, in which enclosed or semi- enclosed spaces and zones explosive mixtures of vapours, gases or dust with air are likely to occur in dangerous concentrations.

The following spaces and zones fall under this category: paint lockers, lantern rooms (for oil lanterns), storerooms for cylinders with flammable gases, battery compartments and spaces, which contain tanks, machinery and pipes for flammable liquids having a flash point 60 °C and below.

Additional requirements for installation of electrical equipment in oil tankers are specified in 19.2; in ships intended for the carriage of motor vehicles with fuel in their tanks — in 19.3; in ships intended for the carriage of dangerous goods — in 19.11.

2.9.2 Safe type of the equipment shall be confirmed by a certificate issued by a competent body.

For simple electrical apparatus and components specified in 19.2.4.1.2 and 19.2.4.2.3, a certificate issued by a competent body as regards safety is not required.

The manufacturer's confirmation of the product compliance with IEC 60079-11 and 60079-0 (or equivalent national standards) will be sufficient.

2.9.3 In dangerous spaces and zones, only safe type electrical equipment may be installed, the protection level of which corresponds to the category and group of the most dangerous gas mixture:

Electrical equipment enclosed in rooms listed below shall have explosion protection levels and temperature class as follows:

.1 paint lockers — sub-group IIB, temperature class T2 (refer also to 2.9.16);

.2 storerooms for cylinders with flammable gases — sub-group IIC, temperature class T2;

.3 battery compartments — subgroup IIC, temperature class T1 (refer also to 13.6).

.4 spaces which enclose tanks, machinery and piping for inflammable liquids having a flash point 60 °C and below — sub-group IIB, temperature class T3.

Depth-sounder oscillators and associated cables shall be installed in compliance with the requirements of 3.7.4 and 3.8.3, Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships, and ventilator motors shall be installed in spaces adapted for the carriage of dangerous cargoes in compliance with 12.7.4, Part VIII "Systems and Piping".

2.9.4 In spaces where explosive mixture of dust or fibre with air may accumulate electrical equipment with the degree of protection not below IP65 shall be installed.

Electrical equipment of IP55 type may be permitted where the occurrence of

explosive mixture of dust or fibre with air is temporary, resulting from the damage or infiltration from processing equipment in operation or ventilation cutoff.

Electrical equipment installed in these spaces shall have such protective enclosure that the temperature of its upper horizontal surfaces or those inclined more than 60° to the horizontal is, under conditions of continuous operation, by 75 °C below the smouldering point of dust accumulated in these spaces (the smouldering point shall be determined for a layer of dust 5 mm thick).

2.9.5 Lighting fixtures of safe type shall be so installed that a free space around them is not less than 100 mm, excluding the place of the fastenings.

2.9.6 Any equipment installed in dangerous spaces and zones, except for fire detectors, shall be provided with switches fitted at a safe position outside dangerous spaces and zones to disconnect all live conductors.

2.9.7 Fastening of electrical equipment directly to the walls of tanks intended for flammable liquids is not allowed.

In any case, electrical equipment shall be fastened at a distance not less than 75 mm from the tank walls.

2.9.8 In enclosed and semi-enclosed spaces where an explosive mixture of gas or vapour with air is not likely to occur, but direct openings lead to dangerous spaces, electrical equipment of safe type shall be generally installed.

Installation of electrical equipment of non-safe type is permitted if the following conditions are observed:

.1 operation of alarms (visual and audible) and automatic disconnection of power supply (in sound cases with time delay) to electrical equipment if the ventilation is shut off;

.2 interlocking to provide for possible connection of electrical equipment only after adequate ventilation of the space (at least 10 air changes).

2.9.9 In compartments/holds intended for carriage of flammable cargoes the electrical equipment, which is essential for the safety and control of the ship, shall have a possibility to be completely isolated and protected against unauthorised actuation.

The equipment shall be isolated from locations outside the dangerous zones by removing special disconnectors, by switches with interlocking devices or other effective means.

If provision of such equipment is necessary for the safety and control of the ship, the equipment shall be of certified safe type: intrinsically safe (*Exia* or *Exib*), pressurised enclosure (*Exp*), flameproof (*Exd*), increased safety (*Exe*).

2.9.10 In dangerous spaces and zones only those cables may be laid, which serve the electrical equipment fitted in such spaces and zones subject to the requirements of 2.9.11.

The through runs of cables may be permitted in the above spaces and zones provided the requirements of 2.9.11 to 2.9.15 are met.

No connections of cables laid in dangerous zones are permitted. In cases where the connections are inevitable, they shall be subject to special consideration by the Register. In such cases, the connections shall be made using metal-reinforced/shock-resistant plastic junction boxes of certified safe type or using thermocontractable/ capsulated cable sleeves of approved type.

2.9.11 Cables installed in dangerous spaces and zones shall have protective covering of one of the following types:

.1 metal armour or braid with

additional insulation covering;

.2 lead sheath with additional mechanical protection, or

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

2.9.12 Cables passing through dangerous spaces and zones shall be suitably protected against mechanical damage.

Penetrations of cables through decks and bulkheads shall be sealed to avoid ingress of flammable gases or vapours.

2.9.13 All shields and metal braids of cables of power circuits for electric motors and lighting systems, which pass through dangerous spaces and zones or supply the electrical equipment installed in these spaces, shall be earthed at both ends at least.

2.9.14 Cables of intrinsically safe circuits shall not be used for more than one intrinsically safe device and shall be laid separately from other cables.

2.9.15 Cables of portable electrical equipment, except for cables of intrinsically safe circuits, shall not pass through dangerous spaces and zones.

2.9.16 Additional requirements to electrical equipment installed in paint lockers.

2.9.16.1 Electrical equipment shall be installed in paint lockers and in ventilation ducts serving such spaces only when it is essential for operational services.

Safe type equipment of the following type is acceptable: intrinsically safe (Exi), pressurized (Exp), flameproof (Exd), increased safety (Exe), special protection (Exs).

2.9.16.2 The minimum requirements for the safe type equipment are as follows: explosion group IIB, temperature class T3.

2.9.16.3 In paint lockers and spaces mentioned under 2.9.16.4, cables (through-runs or terminating cables) of armoured type or installed in metallic conduits shall be used.

2.9.16.4 In the areas on open deck within 1 m of inlet and exhaust ventilation openings or within 3 m of exhaust mechanical ventilation outlets, the following electrical equipment may be installed: safe type equipment permitted by 2.9.16.1, equipment of protection class (Exn), appliances, which do not generate arcs or sparks in service and which surface does not reach unacceptably high temperature under normal conditions.

2.9.16.5 Enclosed spaces giving access to the paint locker may be considered as non-hazardous, provided that:

.1 the door to the paint locker is a gastight door with self-closing devices without holding-back arrangements;

.2 the paint locker is provided with an acceptable, independent, natural ventilation system ventilated from a safe area;

.3 warning notices are fitted adjacent to the paint locker entrance stating that the store contains flammable liquids.

2.10 ANTISTATIC EARTHING

2.10.1 Antistatic earthing is a mandatory mean of ensuring electrostatic intrinsic safety for all types of ships having dangerous spaces and zones.

2.10.2 Equipment to be installed on board, in enclosed and semi-enclosed spaces and zones where explosive mixtures of vapours, gases or dust with air likely to occur (refer to 2.9.1), as well as any portable equipment to be brought and installed in such spaces shall be antistatically earthed.

2.10.3 Bonding straps shall be required for cargo tanks/process plant/piping systems which are not permanently connected to the hull of the ship, e.g.

.1 independent cargo tanks;

.2 cargo tanks/piping systems which are electrically separated from the hull of the ship;

.3 pipe connections arranged for the removal of spool pieces;

.4 wafer-style valves with non-conductive (e.g PTFE) gaskets or seals.

2.10.4 The following equipment does not require use of the antistatic earthing conductors:

.1 fixed and portable electrical equipment, shields and metal armour of cables earthed in accordance with 2.5;

.2 pipes and conduits for installation of cables earthed in accordance with 16.8.8;

.3 electrical equipment, automation equipment, radio equipment and navigational equipment earthed in accordance with 2.2.2;

.4 equipment and structures provided with lightning protection earthing in accordance with 2.6.6.

2.10.5 Arrangement and monitoring of antistatic earthing.

2.10.5.1 Where bonding straps are required, they shall be: clearly visible so that any shortcomings can be clearly detected; designed and sited so that they are protected against mechanical damage and that they are not affected by high resistivity contamination e.g. corrosive products or paint; easy to install and replace.

Bonding straps shall be connected to the non-metallic equipment, e.g. plastic pipes, in a manner defined by the Manufacturer of the equipment.

2.10.5.2 Design of the bonding straps being the component part of the equipment delivered to the ship shall meet the requirements of relevant Parts of the Rules or the standards approved by the Register.

2.10.5.3 Resistance of the antistatic earthing shall be monitored by portable instruments of any type with control d.c. voltage of not more than 10 V. The resistance value measured between the equipment, component, structure being monitored and ship's hull shall not exceed 106 Ohm with the area of contact between the measure electrode and the equipment surface being no more than 20 mm^2.

2.11 ARRANGEMENT AND SYSTEMS FOR INSULATION RESISTANCE MONITORING

2.11.1 In each isolated ship power system with the nominal voltage above 50 V AC or above 110 V DC provision shall be made for an automatic continuous monitoring of insulation resistance of current-carrying components relative to ship's hull.

Measurements periodicity during the periodic monitoring shall not exceed 300 s.

2.11.2 In the networks with the voltage 1000 V and above monitoring of the insulation resistance shall be carried out only alive with the use of passive monitoring methods (for example, with the use of zero-sequence current transformer).

2.11.3 Devices for insulation resistance monitoring in the networks with the voltage up to 1000 V shall:

be fitted with an indicator showing the insulation resistance value;

have visible and audible alarm at decrease of controlled value under the prescribed limit;

allow to perform smooth adjustment of alarm actuating setting value within the range from 100 to 5 kOm;

have an operation speed sufficient for measuring insulation resistance value in the networks with the existing capacity level during the measurement cycle of the device which shall not exceed 30 s;

produce measuring current not exceeding 0.03A under all modes (including transient);

provide for the possibility of periodic intactness monitoring under operational conditions by means of earth leakage current through an active resistance equal to 80 per cent of resistance of the relevant setting actuating.

2.11.4 Location of devices for insulation resistance monitoring shall meet the requirements of 4.6.4.7.

3. MAIN ELECTRICAL POWER SOURCE

3.1 COMPOSITION AND CAPACITY OF MAIN ELECTRICAL POWER SOURCE

3.1.1 In every ship, a main electric power source shall be provided with a capacity sufficient to supply all the electrical equipment on board under conditions specified in 3.1.5. Such a source shall consist of two independently driven generators at least.

In ships of 300 gross tonnage and below (except for passenger ships), accumulator batteries may be the main power source.

3.1.2 The number and capacity of independently driven generators and electric transducers, of which the main electrical power source is composed, shall be such that if any of them failed the rest would ensure:

.1 supply to electrical equipment essential for propulsion, steering and safety of the ship with the normal habitable conditions on board guaranteed;

.2 start of the most powerful electric motor with the greatest starting current. The motor start shall not involve a voltage and frequency drop in the mains that could result in a fall out of synchronism, stop of generator engine or disconnection of machinery and apparatus being in operation;

.3 supply to consumers necessary to start the propulsion plant (refer to 1.2.1, Part VII "Machinery Installation") when the ship is de-energized. For this purpose, emergency electrical power source may be used if its capacity proper or in association with the capacity of any other electrical power source would ensure a simultaneous supply of consumers listed under 9.3.1 to 9.3.3 or under 19.1.2.1 to 19.1.2.3 (refer also to 2.1.6, Part VII "Machinery Installations"), for this purpose their parallel operation may be provided.

3.1.3 Where the main electrical power source is needed to ensure propulsion and steering of the ship, provision shall be made that the power supply to the equipment essential for propulsion and steering and to ensure safety of the ship is maintained continuously or restored immediately in case of failure of any generator being in operation.

Along with that, in ships where electrical power is normally supplied by two or more generators running in parallel, provision shall be made for automatic switching-off of less essential consumers without any overloading of the remaining generators, with retention of power supply to consumers essential for propulsion, steering and to ensure safety of the ship.

In ships where electrical power is normally supplied by one generator, in case of its failure and deenergization of the main switchboard, provision shall be made for:

automatic starting of stand-by

generator of sufficient capacity and its connection to busbars of the main switchboard within 30 s;

automatic re-starting, in the necessary sequence, of essential devices ensuring propulsion, steering and safety of the ship.

In addition, for ships with marks **A**, **A-R1, A-R2**, **A-R2-RS**, **A-R2-S**, **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS** in ship Class notation — automatic disconnection of some essential consumers, in order to prevent overload of the standby generator (if necessary), while retaining power supply of consumers, which provide ship movement, steering and safety.

3.1.4 On non-passenger ships (except of ships with marks **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS**, less than 24 m in length), instead of one independently driven generator as mentioned under 3.1.1, a generator driven by the main engine (shaft generator) may be used if it complies with 3.2.3 under conditions listed below:

.1 the shaft generator operates practically at a constant speed under different operating conditions of the ship;

.2 provision is made for actuation of the ship's propulsion plant in case of failure of any generator with an independent prime mover.

The use of shaft generators operating at different speeds of main engines and shafts and forming part of the main electrical power source is subject to special consideration by the Register.

3.1.5 The number and power output of generators forming the main source of electrical power shall be determined with regard to the following operating conditions of the ship:

.1 running conditions;

.2 manoeuvring;

.3 in case of fire, hole in the ship's hull or other conditions affecting the safety of navigation, with the main sources of electrical power in operation;

.4 other operating conditions according to ship's purpose.

3.1.6 Where accumulator batteries are the main source of electrical power, their capacity shall be sufficient to satisfy the requirements of 3.1.2.1 for 8 hours without recharging; provision shall be made for charging of accumulator batteries from the source of electrical power installed on board.

3.1.7 In ships of restricted area of navigation **R3** and **R3-IN** (except of passenger ships) with a low-power electrical installation as the main source of electrical power, only one generator with an independent prime mover or accumulator batteries may be installed.

3.2 GENERATOR SETS

3.2.1 General.

3.2.1.1 Engines designed for use as generator prime movers shall comply with the requirements set forth in Sections 2, 3 and 8, Part IX "Machinery", and, additionally, with the requirements of the Chapter.

3.2.1.2 Electric machine sets shall be designed for continuous duty, with regard to the power reduction during ship's service under conditions specified in 2.1.1.1.

3.2.1.3 Under short circuit in the ship's mains the generators shall provide for the value of the sustained short-circuit current sufficient for the operation of protective devices.

3.2.1.4 The voltage of generators shall be regulable within the range specified in 10.6 and 10.7 of the present Part, and speed frequency shall be regulable within the range specified in 2.11.3, Part IX

"Machinery".

3.2.2 Load sharing between sets running in parallel.

3.2.2.1 Alternating-current sets intended to run in parallel shall be provided with such a reactive-voltage drop compensating system that when the sets 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 involved or by not more than 25 per cent of the rated output of the smallest generator if this value is lower than the above one.

3.2.2.2 When the alternating-current sets run in parallel at 20 to 100 per cent of the total load, load sharing shall be within the limits specified in 2.11.3, Part IX "Machinery".

3.2.3 Shaft generator sets.

3.2.3.1 Where shaft generators are used for feeding the ship mains, automatic connection of one or more independently driven generators to the ship mains shall be provided, or an alarm shall be activated in the engine room or at the main machinery control room in case the network frequency is below the permissible value.

3.2.3.2 Shaft generators intended for supply of particular consumers may, subject to special consideration by the Register, operate under parameters, which differ from those specified in 3.2.1.4.

3.2.3.3 Shaft generators and semiconductor transducers (inverters) supplying the ship mains shall not be damaged by short circuits at the main distribution board busbars. In this case, a steady short-circuit current shall be ensured, sufficient for protection to be activated.

3.2.3.4 As a minimal requirement, shaft generators shall be designed for short periods of parallel running with other types of generator sets so that manual or automatic (if available) switch-over of the load is possible.

3.2.3.5 For shaft alternators, automatic devices shall be provided to preclude the current overload of their excitation system components when running at a speed below 90 per cent of the nominal speed during more than 5 s. In this case, a proportional voltage lowering across the generator terminals is permitted.

3.2.3.6 For each shaft generator, a de-excitation device shall be provided at the main distribution board, and measuring instruments as listed under 4.6.4.3.

3.2.3.7 When the shaft generator is connected into the ship mains, a visual warning signal shall be activated at the bridge control station indicating that a change in the mode of main machinery operation might bring about a deviation in the ship main parameters beyond the limits stipulated by 10.6 and 10.7 of the present Part and 2.11.3, Part IX "Machinery".

3.2.3.8 A generator with an independent prime mover may be used in shaft generators with semiconductor converters as a synchronous condenser. In such cases, a disengaging clutch shall be fitted between the generator and its prime mover.

3.2.4 Exhaust-heat turbogenerators.

3.2.4.1 Exhaust-heat turbogenerators supplying particular consumers may, subject to special consideration by the Register, have performance characteristics different from those stated under 3.2.1.4.

3.2.4.2 The exhaust-heat turbogenerators used for feeding the ship mains shall be designed for parallel

operation with generators having an independent prime mover. In this case, the distribution of load between the generator sets shall be in accordance with 3.2.2.

3.3 NUMBER AND CAPACITY OF TRANSFORMERS

3.3.1 Ships, where lighting and other essential services are supplied via transformers, shall be provided with at least two transformers of such a power that, if the most powerful transformer fails, the remaining units could meet the full demand for power supply under all ship operation conditions.

Where subdivided system of busbars is used, transformers shall be connected to different sections.

If a subdivided system of busbars is used, transformed shall be connected to different sections.

In ships of less than 300 gross tonnage (other than passenger ships) of restricted areas of navigation **(R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, **R3-IN)**, with the electrical installation of low power installation of only one transformer is allowed.

3.4 POWER SUPPLY FROM AN EXTERNAL SOURCE OF ELECTRICAL POWER

3.4.1 If provision is made for ship's mains to be supplied from an external source of electrical power, an external supply switchboard shall be installed in the ship (refer also to 4.6.4.6).

For ships with the electrical installation of low power it is allowed that cables for supply of the ship's mains from an external source of electrical power shall be connected to the main switchboard directly.

3.4.2 At the external supply switchboard, the following facilities shall be provided:

.1 terminals for flexible cable connection;

.2 switch gear and protection devices for connecting and protection of permanently laid cable of the main distribution switchboard; where the cable length between the external supply switchboard and the main distribution switchboard is less than 10 m, no protection devices may be fitted;

.3 voltmeter or pilot lamps to indicate the presence of voltage from an external

.4 device or facilities for connecting a device to control polarity and phase sequence;

.5 terminal for earthing a neutral wire from an external source;

.6 plate to indicate voltage, type of current and frequency;

.7 arrangement for mechanical fixation of the end of flexible cable connected to the switchboard and a hanger for the cable, which shall both be provided at the external supply switchboard or in its vicinity.

3.5 CONNECTION OF ELECTRICAL POWER SUPPLY UNITS

3.5.1 Where the electrical power supply units are not adapted for long operation in parallel to feed common busbars, it is necessary to use a connection circuit ensuring their switching-on for parallel operation for the duration of load transfer from one unit to another.

3.5.2 Direct current compound-wound generators designed for parallel operation shall have equalizing connections.

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

Where synchronizing is arranged to operate automatically, a standby manual synchronizer shall be provided by one operator.

3.5.4 Where several direct-current generators are installed, a magnetizing device shall be fitted in the main switchboard.

Such device may be also allowed for synchronous alternating-current generators if it is necessary for initial excitation.

3.5.5 Where the ship's and external sources of electrical power are not intended to operate in parallel to the common busbars of the ship's electrical installation, the system of connections shall be so interlocked, in this case, as to prevent their possible switching-on for parallel operation.

3.5.6 Where the main source of electrical power is necessary for propulsion of the ship, the main busbar shall be subdivided into at least two parts, which shall normally be connected by circuit breakers or other approved means (e.g. circuit breaker without release or disconnector).

Bolted links between the main switchboard sections, by which the busbars can be split, are not acceptable.

So far as it is practicable, the connection of generating sets and other duplicated equipment shall be equally divided between the parts.

4. DISTRIBUTION OF ELECTRICAL POWER

4.1 DISTRIBUTION SYSTEMS

4.1.1 The following systems of electrical power distribution are acceptable:

.1 for alternating current up to and including 1000 V:

.1.1 three-phase three-wire insulated system;

.1.2 three-phase three-wire system with neutral earthed through high-value resistor or reactor (compensated-resistored neutral);

.2 additionally for current up to and including 500 V:

.2.1 three-phase four-wire insulated system;

.2.2 three-phase four-wire system with neutral earthed according to 4.1.1.1.2;

.2.3 single-phase two-wire insulated system;

.2.4 single-phase two-wire system with neutral earthed according to 4.1.1.1.2;

.2.5 single-phase single-wire system with hull return for voltage up to 50 V (in ships of less than 1600 gross tonnage), except stated in 6.8.4, provided that any possible current will not pass directly through any of the dangerous spaces;

.3 for direct current:

.3.1 two-wire insulated system;

.3.2 single-wire system with hull return for voltage up to 50 V (in ships of less than 1600 gross tonnage), except stated in 6.8.4, provided that any possible current will not pass directly through any of the dangerous spaces.

Where a hull return system is used, all final circuits shall be two-wire and the insulated return wire shall be earthed by connecting to the earthing busbar of the distribution board supplying the circuit, at the place accessible for inspection. In this case devices shall be provided for isolating the earthing busbars from the hull to test insulation condition.

In ships of 1600 gross tonnage and upwards the use of local earthed systems

is accepted for supplying the following consumers (provided that any possible current will not pass directly through any of the dangerous spaces and zones):

.1 electrical (battery) starter systems of internal combustion engines;

.2 impressed-current cathodic protection systems;

.3 insulation resistance monitoring and measuring systems (refer to 4.6.4.7).

The use of other distribution systems is subject to special consideration by the Register in each case (refer also to 18.2.1 and 19.2.2).

4.2 PERMISSIBLE VOLTAGES

4.2.1 Proceeding from the electrical power distribution system used, the permissible voltage across the terminals of power generating sets of electrical power sources with frequencies of 50 and 60 Hz shall be found under 4.1.

Additional requirements for apparatus designed for a voltage in excess of 1000 V shall be found in Section 18.

4.2.2 Permissible voltage across the terminals of sources of electrical power and direct current sources shall not exceed the values below:

500 V for power systems;

250 V for lighting and heating systems, socket outlets.

4.2.3 Permissible voltage across the terminals of alternating-current consumers shall not exceed the values specified in Table 4.2.3.

4.2.4 Permissible voltage across the terminals of direct-current consumers shall not exceed the values.

Table 4.2.3

Ser. No.	Consumers	Permissible voltage, V
1	Permanently installed power consumers, cooking and heating appliances permanently installed in spaces other than those specified in Ser. No. 2	1000
2	Portable power consumers supplied from socket outlets fixed in position when used, heaters in cabins and passenger accommodations (refer to 15.2.5)	500
3	Lighting, signalling and internal communication, socket outlets for portable consumers with double or reinforced insulation or isolated electrically by isolating transformer, residual-current devices (RCD)	250
4	Socket outlets fitted in locations and spaces with increased humidity, and in extra humid spaces, and intended for supply of consumers having no double or reinforced insulation and not isolated electrically	50

Table 4.2.4

Ser. No.	Consumers	Permissible voltage, V
1	Permanently installed power consumers	500
2	2 Cooking, heating, etc. appliances	250
3	Lighting, socket outlets*	250

* In spaces with increased humidity and extra humid spaces, notices shall be provided at socket outlets with voltage exceeding the overrating voltage to notify of the use of consumers with double or reinforced insulation or those electrically isolated from overrating voltage.

Ser. No.	Consumers	Permissible voltage, V

4.3 POWER SUPPLY OF ESSENTIAL SERVICES

4.3.1 The following services shall be supplied by separate feeders from the main switchboard busbars:

.1 steering gear electric drives (refer also to 5.5.2);

.2 anchor gear electric drives (refer also to 4.3.3);

.3 fire pump electric drives;

.4 bilge pump electric drives;;

.5 electric drives of sprinkler system compressors and pumps equipment to ensure operating of foam generators of high expansion foam system;

.6 gyrocompass;

.7 refrigerating plant switchboard for cargo holds;;

.8 electrical drives of exciter sets of propulsion plant;

.9 section main-lighting switchboards;

.10 radio station switchboard;

.11 navigational equipment switchboard;

.12 navigation light switchboard;;

.13 section switchboards and distribution gear for supplying other essential services combined on the principle of uniformity of their functions;

.14 switchboards of integrated bridge control console (refer also to 4.5);

.15 switchboard of automatic fire detection system;

.16 electric drives of auxiliaries ensuring the operation of main machinery;

.17 switchboards of electric drives for cargo, mooring, boat and other gears, ventilation and heating appliances;

.18 control devices of controllable pitch propeller;

.19 charging facilities of starter accumulator batteries and batteries supplying essential consumers;

.20 switchboards of electric drives for closure of watertight doors and devices holding fire doors in open position and closure of watertight and fire doors;

.21 switchboard of refrigerating plant for the low pressure carbon dioxide extinguishing system;

.22 lighting switchboards for hangars and helicopter deck illumination;

.23 other services not listed above as required by the Register.

It is permitted to supply services indicated in **4.3.1.4, 4.3.1.10 to 4.3.1.12, 4.3.1.15, 4.3.1.16, 4.3.1.18 to 4.3.1.20**, from switchgear indicated in **4.3.1.13 or 4.3.1.14** by separate out-going feeders provided with adequate switching and protective devices.

4.3.2 In case one-purpose machinery with electric drives indicated in 4.3.1 is installed in double or greater number, except for specified in 4.3.1.1, 4.3.1.5 and 4.3.1.8 at least one of these drives shall be energized by a separate feeder from the main switchboard. Electric drives of the rest of such machinery are allowed to be supplied from section switchboards or special distribution devices intended for supply of essential services.

When the collecting busbars in the main switchboard are subdivided into sections having intersectional disconnecting devices, the electric drives, section switchboards, special distribution devices or boards installed in double or greater number

or supplied by two feeders shall be connected to different sections of the main switchboard.

4.3.3 In cargo ships of restricted areas of navigation **R2, R2-RSN, R2-RSN(4,5), R3-RSN and R3**, and in particular cases in ships of unrestricted service and ships of restricted area of navigation **Rl**, the supply feeder of anchor gear may be connected to the distribution board of cargo winches or to another distribution board, on special approval of the Register, provided the boards are supplied directly from the main distribution board and adequate protection is available.

4.3.4 Final sub-circuits having a current rating in excess of 16 A shall supply not more than one consumer.

4.4 POWER SUPPLY OF ELECTRICAL (ELECTRONIC) AUTOMATION SYSTEMS

4.4.1 Power supply of electrical (electronic) automation systems shall satisfy the requirements of Part XV "Automation".

4.4.2 Power supply of automation devices necessary for starting and operating the emergency diesel generator shall be taken from a starter battery or another independent accumulator battery installed in the emergency diesel generator space. Automation devices, which are required for emergency diesel-generator start and operation, shall be supplied by a starter battery or another separate accumulator battery located in the emergency diesel-generator room.

4.5 POWER SUPPLY TO INTEGRATED BRIDGE CONTROL CONSOLE

4.5.1 When locating in the integrated bridge control console the electrical equipment, navigational equipment, radio equipment, electrical automatic and remote-control equipment for the main and auxiliary machinery, such equipment shall be supplied by separate feeders as required in the present Chapter and other parts of the Rules.

It is allowed to feed the equipment specially listed in 4.3.1 from the switchboards of the integrated bridge control console, provided the requirements of 4.5.2 to 4.5.6 are met (refer to 9.4.3 as well).

4.5.2 The switchboards of the integrated bridge control console shall be fed from the main switchboard directly or through the transformers by two independent feeders connected to different sections of the main switchboard busbars, where busbars are subdivided.

When the emergency generator is provided on board the ship, the switchboards of the integrated bridge control console shall be supplied by one feeder from the main switchboard and by one feeder from the emergency switchboard.

4.5.3 In addition, the switchboards of the integrated bridge control console shall 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.

4.5.4 The switchboard shall be provided with a change-over switch for feeders specified in 4.5.2.

If an automatic change-over switch is used, manual switching of feeders shall be also ensured. In this case, provision shall be made for necessary interlocking.

4.5.5 Each consumer specially listed in 4.3.1 fed from the switchboards of the integrated bridge control console shall be

supplied by a separate feeder (refer to 9.4.3 as well).

4.5.6 In the integrated bridge control console, a light signalling device indicating the presence of voltage shall be fitted.

4.6 SWITCHBOARD AND SWITCHGEAR

4.6.1 Switchboard design and construction.

4.6.1.1 Frames, front panels and enclosures of main, emergency, section and distribution switchboards shall be constructed of metal or some other durable non-combustible material.

Where the aggregate capacity of generators intended for parallel operation exceeds 100 kW, barriers shall be installed between the generator sections and adjacent sections for protection against the effects of arcs.

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

4.6.1.3 Switchboards shall at least be protected from drip. This protection is not required if the switchboards shall be located in spaces where the conditions are such that no vertically falling drops of liquid can get into the switchboard (refer also to 4.6.6.2).

4.6.1.4 Switchboards intended to be installed in places accessible to unauthorized persons shall be provided with doors to be opened by means of a special key, the same for all the switchboards in the ship.

4.6.1.5 The design of switchboard doors shall be such that with the doors opened access is assured to all parts which require maintenance, and the live parts located on the doors shall be protected against inadvertent touching.

Opening panels and doors, which are used for mounting electrical control gear and measuring instruments, shall be securely earthed with at least one flexible connection.

4.6.1.6 Handrails shall be fitted to main, emergency and section switchboards and to control panels on their front sides. Switchboards accessible from the rear shall be provided with horizontal handrails fitted at the back.

The materials, which may be used for manufacture of handrails, are insulating material, wood or earthed metal pipes with insulating covering.

4.6.1.7 The generator panels of main switchboards shall be illuminated with lighting fixtures supplied on the generator side before the circuit breaker of the generator or not less than from two different systems of busbars in case these systems are provided according to 3.5.6.

4.6.1.8 The lighting of the front side of switchboard panels shall not interfere with instrument observation or produce a blinding effect.

4.6.1.9 The design of switchboards, which have no space at the rear, shall be such that the access is ensured to all parts, which require maintenance.

Arrangements shall be provided for doors of switchboards to fix them in the open position.

Withdrawable blocks and instruments shall be fitted with devices to prevent their fall-out in the withdrawn position.

4.6.1.10 Each switchboard designed for voltage over the safe, with switchgear and protective devices and without a

voltmeter, shall be furnished with a pilot lamp, which indicates the presence of voltage on busbars.

4.6.2 Busbars and uninsulated conductors.

4.6.2.1 The maximum permissible temperature for switchboard busbars and uninsulated conductors at the rated load and short-circuit current or at the permissible one-second short-circuit load for copper busbars shall be determined according to national standards.

4.6.2.2 Equalizer busbars shall be designed for at least 50 per cent of the rated current of the largest generator connected to the main switchboard.

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

4.6.2.4 Busbars and uninsulated conductors in switchboards shall have adequate electrodynamic and thermal strength during short-circuit currents occurring at relevant points in the circuit.

Such electrodynamic loads as occur in busbars and uninsulated conductors due to short circuit shall be as specified in the relevant national standards.

4.6.2.5 Insulators and other parts designed to support busbars and uninsulated conductors shall be capable of sustaining the loads due to short circuits.

4.6.2.6 The natural frequency of copper tier busbars shall be outside the ranges of 40 to 60 Hz and 90 to 110 Hz for rated frequency of 50 Hz, 50 to 70 Hz and 110 to 130 Hz for rated frequency of 60 Hz.

4.6.2.7 Busbars and uninsulated conductors of different polarity shall be marked with the following distinguishing colours:

.1 red for positive pole;

.2 blue for negative pole;

.3 black or green and yellow for earth connections;

.4 light blue — for middle wire.

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

4.6.2.8 Busbars and uninsulated conductors of different phases shall 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 .5 green and yellow for earth connections.

4.6.2.9 Busbars shall be connected so as to prevent corrosion in way of connections.

4.6.3 Calculation of short-circuit currents and selection of electrical switch apparatus.

4.6.3.1 Electrical switch apparatus shall be calculated on the basis of, at least, relevant national standards. They shall be selected so as to comply with the following requirements:

under normal service conditions, their rated voltages, rated loads and permissible temperature shall not be exceeded;

during transitional conditions, they shall endure expected overloads so that their damage and heating to dangerous temperatures is excluded;

under short-circuit conditions, their specifications shall match expected short circuit current values on leads (terminals) of each switching apparatus, at the design value of power factor.

4.6.3.2 Rated breaking capacity (I_{cn}) of electrical switch apparatus, which are intended for short circuit clearing, at the moment of breaking in their connection point shall be at least equal to:

effective value of a sinusoidal component of expected short circuit current (I_{ac}), for alternate current;

expected short circuit current with the stated device time constant, for direct current.

4.6.3.3 Maximum rated making capacity (I_{cm}) of electrical switch apparatus, which can be connected to a shorted electric circuit, shall be at least equal to expected peak short circuit current (I_p) in their connection point.

4.6.3.4 Peak electrodynamic withstand current of electrical switch apparatus, which are not intended for short circuit clearing, shall be at least equal to expected peak short circuit current (Ip) in their connection point.

4.6.3.5 Thermal short circuit strength of electrical switch apparatus shall match with thermal impact of a sinusoidal component of expected short circuit current (effective value) (I_{ac}) in their connection point, for the time of short circuit determined by selective operation of protection devices.

Note. Thermal strength of an electrical switch apparatus is calculated as a squared effective value of a sinusoidal component of expected short circuit current, kA, multiplied by time, s, $I^2 \times t$, and hall be specified in its specifications.

4.6.3.6 Rated allowable short-time current (I_{cw}) for electrical switch apparatus installed in selective protection circuits shall be at least equal to effective value of a sinusoidal component of expected short circuit current in the first half-period ($I_{cw} > I_{ac}$).

4.6.3.7 If an automatic circuit breaker does not possess maximum operation rated breaking capacity (I_{cs}) and maximum rated making capacity (I_{cm}) matching with the expected short circuit current in the connection point, it may be used provided that it is protected from the generator side with fuses and/or an automatic circuit breaker, which has at least sufficient rated values of short-circuit currents and does not serve as an automatic circuit breaker of a generator.

Similar protection devices, which gave only a rated maximum limit breaking capacity (I_{cu}), shall not be installed in main and emergency switchboards or used in circuits of essential and emergency consumers.

Specifications of these devices shall satisfy the following requirements:

.1 if maximum expected short circuit current is cleared, the automatic circuit breaker on the load side shall not be damaged beyond further operability;

.2 if an automatic circuit breaker makes maximum expected short circuit current, the remaining part of electric installation shall not be damaged; in this case the automatic circuit breaker on load side may be not immediately operable.

4.6.3.8 Electric circuits with rated load current in excess of 320 A shall be fitted with automatic circuit breakers to ensure overload protection.

It is recommended to use automatic circuit breakers if current value exceeds 200 A.

4.6.3.9 If direct current compound-wound generators intended for simultaneous running are used, their circuits breakers shall be fitted with a sensing wire pole, which is mechanically connected to other switch

poles, so that it switches on, once other poles are connected to buses, and switches off once they are disconnected.

4.6.3.10 Short-circuit current shall be calculated on the basis of the standards or calculation methods approved by the Register.

4.6.3.11 In calculations of the maximum and minimum short-circuit currents a source of short-circuit current shall contain all generators including synchronous condensers, which may be connected in parallel, and all electric motors running simultaneously and able to produce current contribution to the short-circuit point[2]. The calculation is performed for a three-phase "metal" short circuit.

Short-circuit currents shall be calculated for all electrical circuits with electrical equipment installed, if such equipment is selected and tested with due regard to the value of permissible short-circuit current and is supplied from busbars of the main switchboard directly. Such calculation shall be also performed for switchboard busbars, in order to check their electrodynamic strength and their heating during short-circuit current flow.

In any case, short-circuit currents shall be calculated for the following design points:

terminals of automatic current breakers on the generator side;

bus bars of the main switchboard;

busbars the emergency switchboards;

terminals of power consumers and busbars of switchboards, which are supplied from main switchboard directly.

To assess protection sensitivity, both maximum and minimum short-circuit currents on terminals of consumers shall be calculated.

Short-circuits currents in the circuit, which connects terminals of the generator to the busbars of the main switchboard, shall be calculated on terminals of the circuit breaker of the generator.

If stator winding is fitted with protection against internal short circuits (such as differential protection), short-circuit currents on generator terminals shall be calculated.

The results of short-circuit currents calculation shall include a list of envisaged electrical switch apparatus with their specifications, as well as expected maximum and minimum short-circuit currents in their connection points.

4.6.4 Electrical switch apparatus and measurement devices.

4.6.4.1 Instrumentation, measurement and monitoring devices that serve as parts of corresponding generators and other significant essential services, shall be installed on switchboards of these generators and services.

This requirement may be neglected for generators, if there is a central control panel with switching and measurement devices of several generators installed on it.

4.6.4.2 For each direct current generator, both main and emergency switchboards shall be fitted with one current meter and one voltmeter for each generator.

4.6.4.3 For each alternating current generator, the following measurement devices shall be installed on the main switchboard (and for emergency generator, on the emergency switchboard):

.1 a current meter with a switch for current measurement in each phase;

.2 a voltmeter with a switch for

[2] Electrical engines which are fed by semiconductor transducers do not generate seed current.

measurement of voltage between phases or line voltages;

.3 Herz meter (one dual Herz meter may be used for simultaneously running generators, with a switch for each generator);

.4 power meter (for power more than 50 kV·A);

.5 other necessary devices.

4.6.4.4 For ships with a low-power electric installation and no simultaneous run of generators intended, it is allowed to install one set of measurement devices, which are stated in paragraphs 4.6.4.2 and 4.6.4.3 and enable measurements on each generator installed, on main and emergency power switchboards.

4.6.4.5 Current meters shall be connected to essential services circuits, which have rated voltage of 20 A and more. Such current meters may be installed on the main switchboard or next to control stations.

These current meters may have switches, which shall not enable change-over to more than 6 consumers.

4.6.4.6 Feeder of the main switchboard, which provides power supply from an external power source, shall be fitted with following devices:

.1 electrical switch apparatus and protection devices;

.2 a voltmeter or a pilot lamp;

.3 a phase loss protection device.

4.6.4.7 Main and emergency switchboards of each network of insulated systems shall be fitted with an electrical switch apparatus or with a separate device for each network providing measurement and indication of insulation resistance.

Hull leakage current caused by measurement device operation shall not exceed 30 mA in any case.

Audible and visible alarm on unacceptable decrease of insulation resistance shall be envisaged.

If the machinery room of a ship is not continually manned, such alarm shall be also installed in the central control station of the ship.

4.6.4.8 Scales of measurement devices shall have graduation margin exceeding rated values of measured parameters.

Scale ranges of measurement devices shall be as follows or wider:

.1 for voltmeters, 120 per cent of rated voltage;

.2 for current meters of consumers and generators that are not indented for simultaneous operation, 130 per cent of rated current;

.3 for current meters of simultaneously running generators, the limit of load current scale shall be 130 per cent of rated current, and the limit of reverse current scale shall be 15 per cent of rated current (the latter requirement is for direct current generators only);

.4 for power meters of generators that are not indented for simultaneous operation, 130 per cent of rated power;

.5 for power meters of simultaneously running generators, the limit of load power scale shall be 130 per cent, and the limit of reverse power scale shall be 15 per cent;

.6 for Herz meters, ± 10 per cent of rated frequency.

The mentioned limits of scales may be modified. Such modification is subject to special consideration by the Register.

4.6.4.9 Rated voltages, currents and powers in circuits of the electric propelling plant and generators shall be clearly marked on scales of measurement devices.

4.6.4.10 Where possible, circuit breakers shall be installed and connected to

the busbar so that moving contacts and protective and measurement devices connected to the switch will not be energized, when the circuit breaker is in the "off" position.

4.6.4.11 If circuit breakers with fuses are installed in circuits of switchboards, the connection point of the fuse must be between the busbar and the circuit breaker.

Connection sequence other than mentioned is subject to special consideration by the Register.

4.6.4.12 Fuses of bearer-mounted switchboards, which are installed at the decking level, shall be positioned at a height between 150 and 1800 mm from the decking.

Exposed parts of live distribution boards shall be positioned a height at least 150 mm above the decking.

4.6.4.13 Fuses shall be installed in switchboards in such a way that they are easily accessible, and replacement of blowing inserts is safe for maintenance personnel.

4.6.4.14 Fuses, that protect poles or phases of same circuit, shall be installed next to each other, horizontally or vertically, taking to account the construction of the fuse.

Relative position of fuses in an alternating current circuit shall be left-to-right or top-bottom, in accordance with phase sequence.

In a direct current circuit, positive pole fuse shall be positioned on the left, on the top or closer to maintenance personnel.

4.6.4.15 Manual actuators of voltage regulators, which are installed on the main or emergency switchboard, shall be located next to measurement devices of corresponding generators.

4.6.4.16 Current meters of direct current compound-wound generators, which are intended simultaneous running, shall be connected into the circuit of the pole which is not connected to the equalizing wire.

4.6.4.17 Movable or semi-movable devices shall be connected with strand flexible conductors.

4.6.4.18 Control elements of electrical switch apparatus, panels, tap-off electric circuit of switchboards and measurement devices shall have notices. Switching positions of the devices shall be marked. In addition, rated current of fuses and switches installed shall be stated, as well as set values of automatic switches and thermal relays actuation.

4.6.4.19 Each circuit leading from a switchboard shall be provided with a circuit breaker, which can disconnect all poles and/or phases. Circuit breakers must not be installed in secondary lighting junction boxes with a common circuit breaker, as well as in circuits of devices, interlocking and alarm devices and local switchboard lighting, if such circuit are equipped with fuses.

4.6.5 Light alarm system.

4.6.5.1 Light alarm system shall use colours specified in Table 4.6.5.1.

4.6.5.2 Letter symbols may be used as light alarm signals, provided that they identify device status clearly.

4.6.6 Location of switchboards.

4.6.6.1 Switchboard shall be installed in places where accumulation of gases, water vapour, dust and acid vapour is excluded.

4.6.6.2 If a switchboard with protective index IP10 or lower is located in a special space, cabinet or recess, such places shall be constructed of or clad in fire-retardant material.

Table 4.6.5.1

Colour	Meaning	Signal type	Device status
Red	Danger	Flashing	Dangerous emergency, requires for immediate intervention
		Steady	Dangerous emergency, detected but not corrected yet
Yellow	Attention	Flashing	Abnormal states, immediate intervention not required
		Steady	Neutral state between abnormal state and safe state Abnormal state, detected but not corrected yet
Green	Safety	Flashing	Machinery has started from backup mode
		Steady	Normal operation and action mode
Blue	Information	Steady	Machinery and devices ready for start Line voltage All right
White	General information	Steady	Signals indicated on demand Notations on automatic actions Other additional signals

4.6.6.3 Arrangement of pipelines and tanks near the switchboards shall conform to the requirements of 5.5, Part VIII "Systems and Piping".

4.6.6.4 The navigation lights switchboard shall be located in the wheelhouse where it is readily accessible and visible to the personnel on watch.

4.6.6.5 The main switchboard and generating sets shall be positioned in close proximity to each other, in the same engine room and within the boundaries of the same "A-60" class vertical and horizontal fire-resistant constructions.

The enclosure situated within the main boundaries of machinery space, provided for the main machinery control room where the main switchboard is positioned, is not considered as separating the main switchboard from the generating sets.

Where essential services for stearing and propulsion of ship are supplied from section switchboards these switchboards and any transformers, converters and similar equipment forming the essential part of the system supplying these services shall be also positioned in the same space as generating sets.

4.6.7 Access to switchboards.

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

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

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

Between the free standing switchboards with open live parts located in special electrical spaces a passageway shall not be less than 1000 mm wide.

4.6.7.3 The space behind the free standing switchboards with open live parts shall be enclosed and fitted with doors in accordance with 2.8.1.

4.6.7.4 For switchboards more than 3 m in length mentioned in 4.6.7.3 at least two doors shall be provided leading from the space where the switchboard is installed to the space behind the switchboard. These

doors shall be as widely spaced as possible.

It is allowed that one of these doors shall lead to the adjacent space having at least another exit.

4.6.7.5 Passageways specified in 4.6.7.1 and 4.6.7.2 are measured from the most protruding parts of apparatus and structure of the switchboard to the protruding parts of equipment or hull structures.

5. ELECTRICAL DRIVES FOR SHIPBOARD MACHINERY AND EQUIPMENT

5.1 GENERAL

5.1.1 The control stations of the drives shall meet the relevant requirements of Part VII "Machinery Installations", while the power supply of electrical (electronic) automation systems shall meet the requirements specified in Part XV "Automation".

5.1.2 Electrically-driven mechanisms shall be provided with light signals to indicate switching-on of the electric drive.

5.1.3 Equipment provided with automatic, remote and local control shall be so designed that the automatic control is switched off as well as the remote control when the change-over to the local control occurs. The local control shall be independent both of the automatic and remote control.

5.2 INTERLOCKING OF MACHINERY OPERATION

5.2.1 The machinery provided with electric and manual drives shall be fitted with an interlocking device that will prevent simultaneous operation of the drives.

5.2.2 If the machinery is required to operate in a certain sequence, appropriate interlocking devices shall be used.

5.2.3 A device may be installed that will switch off the interlocking on condition that this device is protected from switching off the interlocking inadvertently. Informative inscription shall be placed in close proximity to this device that will indicate its application and forbid its use by unauthorized personnel.

Such a device is not permitted for machinery specified in 5.2.1.

5.2.4 Starting of the machinery, which electric motors or switchgear require additional ventilation in normal operation, shall be possible only with ventilation in action.

5.3 SAFETY ISOLATION DEVICES

5.3.1 Control systems of mechanisms, which operation under certain conditions may endanger human or ships safety, shall be provided with pushbuttons or other safety isolation devices that will ensure disconnection of the electric drive from the power supply.

These push-buttons and/or other safety isolation devices shall be suitably protected against inadvertent actuation.

5.3.2 Push-buttons or other safety isolation devices shall be located near the control stations or in other places with a view to ensure safety of operation.

5.3.3 Electric drives of arrangements and machinery which require restriction of motion to prevent damage or break-down shall be provided with terminal switches to ensure reliable isolation of the electric motor.

5.4 SWITCHGEAR AND CONTROL GEAR

5.4.1 The switchgear in the circuits of electric drives, which in itself does not provide for short- circuit protection shall withstand the short-circuit current that may flow at the point of its installation during the time required for operation of a special protection device.

5.4.2 Starting of the engine shall be possible only from the zero position of the control gear.

5.4.3 A discharge protection device shall be provided for the control gear that permits isolation of the shunt-field windings.

5.4.4 For directly started alternating-current electric motors, the requirements of 3.1.2.2 and 16.8.3.3 shall be taken into consideration.

5.4.5 For each electric motor rated at 0.5 kW and more and its control gear, provision shall be made for fitting a device to isolate the power supply. If the control gear is mounted on the main switchboard or on any other switchboard in the same compartment and its visibility is ensured from the place of installation of the electric motor, then for this purpose it is permitted to use a switch mounted on the switchboard.

If the requirements in respect of location of machine control gear stated above are not met, the following shall be provided:

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

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

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

5.5 ELECTRIC DRIVES AND CONTROL OF STEERING GEAR

5.5.1 In addition to the requirements of 6.2, Part IX "Machinery" and 2.9, Part III "Equipment, Arrangements and Outfit", steering gear shall comply with the requirements of the present Part of the Rules.

5.5.2 Main electric or electro-hydraulic steering gear comprising one or more power units shall be supplied by two separate feeders laid directly from the main switchboard in two different runs (refer also to 16.8.4.12).

When the collecting busbars in the main switchboard are subdivided, each feeder shall be supplied from different sections (refer also to 4.3.2). One of these feeders may be supplied through the emergency switchboard.

In case the auxiliary electric or electro-hydraulic steering gear is provided according to 2.9, Part III "Equipment, Arrangements and Outfit", it may be supplied from the feeders of the main electric steering gear.

5.5.3 Each feeder shall be selected so as to supply all the electric motors, which are normally connected thereto and operate 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 feeders, such feeders shall be designed for operation under the most severe loads, and the change-over arrangement shall be installed in the steering gear compartment.

5.5.5 In case a steering gear power unit becomes inoperative, another unit required by 2.9.4, Part III "Equipment, Arrangements and Outfit" shall be actuated manually from

the bridge control station. Provision may be made for an additional automatic actuation of the power unit.

5.5.6 In every ship provided with steering gear according to 2.9.6, Part III "Equipment, Arrangements and Outfit" in the event of failure of the main source of electric power of the steering gear power unit provision shall be made for automatic connection within 45 s to the emergency source of electrical power or another independent source located in the steering gear compartment and intended only for this purpose.

For ships of 10000 gross tonnage and over the power of this source shall be sufficient for continuous supply of the steering gear, associated control system and rudder angle indicators within at least 30 min and for all other ships, within at least 10 min.

5.5.7 The operating conditions for the electric motors of the drives for the active means of the ship's steering shall conform to the conditions prescribed for the entire gear, but the motors shall at least satisfy the short-term operating conditions during not less than 30 min.

5.5.8 The electric or electrohydraulic drive of a steering gear shall ensure:

.1 putting the rudder from hard over to hard over within the time and angle stated in 6.2.2, Part IX "Machinery";

.2 putting the rudder continuously from hard over to hard over during 30 min for each set at the maximum service speed ahead corresponding to the draught at which the rudder is fully immersed (refer also to 2.9.2 and 2.9.3, Part III "Equipment, Arrangements and Outfit");

.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 for one minute from hot state (only for rudders fitted with the direct electric drive);

.5 sufficient strength of electric drive in the presence of mechanical forces arising at maximum speed astern.

It is recommended that a possibility shall be provided for putting the rudder over at the average speed astern.

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

5.5.10 The starting devices shall ensure automatic restarting of electric motors as soon as the voltage is restored after a discontinuity in power supply.

5.5.11 Visual and audible alarm shall be initiated on the navigation bridge in case of:

.1 power supply failure of each power unit and the control system;

.2 feedback control system failures including:

.2.1 short circuit, broken connections, earth faults in command and feedback loops;

.2.2 data communication errors, computer hardware and software failures (if programmable electronic systems are used);

.3 low oil level in any tank of the hydraulic system;

.4 hydraulic locking.

Besides, means shall be provided to indicate operation of electric motors of the steering gear power units.

5.5.12 Alternatively to alarm specified in 5.5.11.2, critical deviations between rudder order and reply may be indicated

visually and audibly as steering failure alarm on the navigation bridge. The following parameters shall be monitored:

.1 actual rudder position following the set value;

.2 rudder's actual position reaching set position within acceptable time limits;

.3 difference between the actual and set ruder position (refer to 2.9.15, Part III "Equipment, Arrangement and Outfit").

5.5.13 The following visual and audible alarm shall be provided at the main machinery control room:

.1 loss of voltage, phase break-off; supply voltage loss, phase interruption;

.2 power supply circuit overload of each power unit;

.3 low oil level in any tank of the hydraulic system.

Besides, means shall be provided to indicate operation of electric motors of the steering gear power units.

5.5.14 The steering gear control systems specified in 2.9.13 and 2.9.14, Part III "Equipment, Arrangements and Outfit" shall be supplied by separate feeders laid in different runs from the power circuits of the steering gear in the steering gear compartment or directly from the busbars of the switchboard serving these power circuits.

5.5.15 Steering gear compartment shall be provided with means enabling disconnection of any control system from its serviced steering drive, disconnection to be executed from bridge control station.

5.5.16 Each remote control system envisaged in paragraphs 2.9.14 and 2.9.15 of Part III "Equipment, arrangements and outfit" shall have its own independent circuit (including all electrical components) of signal transmission to the working units of the steering drive, and to have such an arrangement that failure of one remote control system will not lead to failure of the remaining systems.

Drives, contacts and components of control systems, which are installed in common switchboards or bridge control station panels, as well as circuits of common switch apparatus of control systems, shall be distanced from each other as much as possible or separated with fire-retardant bulkheads.

5.5.17 If there are several follow-up control systems, their amplifiers shall be separated both electrically and mechanically.

If there are both follow-up and non-follow-up control systems, amplifiers of a follow-up control system shall have separate protection devices. In this case, selective actuation of protections shall be ensured.

5.5.18 If additional control systems are envisaged, their electric circuits shall have breaking devices on all poles.

5.5.19 Feedback devices and position switches of steering electric drive control systems, which are connected to a rudderstock or a working unit of the rudder, shall be separated electrically and mechanically.

5.5.20 Any possible failure (loss of supply or fault in closed-circuit control systems) shall not lead to full loss of rudder control.

5.5.21 Direction of steer wheel turning or control device handle movement shall match with the direction of rudder blade putting.

Push-buttons of the button control system shall be positioned so that switching of the button provides the following: push-button on the right — provides rudder movement to the right;

push-button on the left — provides

rudder movement to the left.

5.6 ELECTRIC DRIVES OF ANCHOR AND MOORING MACHINERY

5.6.1 In addition to the requirements of paragraphs 6.3 and 6.4 of Part IX "Machinery", drives of anchor windlasses, vertical shaft windlasses and mooring winches shall meet the requirements of this Part of the Rules.

5.6.2 Electric drives of anchor and mooring machinery shall enable energized stall.

Duration of energized stall shall be limited by the time of overload or windings temperature protection actuation, but not more than 30 s for anchor machinery and not more than 15 s for mooring machinery.

5.6.3 At mooring-dedicated speed levels, vertical shaft windlasses and mooring winches shall be provided with protection against electric engine overload.

5.6.4 Supply of electric drives of anchor windlasses shall meet the requirements of paragraphs 4.3.1 and 4.3.3.

5.7 ELECTRIC DRIVES OF PUMPS

5.7.1 Electric engines of fuel and oil convey pumps and separators, as well as of organic coolant circulation pumps, shall be equipped with breaking devices installed in spaces other than spaces of these pumps and trunks of machinery spaces, but in close proximity to entrances of these spaces.

5.7.2 Electric engines of pumps, that suck liquids overboard through drain holes arranged above light load waterline in the sites of lifeboats or liferafts launching, shall be equipped with circuit breakers installed nearby control stations of drives of launching machinery of respective lifeboats or liferafts.

5.7.3 Electric engines of emergency fire pumps and deep-well bilge pumps shall have remote start devices installed above bulkhead deck (see paragraph 3.2.3.9 of Part VI "Fire Protection").

Remote start devices shall be provided with light alarm indicating that electric drive has switched on.

5.7.4 Breaking gear of electrical drives mentioned in paragraph 5.7.1 shall be located in visible places, enclosed with glass and provided with explaining notations.

Breaking devices shall deenergize supply feeders of these electric drives.

5.7.5 Local starting of fire and bilge pumps shall be possible even if their remote control circuits, including protection devices, are damaged.

5.7.6 Electrical engine of convey, discharge or disposal oily or sewage water pumps shall be provided with remote breaking apparatus installed in places of outlets location, if telephone or radio communication between discharge monitoring place and discharge pump control place is not envisaged.

5.8 ELECTRIC DRIVES OF FANS

5.8.1 Electric engines of fans which service machinery spaces shall have at least two breaking devices; one of them shall be installed in spaces other than these spaces and their trunks, but in close proximity to entrances of these rooms.

It is recommended to install these breaking devices in a common place with similar devices stated in paragraph 5.7.1.

5.8.2 Electric engines of fans installed in cargo holds and galleys shall be provided with breaking devices located in places which are easily accessible from the main deck, but beyond machinery rooms trunks.

Electric drives of galley stoves exhaust ventilation shall have a breaking device installed in the galley room directly, regardless of the quantity of breaking devices.

5.8.3 Electric engines of general ship ventilation shall have at least two remote breaking devices; one of them shall be installed in the wheelhouse, and the other device shall be accessible from the main deck.

Ships with low-power electric installation (other than passenger ships) may employ only one remote disconnecting device installed in the wheelhouse or in a place easily accessible from the main deck.

5.8.4 Electric engines of fans, which are located in spaces protected with the fire-smothering system, shall have a breaking device which is actuated automatically, when fire-smothering system switches on in this room.

5.8.5 Breaking devices of electric engines of fans specified in paragraphs 5.8.1, 5.8.2 and 5.8.3 shall be grouped on the ship so that all electric engines can be stopped from at most three places.

Breaking devices shall deenergize supply feeders of these electric engines of fans.

5.9 ELECTRIC DRIVES OF BOAT WINCHES

5.9.1 Electric drive of a boat winch shall meet the requirements of paragraph 6.20 of Part II "Live-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships.

5.9.2 Control elements of boat winch electric drive shall have self-restoring device, providing return to "stop" position.

5.9.3 A breaker of electric engine power circuit shall be directly nearby boat winch control station.

5.10 ELECTRIC DRIVES OF WATERTIGHT AND FIRE DOORS

5.10.1 Electric drives of fire retardant doors shall meet the requirements 7.12 of Part III "Equipment, arrangements and outfit".

5.10.2 Water-proof doors electric drives and alarm system indicating their position and closed status shall be supplied from main, emergency and transitional emergency power sources according to requirements of paragraphs 4.3.1, 9.3 and 19.1.2.

5.10.3 Electric equipment of watertight doors and associated elements shall be installed, if possible, above bulkhead deck, beyond dangerous areas and rooms.

5.10.4 If electric equipment is installed lower than bulkhead deck, its housing shall have following protection degrees:

.1 for electric engines and associated control elements — 1PX7;

.2 for sensors of door position indication and associated circuit elements — 1PX8;

.3 for elements of door movement sound alarm — 1PX6.

5.10.5 Power circuits, control, indication and warning alarm circuits shall be protected against damages so that if electric circuit or loop of one door is damaged, circuits or loops of other doors do not become damaged.

Short circuits or other damages in warning alarm or door position indication systems shall not cause damages in electric power circuit or control loop.

Design of devices shall exclude door opening due to water ingress to electric equipment installed lower than bulkhead

deck.

5.10.6 A closed sliding watertight door shall not open due to single failure in a power circuit or control loop of this door. Power supply shall be controlled on continuous basis in close proximity to each engine as per requirements of paragraph 7.12.5.7 of Part III "Equipment, Arrangements and Outfit".

Power loss in a power circuit or a control loop shall actuate sound and light alarm in the main machinery control room (MMCP) and on the bridge control station.

5.10.7 Electric drives of units that retain fire doors open (see paragraph 2.1.3.4 of Part VI "Fire Protection") shall:

.1 be supplied from main and emergency sources of electric power;

.2 be provided with remote control from wheelhouse, which allows closing of each door individually, groupwise or of all doors simultaneously;

.3 close all doors automatically and simultaneously in case of supply power loss;

.4 have such a design that any damage of closing device of one door does not disable supply and control systems of other doors.

5.10.8 On passenger ships of restricted navigation area **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS**, which are 24 m in length and longer, power required for operation of slider watertight electrically-driven doors shall be supplied from emergency switchboard, directly from or via a special switchboard located above the bulkhead deck.

Control, indication and alarm warning circuits shall be supplied from emergency switchboard, directly or via a special distributed board located above the bulkhead deck. If both main and emergency sources of electric power fail, automatic supply from a transient emergency source of electrical power shall be provided.

5.11 ELECTRIC DRIVES OF OIL BURNER UNITS OF BOILERS AND INCINERATORS

5.11.1 Electric drives of oil burner units of boilers and incinerators shall be provided with remote disconnecting devices located beyond rooms of said electric drives (see also paragraph 5.3.8 of Part X "Boilers, Heat Exchangers and Pressure Vessels" and paragraphs 4.3.6, 4.10.3.4 and 6.2.3 of Part XV "Automation").

5.11.2 If rooms, where incinerators and boilers are located, are protected with aerosol fire-extinguishing system, electric drives of burning installations of boilers and incinerators shall switch off once this system starts.

5.12 ELECTRIC DRIVES OF DEWATERING ARRANGEMENT OF FORWARD SPACES OF BULK CARRIERS

5.12.1 In addition to requirements of paragraphs 7.9.2 and 7.9.3 of Part VIII "Systems and Piping", electric drives of dewatering arrangements of forward spaces of bulk carriers shall comply with the requirements of this part.

5.12.2 On the bridge control station or in other post complying with requirements of paragraph 7.9.2 of Part VIII "Systems and Piping", indication of fully opened or fully closed valve position shall be envisaged.

5.12.3 Electric equipment of devices designed for bow rooms drying on bulk-carrying ships, when installed in such a room, shall have protection degree IPX8 or higher, in accordance with a pressure head test of 24 hours in duration, where water head is equal to the height of the room where electric equipment is installed.

6. LIGHTING

6.1 GENERAL REQUIREMENTS

6.1.1 All ship rooms, places and spaces, where lighting is important for navigation safety, machinery and devices control, living suitability and evacuation of passengers and crew, shall be equipped with fixed lighting fixtures of main lighting, which are supplied from the main electrical power source.

List of rooms, places and spaces, where lighting fixtures of emergency lighting shall be installed in addition to lighting fixtures of main lighting, is given in paragraphs 9.3.1.1 and 19.1.2.1.1.

6.1.2 Lighting fixtures, which are installed in rooms and spaces where mechanical damage of their housings is likely to occur, shall be provided with protective meshes.

6.1.3 Lighting fixtures shall be installed so that overheating of cables and adjacent materials is excluded.

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

6.1.5 Exterior lighting fixtures shall be installed in such a way that light interference does not constitute a hazard to navigation.

6.1.6 If rooms and spaces are lit with lighting fixtures employing discharge lamps, which do not ensure continuous lighting at voltage variations as per paragraph 2.1.3, they shall also be equipped with lighting fixtures employing incandescent lamps.

6.1.7 Battery compartments and other dangerous spaces shall be lit with lighting fixtures installed in safe adjacent rooms via impermeable glassed apertures, or with fire-proof lighting fixtures installed inside of these rooms (see also paragraph 2.9).

6.2 POWER SUPPLY OF MAIN LIGHTING ELECTRIC CIRCUITS

6.2.1 Main lighting switchboards shall be supplied via separate feeders. Main lighting boards may feed non-essential electric drives with power up to 0.25 kW and separate electric room heaters with rated current up to 10 A.

6.2.2 Protection devices of end branch lighting circuits shall be designed for rated current up to 16 A, total load current of consumers involves shall not exceed 80% of rated current of the protective device.

Number of illuminated points, which are supplied from end lighting loops, shall not exceed the value specified in Table 6.2.2.

Room fans and other household devices may be supplied from end lighting circuits.

Table 6.2.2

Voltage, V	Maximum number of illuminated points
Up to 50	10
From 51 to 120	14
From 121 to 250	24

6.2.3 Lighting of corridors, machinery rooms, shaft line tunnels, boiler water level indicators shall be supplied via at least two independent feeders with such allocation that, if one feeder fails, maximum possible of lighting fixtures uniformity is provided. These feeders shall be supplied from different group boards. If main switchboard employs subdivided lighting buses, these

group boards shall be fed by different bus sections.

For cargo ships with low-power electric installation, lighting of specified rooms (except of machinery rooms) may be supplied via one feeder from a group board or from a main switchboard directly.

6.2.4 Local lighting fixtures of accommodations, as well as socket outlets, shall be supplied from a lighting board via a separate feeder, other than the feeder supplying general ship lamps.

6.2.5 If a ship is divided into basic fire zones, lighting of each zone shall be supplied via two feeders, which are independent from feeders supplying lighting equipment of other fire zones.

If possible, lighting feeders shall be routed in such a way that fire in one zone does not cause damage to feeders that supply lighting equipment in other zones.

If main switchboard employs subdivided lighting buses, such feeders shall be supplied from different bus sections.

6.2.6 Main lighting shall be configured in such a way, that emergency lighting system does not fail in case of fire or other emergency situation in rooms, where main electric power sources and/or main lighting transformers (if available), main switchboard and main lighting board are installed.

6.2.7 Fixed lighting fixtures of holds lighting shall be supplied from a special switchboard. In addition to electric switch apparatus and protection devices, this board shall be equipped with light alarm on switching of particular lighting circuits on.

For ships with a low-power electric installation, lighting fixtures of holds lighting may be supplied from a switchboard located in the wheelhouse; in this case, light alarm is required to indicate voltage supply in the supply circuit of holds lamps.

6.3 EMERGENCY LIGHTING

6.3.1 During emergency lighting, illumination of separate rooms, places and spaces specified in paragraphs 9.3.1.1 i 19.1.2.1.1 shall be at least equal to 10% of general illumination under main lighting (see paragraph 6.7). In machinery room, illumination from lighting fixtures of emergency lighting may comprise 5% of illumination under main lighting, provided that socket outlets supplied from emergency lighting mains are envisaged.

Configuration of this lighting shall provide a clearly visible path from rooms to places of people evacuation (or illumination of at least 0.5 lux shall be provided).

6.3.2 In order to achieve required illumination as per paragraph 6.3.1, emergency lighting fixtures with incandescent lamps may be combined with luminescent lamps.

6.3.3 Main lighting fixtures may be used as emergency lighting fixtures, if they may also be supplied from emergency sources of electric power.

6.3.4 Emergency lighting network shall be arranged in such a way that may lighting system does not fail in case of fire or other emergency situation in rooms where emergency sources of electric power and/or emergency lighting transformers, emergency switchboard and emergency lighting boards are installed.

6.3.5 Emergency lighting may employ fixed lighting fixtures with embedded batteries and automatic charging from the main lighting network.

6.3.6 Each emergency lighting fixture and a luminaire of a combined lighting fixture (see paragraph 6.3.3) shall be marked

with red colour.

6.4 SWITCHES IN LIGHTING CIRCUITS

6.4.1 In all lighting circuits, double-pole switches shall be used.

In dry accomodations and service rooms, single-pole switches may be used in circuits, that switch off stand-alone lamps and lamp groups designed for rated current up to 6 A, as well as lighting fixtures which are designed for operation at safe voltage.

6.4.2 Fixed exterior lighting fixtures shall be provided with devices allowing centralized disconnection of all lighting fixtures from the wheelhouse or another continuously manned post on the weather deck.

6.4.3 Breakers of lighting loops of fire-fighting station rooms shall be installed outside of these rooms.

6.4.4 Lighting breakers behind free standing switchboards shall be installed next to each entrance to space behind the board.

6.4.5 Emergency lighting circuits shall not employ local breakers of lighting fixtures.

Local breakers may be used in loops of emergency lighting fixtures that operate as main lighting fixtures under normal conditions.

Emergency lighting of wheelhouse shall be fitted with a breaker.

Emergency lighting fixtures of rescue ships boarding areas, which operate as main lighting fixtures under normal conditions, shall switch on automatically in case of ship blackout.

6.5 GAS DISCHARGE LAMP INSTALLATIONS

6.5.1 Throttles and capacitors of gas discharge lamp installations shall be protected reliably with grounded metal casings.

6.5.2 Capacitors with capacitance of 0.5 mcF and more shall be provided with discharge devices. A discharge device shall be designed so that its voltage does not exceed 50 V in a 1 minute after the capacitor has been switched off.

6.5.3 Throttles and transformers with high inductive reactance shall be positioned as close to the associated lamp as possible.

6.5.4 Glow discharge lamp installations, which are supplied with voltage of 250 V and more, shall be provided with warning notations with voltage indication. All live parts of such lamp installations shall be protected.

6.6 SOCKET OUTLETS

6.6.1 Socket outlets for portable lighting equipment shall be installed at least in following places:

.1 on the deck near the windlass,

.2 in the gyrocompass room,

.3 in the space where radio station transducers are installed,

.4 in the steering gear compartment,

.5 in the space of emergency generator set,

.6 in machinery compartments,

.7 behind the main switchboard,

.8 in special electric space,

.9 in the propeller shaft tunnel,

.10 in the wheelhouse,

.11 in the radioroom,

.12 in the zone where winches are located,

.13 in the zone of log and depth-sounder enclosures,

.14 in the room of centralized air ventilation and conditioning installations.

6.6.2 Design of socket outlets supplied with different voltage shall exclude

connection of a plug meant for one voltage to a socket meant for another voltage.

6.6.3 If socket outlets for portable lighting equipment and other power consumers are installed on open decks, they shall be secured with plug connection turned down.

6.6.4 Socket outlets shall not be installed in machinery rooms below the decking level, in rooms of fuel and oil separators and in places requiring for equipment of an approved safety type.

6.7 ILLUMINATION

6.7.1 Illumination of separate spaces and zones shall be equal to or higher than values specified in Table 6.7.1. This requirement is not applied to ships where lighting is supplied with a voltage of 30 V or lower.

General illumination standards of Table 6.7.1 are specified for the level of 800 mm above room deck (decking), and total plus local illumination standards are given for the working surface level.

6.8 NAVIGATION LIGHTS

6.8.1 Navigation lights board shall supply top, side and poop lanterns via separate feeders. On tug, push-towing, fishing, boatswain ships, ships with limited manoeuvrability and air-cushion ships it shall also supply fixed lanterns, which are specified in Table 2.4.1 of Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships, and auxiliary top and poop lanterns, which are specified in Table 5.2.1 of Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships.

6.8.2 Navigation lights switchboard shall be supplied via two feeders:

.1 via one feeder from the main switchboard through the emergency switchboard;

.2 via another feeder from the nearest group switchboard which is not supplied from emergency switchboard.

Control devices of navigation lights may be installed into the console, which is located in the wheelhouse and is supplied as per paragraph 4.5.2.

On ships, where main electric power source is a battery and main switchboard is installed in the wheelhouse, navigation lights may be controlled from the main switchboard directly.

6.8.3 Navigation lights shall be connected to supply mains with a flexible cable and a plug connection.

If a ship is equipped with dual lanterns, they may be connected to the supply mains with a cable without a plug connection.

6.8.4 Supply circuit of navigation lights shall comprise a two-wire system; each circuit shall be provided with a two-pole switch, which is installed on the switchboard of navigation lights.

Table 6.7.1

Ser. No.	Places and surfaces	Illumination, lux			
		with luminescent lamps		with incandescent/LED lamps	
		general+ local	general	general+ local	general
1	Radio communication post:				

	at a set level above the deck	–	–	–	100
	work tables of a radio communication post	–	–	200	–
2	Navigation room:				
	at a set level above the deck	–	100	–	50
	navigation tables	150	–	150	–
3	Wheelhouse, at a set level above the deck	–	75	–	50
4	Machinery rooms, rooms of switchboards, manoeuvre and control stations and panels, rooms of automatic devices and gyrocompasses:				
	at a set level above the decking	–	75	–	75
	surfaces of switchboards and control panels	200	100	150	75
	places of main machinery control	150	100	150	75
	passages between boilers and machinery, stairs, platforms etc.	–	75	–	30
	boilers face	100	75	75	75
5	Battery storage room, at a set level above the deck	–	75	–	50
6	Shaft line tunnels, log and depth-sounder trunks, chain wells:				
	at a set level above the deck	–	50	–	20
	surfaces of shaft bearings, as well as connection flanges etc.	75	–	50	–
7	Passageways on decks, gangways and lifeboat and life- raft positions, at the predetermined level above the deck	–	50	–	20
8	Overboard spaces in way of lifeboat and liferafts launching near the load waterline	–	–	–	5

6.8.5 Each navigation light power supply circuit shall be provided with protection in both wires and with indication of the navigation light switching in compliance with the requirements of 4.1.4, Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships.

The indication device of the navigation light switching shall be so designed and installed that its failure does not cause the navigation light disconnection.

The voltage drop at the distribution board supplying navigation lights including the system of indicating the lights operation shall not exceed 5 per cent at rated voltage up to 30 V and 3 per cent at rated voltage above 30 V.

6.8.6 Independent of the navigation light switching indication referred to in 6.8.5, provision shall be made for visual and audible alarms operating automatically in case of failure of any navigation light with the switch in the "on" position.

Alarms shall be supplied from a source or feeder other than that used for power supply to navigation light switchboard or from an accumulator battery.

6.8.7 Lamp holders and lamps used in navigation lights shall comply with the requirements of 3.1.7, Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships.

6.9 LIGHTING AND ILLUMINATION MEANS OF HELIDECKS

6.9.1 General.

6.9.1.1 Lighting and illumination means of helidecks shall comply with applicable requirements of Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships.

6.9.1.2 The lighting and illumination means for helidecks shall at least provide for the following:

indication of the perimeter (boundaries) of the helideck;

illumination of the landing area;

indication of the elevated structures within the landing area.

6.9.1.3 Lights used for this purpose shall be protected to not lower than level IP56 and shall function reliably under environmental effects mentioned in Section 2.

6.9.1.4 All lighting and illumination means as well as other electrical equipment within helicopter refuelling stations and hangars shall be of certified safe type and designed to not lower than the temperature class T3 and subgroup IIA.

6.9.1.5 In respect to their lighting characteristics and arrangement, the lights shall meet the requirements of ICAO (International Civil Aviation Organization) which shall be confirmed by the appropriate conclusion or by a Certificate of the Civil Aviation competent body.

6.9.1.6 Lighting and illumination equipment specified in this Chapter shall be supplied from a separate switchboard, which is fed by the main and emergency sources of power supply, with automatic switching in case of power loss.

6.9.2 Perimeter indication lanterns.

6.9.2.1 Lighting and distinguishing circuit, which indicates the perimeter (boundaries) of a helideck, shall consist of green all-round lanterns (lights) installed along the perimeter of a helideck.

Lanterns (lights) shall be positioned at uniform intervals (up to 3 m) along the perimeter of a helideck.

6.9.2.2 For rectangular or square helicopter decks, a minimum number of lights installed on each side of the deck shall be at least 4, including lights installed in each corner.

6.9.2.3 The lights shall be divided into two independent circuits and supplied in such a manner that when the power to any one circuit fails, 50 per cent of lights to indicate the perimeter remain functioning**.**

6.9.2.4 After assembly, lantern housing shall not elevate above the landing site level by more than 250 mm.

6.9.3 Landing area lighting.

6.9.3.1 The landing area and wind direction indicator shall be properly illuminated. For this purpose, floodlights may be used.

6.9.3.2 Helideck floodlights shall be located so as to avoid glare to pilots during take-off, landing and manoeuvring.

Height of lighting equipment above the helicopter deck level shall not exceed 250 mm.

6.9.4 Obstruction/warning lights.

6.9.4.1 To provide flight safety, all considerably elevated structures and items such as superstructure components, drill and production strings, etc. shall be marked by special obstruction/warning red lights.

6.9.4.2 Structures and objects rising above the helideck by 15 m and more shall be marked with obstruction lights every other 10 m along their height, starting from

the topmost structure point.

6.9.4.3 All-round lanterns with power of at least 40 V each may be used as obstruction and warning lights.

6.9.4.4 Lights shall be divided into several independent circuits and supplied in such a manner that when power supply to one of the circuits fails, the basic part of the obstruction/warning lights remains functioning.

7. INTERNAL COMMUNICATION AND SIGNALLING

7.1 ELECTRIC ENGINE ROOM TELEGRAPHS

7.1.1 In addition to the requirements of the present Chapter, the engine room telegraphs shall meet the requirements of 3.3.1, Part VII "Machinery Installations".

7.1.2 Engine room telegraphs shall be provided with visual alarm on voltage availability in the power supply circuit and audible alarm on loss of voltage in the power supply circuit.

7.1.3 Engine room telegraphs installed in the wheelhouse shall be provided with an illuminated dial of regulated illumination.

7.1.4 Engine room telegraphs shall be fed from the main switchboard or from the navigation equipment switchboard.

If the ship is provided with the integrated bridge control console the engine room telegraph may be fed from this control console.

7.1.5 The engine room telegraph transmitter shall be so intailed in the wheelhouse that when orders are given out for ship's motion, the telegraph operating handle is shifted in the same direction with the ship.

Vertical position of the handle shall correspond to the "stop" order.

7.1.6 Where engine room telegraphs and devices for remote control of the main engines and the controllable pitch propellers are installed on sloping desks of control panels, the handle in the "stop" position shall be perpendicular to the panel surface and be fixed precisely in this position.

7.1.7 Where two and more engine room telegraphs are located in close proximity to one another (on one deck), they shall ensure the transmission of an order from any telegraph and the reception of order by all of them simultaneously, without additional changing-over.

Change-over to telegraphs located on another deck or in another part of the ship shall be effected with the use of switches fitted on the navigation bridge.

7.1.8 Each engine room telegraph shall be provided with an audible signal arrangement that will ensure the operation of an audible signal on the bridge and transmission of orders and reception thereof in the engine room.

In case of a wrong reply, the operation of the audible signal arrangement shall not stop (refer also to 3.3.1, Part VII "Machinery Installations").

7.2 INTERNAL SERVICE COMMUNICATION

7.2.1 The system of internal service communication (refer to the requirements below) shall provide a subscriber call and clear voice communication under the normal and emergency ship's operation conditions, as well as under specific noise conditions in places where the communication facilities are installed.

7.2.2 Sound-powered telephones, voice communication facilities, two-way loud-

speaking communication facilities, automatic telephone systems or mobile phones of a local network may be used in the system of internal service communication.

7.2.3 The system of internal service communication shall provide voice communication between the wheelhouse and main service spaces and stations. In this case the separate two-way voice communication may be omitted if the communication facility provides at any time the call priority and communications between the wheelhouse and the following main service spaces and stations:

.1 .main machinery control room;;

.2 local control stations of the main machinery and propellers (for this purpose the two-way telephone communication between the wheelhouse and the main machinery control room with telephones connected in parallel and fitted at local control stations may be used);

.3 radioroom (may be omitted where communication may be established without hardware);

.4 steering gear compartment;

.5 space containing the emergency switchboard;

.6 forecastle and poop stations;

.7 gyrocompass room;

.8 fire-smothering station (refer also to 3.1.3.2.6 of Part VI "Fire protection");

.9 space containing electric propulsion motors;

.10 cargo operations control station (in oil tankers);

.11 fire and rescue control station (in ships with distinguishing mark of provision with means for fire fighting aboard other ships in the class notation);

.12 other spaces where equipment ensuring ship's safe navigation is installed.

7.2.4 Provision shall be made for communications between the main machinery control room or local control stations of the main machinery and propellers and the engineers' accommodations.

7.2.5 For the communication facilities specified in 7.2.3 and 7.2.4, in addition to sound-powered telephones, provision shall be made for power supply from the main source of electrical power and accumulator battery actuated automatically in case of failure of the main source of electrical power with a capacity sufficient to supply the communication facilities during the time specified in 9.3.1.3 or 19.1.2.1.4.

7.2.6 The communication facilities between the wheelhouse and the main machinery control room or local control stations of the main machinery and propellers shall include an additional audible and visual alarm to indicate the call both in the main machinery control room and the engine room.

7.2.7 A damage to, or disconnection of one communication facility shall not interfere with the functioning of other communication facilities.

7.2.8 A two-way loudspeaker set may be either autonomous or connected with a command and broadcasting device, which is envisaged by Subchapter 11 of Part IV "Radio Equipment" of the Rules for the Equipment of Sea-Going Ships.

Loudspeaker system shall comply with the requirements of paragraphs 2.1.3, 2.1.4 and 6.22.2 of Part II "Live-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships.

7.3 SIGNALLING. GENERAL.

7.3.1 The requirements cover the following systems signalling the equipment

or ship's condition requiring attention of personnel or passengers, activating an audible and visual alarm:

.1 general alarm and fire alarm systems;

.2 fire detection and fire alarm system;

.3 release indication of fire smothering system;

.4 indication of closing of watertight and fire doors and also the doors indicated in 7.12;

.5 machinery alarm system;

.6 high level of bilge water alarm;

.7 cargo hold water level alarm on bulk carriers, passenger ships carrying 36 persons and more and single-hold cargo ships other than bulk carriers;

.8 engineer's alarm;

.9 personnel alarm, cargo control alarm and alarm of ultimate concentration of dangerously explosive and noxious gases;

.10 side port doors condition alarm;

.11 alarm on presence of people inside refrigerated holds: "Man in hold" alarm (for ships used for processing the living resources of the sea and not engaged in their catching); presence of people inside of refrigeration places or stowage compartments: "Man in room";

.12 sewage holding tanks level alarm;

.13 release indication of fixed local application fire extinguishing system;

.14 bulkhead shaft glands, bearing and pump case temperature alarm system;

.15 maximum permissible cargo temperature alarm system;

.16 overpressure or under pressure in the cargo tanks alarm system;

.17 high- and limit-level alarms in cargo tanks.

.18 high level alarm in the overflow tank of fuel inflow and transfer system;

.19 high level alarm in drainage tanks of fuel system and lubrication oil leakage system;

.20 low level alarm in a service tank of remote valve control system;

.21 gas fuel system signalling and control system;

.22 alarm of maximum permissible water level in drainage wells of cargo holds, which are provided with splash-permeable shields and are located above superstructure decking beyond zones 1 and 2 (see paragraph 7.6.13 of Part VIII "Systems and Piping");

.23 high level alarm of drainage wells of cargo pump rooms of oil tankers.

7.3.2 An opportunity to functionally test each alarm system shall be provided.

Unless otherwise stated, all alarm systems shall be designed on the fail safe principle with provision for power supply failure alarm, alarm on contact-to-frame fault or circuit break, as well as the possibility of checking visual and audible alarms operability.

7.3.3 Audible alarms shall be heard and distinguishable in all the spaces and areas they intended for.

7.3.4 Audible alarms of an alarm system shall be given until their acceptance (acknowledgement) is confirmed, and the visual indication of each separate alarm shall remain until the fault has been corrected.

7.3.5 The sound frequency of audible alarm devices, excepting a bell, shall be within the range of 200 Hz to 2500 Hz.

7.3.6 Where the visual alarm is applied, the colours specified in Table 4.6.5.1 shall be used unless otherwise stated.

7.3.7 The height of inscription text symbols for operating and alarm controls, unless they have been duplicated with symbols/a plate of an established pattern,

shall be at least 7 mm, the width is 0.7 symbol height.

This requirement, excepting the visual alarms mentioned in 7.3.1, also applies to the texts of inscriptions above the controls in switchboards, control consoles, starting, protection and control equipment for electric drives of essential machinery listed in 1.3.2.1.5.

7.3.8 The texts of inscriptions above operating and alarm controls not mentioned in 7.3.8, as well as the texts of watch-keeping and other instructions used for the description of a working procedure, starting and control of an object shall have symbols of at least 3.5 mm high, the width is 0.7 symbol height.

7.3.9 Flashing alarms shall emit light within 50 per cent of the entire work cycle, the pulse frequency therewith shall be within the range of 0.5 Hz to 1.5 Hz.

7.3.10 Receivers of emergency warning systems shall clearly differentiate operating, emergency, acknowledgement, failure conditions and mute mode.

After emergency or failure signal is corrected, the system shall return to normal operating conditions automatically.

7.4 GENERAL ALARM SYSTEM

7.4.1 Ships in which a general alarm given by voice or by any other means cannot be heard simultaneously in all locations where people may be, shall be fitted with electrical general alarm system that will ensure good audibility of signals in all such places.

In addition to the requirements stated above, the general alarm system shall meet the requirements of 2.3.1 and 6.22.1, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships.

7.4.2 Sound devices shall 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 of passenger ships;

.5 in working spaces.

7.4.3 General alarm system shall be supplied from the ship mains and the busbars of the emergency distribution board in conformity with 9.3.1.3 and 19.1.2.1.4.

General alarm system may be energized from the ship mains and from an independent accumulator battery if provision is made for an automatic changeover of general alarm circuits to the battery. In this case, no supply either from the emergency source or from an intermediate emergency source of electrical power is necessary.

7.4.4 The general alarm system shall be energized continuously, no matter if the accumulator battery is set in position for charging or discharging.

7.4.5 In case a separate accumulator battery is used for supply of the general alarm system, it may also energize other internal communication and signalling facilities if the battery capacity is sufficient for simultaneous supply of all consumers for at least 3 hours and also if these facilities are so designed that a damage to one circuit will not interfere with operation of other circuits provided no longer supply time is required for those facilities.

7.4.6 In circuits supplying the general alarm system the protection only from short circuit shall be provided. Protective devices shall be fitted in both conductors of the

feeder and also in circuits of each sound device.

Several sound devices may be protected with one common protection device, if rooms where they are installed provide for good audibility of other sound devices with independent protection.

7.4.7 General alarm sound devices shall be so located that a signal is clearly heard against the noise in the given space.

Sound devices installed in spaces with high intensity of noise shall be fitted with luminous indicators.

The sound of general alarm devices shall differ in tone from the sounds of all other kinds of signalling. With the exception of bells, audible alarms shall have a sound frequency between 200 Hz and 2500 Hz. Facilities may be provided for regulating the audible signal frequency within the above limits.

7.4.8 The general alarm system shall be actuated by means of a double-pole self-return switch.

If the general alarm signal is not heard from the wheelhouse or from the station where it has been given, a pilot lamp shall be fitted after the switch to indicate that the general alarm system is activated.

The switches shall be provided with the inscriptions indicating their purpose.

7.4.9 No switching devices shall be incorporated into the circuits of the general alarm system other than the switch specified in 7.4.8.

Where a power supply switch is installed on the general alarm system switchboard, provision shall be made for its interlocking in the "on" position or it shall be otherwise protected against access thereto of unauthorized persons.

It is permitted to use intermediate contactors controlled by the switch, but not more than one contactor in each loop.

7.4.10 Sound devices, switches and distribution devices of the general alarm system shall be provided with readily visible distinctive symbols.

7.4.11 The general alarm system shall consist of at least two loops controlled by one switch.

Short-circuit protection shall be provided at both poles of each loop of the general alarm system.

7.4.12 Sound devices connected to different loops of the general alarm system shall be fitted in large area spaces (machinery spaces, boiler rooms, fish-processing shops, etc.).

7.5 FIRE DETECTION AND FIRE ALARM SYSTEM

7.5.1 Fire detection and fire alarm systems used on ships shall be of the Register-approved type and, in addition to the requirements of the present Chapter, meet the requirements of 4.2.1, Part VI "Fire Protection" and of the Fire Safety Systems Code (refer to 1.2, Part VI "Fire Protection").

7.5.2 Application of fire detectors located in spaces where explosive vapours may accumulate or in a flow of air sucked out of these spaces is regulated by 2.9, 19.2 to 19.4.

7.5.3 There shall be not less than two sources of power supply for the electrical equipment used in the operation of the fixed fire detection and fire alarm system, one of which shall be an emergency source.

Power of electric supply source shall provide uninterruptible operation of the system with all automatic detectors that have been actuated (see also paragraph 7.5.11.4).

Electric power shall be supplied only via separate dedicated feeder. Such feeders shall be connected to an automatic switch installed nearby the station of fire detection system. Failure of such a switch or one of power sources shall not impair normal operation of a fixed fire detection and fire alarm system. On ships built on July 1, 2014, or later, design of the automatic switch shall exclude loss of supply from both power sources due to automatic switch failure.

If there is an evidence of short-term abnormal operation of a fixed fire detection and fire alarm system in the course of automatic supply switching, it is necessary to provide transient emergency source of electrical power which starts immediately in case of a blackout, with a capacity sufficient to provide supply as per paragraphs 9.3.7.3 or 19.1.2.7.3, depending on which clause is applicable. On ships built on July 1, 2014, or later, automatic switch actuation to failure of one of power sources shall not disable fire detection. If short-term power loss impairs system operation, a battery of sufficient capacity shall be provided to ensure uninterruptible system operation during switching.

Emergency power supply of a fixed fire detection and fire alarm system is provided by a battery or an emergency switchboard. If emergency power supply is provided by a battery, its capacity shall be sufficient to ensure operation of a fire detection and fire alarm system during the period required as per paragraphs 9.3.1.5 or 19.1.2.1.5, depending on which clause is applicable; after this period is over, the system shall be able to ensure operation of all connected sound and light fire alarm signals during at least 30 minutes.

In case of power supply from emergency switchboard, supply feeder shall be routed directly from this board to the automatic switch.

On ships built on July 1, 2014, or later, if the system is supplied by batteries, they shall be installed on the control panel of fire detection system or around it, or in another place which is suitable for use in emergency situation.

Battery charge unit shall be sufficiently large to ensure regular supply of fire detection system during battery recharging from fully discharged state.

On ships built on July 1, 2014, or later, which have cargo operations control station, an additional alarm panel shall be installed in the cargo operations control station.

7.5.4 Fire detection system with operation based on air sampling (see paragraph 4.2.1.6 of Part VI "Fire Protection") shall be supplied together with fans via separate feeders from the main electrical power source or another electrical power source, which is independent from the new source.

7.5.5 Panels of a fire detection and fire alarm system (except of the system stated in paragraph 7.5.4).

7.5.5.1 A panel of a fixed fire detection and fire alarm system shall have an appropriate design to provide the following:

.1 provide control over power sources and electric circuits required for system operation, in order to detect power losses and failures, including:

one damage of a supply circuit;

one short circuit of a current-carrying conductor to a metal element of the system;

one short circuit of two current-carrying conductors.

Failure condition shall initiate visual and sound signals on the control panel, which shall be different from fire signals;

.2 provide manual confirmation of all alarm signals and system failure signals.

Sound alarm devices may be switched off manually.

Devices that switch off local sound alarms are prohibited for use in living rooms;

.3 provide clear differentiation of the following system conditions: normal, fire alarm, confirmed fire alarm, system failure signal, mute sound signal;

.4 provide automatic return to normal operating condition after alarm or failure condition has been cleared.

7.5.5.2 A panel of a fire detection and fire alarm system shall have an appropriate design to ensure the following:

.1 any signal or damage in one circuits shall not impair normal operation of other circuits;

.2 fire evidence detection signal shall prevail over other signals received by the panel and enable determination of the room which has sent the fire detection signal;

.3 circuits of contact detectors of fire evidence detection alarm system shall perform breaking operation.

Closing contact detectors may be used, if their contacts are sealed, and their circuit is controlled for damages on a regular basis;

.4 there must be a possibility to control its operation.

7.5.6 Fire alarm system panel (applicable to fire detection system with operation based on air sampling and fixed fire detection alarm system) shall provide data stated in Table 7.5.6.

Visual signal of fire detection shall be arranged so that it consists of two indicators (two lamps or a double filament), or a special device shall be envisaged to control alarm lamps operability. Light signal colour shall be as per requirements of paragraph 4.6.5.

Visual signals shall be separated foe each type of information.

Signals that are used to determine location of a room or an area from where the impulse has been sent, may be common with a signal of fire evidence detection or failure.

Visual signals shall be active from the moment of impulse receipt to the moment of actuation cause clearance, while the signal stated in pt. 1 of Table 7.5.6 shall be active regardless of its supply type.

7.5.7 Fire detection and fire alarm system shall comply with following requirements:

.1 activation of any automatic or manual detector shall lead to visual and sound fire alarm occurrence on the control panel and alarm panels.

If these signals will not be acknowledged (confirmed) within 2 minutes, sound alarm shall be activated automatically in all crew living rooms, service rooms, control stations, as well as in machinery rooms of A category.

This sound alarm system is not required to constitute a part of fire detection alarm system.

.2 control panel shall be located:

.2.1 on passenger ships — in the ship safety centre;

.2.2 on cargo ships — on the bridge control station, or in the fire control station where continuous manning is envisaged or in the central fire control station, depending on which is applicable.

.3 alarm panel:

.3.1 on passenger ships — if used on passenger room balconies, it shall be able to

determine which automatic or manual detector has been activated (see paragraph 4.2.1.1.5 of Part VI "Fire Protection") — at least, it shall indicate the leg where automatic or manual detector has been activated. It shall be situated on the bridge control station.

Table 7.5.6

Ser. No.	Operation condition and failure alarm	Signal (if temperature fire detection alarm systems are used)	Signal (if air from protected rooms enters the receiving device of the alarm system used)
1	Device operation	Visual	Visual
2	Supply from an emergency power source	Visual	Visual
3	Fire evidence and location of a room or an area where fire evidence has been detected	Acoustic Visual	Acoustic Visual
4	No draft in the detection chamber	–	Visual Acoustic
5	No draft in pipelines	–	Visual Acoustic*
6	Disconnection in sensors circuit	Visual Acoustic	–
7	Location of sensor circuit damage	Visual	–
8	Detector circuit is off*	Visual	–
9	Main power loss	Visual Acoustic	Visual Acoustic

* Recommended

.3.2 on cargo ships — it shall at least indicate the leg where automatic or manual detector has been activated; if station control panel is located in the central fire post, one of alarm panels shall be situated on the bridge control station;

.4 clear information shall be provided on each alarm panel or nearby about rooms serviced by the panel and legs allocation.

7.5.8 Fire detection and fire alarm systems which allow remote determination of a originating room of the fire detection alarm shall be constructed in such a way to provide the following:

.1 a circuit shall not pass through the room more than once to exclude its damage in more than one point in case of fire.

If such routing is inevitable in rooms with large area, circuit parts which pass through the room twice shall be distanced from each other as much as possible;

.2 measures shall be provided to retain circuit operability in case of its damage (such as disconnection, short circuit, connection to ground). It means that, in case of circuit damage, only a part of the circuit becomes inoperable, similarly to the fire detection alarm system without remote determination of each detector location, where no more than one section becomes inoperable.

.3 fast recovery of a system operability shall be enabled in case of its electric or electronic elements failure, as well as

information garbling;

.4 activation of the first fire alarm shall not prevent activation of any other detector and issuing of subsequent alarm signals.

7.5.9 Detectors of a fire detection and fire alarm system, that contain ionizing radiation sources (radioactive isotopes) shall have a certificate confirming their radiological safety and issued by a competent body.

7.5.10 Detectors shall comply with following requirements:

.1 automatic detectors shall be activated by an impact of heat, smoke or other combustion products, flame or any other combination of this factors.

The Register may consider the use of automatic detectors which are activated by other factors indicating fire emergence, provided they are not less sensitive than detectors mentioned above.

Light detectors shall be used as a supplement of heat or smoke detectors only;

.2 smoke detectors installed as per paragraph 4.2.1.1 of Part VI "Fire Protection" shall be activated before smoke density reaches the value whereby light intensity is reduced by more than 12.5% per 1 m, but not before smoke density reaches the value whereby light intensity is reduced by more than 2% per 1 m.

Smoke detectors installed in machinery rooms of A category shall be activated when smoke density reaches the value whereby light intensity is reduced by no more than 50% per 1 m;

.3 heat detectors installed in rooms with standard air temperature shall be activated in the range of temperatures 54–78 °C, with temperature rising to this range at a rate of up to 1 °C per minute.

The Register may consider the use of heat detectors with faster temperature increase, provided they are not less sensitive than detectors mentioned above;

.4 activation temperature of heat detectors in drying rooms and similar rooms, where high air temperature is typical, may be set to 130 °C, and in saunas — up to 140 °C;

.5 heat detectors shall operate reliably at a temperature by at least 5 °C higher than set temperature of the sensing element;

.6 in machinery rooms of A category heat pulsation detectors may be used, which detect fire seat by evidence of temperature pulsation.

Detectors shall be set to temperature pulsation frequency from 1.9 to 2.3 Hz and higher, and be activated in case of amplitude excess by (2 ± 0.5) °C regardless of room temperature;

.7 type of automatic detectors shall enable successful operation tests and return to normal operation mode without replacement of any elements.

7.5.11 Detectors legs and their cables shall meet the requirements as follows:

.1 automatic and manual detectors shall be grouped into legs (sections);

.2 a leg of automatic fire detectors serving a control station, a living or service room, shall not serve machinery rooms of A category and cargo rooms of roll-on-roll-off ships (ro-ro ships).

If fire detection alarm systems enables remote determination of fire emergence location, then the circuit, which includes legs of automatic detectors in living and service rooms, shall not serve machinery rooms of A category and cargo rooms of roll-on-roll-off ships (ro-ro ships);

.3 any one leg may not serve more than one deck within living and service rooms and control stations, except of the leg serving the bulkhead of gangway stairs, if

the fixed fire detection and fire alarm system does not includes facilities of remote determination of a specific fire emergence place by each separate fire detector.

A number of enclosed rooms served by one leg shall not exceed 50.

If a fire detection and fire alarm system allows remote determination of a specific fire emergence place by each separate fire detector, legs may serve several decks and any number of rooms;

.4 it is not allowed to install more than 100 detectors on one leg;

.5 leg cables, including their supply cables which constitute a part of the system, shall be routed bypassing galleys, machinery rooms of category A and other enclosed rooms with high fire hazard, except of cases when fire detection or fire alarm must be provided in such rooms (see paragraph 16.8.1.8).

7.5.12 Fire detection and fire alarm system for unmanned machinery rooms of category A with periodic maintenance shall have an appropriate design, and automatic detectors shall be installed with appropriate allocation, to enable fast fire detection in any part of these rooms, under conditions of any normal operation modes of machinery and changes of ventilation mode.

It is not allowed to use systems which employ heat detectors only, except for rooms with limited height, where use of such systems is especially substantiated.

Fire detection and fire alarm system shall issue sound and light warning alarms, which are different from sound and light alarms of any other system without facilities of remote determination of a particular fire emergence location, in a sufficient number of places, so that they can be heard and seen from the bridge control station, as well as by a responsible engineer.

If manning on the bridge control station is not envisaged, sound alarm shall be announced on the place of continuous manning.

7.5.13 Fire detection and fire alarm system of machinery rooms without continuous manning, which is required as per paragraph 4.2.3 of Part VI "Fire Protection", shall meet requirements as follows:

.1 alarm panel shall be situated on the bridge control station, in the fire post or any other fire-protected accessible place of an machinery room of category A;

.2 light signal on the alarm panel shall indicated the place (zone) of fire emergence;

.3 the alarm system shall issue sound and light warning alarms, which are different from sound and light alarms of any other system without facilities of remote determination of a particular fire emergence location, in a sufficient number of places, so that they can be heard and seen from the bridge control station, as well as by a responsible engineer;

.4 in case of power loss or system damage, sound alarm shall be issued apart from visual alarm;

.5 type and location of detectors shall provide fast detection of fire evidence and exclude false operation under normal operation conditions of machinery room.

Detectors of at least two types, based on different fire detection principles, shall be envisaged. It is allowed to use only heat detectors in rooms of less than 2.5 m in height, which is a subject a special consideration by the Register.

.6 location of detectors legs shall enable detection of fire emergency location. Air motion caused by machinery shall not affect system operation efficiency;

.7 detectors with adjustable sensibility

shall have locking facilities and an indicator of set sensibility;

.8 if temporary disconnection of a particular detector or leg is expected, this state shall be clearly specified. After set time period expires, the particular disconnected detector or leg shall be switched on automatically;

.9 fire alarm activation from the following rooms shall be enabled:

.9.1 corridors that have entrances to machinery rooms of category A;

.9.2 wheelhouse;

.9.3 machinery room control station.

7.6 RELEASE INDICATION OF FIRE-SMOTHERING SYSTEM

7.6.1 The indication system shall meet the requirement of paragraph 4.3 of Part VI "Fire protection".

7.6.2 The indication system shall be supplied from ship mains and battery of a sufficient capacity to provide supply during 30 minutes.

In addition, a device shall be envisaged to provide automatic transfer of alarm system supply circuits to the battery in case of power loss in ship mains.

7.7 INDICATION OF CLOSING OF WATERTIGHT AND FIRE DOORS

7.7.1 Indication of closing of watertight and fire doors as per paragraphs 7.1.9, 7.1.11, 7.1.13, 7.4.1.7, 7.12.4, 7.12.5, 7.12.6 and 7.15 of Part III "Equipment, arrangements and outfit", shall meet requirement as follows:

1. Devices of visual indication of each door open and closed position shall be provided on the bridge control station and in control stations controlling water-proof doors closing/opening, as well as in close proximity to them.

2. Light and sound alarm system providing control over doors closing shall be envisaged.

3. Doors state indication and indication of closing of watertight and fire doors shall be supplied independently from sources supplying doors closing drives, and provided with standby supply from an emergency source (for example, uninterruptible power supply).

7.7.2 Indication of fire doors position as per paragraphs 2.2.3.3, 2.2.4 and 3.1.2.3 of Part VI "Fire Protection" shall meet the following requirements:

1. Bridge control station shall be equipped with visual indication facilities informing about closed state of each doors.

2. Remote-release slider doors, or power source driven doors shall be equipped with an emergency warning signalling system, which issues a sound signal during 5÷10 s from the moment when a door starts closing till the moment it is fully closed.

3. Doors state indication and doors release emergency warning signalling system shall be supplied independently from sources supplying doors closing drives, and provided with standby supply from an emergency source (for example, uninterruptible power supply).

7.8 SOUND SIGNALS IN ENGINEERS' ACCOMMODATION SPACES

7.8.1 Accommodation spaces of engineers shall be equipped with sound signal facilities providing emergency call of an engineer, which is actuated manually from the main engines control station in the engine compartment of from the central control station (if available).

7. 9 PERSONNEL ALARM

7.9.1 On ships with a one person on watch in the engine compartments, or with unmanned maintenance of engine

compartment, personnel alarm shall be provided. In this case:

.1 the system shall control operability of the engine compartment personnel each 30 minutes or more frequently;

.2 control signal shall be sent to machinery spaces.

If control signal will not be acknowledged within 3 minutes, a corresponding signal shall be sent to the bridge control station and to living, service and public spaces, where servicing personnel of the machinery plant can be situated;

.3 alarm system is switched on with servicing personnel of the machinery plant, if one person stays in the space, and is switched on when this person leaves the space;

.4 the system shall also comply with requirements of paragraph 2.4.1.14 of Part XV "Automation".

7.10 CARGO HOLD WATER LEVEL ALARM SYSTEM ON BULK CARRIERS, PASSENGER SHIPS CARRYING 36 PERSONS AND MORE AND SINGLE-HOLD CARGO SHIPS OTHER THAN BULK CARRIERS

7.10.1 Unless otherwise stated in this Subchapter, cargo hold water level alarm system on bulk carriers shall comply with the requirements of Subchapter 7.3 of this Chapter, as well as paragraph 3.4.11 of Part V "Subdivision" and paragraphs 7.6.16 and 7.9.9 (where applicable) of Part VIII "Systems and Piping".

7.10.2 Alarm system shall provide warning and emergency light and sound alarm informing of water penetration into cargo holds, and for ballast tanks and dry bulkheads from the bow to the collision bulkhead, emergency light and sound alarm only.

Warning alarm shall be activated when water reaches the low level, and emergency alarm shall be activated when water reaches the high level, levels specified in paragraphs 7.6.16 and 7.9.9 (where applicable) of Part VIII "Systems and Piping".

The same sensor for warning and emergency alarm issuing cam be used.

Inaccuracy of water level determination by sensors shall not exceed 100 mm.

Sound signals of warning and emergency alarm shall be different.

The system shall identify originating spaces of the signal clearly.

Sound signal cut off shall be provided from the alarm panel installed in the bridge control station.

7.10.3 Alarm system shall be supplied from the main and emergency power sources. Instead of the emergency power source, the system may be supplied by a separate battery, which is constantly being charged from the ship charger, meets the emergency source requirements and provides system supply during at least 18 hours.

Warning emergency alarm (WEA) shall be provided in case of main or emergency power loss or automatic transfer to emergency power supply.

7.10.4 System self-monitoring shall be provided. WEA signal shall be issued, at least, in case of following failures: short circuit, circuit disconnection, connection to housing. Computer systems shall be provided with additional alarms of program run time expiry, failure of a central processing units and input/output unit.

The system shall allow for sound and light alarm test.

7.10.5 The system shall provide alarm locking in case when cargo holds and forepeak are used as ballast tanks. In this case, if such ballast tanks are out of water, the lock shall be released automatically when water level drops below the level of undermost sensor in this hold.

7.10.6 Alarm system elements which are installed in cargo holds, ballast tanks and dry compartments shall be corrosion-resistant and have protection index at least equal to IP68, while elements installed on the open part of weather deck shall have protection index at least equal to IP56.

7.10.7 If system elements are installed in holds intended for dangerous goods, as well as other goods that may lead to explosive mixtures formation in the hold, such elements and their circuits shall have intrinsical-proof design and explosion protection level at least equal to (*Exi*).

7.11 ALARM OF ULTIMATE CONCENTRATION OF DANGEROUSLY EXPLOSIVE AND NOXIOUS GASES

7.11.1 Alarm of ultimate concentration of dangerous explosive and noxious gases shall meet the requirements of paragraphs 9.14.3, 9.14.4, 9.14.5 and 9.14.6 (where applicable) of Part VIII "Systems and Piping", paragraph 7.2.7 of Part XII "Refrigerating Plants".

7.11.2 Alarm of ultimate concentration of dangerous explosive and noxious gases shall provide sound and light signal in the cargo operations control station, on the bridge control station and nearby the analysis block, if hydrocarbon vapour concentration reaches a set value, which shall not exceed 30% of the lower flammability limit.

7.11.3 Alarm system shall be supplied by two power sources, one of them shall be an emergency power source.

A separate battery, which is constantly being charged from the ship charger and meets the emergency source requirements, may be used as emergency power source.

7.11.4 Alarm control panel shall be situated in the cargo operations control station, on the bridge control station or in the gas-proof central control station with continuous manning.

Clear information on emergency signal cause or system failures shall be provided on the panel or nearby.

7.11.5 The bridge control station shall be supplied with indication panel, if control panel is located in other place.

7.11.6 Control panel shall be provided with a manual device which returns alarm control system to normal operation after emergency or failure signal has been cleared.

7.11.7 Emergency signals on indication and control panels shall be different from failure signals.

7.11.8 Indication panels may have common emergency signal from reusable sampling points, if all sampling points are located in the same space.

7.11.9 Control panels shall enable manual control of sound and light alarm operability.

7.11.10 On the bridge control station, on the control panel and on each indication panel the following sound and light signals shall be provided:

.1 of ultimate gas concentration in each controlled space;

.2 of power loss or electric circuits connection to hull;

.3 of insufficient or absent air stream in each sampling pipeline;

.4 of unauthorized change of set emergency alarm value of maximum permissible gas concentration; or

.5 of failure of the self-monitoring function in computer alarm systems.

7.11.11 Self-monitoring function of commuter alarm system shall control power supply and availability of volatile memory each time when the device is put into operation, but at least each 24 operating hours.

7.11.12 Sound signals shall be sounded until reception confirmation (acknowledgement) returns, and visual indication of each signal shall be given until the fault is cleared.

7.11.13 Electric components of the system of explosive gases concentration detection, which can contact with gas samples during normal operation, shall have explosive-proof construction.

7.11.14 Testing and calibration of explosive gas detecting equipment shall be enabled.

7.12 INDICATION OF DOOR POSITION IN RO-RO PASSENGER SHIPS AND RO-RO CARGO SHIPS

7.12.1 Control bridge station and doors closing/opening control posts shall be provided with light and sound signalling facilities informing of closed and separately of fully battened state of doors stated in paragraphs 7.4 and 7.15 of Part III "Equipment, Arrangements and Outfit" (external bow doors of Visor type, folding doors, inner bow doors, side and aftermost doors).

Hereinafter in this Section — doors.

Indication panel shall provide control of light indicators operability and exclude their accidental or unauthorized switching off.

Indication panel shall provide control of light indicators operability and exclude their accidental or unauthorized switching off.

7.12.2 Indicator system shall be designed on the fail safe principle and provide for the following:

.1 indication panels installed on the bridge control station and in doors closing/opening control stations shall be provided with:

system power loss alarm;

disconnection or connection to hull alarm;

light indicators operability control;

separated indication of: closed, non-closed, battened and non-battened door status;

.2 circuits of door position switches (sensors) shall be closed when doors are closed (if several sensors are installed on one door, they may be connected in series);

.3 circuits of position switches (sensors) of battening devices (securing devices) shall be closed when doors are battened (if several sensor are installed on one door, they may be connected in series);

.4 indication circuits "door closed/non-closed" and "door battened/non-battened" shall be independent, but may be routed inside of a one bundled cable;

.5 if position of any position switch (door position sensor) changes, signals shall be actuated: "door non-closed/non-battened", "securing device not locked".

7.12.3 The system shall issue light and sound alarm in the following cases:

.1 if doors are not fully closed or non fully battened, or

.2 at least one battening or closing device is opened.

7.12.4 Indication panel installed on the bridge control station shall be equipped with an operation mode switch "port/sea", and shall sound a sound signal in its installation place, if doors will be not closed or non battened during port exit.

7.12.5 Indication system shall be supplied independently from supply of door closing and battening drives, and provided with standby supply from an emergency source or another reliable source (for example, uninterruptible power supply).

Indication system sensors shall have reliable protection against water impact, icing and mechanical damages, or have an appropriate design allowing impact of these factors.

7.12.6 Passenger roll-on-roll-off ships shall be equipped, apart from door status indication system, with facilities of television monitoring and control of water leakages. These facilities shall be equipped with sound alarm system which is designed so that television control of any leakages through inner, side and aftermost doors is provided on the bridge control station and in the main machinery control room.

For cargo roll-on-roll-off ships, television control of water leakage through side and aftermost doors may be provided from the bridge control station only.

7.12.7 In order to control status of bow and inner bow doors and their securing devices, television monitoring facilities shall be provided, with video signal connected to monitors installed on the bridge control station and the MMCP/CPCP (central post control panel). In this case, monitored objects shall be well-lit and painted with contrast colours.

7.12.8 Outboard water leakage collection system (drainage wells) shall be provided between bow door and ramp, and if the latter does not exist, between bow and inner doors. In this case, a signal shall be actuated on the bridge control station when there is high water level in the well of leakage collection system, or when water level in this space reaches 0.5 m, depending on the design type.

7.12.9 On internationally cruising passenger roll-on-roll-off ships, special category spaces and cargo spaces as per paragraphs 1.5.4.3 and 1.5.9 of Part VI "Fire protection" (if continuous manning or other efficient control methods are not available) shall be controlled with television facilities, so that movements of wheeled vehicles in the sea under poor weather conditions or unauthorized access of passengers into these spaces can be detected while the ship is underway.

7.13 RELEASE INDICATION OF FIXED LOCAL APPLICATION FIRE EXTINGUISHING SYSTEM

7.13.1 The system of warning release indication of fixed local application fire extinguishing system shall meet the requirements of paragraph 3.1.2 of Part VI "Fire Protection".

7.13.2 The system shall provide light and sound signalling informing of the system start both in the protected space and in posts with continuous manning. If there are several system, the signalling shall clearly indicate which particular system has been actuated.

7.13.3 No electronic or electric equipment shall be installed in the protected area and the adjacent area. If such equipment must be installed in such areas to provide safe operation of protected objects, protection index of electric equipment shall be at least equal to IP44.

7.13.4 When installing electric equipment in areas that are adjacent to the protected area but are not directly affected by the system, lower protection indexes may be allowed upon the agreement with the Register, provided that appropriate actions on electric equipment protection are taken (installation of additional coverings and exhaust ventilation filters, protective shields etc.).

7.13.5 The indication system shall be supplied from two sources of electric power, one of them being an emergency source.

A separate battery, which is constantly being charged from the ship charger, meets the emergency source requirements and provides system supply during at least 18 hours, may be used as the emergency source.

7.14 TELEVISION SURVEILLANCE AND INDICATION SYSTEMS

7.14.1 Television surveillance and indication system (TSI system) shall comply with requirements of paragraphs 7.12.6, 7.12.7, 7.12.9 of this Part and of paragraph 7.15.5 of Part III "Equipment, arrangements and outfit".

7.14.2 Generally, television surveillance and indication systems shall include:

.1 television cameras (TC);

.2 video monitors (VM);

.3 video signals control and routing devices;

.4 movement detection device;

.5 video recording device.

7.14.3 TSI system shall provide transmission of visual information on condition of controlled areas and spaces to posts with continuous manning. In addition, TSI system shall issue light and sound signalling informing on change of controlled object/space condition.

7.14.4 TMA system shall provide warning emergency signals as follows:

.1 main power loss;

.2 TSI failure;

.3 failure (short circuit, disconnection) of a "television camera-monitor" channel;

.4 television camera(s) failure;

.5 failure of a movement detection device;

.6 failure of a video recording device.

7.14.5 TSI systems may display in monochrome or in full colour. Installation of a certain type system depends in required TSI informative capacity, controlled object characteristics (location, illumination and other properties) and possible targets (a person, cargo, water and other targets).

7.14.6 In order to minimize noise on monitor display, TSI systems must use television cameras with transmitted signal parameter at least 50 dB (at the ratio "signal/noise" (S/N)).

7.14.7 Resolution of camera lens shall be at least 480 TVL (for colour image) or at least 570 TVL (for monochrome image).

7.14.8 Protection index of TC used in TMA systems, depending on their location, shall be at least:

.1 IP22 — interior service spaces;

.2 IP44 — machinery spaces;

.3 IP56 — roll-on decks and open area of weather deck.

7.14.9 TC must be installed so that "blind spots" are overlapped.

7.14.10 Place of TC installation in interior spaces shall have minimum temperature differential, in order to minimize water condensation on lenses of camera objectives.

7.14.11 TC installed in open areas of weather decks shall be covered with heat-insulated enclosures, which are equipped

with sun hoods.

7.14.12 During night time, if illumination of the controlled area is lower than TC sensibility, the object (object zone), shall be provided with additional visible and infrared illumination. In this case, camera objectives shall not be flashed with lighting lamps, otherwise TC with background light compensation (BLC) shall be used. When using full colour TMA systems, infrared lighting is not allowed.

7.14.13 Information transmitted from TC shall be displayed by special monitors that endure long-term operation 24 hours a day with a static image. For a multiimage display, diagonal axis of a monitor shall be within 15–21″ with resolution at least equal to 800 TVL for a monochrome image (400 TVL for a full-colour image), and for full-screen display, diagonal axis shall be within 10–14″ with resolution at least equal to 600 TBL for a monochrome image (300 TVL for a full-colour image).

7.14.14 Television images shall be recorded with special video recorders (SVR) with prolonged recording time, or with digital information storages.

7.14.15 SVR recording time shall not exceed 24 hours per a 3-hour video cassette. SVR with longer recording time may only be used if its automatic transfer to real-time recording mode is possible. in case movement sensor alarm becomes activated.

7.14.16 Control and routing devices shall provide automatic priority displaying of indication originating areas on monitors.

7.15 SEWAGE HOLDING TANKS LEVEL ALARM

7.15.1 Sewage holding tanks level alarm shall meet the requirements of Part III "Requirements to Ship Equipment and Devices on Sewage Water Pollution Prevention" of the Rules for Prevention of Pollution by Ships.

7.15.2 Alarm system shall be supplied from the main source of electrical power.

7.15.3 The alarm system shall provide sound and light alarm in posts with continuous manning when the tank is 80 per cent filled.

7.16 BULKHEAD SHAFT-GLAND, BEARING AND PUMP CASE TEMPERATURE EXCESS ALARM

7.16.1 Bulkhead shaft-gland, bearing and pump case temperature excess alarm shall meet the requirements of paragraph 4.2.5 of Part VII "Machinery Installations".

7.16.2 Alarm system shall be supplied from the main source of electrical power.

7.16.3 Warning emergency alarm signals shall be sent to cargo operations control station or pump control station.

7.17 MAXIMUM PERMISSIBLE CARGO TEMPERATURE EXCESS ALARM

7.17.1 Maximum permissible cargo temperature excess alarm shall meet the requirements of paragraph 9.6.6 of Part VIII "Systems and Piping".

7.17.2 Alarm system shall be supplied from the main source of electrical power.

7.17.3 The alarm system shall provide sound and light alarm in posts with continuous manning.

7.18 OVERPRESSURE OR UNDERPRESSURE IN THE CARGO TANKS ALARM SYSTEM

7.18.1 Overpressure or underpressure in the cargo tanks alarm system shall comply with the requirements of paragraph 9.7.12 of Part VIII "Systems and Piping".

7.18.2 Alarm system shall be supplied from the main source of electrical power.

7.18.3 The alarm system shall provide sound and light alarm in posts with continuous manning.

7.19 HIGH- AND LIMIT-LEVEL ALARMS IN CARGO TANKS

7.19.1 High- and limit-level alarms in cargo tanks shall meet the requirements of paragraph 9.11.5 of Part VIII "Systems and Piping".

7.19.2 Alarm system shall be supplied from the main source of electrical power.

7.19.3 The alarm system shall provide sound and light alarm in posts with continuous manning when tanks are 95 per cent and 98 per cent filled respectively.

7.20 ALARM SYSTEM INFORMING OF HIGH LEVEL IN OVERFLOW TANK OF FUEL INFLOW AND TRANSFER SYSTEM

7.20.1 Alarm system informing of high level in overflow tank of fuel inflow and transfer system shall meet the requirements of paragraph 10.3.2 of Part VIII "Systems and Piping".

7.20.2 Alarm system shall be supplied from the main source of electrical power.

7.20.3 The alarm system shall provide sound and light alarm in posts with continuous manning when the tank is 75 per cent filled.

7.21 ALARM SYSTEM INFORMING OF HIGH LEVEL IN ship FUEL SYSTEM DRAINAGE TANK AND/OR LUBRICATION OIL LEAKAGE COLLECTION TANK

7.21.1 Alarm system informing of high level in ship fuel system drainage tank and/or lubrication oil leakage collection tank shall meet the requirements of paragraphs 13.5.4 and 14.6 respectively of Part VIII "Systems and Piping".

7.21.2 Alarm system shall be supplied from the main source of electrical power.

7.21.3 The alarm system shall provide sound and light alarm in posts with continuous manning when the tank is 85 per cent filled.

7.22 ALARM SYSTEM INFORMING OF PEOPLE PRESENCE INSIDE OF COOLED ROOMS, STOWAGES AND HOLDS

7.22.1 Alarm system informing of people presence inside of cooled rooms, stowages and a hold: "A person in a stowage/hold" shall meet the requirements of paragraph 19.10.7 of this Chapter and paragraph 3.3.12 of Part XII "Refrigeration plants".

7.22.2 Alarm system shall be supplied from the main source of electrical power.

7.22.3 The alarm system shall provide sound and light alarm in posts with continuous manning.

7.23 ALARM AND CONTROL SYSTEM OF GAS FUEL SYSTEM

7.23.1 Pressure and temperature control.

7.23.1.1 Each gas fuel storage tank shall be equipped with devices enabling remote control from the bridge control station and local control of fuel pressure and temperature.

Allowable operation pressure range shall be indicated on the devices.

Emergency alarm system shall be provided to inform of maximum and minimum (if tank design required for vacuum protection) pressure level in the fuel tank. This alarm shall be actuated before safety valves are actuated.

7.23.1.2 Inflow gas fuel pipeline shall be equipped with a pressure control device

installed between the inflow valve and land connection.

7.23.1.3 Pressure control devices shall be installed on a feeding gas fuel pipeline after the pump and on an inflow gas fuel pipeline after the inflow valve.

7.23.1.4 A space where liquefied gas fuel tanks are stored shall be provided with level and temperature sensors installed in a drainage well.

Main gas valve of the tank shall close automatically due to temperature sensor activation.

Maximum level sensor shall activate alarm system.

7.23.1.5 Fuel tanks for liquefied gas fuel storage shall be equipped with level indicating sensors.

7.23.2 Prevention of gas fuel tanks overflow.

7.23.2.1 Each liquefied gas tank shall be equipped with overflow prevention facilities which meet the requirements for cargo tanks of gas-carrying ships presented in Subchapter 3.1 of Part VIII "Control and Measurement Instrumentation" of Rules for Classification and Construction of Liquified Gases Bulk Carriers.

Overflow prevention facilities shall be independent from level control facilities stated in paragraph 7.23.1.4.

7.23.2.2 Each compressed gas fuel ship shall be equipped with facilities which prevent pressure rising over design value during fuel inflow and send and alarm when pressure reaches 95% of the design pressure.

7.23.3 Gas contamination control in spaces.

7.23.3.1 All closed gas-dangerous spaces shall be equipped with an efficient system of gas detection in places of its possible accumulation and leakages.

Number of sensors in each space is considered specially in each case with regard to space size and layout.

Requirements shall be met as follows: of paragraphs 12.14.3, 12.14.10, 12.14.13 and paragraph 13.12.13 of Part VIII "Systems and Piping" (where applicable)**.**

If gas concentration in a controlled space reaches 20% of the lower combustibility limit, light and sound alarm shall be activated on the bridge control station. For ventilation ducts with gas fuel pipelines routed, alarm shall be activated when gas concentration reached 30% of the lower combustibility limit.

If gas concentration reached 40% of the lower combustibility limit, measures shall be taken automatically to stop gas fuel inflow into the space. These measures shall at least include measures specified in Table 7.23.3.4.

7.23.3.2 Gas-dangerous machinery spaces require for two independent control systems controlling gas inflow into an machinery space.

7.23.3.3 Gas-safe machinery spaces shall be equipped with sensors (at least two) of a gas inflow control system, which issue an alarm when gas concentration reached 30% of the lower combustibility limit.

7.23.3.4 If gas leakages are detected or failure has occurred, safety system shall automatically perform control actions specified in Table 7.23.3.4

Table 7.23.3.4

Controlled parameter	WEA	Automatic automatic closing	
1	2	3	
Gas detection in the space where	X		

gas fuel tanks are stored with concentration more than 20% of LCL[2]				an ventilation duct inside of a gas consuming engine compartment with concentration more than 40% of LCL			
Gas detection by two sensors[3] in the space where gas fuel tanks are stored with concentration more than 40% of LCL	X	X		Gas detection in a gas consuming engine compartment with concentration more than 20% of LCL	X		
Fire detection in the space where gas fuel tanks are stored	X	X		Gas detection by one of two sensors3 in a gas consuming engine compartment with concentration more than 40% of LCL	X		
High level in a drainage well of the space where gas fuel tanks are stored	X						

Table 7.23.3.4 continuation

1	2	3	4	5		
Low temperature in a drainage well of the space where gas fuel tanks are stored	X	X		Ventilation interruption in a ventilation duct between gas fuel tank and gas consuming engine compartment[8]	X	
Gas detection in an ventilation duct between gas fuel tank and gas consuming engine compartment with concentration more than 20% of LCL	X			Ventilation interruption in an ventilation duct inside of a gas consuming engine compartment8	X	
Gas detection by two sensors3 in an ventilation duct between gas fuel tank and gas consuming engine compartment with concentration more than 40% of LCL	X	X[4]				
Gas detection in a gas compressors space with concentration more than 20% of LCL	X					
Gas detection by one of two sensors3 in a gas compressors space with concentration more than 40% of LCL	X	X[4]				
Gas detection in an ventilation duct inside of a gas consuming engine compartment with concentration more than 30% of LCL	X					
Gas detection by two sensors3 in	X					

End of Table 7.23.3.4

1	2	3	4	5
Ventilation interruption in a gas consuming engine compartment	X		X	Only for gas-dangerous engine compartments protection
Fire detection in a gas consuming engine compartment f gas	X		X	
Abnormal gas or pressure in a gas fuel pipe	X		X[6]	a uble
Valves control system f gas	X		X[7]	Time delay if necessary

fault				
Automatic engine stop (engine fault)	X		X [7]	
Emergency engine stall (manual or by operator)	X		X	

[1] FTMV — fuel tank main valve

[2] LCL — lower combustibility limit

[3] Two independent gas sensors which are installed close to each other are required due to reliability considerations. If gas sensors are self-monitoring, one-sensor installation are allowed.

[4] If gas fuel tank supplies more than one engine, and fuel is supplied to each engine via a separate pipe laid in a separate vent with a separate main gas valve beyond the vent, then only main gas valve, which leads to the channel where gas leakage has been detected or ventilation has interrupted, shall be closed.

[5] If gas fuel is supplied to more than one engine, and gas is supplied to each engine via a separate pipe laid in a separate vent with a separate main gas valve beyond the vent and beyond the gas consuming engine compartment, then only main gas valve, which leads to the channel where gas leakage has been detected or ventilation has interrupted, shall be closed.

[6] This parameter shall not lead to cutoff of gas supply to single fuel gas engines, and is applicable only to dual fuel engines.

[7] Only for activation of 3 valves specified in paragraph 13.12.5 of Part VIII "Systems and Piping".

[8] If the vent is protected with inert gas (see paragraph 13.12.2 of Part VIII "Systems and Piping"), inert gas pressure drop shall result in the same actions as ones specified here.

7.24 ALARM SYSTEM INFORMING OF LOW LEVEL IN SERVICE TANKS OF REMOTE VALVES CONTROL HYDRAULIC SYSTEM

7.24.1 Alarm system informing of low level in service tanks of remote valves control hydraulic system shall meet the requirements of paragraph 4.1.1.5 of Part VIII "Systems and Piping".

7.24.2 Alarm system shall be supplied from the main source of electrical power.

7.24.3 The alarm system shall provide sound and light alarm in posts with continuous manning when low level in tanks reaches 25 per cent or according to the requirements of a particular system.

7.25 ALARM SYSTEM INFORMING OF MAXIMUM ALLOWABLE LEVEL IN DRANAGE WELLS OF CARGO HOLDS WITH SPLASH-PERMEABLE SHIELDS

7.25.1 Alarm system informing of maximum allowable level in drainage wells of cargo holds with splash-permeable shields located above superstructure decking beyond zones 1 and 2 (see paragraph 7.6.13 of Part VIII "Systems and Piping").

7.25.2 Alarm system shall be supplied from the main source of electrical power.

7.25.3 The alarm system shall provide sound and light alarm in posts with continuous manning when maximum permissible water level in drainage wells is reached or according to the requirements of a particular system.

7.26 ALARM SYSTEM INFORMING OF MAXIMUM ALLOWABLE LEVEL IN DRANAGE WELLS OF

CARGO PUMPS ROOMS ON OIL TANKERS

7.26.1 Alarm system informing of maximum allowable level in drainage wells of cargo pump rooms on oil tankers shall meet the requirements of paragraph 7.7.1 of Part VIII "Systems and Piping".

7.26.2 Alarm system shall be supplied from the main source of electrical power.

7.26.3 The alarm system shall provide sound and light alarm in the cargo operation control station and on the bridge control station.

8. PROTECTIVE DEVICES

8.1 GENERAL.

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

No overload protection is required for the switchboard power supply if the current consumers supplied from this switchboard have individual protective devices, and the power supply cable is selected on the basis of maximum working current.

8.1.2 Protective devices shall be so adapted to the characteristics of the equipment under protection that they operate under inadmissible overloads and short-circuit currents.

8.1.3 The electric protection system shall be discriminative with regard to both the overload currents and the short-circuit currents. Such protection system shall be designed so that its operation could not adversely affect the reliable functioning of ship's generating plant and the power supply of essential consumers.

Short-circuit and overload protective devices shall not operate at starting currents of the electrical equipment under protection.

8.1.4 Overload protection shall be provided in:

.1 at least one phase or positive pole in a two-wire system;

.2 at least two phases in an insulated three-wire three-phase current system;

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

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

Short-circuit current protective devices shall be set to operate at not less than 200 per cent of the rated current of the electrical equipment under protection. Operation of the protective devices may be without time delay or with a time delay necessary for the proper discrimination.

The short-circuit current protective device may be used for the protection of both the electrical equipment itself and its supply cable.

8.1.6 Where cables of reduced cross-sectional area are used in some lengths of power supply circuit, additional protection shall be provided for each of such cables unless the preceding protective device is capable of protecting the cable of reduced cross-sectional area.

8.1.7 Protective devices excluding the possibility of immediate repeated switching after operation of the protection shall not be used in supply circuits of the emergency switchboard, as well as in supply circuits of emergency consumers.

8.1.8 The design of the electronic and computer protection devices of generators and major services shall be such as to ensure

easy identification and regulation of their operational settings.

Protection devices shall be equipped with the necessary apparatuses and instruction manuals shall be provided for checking their serviceability and the condition of the settings.

The protection devices of generators and important major services shall be tested once in 5 years to confirm the accuracy of their operation.

8.2 PROTECTION OF GENERATORS

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

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

.1 against overloads,

.2 against short circuits,

.3 against reverse current or reverse power,

.4 against under voltage.

It is necessary that the devices used for generator overload protection shall be provided with light and sound alarms to operate with a time delay of up to 15 min at the loads from 100 to 110 per cent of the rated current, and shall be capable of disconnecting the generator under protection after a time delay to suit the generator thermal time constant at the loads from 110 to 150 per cent of the rated current.

It is necessary that for a setting of the protection to operate at 150 per cent of the rated generator current the time delay shall not exceed 2 min for an alternating-current generator and 15 s for a direct- current generator. An overload exceeding 150 per cent of the rated current may be allowed where it is required by operating conditions and is admitted by the generator construction.

Overload protection settings and time delay shall be selected to suit 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 shall not prevent the possibility of re-starting the generator immediately.

8.2.3 Automatic and selective disconnect of non-essential services shall be provided in the event of the generator overload. These services shedding may be carried out in one or several steps, depending on the generator overload capacity.

Therewith:

.1 the automatic disconnect is not allowed for primary essential services;

.2 the automatic disconnect is allowed for secondary essential services, provided disconnection will not prevent services required for safety being immediately available when the power supply is restored to normal operating conditions;

.3 the automatic disconnect is allowed for services needed for maintaining the minimum comfort habitability conditions for the crew and passengers on the ship.

Examples of such services are as follows:

.3.1 cooking equipment;

.3.2 heating equipment;

.3.3 domestic refrigeration plant;

.3.4 domestic ventilation drives;

.3.5 sanitary and fresh water, etc.

Upon agreement with the Register, this

requirement may be dispensed with in the case of electrical installations of low power.

8.2.4 Reverse-current and reverse-power protection of generators intended for parallel operation shall be selected to suit characteristics of generator prime mover. The respective protection settings shall be in accordance with those specified in Table 8.2.4.

Table 8.2.4

Current type	Settings of reverse-current or reverse-power protection, depending on type of generator prime mover	
	Turbine	Internal combustion engine
Alternating	2–6% of rated power of the generator, kW	8-15% of rated power of the generator, kW
Direct	2–6% of rated current of the generator, A	8–15% of rated current of the generator, A

With settings specified in the Table the protection of the types in question shall be activated in 10 s.

Reverse-current protection for direct-current generators shall be installed in the pole opposite to that, in which the equalizer lead is connected. Reverse-power or reverse-current protection shall still 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-current and reverse-power protection shall permit transfer of power fed from the ship's mains (as, for example, from cargo winches).

8.2.5 Undervoltage protection shall ensure the possibility of a reliable connection of generators to the busbars at a voltage of 85 per cent or more of rated voltage and shall exclude the possibility of generator-to-busbar connection at a voltage less than 35 per cent of rated voltage. Besides, it shall disconnect the generators in case of reduction of voltage across its terminals in the range from 70 to 35 per cent of the rated value.

Undervoltage protection shall disconnect generators from busbars with a time delay in case of voltage reduction, and ensure immediate activation in case of attempt to perform generator-to-busbars connection before abovementioned minimum voltage is reached.

8.2.6 For generators with the ratings of 1000 kVA and above, it is recommended that provision shall be made for protection against internal faults, as well as for the protection of the lead connecting the generator to its switchboard and switch.

Where the generator and its switchboard are installed in different spaces, such protection is compulsory.

8.2.7 If a turbine-driven direct-current generator is intended for operation in parallel, provision shall be made for tripping the circuit breaker of the generator when the automatic safety device of the turbine operates.

8.2.8 The current settings of protective devices with time delay shall be chosen in such a way that in any case a reliable interruption of short-circuit current is ensured after the prescribed time delay.

8.2.9 It is permitted to use safety devices in excitation systems of generators as protective devices for semiconductor elements.

8.3 PROTECTION OF ELECTRIC MOTORS

8.3.1 Outgoing feeders from switchboards supplying electric motors rated

at over 0.5 kW shall be provided with means of protection against short- circuit currents and overloads, as well as with no-voltage protection if the motor need not be automatically restarted.

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 running motors shall disconnect the motor under protection when the load is in the range from 105 to 125 per cent of the rated current.

It is admissible for the overload protective devices to be replaced by tight and sound alarms, which is subject to special consideration by the Register in each case.

8.3.3 In supply circuits of fire pump electric drives the overload protective devices operating on the principle of electrothermal and temperature relays shall not be used.

The overload protective devices may be substituted by tight and sound alarms.

8.4 STEERING GEAR PROTECTION

8.4.1 Only short-circuit current protection shall be provided for electric motors and control systems of electric or electrohydraulic steering gear.

Light and audible warning shall be provided of the motor overload or of any phase failure of the feeder supplying the motor.

8.4.2 Circuit breakers used to protect direct- current motors against short-circuit currents shall be set for release without time delay at currents 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 with alternating-current motors shall be set for release without time delay at currents not lower than 125 per cent of the peak starting current of the motor under protection.

In case fuses are used as protective devices the rated current for the fuse links shall be one grade of rating higher than it follows from the values specified for the electric motor starting currents.

8.4.3 For electric motors of the drives for the active means of the ship's steering short-circuit and overload protective devices shall be provided.

Overload protective devices of the above mentioned motors shall be fitted with tight and sound alarms to warn of the motor overload and shall disconnect the electric motor over the load range specified in 8.3.2.

Short-circuit protection shall be in compliance with the requirements of 8.4.2.

8.4.4 For directly driven electric motors of steering gear, overload protection is permitted for locked rotor periods above 60 s with a setting of not less than twice the full load current of the motor protected.

Where such electric motors obtain their power supply via an electronic converter, e.g. for speed control, and which are limited to full load current are exempt from the requirement to provide overload protection. Alarm at electronic converter overload shall be provided with a setting equivalent to the highest permissible current for the normal operation of steering gear.

8.5 PROTECTION OF TRANSFORMERS

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

If the supply feeder of the transformer primary is protected against short-circuit currents only, then the supply feeder of the

secondary shall be protected against overload.

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

No overload protection or alarm is required for voltage transformers and supply transformers of the control circuits.

8.5.2 Where transformers are intended for parallel operation, it is necessary that switches shall be provided to disconnect their primaries and secondaries, but not necessarily at the same time.

If such transformers are fed from different main switchboard sections, which may be isolated in service, provision shall be made for an interlock to preclude their parallel operation in case of main switchboard sections isolation.

8.5.3 The switching-over of instrument current transformers shall be so arranged as to prevent the possibility of their secondary windings being on open circuit.

8.6 PROTECTION OF ACCUMULATOR BATTERIES

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

8.6.2 Each battery charging system shall be provided with protection against battery discharge due to a drop or loss of the charger output voltage.

8.6.3 For accumulator batteries designed for starting internal combustion engines, it is recommended that disconnectors shall be fitted at the start of the circuit on the accumulator side to disconnect the batteries from services (the disconnector may be fitted in one pole).

8.7 PROTECTION OF PILOT LAMPS, VOLTMETERS, CAPACITORS AND VOLTAGE COILS

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

Pilot lamps may have no short-circuit protection of their own, nor short-circuit current limiting devices, provided that all the conditions specified below are met:

.1 the lamps are enclosed together with the device;

.2 the lamps are supplied from circuits inside the enclosure of the device;

.3 the protection of the circuit of the device is rated for current not exceeding 25 A;

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

Short-circuit protection or current limiting devices shall be located as close as practicable to the terminals of the device under protection 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 shall be protected against short-circuit currents.

8.7.3 The voltage coils of apparatus and devices for control and protection shall be protected against short-circuit current, but they may have no protection of their own, provided that the conditions specified below are met:

.1 the coils are enclosed with the device, are under overall protection and belong to the control system of one device;

.2 the coils are supplied from a device

circuit, the protection of which is rated for current not exceeding 25 A.

8.8 PROTECTION OF POWER SEMICONDUCTOR UNITS

8.8.1 Provision shall be made for protecting power semiconductor units from internal and external overvoltage.

8.8.2 Semiconductor element units shall be protected against short-circuit.

The overload protection of diodes and semiconductors shall be isolated from the overload protection of power circuits.

8.8.3 Where only one consumer is available, a common overload protection is permitted for diode and semiconductors units, and power circuits.

8.9 RESIDUAL-CURRENT DEVICES (RCD)

8.9.1 To protect personnel against current injury and to protect some kinds of electrical equipment against single-phase earth fault residual-current devices shall be used.

8.9.2 The residual-current devices shall be fitted in the supply circuits of socket outlets intended to feed the portable equipment and in the supply circuits of cabin's socket outlets as well as the socket outlets in public and other spaces with the voltage in excess of the safe one (50 V).

8.9.3 The residual-current devices shall be set to operate at zero sequence current within 10 to 30 mA.

8.9.4 For essential electrical equipment, installation of the residual-current devices is not permitted.

9. EMERGENCY ELECTRIC INSTALLATIONS

9.1 GENERAL

9.1.1 In each self-propelled ship, an autonomous emergency source of electrical power shall be provided. Such source is not required for ships, in which the main sources of electrical power are accumulator batteries, on condition that at least one of the batteries installed satisfies the capacity and location requirements imposed upon the emergency source of electrical power.

In the case of non-self-propelled ships, the installation of an emergency source of electrical power is subject to the special approval by the Register in each case.

9.1.2 A generator or an accumulator battery may be used as an emergency source of power.

9.1.3 The capacity of the emergency source of power shall be sufficient to supply simultaneously all those services that are essential for the safety of navigation in an emergency.

In ships where electrical power is necessary for propulsion, the capacity of the emergency source of electrical power shall be sufficient to restore propulsion to the ship (in conjunction with other machinery, as appropriate) from a dead ship condition within 30 min after blackout.

9.1.4 The possibility shall be provided for functional testing of the complete emergency installation including testing of automatic starting arrangements of the diesel generator.

9.1.5 An indicator shall be mounted in the main machinery control room or on the main switchboard to show when the battery, which serves as an emergency source of electrical power, is being discharged.

9.1.6 The emergency sources of electrical power shall be provided only with short-circuit protection.

If the emergency source of power is a generator, in the main machinery control room or in the main switchboard visual and audible alarms shall be fitted to warn of the generator overload.

9.2 SPACES OF EMERGENCY SOURCES OF ELECTRIC POWER

9.2.1 The spaces of emergency sources of electrical power and of their transformers (if any), of emergency transitional sources of electrical power, emergency distribution board and distribution board of emergency lighting shall be located above the uppermost continuous deck outside machinery casings and astern from forepeak bulkhead (collision bulkhead).

The above mentioned spaces in ships covered by the requirements of Part V "Subdivision" shall be also located, as a minimum, at a height of 300 mm above the deepest (damage) waterline.

The exits from the spaces shall be easily accessible and shall be direct exits to the open deck, on which the emergency source of electrical power is installed.

9.2.2 The arrangement of emergency sources of electrical power and pertinent transformers, if any, of transitional sources of electrical power, emergency distribution board and distribution board of emergency lighting with regard to the main sources of electrical power and pertinent transformers, and with regard to the main distribution board, shall be such that a fire or another emergency in the space of the main source of electrical power, of pertinent transformers, main distribution board or in any machinery space of category A would not hamper the supply, control and distribution of electrical power from the emergency source.

9.2.3 Spaces containing emergency sources of electrical power, pertinent transformers, transitional sources of electrical power, emergency distribution board and distribution board of emergency lighting shall not, where possible, be adjacent to machinery and boiler spaces or to spaces containing the main source of electrical power, pertinent transformers and main distribution board.

In case of adjacent arrangement, the decks and bulkheads separating these spaces shall be constructed in accordance with the requirements of Part VI "Fire Protection" relating to control stations.

9.2.4 Emergency distribution board shall be as close as possible to the emergency source of electrical power.

9.2.5 Where a generator serves as the emergency source of electrical power, the emergency distribution board shall be installed in the same space as the diesel generator except where such an arrangement would adversely affect the distribution board operation.

All starting arrangements, charging facilities and starter accumulator batteries of the emergency unit shall also be installed in this space, provided the requirements of 13.2 are complied with.

9.2.6 The emergency diesel generator space shall be provided with heating appliances to ensure the temperature in the space sufficient for starting, without fail, of the emergency generating set and ventilation in accordance with the requirements of

12.5.3, Part VIII "Systems and Piping".

9.2.7 Where the emergency source of electrical power is an accumulator battery, this battery and the emergency switchboard shall be installed in separate spaces.

The requirements for the battery compartments are given in 13.2.

9.2.8 In ships with markings **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **D-R3-RS,** the requirements of paragraph 9.2.1 are not essential, if these ships are equipped with two fully duplicated machinery spaces separated by at least one watertight space, which meets the requirements of paragraph 2.2.1.3.*10)* of Part VI "Fire Protection", and with two bulkheads or any other structure providing equal protection degree, and if at least one generator with an associated board and other equipment as per requirements of paragraph 9.2.1 is available in each of such machinery spaces.

9.3 EMERGENCY SOURCES OF ELECTRIC POWER IN CARGO SHIPS

9.3.1 In cargo ships, the emergency sources of electrical power shall supply the following services:

.1 emergency lighting for:

all corridors, stairways and exits from service spaces as well as passenger lift cars and trunks;

machinery spaces, main generating stations;

all control stations, main and emergency switchboards;

emergency diesel generator space;

wheelhouse;

chartroom and radioroom;

stowage positions for emergency and fireman's outfit and also positions where manual fire alarms are fitted;

steering gear compartments;

positions at fire and sprinkler pumps, emergency bilge pump and starting positions of their motors;

cargo pump rooms;

helicopter hangars and landing areas;

gyrocompass space;

medical rooms;

.2 navigation lights, lights of "Vessel not under command" signal and other lights required by Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships;

.3 internal communication means and general alarm signals;

.4 radio equipment and navigational equipment according to the requirements of Part IV "Radio Equipment" and Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships where the emergency source of power is a diesel generator;

.5 fire detection and alarm systems;

.6 daylight signalling lamps, sound signal means (whistles, gongs, etc.), manual calling and other signals required under emergency conditions;

.7 machinery and devices mentioned under 3.2.1.2, 3.4.7, 3.7.3.7, Part VI "Fire Protection";

.8 electric drives of watertight doors with their indicators and alarms;

.9 electric drives of devices holding fire doors;

.10 other systems, the operation of which would be found necessary by the Register to ensure the safety of the ship and the persons on board.

.11 electric drive of the launching appliance for the lifeboat specified in

6.20.4.7, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships.

In ships of unrestricted service and restricted area of navigation **R1** of 300 and above gross tonnage, the emergency sources of electrical power shall ensure the supply of services listed under 9.3.1.1 to 9.3.1.9 during 18 h.

Consumers mentioned under 9.3.1.3 to 9.3.1.6 may be supplied from their own batteries arranged as provided for in 9.2 and having a capacity sufficient to supply those consumers during 18 h.

For ships of gross tonnage 300 and above of restricted areas of navigation **R2, R2-RSN, R2-RSN(4,5), R3-RSN and R3** the required period of 18 h may be reduced to 12 h.

For ships of less than 300 gross tonnage, the period of 18 h may be changed to 6 h in the case of unrestricted service and restricted area of navigation **R1** and to 3 h in the case of restricted areas of navigation **R2, R2-RSN, R2-RSN(4,5), R3-RSN and R3**.

9.3.2 The emergency source of electrical power shall ensure, during 3 h, the emergency lighting of muster and embarkation stations for boarding life-saving appliances on deck and overboard according to 2.3.4 and 2.7.7, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships.

9.3.3 The supply of steering gear shall be effected from the emergency source of electrical power in accordance with 5.5.6.

9.3.4 Where a generator is used as the emergency source of electrical power, it shall be:

.1 driven by an internal combustion engine (refer to 2.2.5, Part IX "Machinery");

.2 automatically started upon failure of the electrical supply from the main source of electrical power monitored at the emergency switchboard busbars and automatically connected to the emergency switchboard, and consumers stipulated under 9.3.1 shall be automatically supplied by the emergency generator.

The total time of starting and load take-over by the generator shall not exceed 45 s;

.3 in case the automatic start of emergency unit stipulated by 9.3.4.2 shall not take place within 45 s, an emergency transitional source of electrical power shall be provided, which shall start immediately on failure of the main source of electrical power.

9.3.5 Where an accumulator battery is used as the emergency source of electrical power, it shall:

.1 operate without recharging with voltage variations across the terminals within 12 per cent of rated voltage during the whole discharge period, where voltage variations across the terminals of accumulator battery connected to an electronic voltage converter are determined by the permissible range of voltage variation across the terminals of the converter;

.2 be automatically connected to emergency distribution board busbars in case of failure of the main source of electrical power and supply at least the consumers mentioned under 9.3.7 during the time stipulated by 9.3.1 excepting electric drives of fire doors with their indicators and alarms, which can be supplied during 30 min.

9.3.6 As transitional emergency source of electrical power stipulated by 9.3.4.3, an accumulator battery shall be used, which shall operate without recharging with voltage variations across the terminals within 12 per cent of rated voltage during the whole discharge period.

Voltage variations across the terminals of accumulator battery connected to an electronic voltage converter are determined by the permissible range of voltage variation across the terminals of the converter, which shall not be above values specified in 2.1.3.1.

9.3.7 The capacity of the battery serving as the transitional source of electrical power shall be sufficient to supply, during 30 min, the following consumers:

.1 lighting and essential navigating fights according to 9.3.1.1, 9.3.1.2 and 9.3.2;

.2 all internal communications and announcing systems required in an emergency;

.3 general alarm system, fire detection and alarm system and warning system on starting a smothering fire-extinguishing system;

.4 daylight signalling lamps, sound signal means (whistles, gongs, etc.);

.5 command broadcast apparatus in accordance with item 11 of Table 2.3.4, Part IV "Radio Equipment" of the Rules for the Equipment of Sea-Going Ships;

.6 closing gear of watertight doors, their position indicators and signals warning of their closure;

.7 ship's security alarm system required by Part IV "Radio Equipment", as well as AIS installation and long-range identification and tracking system equipment, as required by Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships.

Services listed under 9.3.7.2 to 9.3.7.7 may not be supplied from the transitional source if they have their own accumulator batteries, by which they are supplied during the required period of time.

9.3.8 For Class **INF2** and Class **INF3** ships, in accordance with the classification given in 7.3.2, Part VI "Fire Protection", regardless of the navigation area and tonnage of the ships, the emergency source of electrical power shall supply the services fisted in 7.3.6 and 7.3.8, Part VI "Fire Protection" for a period of 36 hours.

9.4 DISTRIBUTION OF ELECTRICAL POWER FROM EMERGENCY SOURCES

9.4.1 Under normal service conditions, emergency distribution board shall be supplied from the main distribution board. The supply feeder shall have an overload and short-circuit protection fitted at the main distribution board.

At the emergency distribution board, a switch shall be provided, which shall switch off automatically in the case of de-energizing the busbars of the main distribution board.

Where the main distribution board shall be supplied from the emergency distribution board, the automatic switch on the emergency switchboard shall be fitted with at least short-circuit protective devices.

9.4.2 The emergency generator, during the stay of the ship in port, may be used to supply non-emergency consumers (refer also to 2.2.6, Part IX "Machinery"), which is subject to special consideration by the Register in each case.

In doing so, the following conditions shall be met:

provision is made for automatic disconnection of non-emergency consumers from the emergency switchboard to prevent overloading of the generator and to ensure the supply of emergency consumers;

damage of any control, protection and alarm circuits intended to maintain operation of the emergency generator during the stay of the ship in port, shall not affect the work

of the main and emergency electrical power sources;

arrangements are provided to select the operating modes of emergency generators with a quick change-over to emergency mode being possible;

provision is made for instructions to be available onboard, for bringing all the controls (valves, switches, etc) in a position ensuring independent operation of the emergency generator when the ship is underway, and also containing information on the required oil fuel capacity, on the position of the operating mode switch (if any), on the position of ventilation closures, etc.

9.4.3 Consumers listed under 9.3.1 and 19.1.2 shall be supplied through separate feeders from the busbars of the emergency distribution board fitted up with relevant switch gear and protection. Supply of consumers mentioned under 9.3.1.2 to 9.3.1.6 and 19.1.2.1.2 to 19.1.2.1.6 may be effected from the main control console in the wheelhouse, which is supplied in conformity with 4.5.2.

9.4.4 Where a transitional source of power is available, consumers listed under 9.3.7 and 19.1.2.7 shall be supplied through a special distribution board on the feeders, of which no switches shall be fitted.

9.4.5 The switchboards for emergency services shall be installed above the bulkhead deck.

9.5 STARTING ARRANGEMENTS FOR EMERGENCY DIESEL GENERATORS

9.5.1 The following arrangements may be used as starting arrangements for emergency diesel generators:

.1 electric starter with its own accumulator battery and charging device;

.2 compressed air system with its own independent air receiver;

.3 hydraulic starting system;

.4 manual starting arrangements: starting handle for manual cranking, inertia starters, manually charged hydraulic accumulators or powder charge cartridges.

9.5.2 Each emergency generating set arranged to be automatically started shall be equipped with a starting device of an approved type with a stored energy capability of at least three consecutive starts.

The source of stored energy shall be protected to preclude critical depletion by the automatic starting system, unless a second independent means of starting is provided.

In addition, a second source of energy shall be provided for additional three starts within 30 minutes unless manual starting can be demonstrated to be effective.

9.5.3 Where automatic starting of the emergency diesel generator is not required, manual starting is permissible with the use of one of the starting arrangements specified in 9.5.1.4.

When manual starting is not practicable, the starting arrangements shall comply with the requirements of 9.5.2.

9.5.4 The starting arrangements of the accumulator batteries and the electric drives of the machinery ensuring the functioning of the compressed air or hydraulic systems of the emergency diesel generator starting shall be supplied from the emergency switchboard by separate feeders..

9.6 ALARM SYSTEM AND PROTECTION OF EMERGENCY DIESEL GENERATORS DRIVES

9.6.1 Emergency diesel generator drives having power of 220 kW and above shall be equipped with a protective device ensuring the shutdown of the engine in case

of overspeed.

9.6.2 Protective devices that may influence the shutdown of emergency diesel generator drives, except for those preventing overspeed, shall be automatically overridden when the emergency diesel generator is in remote control or automatic mode during navigation. This requirement covers all emergency diesel generators regardless of their drives' output.

9.6.3 In addition to the remote fuel stop control, a local means of emergency shutdown of emergency diesel generator drives shall be provided.

9.6.4 For emergency diesel generator drives alarm system shall be activated at:

.1 fuel oil leakage from high pressure pipes;

.2 lubricating oil pressure below the minimum permissible value;

.3 high temperature of cooling water or cooling air.

9.6.5 For drives having power of 220 .

9.7 UNINTERRUPTIBLE POWER SYSTEMS

9.7.1 Uninterruptible power system (UPS), in addition to the requirements set forth below, shall comply with the requirements of IEC 62040 and applicable requirements of national standards.

9.7.2 UPS complying with these requirements may be used as emergency or transitional sources of electrical power as required by the present Part.

9.7.3 UPS type selection shall be appropriate to power supply requirements of the connected load equipment.

9.7.4 UPS shall be provided with a bypass, which ensures power supply to connected load from the ship's mains if the inverter fails.

kW and above, in addition, provision shall be made for alarm system activating at:

.1 high lubricating oil temperature;

.2 pressure or flow of cooling water below the minimum permissible value;

.3 overspeed.

9.6.6 For drives having power of more than 2250 kW or with cylinder bore of more than 300 mm, in addition, provision shall be made for alarm system activating at excess of the oil mist concentration in crankcase.

9.6.7 Alarm system shall comply with the requirements given in 2.4.1, Part XV "Automation".

9.6.8 Grouped alarms shall be arranged on the navigation bridge.

9.6.9 Proceeding from the power of drives, local indication of the parameters listed in 9.6.4 to 9.6.6 shall be provided (within the same space as the emergency diesel generator) independent of the alarm and safety systems

9.7.5 Each UPS shall be provided with audible and visual alarm to be given in normally manned location for:

.1 power supply failure to the connected load;

.2 earth fault;

.3 operation of battery protective device;

.4 when the battery is being discharged; and

.5 when the bypass is in operation for on-line UPS.

9.7.6 The requirements for location of the UPS shall be similar to the requirements for the location of the emergency or transitional source of electrical power.

9.7.7 UPS utilising sealed batteries may be located in any space other than the accommodation space, provided sufficient ventilation is ensured in the space.

9.7.8 UPS shall maintain rated voltage and frequency on the load side throughout the whole time necessary to supply the connected services.

9.7.9 On voltage recovery in the power supply circuit, the capacity of the UPS rectifier shall be sufficient to maintain rated voltage and frequency on the load side with simultaneous recharging the battery by the maximum possible charging current.

9.7.10 The accelerated (boost) charging of the UPS batteries by the maximum possible charging current shall be interlocked with the ventilation of the space where the UPS batteries are installed.

10. ELECTRICAL MACHINES

10.1 GENERAL

10.1.1 The materials of propulsion motor shafts, generators and slip couplings built into the shafting shall comply with the requirements of 3.7, Part XIII "Materials".

10.1.2 Alternating-current generators with excitation systems and voltage correctors shall be capable to sustain, under steady short-circuit conditions, at least three times the rated current within 2 s.

10.1.3 Electric propulsion generators and electric propulsion motors, or, where justified, also machines of different designation, shall have heating arrangements to maintain their temperature at least 3 °C above the ambient air temperature.

10.1.4 Generators built into the shafting of the main machinery shall have split stators and bearing shields if, due to the shaft arrangement, the stator displacement in the direction of the shaft from the rotor is not possible.

Such generators shall have an air gap preventing mechanical contact of the rotor and stator under the most unfavourable service conditions.

10.1.5 Rotors and armatures of alternating and direct-current machines shall be capable of withstanding for 2 min, without damage and permanent set, the following increased speeds of rotation:

.1 generators, rotating converters, electric slip couplings and brakes: 120 per cent of the rated speed, but at least 3 per cent more than the maximum speed as specified for transient modes;

.2 series-wound motors: 120 per cent of the maximum permissible speed as indicated on the rating plate, but not less than 150 per cent of the rated speed;

.3 all motors other than mentioned above, 120 per cent of the maximum no-load speed.

10.1.6 Where a machine is so designed that after installation on board the ship its bottom part is positioned below floor level, ventilation air intake shall not be through the bottom part of the machine.

10.1.7 Application of external cooling fans is not recommended for machines intended for installation on weather decks.

10.1.8 The power of electric motors supplied from an electrical power source, which does not comply with the requirements of 2.2.1.3, shall be calculated taking into account the additional heating due to the higher harmonic components.

10.2 SLIP RINGS, COMMUTATORS AND BRUSHES

10.2.1 Direct-current machines for driving the propulsion plants and direct-current machines rated at 200 kW and over shall be provided with sight holes to enable observation of the commutator and brushes without removing the lids.

10.2.2 The permissible wear of commutator segments or slip rings shall be indicated on their sides. It shall be taken equal to at least 20 per cent of the commutator segment or slip ring height.

10.2.3 For armatures more than 1000 kg in mass provision shall be made to allow reconditioning of the commutator without removing the armature from the machine.

10.2.4 A flexible copper conductor shall be used to draw current from brushes. Brush holder springs shall not be used for this purpose.

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

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

No sparking shall be possible at the specified overloads, reversals or startups, to such an extent as to cause damage to brushes or commutators.

10.3 BEARINGS

10.3.1 Bearings shall 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 The casing of the sliding bearing shall be fitted with a hole for excessive lubricating oil drain and with a lid in the upper part of the casing. Oil level indicators shall be provided on machines rated at 100 kW or more.

10.3.3 Pressure lubrication system shall incorporate pressure indicators for oil entering the bearing.

10.3.4 In electric propulsion machinery, or machines of different designation, where so justified, provisions shall be made to prevent flow of shaft currents through sliding friction bearings.

10.3.5 Generators driven by belts or chains from the main machinery of the ship shall be so designed that the effect of the lateral forces is taken into account.

10.4 TEMPERATURE DETECTORS

10.4.1 Stators of alternating-current machines rated at over 5000 kW, or having a core length of more than 1 m, shall be provided with temperature detectors installed where the machine may be expected to develop the highest temperatures.

10.4.2 Embedded temperature detectors are recommended for electric motors with short-time or intermittent operating conditions.

10.4.3 It is recommended that overload protection for windlass-driving electric motors shall be by means of embedded temperature detectors so selected that the protection device will disconnect the motor when the temperature rise limit for the insulation employed is exceeded by more than 30 per cent.

The terminals of the detector shall be easily accessible.

10.5 OVERCURRENT

10.5.1 Generators shall be so designed

that after reaching the steady-state temperature corresponding to the rated load they are capable of sustaining overcurrent as specified in Table 10.5.1.

Table 10.5.1

Generator type	Overcurrent, %	Duration of overcurrent, s
Alternating current	50	120
Direct current	50	15

10.5.2 Electric motors shall be so designed that they are capable of developing, without stopping or sudden rotation frequency changes, the increased torque specified in Table 10.5.2.

10.5.3 For electric propulsion motors overload in torque and duration of overcurrent specified in 10.5.2 are subject to special consideration by the Register.

10.6 ALTERNATING-CURRENT GENERATORS

10.6.1 General

10.6.1.1 Each alternating-current generator shall have a separate, independent automatic voltage regulation system.

10.6.1.2 Alternating current generators shall have sufficient excitation capacity to maintain the rated voltage with an accuracy of 10 per cent for 2 min at generator overcurrent equal to 150 per cent of the rated value and at a power factor of 0.6.

10.6.1.3 Protection of alternating-current generators shall comply with the requirements of 8.2.

Table 10.5.2

No.	Motor type	Overload in torque, %	Duration of overload, s	Testing conditions
1	Synchronous motors and squirrel-cage motors with starting current not less than 4.5 times the rated current	50	15	Frequency, voltage and excitation to be maintained at rated levels
2	Asynchronous motors for continuous or intermittent duty	60	15	Frequency and voltage to be maintained at rated levels
3	Motors as specified in item 2, but for short-time and continuous duty with varying load	100	15	As above
4	Direct current motor	50	15	Voltage to be maintained at rated levels

10.6.2 Voltage regulation systems

10.6.2.1 Alternating-current generators shall have automatic voltage regulation systems ensuring that the voltage may be maintained within 2.5 per cent of the rated value (up to 3.5 per cent for emergency generators) at all load changes from no-load to rated load values at the rated power factor. The speed in this case shall be within the range specified in 2.11.3, Part IX "Machinery".

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, shall not cause a drop of voltage below 85 per cent or a rise above 120 per cent of the rated value.

After the completion of transient processes, the generator voltage shall be restored within not more than 1.5 s with a deviation from the rated value being + 3 per cent. For emergency sets these values may be increased, respectively, to 5 s and ±4 per cent of the rated voltage.

Where no precise data are available on peak values of sudden load that may be connected additionally to the existing generator load, these may be taken equal to a load of 60 per cent of the rated current at a power factor of 0.4 or less, which is connected at idle speed and then disconnected. The speed in this case shall be within the range specified in 2.11.3, Part IX "Machinery".

10.6.2.3 For alternating-current generators the deviation from sine voltage shall not exceed 5 per cent of the harmonic component peak value.

10.7 DIRECT-CURRENT GENERATORS

10.7.1 General

10.7.1.1 Compound-wound and shunt-wound direct-current generators shall be equipped with automatic voltage regulation systems.

10.7.1.2 Protection of direct-current generators shall comply with the requirements of 8.2.

10.7.2 Voltage regulation systems

10.7.2.1 Voltage regulators of direct-current compound-wound generators shall enable reduction of no-load voltage, with the generator cold, by not less than 10 per cent below the rated generator voltage, taking into account the increased revolutions of the prime mover running at no load.

10.7.2.2 Manual voltage regulators shall be so designed that the voltage increases when their controls are rotated clockwise.

10.7.2.3 Voltage regulators of direct-current shunt-wound generators shall be so designed that, when the field current is removed, the field winding is closed to the discharge circuit.

10.7.2.4 Direct-current compound-wound generators shall have independent devices for voltage regulation within a tolerance of ± 1 per cent for generators rated at up to 100 kW, or within +0.5 per cent for generators of rating exceeding 100 kW.

The above regulation limits shall be maintained with the generator cold and hot and at any load within the operating load range of generators.

10.7.2.5 Direct-current sets comprising compound-wound generators shall have such external characteristics that the voltage of a hot generator adjusted to the rated value with an accuracy of ±1 per cent at 20 per cent of the 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 lower output.

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

.1 ±3 per cent for generators rated at 50 kW and more;

.2 ±4 per cent for generators rated over 15 kW but less than 50 kW;

.3 ±5 per cent for generators rated at 15 kW and less.

10.7.2.6 Direct-current sets comprising shunt-wound generators shall have such external generator characteristics and

automatic voltage regulators that voltage is maintained to 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 shall operate when the brake operating coil is de-energized.

10.8.2 A 30 per cent voltage drop below the rated value shall not cause a hot brake to operate.

10.8.3 Electromagnetic brakes shall allow for manual release.

10.8.4 Electromagnetic brakes shall be fitted with at least two pressure springs.

10.8.5 The shunt windings of a compound-wound electromagnetic brake shall 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 shall be so constructed or protected that they are safe from damage at overvoltages such as occur when they are being disconnected (refer also to 5.4.3).

10.9 ASYNCHRONOUS ELECTRIC MOTORS SUPPLIED FROM FREQUENCY CONVERTERS

10.9.1 Asynchronous electric motors supplied from frequency converters shall have output reserve in order to prevent overheat caused by the voltage curve harmonic distortion.

10.9.2 Stator winding of asynchronous electric motors less than 100 kW supplied from frequency converters shall be two-layer winding or single layer with equal length of conductors with F- or H- class reinforced insulation.

10.9.3 In order to reduce overvoltage in stator winding of asynchronous motors supplied from frequency converters with the pulse-width modulation (PWM) it is necessary to:

.1 apply star phase splicing of stator winding;

.2 optimum selection of impedance of the electric motor stator winding and cable between electric motor and frequency converter;

.3 use control algorithm for frequency converter limiting minimum pulse duration and pause between impulses.

11. TRANSFORMERS

11.1 GENERAL

11.1.1 The requirements of the Section apply to transformers listed in 3.3.

For additional requirements for transformers with voltages over 1,000 V – refer to 18.4.

11.1.2 Dry-type transformers shall be used in ships. The use of other transformer types is subject to special consideration by the Register.

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

11.2 OVERLOAD, VOLTAGE VARIATION AND OPERATION IN PARALLEL

11.2.1 Transformers cooled by air or dry dielectric shall be so designed as to be capable of withstanding 10 per cent overloads for 1 hour and 50 per cent overloads for 5 min.

11.2.2 For single-phase and three-phase transformers used to supply the ship's

mains, voltage variation at an active load between zero and rated load shall not exceed 5 per cent for transformers rated at up to 6.3 kVA per phase and 2.5 per cent for transformers of higher rating.

11.2.3 Transformers intended to operate in parallel shall have their winding connections grouped together, their transformation ratios shall be the same, and their short circuit voltages shall be such that the load on any transformer does not depart from the corresponding proportional part of power output of each transformer by more than 10 per cent of the rated current for a given transformer.

11.2.4 Nominal capacities of transformers for parallel work shall not differ from each other more than twice.

12. POWER SEMICONDUCTOR UNITS

12.1 GENERAL

12.1.1 In power semiconductor units use shall be made of semiconductor elements of silicone type.

Elements of other types are subject to special consideration by the Register in each case.

12.1.2 To prevent condensation in semiconductor units having the dissipation power above 500 W, provision shall be made for heating so that their temperature is at least by 3 °C higher than that of the ambient air.

12.1.3 Power semiconductor units shall be provided with air cooling (natural or artificial).

The use of liquid cooling is subject to special consideration by the Register in each case.

12.1.4 For power semiconductor units with forced cooling, provision shall be made for the protection reducing or disconnecting the load in case of inadequate cooling.

The activation of protection shall be preceded by the activation of light and sound alarms for exceeding the maximum permissible temperature of cooling medium at the system outlet.

12.2 PERMISSIBLE PARAMETERS OF VOLTAGE DISTORTION

12.2.1 The voltage curve harmonic distortion factor for the ship mains depending upon the operation of the power semiconductor units shall not exceed 10 per cent.

The use of power semiconductor units which cause the harmonic distortion of the voltage curve above 10 per cent is subject to special consideration by the Register in each case.

The voltage curve harmonic distortion factor shall be determined by the formula given in 2.2.1.3.

12.2.2 The factor of maximum relative deviation of instantaneous voltage value from the first harmonic component shall not exceed 30 per cent.

K_{MD} factor shall be determined by the formula

$$K_{MB} = \frac{U_m - U_{1m}}{U_{1m}} \cdot 100\%, \quad (12.2.2)$$

where U_m – is the peak value of the ship mains voltage;

U_{1m} – is the peak value of the first harmonic component.

12.3 CONTROL AND SIGNALLING SYSTEMS

12.3.1 Semiconductor arrangements shall be provided with light signals for connection or disconnection of power circuits and control circuits.

12.3.2 The power section of semiconductor arrangements shall be electrically insulated from the control system.

12.3.3 The long-term current deviation in the parallel branches of semiconductor arrangements shall not exceed 10 per cent of average current value.

12.3.4 The operation of semiconductor arrangements shall not be hampered by the failure of particular gates. Where the load upon particular gates exceeds permissible values, it shall be reduced automatically.

When a gate fails, light and sound signals shall be activated.

12.4 MEASURING INSTRUMENTS

12.4.1 Semiconductor arrangements shall be fitted with measuring instruments in accordance with their purpose.

12.4.2 In the scales of measuring instruments of semiconductor arrangements, maximum permissible parameter values shall be marked off. Where forced cooling is applied, the maximum permissible temperature shall be marked off clearly in the scale of the instrument for measuring the cooling air temperature.

13. ACCUMULATOR BATTERIES

13.1 GENERAL

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

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

Closures shall be made from durable material resistant to electrolyte.

Closure design shall be such as to avoid building up of excess gas pressure inside the battery.

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

13.1.4 Materials used for fabrication of crates to house battery cells shall be resistant to electrolyte. Individual cells arranged within the crates shall be so secured that it is impossible for them to move relative to one another.

13.1.5 Where batteries are fitted for use for essential and emergency services, a condition monitoring and maintenance schedule for such batteries shall be compiled and maintained.

The schedule, which shall be reviewed by the Register, shall include the following information regarding the battery:

type and manufacturer;

voltage and capacity;

location;

equipment and systems served;

routine maintenance/replacement cycle dates;

date of last maintenance or replacement;

for replacement batteries in storage, the date of permissible shelf life.

Details of the schedule shall be included in the ship's safety management system specified in Chapter IX of SOLAS-74.

13.1.6 Where batteries are replaced, they shall be of an equivalent performance type, which shall be reflected in appropriate instructions.

13.1.7 Where vented type battery replace valve-regulated sealed type at its location, the requirements of the Rules relevant to the location and ventilation of the batteries shall be met.

13.2 ARRANGEMENT OF ACCUMULATOR BATTERIES

13.2.1 Batteries having a voltage in excess of the safety voltage, as well as batteries having a capacity over 2 kW computed from the maximum charging current and the rated voltage, shall be located in special battery compartments accessible from the deck, or in appropriate boxes installed on deck. These spaces shall be special electrical spaces.

Batteries having a charge capacity of 0.2 kW up to 2 kW may be installed in boxes or cabinets located inside the ship's hull.

In ships with low-power electrical installation, except passenger ships, the above batteries may be installed in the machinery space in such a way that their upper section is at least above the margin line in case the ship is flooded.

Accumulator batteries intended for the electric starting of internal combustion engines except for emergency units may be installed in machinery spaces in special cabinets with sufficient ventilation.

Batteries having a charge capacity less than 0.2 kW and unattended batteries giving off no gases in operation are allowed to be installed in any space, other than accommodation spaces, provided 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 shall not be placed in one compartment or in one box.

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

13.2.3 The inside part of a battery compartment or cabinet, as well as all structural parts, which may be subjected to harmful effects of electrolyte or gas, shall be suitably protected.

13.2.4 Accumulator batteries and individual cells shall be properly fixed in position. In case they are installed on shelves in two or more rows, all the shelves shall have a clearance of at least 50 mm on the face and back side for air circulation, and the distance from the deck to the plugs in the upper row of cells shall not exceed 1,500 mm.

13.2.5 When installing the accumulator batteries or individual accumulators (cells), provision shall be made for fitting linings and spacers between them that will ensure a clearance for circulation of air of not less than 15 mm on all sides.

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

13.3 HEATING

13.3.1 The battery compartments and

boxes wherein temperature in operation may fall down below +5 °C shall 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 (also refer to 2.9.3.3).

13.3.2 The heating system valves shall be located outside the battery compartments.

13.3.3 The shipboard air conditioning system shall not be used for heating the battery compartments.

13.4 VENTILATION

13.4.1 The battery compartments and boxes, except for unattended batteries not releasing gases during operation, shall have sufficient ventilation to prevent accumulation of explosive air-gas mixture.

The ventilation system shall meet the requirements of 12.10, Part VIII "Systems and Piping".

13.4.2 The battery compartments equipped with mechanical ventilation shall be provided with devices that will prevent charging of accumulator batteries before ventilation has been switched on.

Charging cycle shall be automatically discontinued, shall the ventilators stop.

13.5 CHARGING OF ACCUMULATOR BATTERIES

13.5.1 Provision shall be made for charging facilities to charge the accumulator batteries of essential services within 8 h.

In case an additional battery is used substituting the battery being charged, the charging time may exceed 8 h.

13.5.2 The charging facilities shall have means for measuring the voltage across battery terminals and charging current, as well as discharging current for emergency sources of electrical power.

13.5.3 In ships equipped with portable accumulator-fed lanterns or with spare accumulator-fed navigation lanterns the facilities shall be provided for charging the accumulators of these lanterns.

13.6 INSTALLATION OF ELECTRICAL EQUIPMENT IN BATTERY COMPARTMENTS

13.6.1 Apart from safe-type lighting fixtures and cables led to accumulators and lighting fixtures, no other electrical equipment shall be installed in battery compartments.

Cables led to accumulator batteries and lighting fixtures may run openly, provided they have metal armour or braid covered with non-metal sheath and this metal armour or braid is reliably earthed at both ends.

13.7 ELECTRICAL STARTERS FOR INTERNAL COMBUSTION ENGINES

13.7.1 Number of starter accumulator 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 shall be permanently installed for starting each of the main and auxiliary engines, or not less than two common batteries for starting all the engines.

Moreover, provision shall be made for a permanent switching system that will ensure possible use of any battery for starting any of the engines in the group serviced by this battery. In this case parallel connection of the batteries is not allowed.

13.7.1.2 For ships of restricted area of navigation **R3**, **R3-IN,** and **D-R3-S**, **D-R3-RS**, as well as for ships of restricted area of navigation **R2** with the electrical installation

of low power (other than passenger ships), it is permitted to have only one starter accumulator battery, provided that it may be used for starting all the engines.

13.7.2 Battery characteristics

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

13.7.2.2 Capacity of each battery shall be sufficient for six starts of the engine in the ready-for-start condition, or in case of two or more engines, for not less than three starts of each engine.

Total capacity of the batteries for starting main engines shall provide the required number of starts during 30 min.

13.7.2.3 In computing battery capacity, the duration of each start shall be considered not less than 5 s.

13.7.3 Charging facilities

13.7.3.1 A starter battery charging facility shall be supplied by a separate feeder from the main switchboard even if the battery is charged from the appurtenant generator.

13.7.3.2 For ships of restricted area of navigation **R3**, **R3-IN,** and **D-R3-S**, **D-R3-RS**, as well as for ships of restricted area of navigation **R2** with the electrical installation of low power (other than passenger ships) the starter battery may be charged only from the appurtenant generator.

14. ELECTRICAL APPARATUS AND ACCESSORIES

14.1 ELECTRICAL APPARATUS

14.1.1 General

14.1.1.1 The design of switchgear with renewable contacts shall be such that renewal of contacts is possible by means of standard tools, without dismantling the switchgear or its basic components.

14.1.1.2 All switches, circuit breakers and isolating switches, except those for cabins, shall be provided with mechanical or electrical contact-making position indicators located where the apparatus is actuated by the operator.

14.1.1.3 The positions of controller and master controller drums shall be rigidly locked by mechanical means, location in zero position being more rigid than elsewhere.

Controller and master controlled drums shall be fitted with a scale and a position indicator.

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

14.1.2 Manually operated controls

14.1.2.1 The direction of movement of manually operated controls of switchgear or machine control gear shall be such that clockwise rotation of a handle (lever) corresponds to closing of an apparatus, startup of a motor, increased speed, increased voltage, and so forth.

When controlling the lifting or lowering gear, clockwise rotation of a handle (lever) or movement of a handle (lever) towards the operator shall be associated with lifting, and counter-clockwise rotation of a handle (lever) or movement thereof in the direction from the operator shall be associated with lowering.

14.1.2.2 The design of circuit-breaking

push buttons shall prevent their accidental actuation.

14.1.3 Machine-operated controls

14.1.3.1 Actuators of switches and circuit breakers shall be so designed that in the event of loss of supply to the actuating motor the switch or circuit breaker contacts remain in closed or in open position only.

14.1.3.2 Electrical machine actuators shall ensure correct actuation of the apparatus in the event of voltage variations within 85–110 % of the rated value in the control circuit, and for alternating current – in the event of voltage deviations within ±5 % of the rated value.

14.1.3.3 The reduction of voltage in the control circuit to up to 70 % of the rated value shall not cause contact breaking in the apparatus or reduced movable contact pressure force.

14.1.3.4 The design shall allow for the manual control of machine-operated circuit breakers.

14.1.4 Coils.

14.1.4.1 A conductor or a shoe shall be attached to a coil winding so as to avoid the mechanical stresses of the connection affecting the coil turns.

Voltage coil taps shall be made of bunched flexible conductors, unless terminal clamps are fixed directly to the coil frame.

14.1.4.2 The coils of electromagnetic apparatus shall bear notations giving particulars of their characteristics.

14.1.5 Resistor elements

14.1.5.1 Resistor elements shall be easily replaceable, in sections or in total.

14.1.5.2 Resistors shall be arranged and ventilated so that they don't cause heating of other appliances above the permissible values.

14.1.5.3 Connections between the resistor elements, or between the resistor elements and terminal clamps shall be welded or crimped, unless provision is made for their disassembly.

Brazing is allowed provided that the temperature at the junction point does not exceed the allowable limits for brazing.

14.1.6 Fuses

14.1.6.1 Fuse link housings shall be of totally enclosed type

and shall allow no arc ejection to the outside, or sparking, or any other harmful effect upon the adjacent parts in case the fuse blows.

14.2 ELECTRICAL ACCESSORIES

14.2.1 General

14.2.1.1 The enclosures of accessories and fittings shall be constructed from materials of adequate mechanical strength, which are corrosion-resistant or adequately protected from corrosion and at least flame-retardant.

The enclosures of accessories and fittings designed for installation on weather decks, in refrigerated cargo spaces, fish processing shops, or other humid areas shall be made of brass, bronze, or equivalent alloy, or from plastics of suitable quality. If steel or aluminium alloys are used, anti-corrosive protection shall be provided.

It is inadvisable to use threaded connections or tight-fit mating of parts in accessories and fittings made of aluminium alloys.

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

14.2.1.3 The lighting fixtures designed to be mounted on or close to combustible

materials shall 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 shall 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 lighting lampholder shall be marked to indicate rated voltage and allowable current or load.

14.2.3 Plug and socket connectors

14.2.3.1 The pinjacks of socket outlets shall 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 shall be cylindrically shaped, solid or hollow.

14.2.3.3 Socket outlets and plugs for voltages exceeding the safety level shall have contacts for connecting the earth continuity conductors of the incoming cables from current consumers.

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

14.2.3.5 Socket outlets rated at over 16 A shall be provided with built-in switches. Provision shall be also made for interlocking such socket outlets to prevent the possibility of the plug being inserted or withdrawn when the socket switch is in the "closed" position.

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

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

When inserting a plug into a socket outlet, the earthing part of the plug shall contact the earthing part of the socket outlet until live contact pins are connected.

14.2.3.8 In socket outlets, plugs and branched pin jacks, no fuses shall be fitted.

15. ELECTRICAL COOKING AND HEATING APPLIANCES

15.1 GENERAL

15.1.1 Only stationary-type electrical cooking and heating appliances are permitted for use.

15.1.2 Electrical cooking and heating appliances shall be supplied from the main switchboard or from distribution boards intended for this purpose, as well as from lighting distribution boards, taking into consideration the requirements of 6.2.1.

15.1.3 The supporting structural parts of electrical cooking and heating appliances, as well as the internal surfaces of enclosures, shall be fabricated entirely from non-combustible materials.

15.1.4 In heated condition, permissible loss current shall not exceed 1 mA per 1 kW

of rated power for a separately connected heating element or 10 mA for the appliance as a whole.

15.1.5 Electric cooking and heating appliances shall be so designed that the temperature of their components, which shall be handled by the personnel or which can be touched inadvertently, does not exceed the value indicated in Table 15.1.5.

15.2 HEATING APPLIANCES

15.2.1 Electric heating appliances intended for space heating shall be of stationary type. These appliances shall be provided with devices for disconnection of the supply source when the temperature rise of the enclosure exceeds the permissible limit.

15.2.2 If built-in disconnecting devices are not provided in the heating and cooking appliances, such devices shall be installed in the rooms wherein these appliances are located.

Switches shall disconnect power supply at all poles or phases.

15.2.3 The enclosures of electric heating appliances shall be so constructed as to prevent the possibility of any objects being placed upon them.

15.2.4 Stationary heating appliances - rated at 380 V and upwards and admitted for use in accordance with Table 4.2.3 shall be protected against access to live parts, except with the aid of special tools.

The enclosures shall bear notices giving the voltage value.

Table 15.1.5

No.	Appliance parts	Permissible temperatures, °C
1	Control knobs and other parts intended for use over a long period:	
	metal	55
	other	65
2	As above, but intended for short-time contact:	
	metal	60
	other	70
3	Housings of electrical space heating appliances at the ambient temperature of 20 °C	80
4	Air emitted from electrical heating appliances into the spaces being heated	110

15.2.5 Electric cooking appliances forming part of galley equipment shall be so constructed as to avoid the possibility of cooking utensils being brought into contact with live parts, and to prevent short circuits or damage to insulation due to liquid spilling or leakage.

15.2.6 Sauna shall be fitted with the temperature limiter, which shall cut off the electrical heater from the mains (at that, electrical heater control circuits shall also be de-energized), if the temperature in the area of 0,3 m from the ceiling exceeds 140 °C. In this area the electrical heater control devices (thermostats and temperature limiters) and associated cables withstanding a temperature not less than 170 °C may only be installed.

15.3 OIL, FUEL AND WATER HEATERS

15.3.1 In addition to the requirements

of this Subsection, heaters shall meet the requirements of Section 6, Part X "Boilers, Heat Exchangers and Pressure Vessels".

15.3.2 Oil and fuel having a flash point above 60 °C may be heated by means of electric heaters, provided the requirements of 15.3.3 and 15.3.4 are fulfilled.

15.3.3 Electric heaters for pipelines shall be equipped with devices for temperature control, light signals for indication of operating conditions and also with light and sound signals for indication of fault conditions and inadmissible temperature rise.

15.3.4 Electric heaters for oil and fuel heating in tanks shall be equipped with devices for temperature control of the heated medium, temperature sensors for surfaces of heating coils, low level indicators and means for disconnection of power supply to the heaters in case the upper temperature limit or the lowest permissible level is exceeded.

15.3.5 Oil and fuel heaters shall be fitted up with devices for temperature control of the medium heated. Irrespective of those devices, a manually disengaged device shall be provided for de-energizing the heaters as soon as their surface temperature reaches the value at least 15 °C lower than the flash point.

For self-regulating heaters protection may be omitted.

15.4 SYSTEMS UTILISING HEATING CABLES

15.4.1 Systems utilising heating cables for removing ice and avoiding icing shall be provided for ship's arrangements, equipment and spaces intended for:

performance of the ship's purpose (descriptive notation in the class notation);

maintaining manoeuvrability;

maintaining stability;

safety of crew (rafts, boats, ladders, guard rails, etc.).

15.4.2 Heating capacity of such systems shall not be less than:

300 W/m² for the spaces of open decks, helidecks, ladders and gangways;

200 W/m² for superstructures;

50 W/m² for guard rails with internal heating.

The heating capacity for other areas and spaces is subject to special consideration by the Register.

15.4.3 In the systems utilising electrical heating cables, particular attention shall be paid to the heat transfer between the cable and the equipment (space) to be heated to provide efficient heating.

15.4.4 The switchboard for the said systems shall be equipped with:

wattmeter or ampermeter to indicate the total load;

name plate indicating the rated load of each circuit and the switchboard as a whole;

residual-current device for each circuit;

load signal lamps for each circuit.

15.4.5 The heating cables shall be protected against overload exceeding 125 per cent of the rated current of the circuit. For cables of self-regulating type the overload protection may be omitted.

15.4.6 The use of heating cables for heating of pipelines carrying combustible media, as well as for pipelines and valves located in dangerous rooms and spaces, is only allowed when fitted with the appropriate type of explosion protection proved by a competent body certificate.

16. CABLES AND WIRES

16.1 GENERAL

16.1.1 The requirements of this Section do not apply to radio frequency, telephone cables, and to power cables designed for voltages above 1,000 V.

16.2 CABLE CONDUCTORS

16.2.1 Cables intended for supplying essential services shall have stranded conductors (refer also to 16.8.1.2).

Table 16.2.1 specifies the minimum number of wires per conductor.

16.2.2 Connections of separate wires of the conductor shall be displaced from one another by not less than 500 mm along the length of the conductor.

Such connections shall not impair the mechanical and electrical properties of the wire nor change the cross-sectional area of wires or the conductor as a whole.

Table 16.2.1

Nominal cross-sectional area of conductor, mm^2	Minimum number of wires per conductor	
	circular non-tightened conductors	tightened sector and circular conductors
0.5–6	7	–
10-16	7	6
25-35	19	6
50-70	19	15
95	37	15
120-185	37	30
240-300	61	30

Note. The ratio between nominal diameters of any two wires in the mechanically tightened cable conductor shall not exceed 1:1.3, and for conductors formed geometrically, but not tightened, 1:1.8.

16.2.3 Separate wires of rubber-insulated copper conductors shall be tinned or coated with suitable alloys.

Tinning or other anticorrosive coating of external stranding or of all wires of a rubber-insulated core may be dispensed with, if the manufacturer takes steps 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 For conductors of cables and wires, insulating materials specified in Table 16.3.1 may be used.

Application of other insulating materials is subject to special consideration by the Register in each case.

16.4 SHEATHING

16.4.1 Protective sheathing of cables and wires may be manufactured of materials as follows:

.1 Non-metallic materials specified in Table 16.4.1;

.2 lead;

.3 copper.

Application of alternative sheathing materials is subject to special consideration by the Register in each case.

16.4.2 Sheathing shall be of uniform thickness within allowable limits, throughout the manufacturing length of

cable, and shall envelope the cable cores concentrically.

The sheaths shall form an impervious covering in tight contact with the protected cores.

16.4.3 Lead cable sheaths shall be made of appropriate alloys specified by the national standards.

Pure lead sheaths may only be used when the lead sheath is covered with an additional protective envelope.

Table 16.3.1

Type of insulating compound	Insulation designation	Permissible operating temperature, °C[1]
Thermoplastic		
Polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate	PVC	70
Elastomeric or thermoset		
Ethylene-propylene rubber or similar (EPM or EPDM)	EPR	90
Hard grade ethylene propylene rubber	HEPR	90
Cross-linked polyethylene	XLPE	90
Silicon rubber	S 95	95
Ethylene-propylene rubber or similar (EPM or EPDM) halogen-free	HF EPR	90
Hard grade halogen-free ethylene propylene rubber	HF HEPR	90
Halogen-free cross-linked polyethylene	HF XLPE	90
Halogen-free silicon rubber	HF S 95	95
Halogen-free cross-linked polyolefin	HF 90	90

[1]Wire temperature for calculating the permissible continuous load of cable.

Table 16.4.1

Type of insulating compound	Insulation designation	Permissible operating temperature, °C
Thermoplastic		
Polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate	ST 1 ST 2	60 85
Halogen-free composition	SHF 1	85
Elastomeric or thermoset		
Polychloroprene rubber	SE 1	85
Chlorosulphonated polyethylene or chlorinated polyethylene rubber	SH	85
Halogen-free composition	SHF	85

16.5 PROTECTIVE COVERINGS

16.5.1 Metal shielding braid shall be made of tinned copper wire. If plain copper wire is used, it shall be protected by suitable sheath.

Non-shielding braids may be made of galvanized steel wires.

The braid shall be uniform and its density shall be such that its mass is at least equal to 90 per cent of the mass of tube of equal diameter made of the same material and with a wall thickness equal to the braiding wire diameter.

16.5.2 Metal armour shall be made of annealed and galvanized steel wire or tape, 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 request, 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 shall be effectively protected against corrosion.

16.5.4 Armour bedding shall be made of moisture-resistant materials.

16.6 MARKING

16.6.1 Rubber- or polyvinylchloride-insulated cables having a limiting temperature at core 60 °C shall be marked in such a manner as would enable their identification.

16.6.2 Cable cores shall be marked in such a manner as to assure adequate preservation of the markings.

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

16.6.3 Cables of fire resistant type shall be clearly marked.

16.7 HOOKUP WIRES

16.7.1 For internal wiring of distribution boards and electric devices, single-wire insulated conductors may be used (refer also to Table 16.3.1).

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

16.8.1.1 Use shall be made of flame-retarding or non-combustible cables and conductors with copper cores manufactured in compliance with this Part of the Rules, national standards, as well as with the relevant requirements of IEC 60092.

As far as the fire resistance testing of cables is concerned, use shall be made of IEC 60331-1 for cables with outside diameter more than 20 mm and IEC 60331-21 or 60331-2 for other cables.

The use of cables and conductors of other types shall be subject to special consideration by the Register in each case. In this case, IEC 60331-23 for data transfer cables and IEC 60331-25 for optical fibre cables may be used.

16.8.1.2 Cables and wires having stranded conductors shall be used, with the cross-sectional area of the conductors being not less than:

.1 1.0 mm^2 for power, control and signalling circuits of essential services and for power circuits of other services;

.2 0.75 mm^2 for control and signalling circuits;

.3 0.5 mm^2 with the number of cores in the cable not less than four for instrumentation and internal communication circuits.

For power circuits supplying non-essential services, the use is permitted of cables with single-wire conductors having a

cross-sectional area of 1.5 mm^2 and less.

16.8.1.3 In circuits with heavy inductive and capacitive loads, the use shall be made of cables designed for working voltages approximately equal to twice the rated voltage of the circuit.

16.8.1.4 Maximum permissible temperature for the insulating material of the cable cores or wires shall be at least 10 °C higher than the maximum specified ambient temperature.

16.8.1.5 In locations affected by the action of petroleum products or another aggressive medium, the use shall be made of cables having a sheath resistant to such medium. Cables not having such properties may be installed in such locations only fitted in metallic pipes (refer to 16.8.8).

16.8.1.6 In locations where cables may be subjected to mechanical damage, the use shall be made of cables having an appropriate armour, while other types of cables in such locations shall be protected with special reliable covers or shall be installed in metallic pipes (refer to 16.8.8).

16.8.1.7 Cables supplying the electric drives of the sprinkler system and of the fire pump from the emergency source of electrical power and running through casings of machinery spaces of category A, galleys, drying rooms and other similar fire-hazardous spaces, shall be of fire-resisting type or protected from the action of flame.

The above requirements cover the remote-control cables of those devices as well.

16.8.1.8 Cables for essential and emergency services as well as cables for services required for operation under fire conditions, including cables for their power supply shall be routed clear of high fire risk spaces (refer to 16.8.1.9), and in addition to passenger ships, main vertical fire zones, except for cases, when the services are installed in such spaces.

Where such installation of cables is necessary, the cables shall be of fire resistance type according to 16.8.1.1.

16.8.1.9 The high fire risk spaces include:

machinery spaces of A category;

spaces containing fuel treatment equipment and other highly flammable substances;

galleys and pantries containing cooking appliances;

laundries containing drying equipment;

accommodation spaces of high fire risk;

paint rooms, store rooms and similar spaces for storage of flammable liquids;

enclosed and semi-enclosed spaces requiring installation of safe-type electrical equipment.

16.8.1.10 Cables, distribution gear, switch apparatus, protective devices and accessories associated with the services specified in 16.8.1.11 shall be so designed or installed that the likelihood of the device failing in case of fire in any one such space or area is minimised.

16.8.1.11 Among the services required for operation under fire conditions are the following:

general alarm system;

fire detection and fire alarm system;

fire extinguishing systems;

warning system on starting a smothering fire-extinguishing system;

controls of fire doors with door-position indicators;

controls of watertight doors with door-position indicators and warning alarm;

emergency lighting;

public address system;

low-location lighting;

remote emergency shutdown arrangements for systems, which operation may support the propagation of fire and/or explosion.

16.8.1.12 Use of fire resistant cables for devices listed in 16.8.1.11 is not mandatory provided that:

.1 fail safe functioning of devices is provided by, at least, two-loop or radial laying of cables spaced apart as far as practical so that if one loop or radial section fails, the rest sustain operability of the devices;

.2 the devices are provided with self-monitoring with such damages like a short circuit, an open- circuit fault, earth fault, or trouble-free functioning of these devices is ensured by duplicating cables laid in separate runs spaced apart as far as practical.

16.8.2 Choice of cables and wires for loads required

16.8.2.1 Permissible continuous loads on single-core cables and wires with different insulation materials shall comply with the values specified in Table 16.8.2.1.

Current ratings as specified in this table shall refer to cable installations as follows:

.1 when cables are laid in a bunch or in a row of six cables maximum, in tight contact between them;

.2 when cables are laid in two rows, irrespective of the number of cables in a row, provided that free circulation of air is possible within a group or a bunch of six cables.

Where a bunch contains more than six cables which may carry the rated current simultaneously, or where there is no free air circulation between them, the permissible current ratings for the concerned cross-sectional area shall be reduced by 15 % (a factor of 0.85).

Table 16.8.2.1 **Current ratings, A, in continuous service of single-core cables and wires with different insulation materials for ambient temperatures of + 45 °C**

Nominal cross-sectional area of conductor, mm^2	Insulating material				
	Regular polyvinyl chloride	Heat-resistant polyvinyl chloride	Butyl rubber	Ethylene-propylene rubber, cross-linked polyethylene	Silicone rubber or mineral insulation
	Maximum permissible conductor operating temperature, °C				
	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	–

16.8.2.2 Current ratings in amperes for cross-sectional areas given in Table 16.8.2.1 and also for any other cross-sectional areas shall be calculated from the formula

$$I = \alpha S^{0.625}, \qquad (16.8.2.2)$$

where a = factor corresponding to the maximum permissible service temperature of the conductor obtained from Table 16.8.2.2;

S = nominal cross-sectional area of conductor, mm2.

16.8.2.3 The permissible current ratings for two-, three- and four-core cables shall be determined by way of reducing the load specified in Table 16.8.2.1 for the concerned cross-sectional area using correction factors as follows:

Table 16.8.2.2

Maximum permissible conductor operating temperature, °C	α factor for the nominal cross-sectional area of the core *S*, mm²	
	≥ 2.5	< 2.5
60	9.5	8
65	11	10
70	12	11.5
75	13.5	13
80	15	15
85	16	16
90	18	20

0.85 for two-core cables,

0.70 for three- and four-core cables.

16.8.2.4 The permissible current ratings for cables and wires in circuits of intermittent or shorttime service shall be determined by multiplying the current ratings for continuous service stated in Table 16.8.2.1 or chosen according to 16.8.2.2 by the correction factors given in Table 16.8.2.4.

Table 16.8.2.4 **Correction factors for cables and wires with metal sheath and without metal sheath**

Nominal cross-sectional area of conductor, mm²	Intermittent service, CDF 40 %		Shorttime service, 30 min.		Shorttime service, 60 min.	
	Cables and wires					
	with metal sheath	without metal sheath	with metal sheath	without metal sheath	with metal sheath	without metal sheath
1	2	3	4	5	6	7
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	1.06	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 The permissible current ratings given in Table 16.8.2.1 refer to the ambient temperature of +45 °C.

The correction factors for converting the permissible current ratings to be introduced depending on the ambient temperature are stated in Table 16.8.2.5.

16.8.2.6 In choosing the cables for final branch circuits of lighting and cooking appliances correction factors or simultaneity factors are not applicable.

16.8.2.7 The cables shall be so designed that they could withstand maximum short-circuit current that occurs in the circuit considering time and current ratings of the protective devices and peak value of the prospective short-circuit current of the first one-half period.

Table 16.8.2.5 **Correction factors based on the ambient temperature**

Maximum permissible core temperature, °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

16.8.2.8 Cables installed in parallel and belonging to the same phase or pole shall be of the same type, be laid together and 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 Voltage drop on the cable connecting the generators with the main switchboard or the emergency switchboard shall not exceed 1 per cent.

16.8.3.2 Voltage drop between busbars of the main or emergency switchboard and any points of the installation shall not exceed 6 per cent of the rated voltage under normal operating conditions; for consumers supplied from the accumulator battery with the rated voltage up to 50 V this value may be increased to 10 per cent.

For circuits of navigation lights it may be required to limit the voltage drop by a lesser value in order to ensure necessary luminous intensity.

At short-term loads (e. g. when starting the electric motors) the greater voltage drop

may be permitted if it does not cause disturbance of normal operation of the ship's electrical installation.

16.8.3.3 The cables used for feeding the directly-started alternating current electric motors shall be computed in such a manner that the voltage drop on motor terminals at starting is not over 25 per cent of the rated voltage.

16.8.4 Installation of cables

16.8.4.1 Cables shall be installed in runs, which shall be, as far as possible, straight and accessible.

The cable runs shall pass through locations where cables are not exposed to oil, fuel, water and excessive external heating.

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

16.8.4.2 No cables shall be installed at a distance less than 50 mm from the double bottom and from the fuel and oil tanks.

Cable runs shall be installed at a distance not less than 20 mm from the shell plating, as well as from fireproof watertight and gas-tight bulkheads and decks.

16.8.4.3 For bunches of cables consisting of cable types, which have not been subjected to a bunch fire test, the following measures shall be taken during installation to limit the propagation of fire:

.1 fire-retarding divisions shall be used, B-0 class at least, (refer also to 2.1.2.5, Part VI "Fire Protection") where bunches enter the main and emergency switchboards, central control stations and consoles for the main propulsion plant and for important auxiliaries, as well as at each entry and exit point of cable runs in fully enclosed metal conduits (refer to Fig. 16.8.4.3,***a***);

.2 in closed and semi-enclosed rooms and spaces, bunches installed in partly enclosed and open cable runs shall be protected by:

flameproof coatings over the entire length of vertical cable runs and over a length of 1 m every 14 m apart – on horizontal cable runs (Fig. 16.8.4.3,***b***), or B-0 fire-retarding divisions at least at every second deck or every 6 m apart for vertical cable runs and every 14 m apart for horizontal cable runs (Fig. 16.8.4.3,***c***).

Cable runs protected with flameproof coatings made of steel plates at least 3 mm thick and having dimensions as shown in Fig.16.8.4.3,***c***;

.3 bunches installed in cargo holds shall be protected by B-0 fire-retarding divisions at least at the entry and exit points of cable runs.

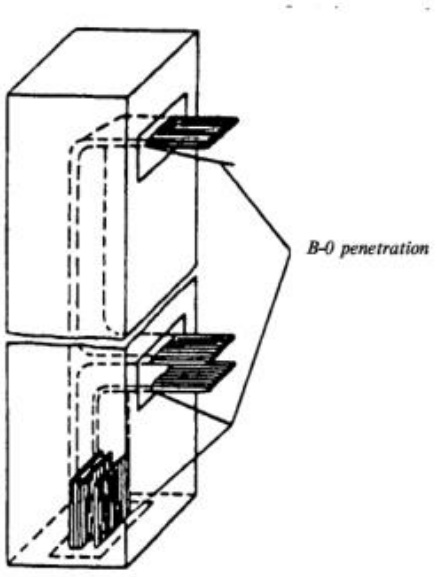


Fig. 16.8.4.3,***a***. Protection of B-0 fully enclosed cable run

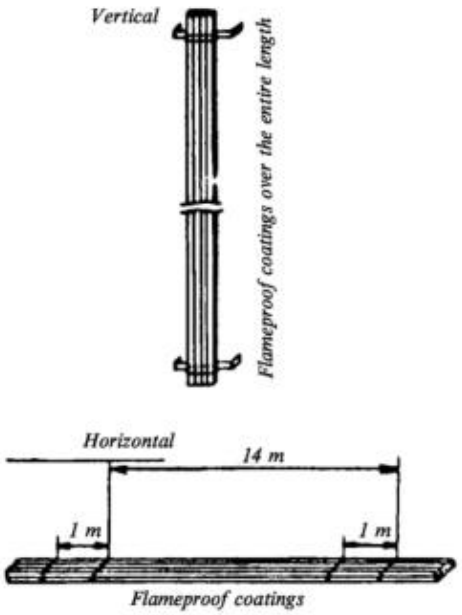


Fig. 16.8.4.3,***b***. Protection of a cable run with flameproof coating

16.8.4.4 Cables having external metallic sheaths may be installed on structures of light metal or be fastened in position by means of cable clips of light metal only in cases where reliable anticorrosive protection is provided.

16.8.4.5 In the holds of dry cargo ships intended for the carriage of dangerous cargoes, no through runs of cables shall, generally, be installed.

Where such cable-laying is necessary the requirements of 2.9 shall be fulfilled.

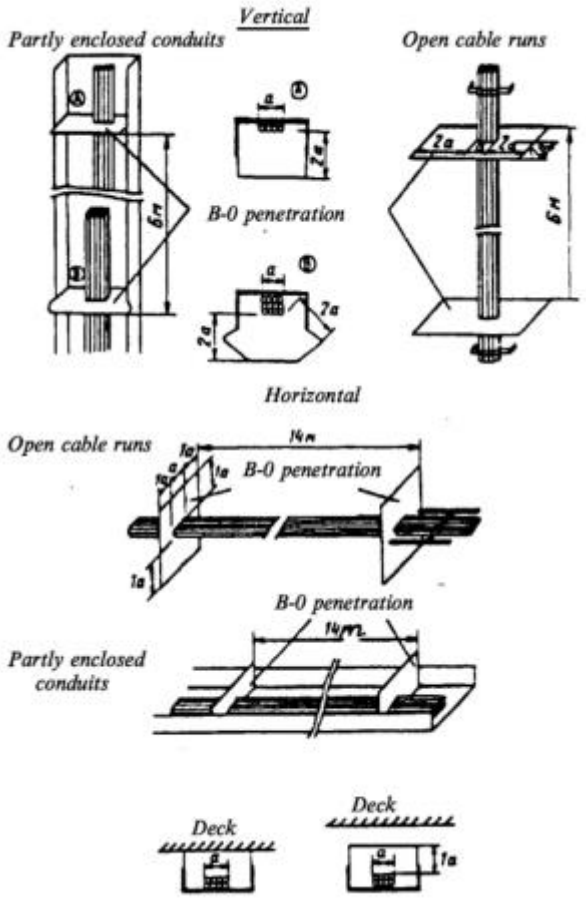


Fig. 16.8.4.3,*c*. Protection of cable runs with B-0 type fire-retarding structures

16.8.4.6 Cables installed in fishing vessels at locations subjected to the action of salt shall be adequately protected with casings or be provided with salt-resistant sheaths.

16.8.4.7 No cables are recommended to be installed under the flooring of machinery spaces. If such installation is required, cables shall be laid in metallic pipes or in closed conduits (refer to 16.8.8).

16.8.4.8 Cables installed across expansion joints in the hull structure shall be provided with expansion loops having a radius adequate for such joint. The inside diameter of a loop shall not be less than 12 outside diameters of the cables.

16.8.4.9 Installation of cables having insulation intended to withstand different permissible temperatures in the common cable runs shall 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 hard of which may be damaged shall not be installed in one common pipe, one common duct or in other runs of unsupported common laying.

16.8.4.11 Cores in multi-core cables shall not be used for supplying power and control currents to essential services not associated with one another.

Multi-core cables shall not be used simultaneously for safety voltage and service voltages exceeding the safety level.

16.8.4.12 When machinery is energized through two separate feeders, these feeders shall be installed in different runs as far apart as possible in horizontal and vertical directions.

16.8.4.13 When installing cables in ducts or other structures of combustible material, the ways of cable installation shall be protected from igniting
by means of suitable fire protection, such as lining, coating or impregnation.

16.8.4.14 Cables shall not be embedded into thermal or acoustic insulation in case it is made of combustible materials. Cables shall be separated from such insulation by the lining of non-combustible materials or shall be installed at a distance at least 20 mm from it.

When cables are laid in thermal or acoustic insulation made of combustible materials, they shall be computed with relevant reduction in current rating.

16.8.4.15 Cables installed in refrigerated spaces shall be provided with protective sheath of metal, polychloroprene composition, or of any other material resistant to the exposure of the cooling agent.

If cables are provided with armour, this armour shall be adequately protected against corrosion.

16.8.4.16 Cables in refrigerated spaces shall be installed on perforated panels or bridges and 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 shall be protected against corrosion.

If cables cross the thermal insulation of a refrigerated space, these cables shall run at right angles through an appropriate gland pocket on both ends.

16.8.4.17 When installing the cables, minimum internal bending radii shall be maintained in accordance with Table 16.8.4.17.

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

16.8.4.19 Cables laid on the open parts of the ship and masts shall be protected against direct exposure to sun radiation.

Table 16.8.4.17

Cable type		Outside diameter of the cable, mm	Minimum bending radius of the cable
Cable insulation material	Protective covering type		
Rubber or polyvinyl chloride	Metal band or wire armouring	Any	10*d*
	Metallic braid	Any	6*d*
	Lead alloy and armour	Any	6*d*
	Other coverings	Up to 9.5	3*d*
		9.5 to 25.4	4*d*

		Over 25.4	6*d*
Varnished cloth	Any	Any	8*d*
Mineral insulation	Metal	Up to 7	2*d*
		7 to 12.7	3*d*
		Over 12.7	4*d*
Ethylene-propylene rubber or cross-linked polyethylene	Semiconducting and/or metal	25 and more	10*d*

16.8.5 Fastening of cables

16.8.5.1 Cables shall be adequately fastened in position by means of clips, holders, hangers, etc., manufactured of metal or another non-combustible material.

The fastener surface shall be sufficiently wide, without sharp edges. The fasteners shall be selected in such a manner that the cables are securely fastened in position without damage to their protective coverings.

16.8.5.2 Distances between cable fastening points in case of horizontal installation shall not exceed the values given in Table 16.8.5.2.

When laying cable runs on cable ladders inside spaces the distance between cable fastening points may be enlarged up to 900 mm. Meanwhile, the distance between the supports of cable runs (ladder rung) shall not exceed 400 mm.

For vertical runs of cables these distances may be increased by 25 per cent.

16.8.5.3 Cables shall be fastened in such a manner that mechanical strains in cables, if any, are not transmitted to their inlets or connections.

16.8.5.4 Cable runs and cables installed parallel to shell plating shall be fastened to ship's structures.

On watertight bulkheads and masts, cables shall be fastened on special supports (saddles, tray plates, chocks, etc.).

Table 16.8.5.2

Outside diameter of the cable, mm		Distance between cable fastening points, mm, for cables		
over	up to	unarmoured	armoured	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

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

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

16.8.5.7 For ships constructed from

non-conducting materials it is permitted, due to the technology of hull construction from these materials, the properties of the materials used, etc., to accept the equivalents to the requirements for the installation, fastening and sealing of penetrations of cables and cable runs specified in the Rules for steel ships.

16.8.6 Cables penetrating decks and bulkheads

16.8.6.1 Cable penetrations through watertight, gastight and fire-resisting bulkheads and decks shall be sealed.

Sealings where cables penetrate through the above bulkheads and decks shall not reduce their tightness; no force shall be transmitted to cables resulting from elastic deformations of ship's hull.

16.8.6.2 When installing the cable through nontight bulkheads or elements of ship's structure less than 6 mm thick, linings or bushings that will prevent damage to cables shall be provided.

When bulkheads or ship's structure is 6 mm or more thick, no linings or bushings are required, but the edges of holes shall be rounded.

16.8.6.3 Installation of cables over watertight decks shall be effected by one of the following methods:

.1 in metal pipes (shafts) protruding above the deck to a height of not less than 900 mm in locations where mechanical damage to cable is possible and to a height not less than that of the door sill in spaces where there is no risk of such damage;

.2 in common metal sockets or boxes with additional protection of cables by enclosures having the height specified in 16.8.6.3.1.

Cable boxes shall be packed with cable compound, while the pipes shall be provided with glands or be stuffed with cable compound.

16.8.7 Packing compounds

16.8.7.1 To fill the cable boxes in watertight bulkheads and decks, the use shall be made of packing compounds having good adhesion to the inside surfaces of cable boxes and cable sheath 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 Packings of cable penetrations through fire-resisting bulkheads shall withstand standard fire test specified for the given type of bulkhead in 2.1.2, Part VI "Fire Protection".

16.8.7.3 The inside cross-section of each cable penetration shall be filled by cables to not more than 40 per cent.

16.8.8 Installation of cables in pipes and conduits

16.8.8.1 Metallic pipes and conduits wherein cables are installed shall be protected from corrosion on the inside and the outside surfaces. The inside surface of pipes and conduits shall be even and smooth. Ends of pipes and conduits shall 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 covering shall not be installed in pipes and conduits.

16.8.8.2 Pipe bending radius shall not be smaller than the permissible radius for cable of the largest diameter installed in this pipe (refer to 16.8.4.18).

16.8.8.3 The total cross-sectional areas of all cables measured on their outside diameters shall not exceed 40 per cent of the inside cross-sectional area of the pipe and the conduit.

16.8.8.4 The pipes and conduits shall

be mechanically and electrically continuous and securely earthed if the earthing has not been already effected by the method itself of pipe and conduit installation.

16.8.8.5 The pipes and conduits shall be installed in such a manner that no water can accumulate therein. When required, ventilation holes shall be provided in the pipes and conduits, as far as possible, in the highest and lowest points, so that circulation of air is ensured and vapour condensation is prevented. Holes in pipes and conduits are permissible only at places where it will not enhance the danger of explosion or fire.

16.8.8.6 Cable pipes and conduits installed alongside ship's hull, which can be damaged due to deformation of ship's hull, shall be provided with compensation devices.

16.8.8.7 If in accordance with 16.8.1.1, the use is allowed of cables with combustible covering, these cables shall be installed in metallic pipes.

16.8.8.8 Cables installed in pipes and conduits vertically shall be fastened so that they are not damaged under tension due to gravity.

16.8.8.9 It is allowed to use cable trays/protective casings of the approved type made of reinforced and plain thermoplastic polymeric materials like polyvinylchloride (PVC) or fibre reinforced plastic (FPR).

The protective casing shall have round or other closed cross-section.

16.8.8.10 Cable trays/protective casings made of polymeric materials shall be supplemented by metallic fixing and straps such that in the event of a fire they, and the cables affixed, are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route.

When cable trays/protective casings made of polymeric materials are used on open deck, they shall additionally be protected against UV radiation.

16.8.8.11 The load on the cable trays/protective casings made of polymeric materials shall be within the safe working load (SWL).

The support spacing shall not be greater than the manufacturer's recommendation nor in excess of spacing at the SWL test. In general the spacing shall not exceed 2 m.

The selection and spacing of cable tray/protective casing supports shall take into account: cable trays/protective casings' dimensions; mechanical and physical properties of their material; mass of cable trays/protective casings; loads due weight of cables, external forces, thrust forces and vibrations; maximum accelerations to which the system may be subjected; combination of loads.

16.8.8.12 The sum of the cables installed in cable trays/protective casings made of polymeric materials total cross-sectional area shall not exceed 40 per cent of the protective casing's internal cross-sectional area.

16.8.9 Special installation requirements for single-core A.c. cables

16.8.9.1 A.c. wiring shall not be carried out, as far as possible, in single-core cables. When, however, it is necessary to use single-core cables for circuits rated in excess of 20 A, the following precautions shall be observed:

.1 the cables shall be armoured with non-magnetic material;

.2 cables that belong to the same circuit shall be placed in the same run or metal pipe and shall be as short as practicable. Each of such cables may be installed separately under a non-magnetic screen (in a pipe) earthed at one point and isolated from the

screens of other cables and from the hull;

.3 cable clamps, unless they are made of non-magnetic material, shall include all the single-core cables of a circuit;

.4 the distance between the cables shall not be greater than one cable diameter.

16.8.9.2 Where single-core cables pass through bulkheads or decks, there shall be no magnetic material between cables that belong to the same circuit. The clearance between the cables and the magnetic material shall not be less than 75 mm.

16.8.9.3 When single-core cables having a current rating greater than 250 A are installed near steel structures, the clearance between the cables and the structure shall be at least 50 mm.

16.8.9.4 When single-core cables of a conductor cross-section of 185 mm^2 or over are installed, a transposition of phases shall be effected at intervals not exceeding 15 m. Where cable length is below 30 m, no transposition is necessary.

16.8.9.5 Multicore cables with conductors in parallel shall be installed as single-core cables, and all the requirements for single-core cables apply in this case.

16.8.10 Connection and tapping of cables

16.8.10.1 Ends of rubber-insulated cables to be introduced into machines, apparatus, switchgear and other equipment shall be provided with contact, protection and packing terminals that will ensure reliable electrical contact, will not permit moisture to penetrate inside the cable and will protect the insulation of cable cores from mechanical damage and effects of air and oil vapours.

At places of connection, rubber-insulated cable cores shall be provided with protective insulation against damage (wear, etc.).

16.8.10.2 Protective covering of a cable inserted into a device shall enter not less than 10 mm inside.

16.8.10.3 At places of tappings, connection of cables shall be effected in junction boxes by means of clamps.

16.8.10.4 If during the installation of cables it is necessary to make additional connections, these shall be effected in suitable junction boxes provided with clamps. The joint as a whole shall be protected from ambient conditions.

Other methods of cable connection approved by the Register may be allowed.

17. ELECTRIC PROPULSION PLANTS

17.1 GENERAL

17.1.1 The requirements of the present Section apply to all electric propulsion plants (EPP) and their components, as well as to manufacture, installation and tests including:

.1 generators and their prime movers;

.2 switchboards;

.3 transformers/reactors;

.4 semiconductor frequency converters;

.5 electric propulsion motors;

.6 excitation systems;

.7 EPP control systems, monitoring systems (alarm system, indication and logging systems), as well as safety devices;

.8 systems of power bus ducts and cable runs.

17.1.2 The requirements of this Section do not apply to bow and aft thrusters being auxiliary arrangements for ship's steering.

17.1.3 The requirements of the present Section and applicable requirements of other

Sections of the present Part are mandatory for ships with the character of classification supplemented with the mark **EPP** in compliance with the requirements of 2.2.12, Part I "Classification".

17.1.4 The electrical equipment of the EPP shall meet the requirements of other sections of this Part unless otherwise specified in this Section.

17.1.5 In electrical systems of EPPs, the voltages used shall not exceed those specified in 4.2 and Section 18.

17.1.6 It is recommended to provide electric heating in spaces enclosing electrical machines, switchboards and control panels.

17.1.7 Stationary lighting shall be provided underneath generators and motors of the electric propulsion plant.

17.1.8 Parts of electric propulsion machines (motors and generators) located under the floor shall have the degree of protection not below IP56.

Where they are installed in a dry compartment or protected against the ingress of water by a watertight foundation, and additionally, an alarm operating with the ingress of water in that compartment is provided, degree of protection IP23 may be allowed.

17.1.9 Provisions shall be made for arrangements preventing the generation and accumulation of moisture and condensate, in particular, while being idle for a long time, in casings of electric propulsion motors, generators, semiconductor frequency converters and other EPP components.

These arrangements may be electric heaters, air dryers, etc.

17.1.10 EPP shall be fitted with an arrangement for insulation resistance monitoring complying with the requirements of 2.11.

17.2 DEFINITIONS AND EXPLANATIONS

17.2.1 For the purpose of this Section the following definitions and explanations have been adopted:

Azimuth drive – drive which moves the propulsion unit around the vertical axis.

Main control station of the electric propulsion plant – control station of the main propulsion plant which is attended under seagoing condition.

Double sensor – a sensor with two sensor elements in one housing.

Local control station – control station located where a system is installed intended for selection and input of reference values for semiconductor frequency converters independent from reference values for remote control system and any external limitations.

Podded drive – propulsion system in which the electric propulsion motor is located in a dedicated, submerged unit (pod housing) of the ship.

Redundant sensor – two sensors in separate housings to control the same parameter.

17.3 CONFIGURATION OF ELECTRIC PROPULSION PLANTS

17.3.1 The electric propulsion plant includes:

.1 main generators of the EPP – at least 2;

.2 main switchboard separated into two parts with a section circuit breaker or break switch;

.3 power transformers for conversion of the main switchboard voltage to that of semiconductor converters – one per each converter;

.4 power semiconductor converters to supply the electric propulsion motor – at least 2;

.5 electric propulsion motor with two systems of stator windings each supplied from its semiconductor converter;

.6 control system.

17.3.2 For EPPs with one electric propulsion motor, synchronous and induction main propulsion motors shall have two systems of stator windings which can independently be disconnected from the relevant semiconductor frequency converter.

Each converter shall be designed for at least 50 per cent of the rated power of the electric propulsion plant.

17.3.3 Propulsion DC motors shall be of the double-armature (double-commutator) type with each armature winding designed for at least 50 per cent of the rated power of the plant. Each armature winding shall be supplied from its independent converter.

Any single failure in one converter shall not result in complete loss of power.

17.3.4 Provision shall be made for braking or locking devices for a propulsion shaft to prevent its free rotation with a switched-off propulsion motor (shaft) at any environmental conditions or during ship towing.

17.3.5 The EPP system shall follow the one failure principle, i. e. if any component of the EPP fails, a ship shall be underway at least at the partial power.

17.3.6 Provision shall be made for a warning alarm at all active control stations when any failure occurs in the EPP system.

17.3.7 For all auxiliary machinery and essential services, provision shall be made for local control stations to which control is transferred if any component of the remote automated control system of the EPP fails.

17.4 EXCITATION SYSTEMS

17.4.1 General

17.4.1.1 Every excitation system shall be supplied by a separate feeder. The obtainable current and voltage of the excitation system, as well as source of power shall fully comply with the requirements for all electric propulsion plant modes including manoeuvring, overcurrent and short circuit, as well as the capsizing moment conditions.

17.4.1.2 Power supply of excitation systems shall be protected against short circuits only.

The activation of an electromagnetic release at short circuit shall be supplemented with an alarm at control stations.

17.4.1.3 If the built-in short-circuit monitoring device of the excitation system trips, the respective circuit breaker of the generator or propulsion motor shall also trip.

17.4.1.4 If the excitation system is fitted with independent safety devices against underfrequency and over-voltage or U/f-functions, they shall be adjusted in such a way that the system protection reacts first.

17.4.1.5 Excitation circuits shall be provided with means for suppressing voltage rise when an excitation switch is opened (field suppression system).

17.4.1.6 Means (filters, etc.) shall be provided to limit harmonic distortions and reduce a power factor.

17.4.2 Generator excitation

17.4.2.1 Excitation systems shall be supplied from the generator, the generator shall be self-excited. The voltage built up shall be done without the aid of external sources of electrical power.

17.4.2.2 External source of electrical power may be used for exciter control circuits, as well as for initial excitation, provided it is redundant.

The external source of power shall be supplied from the main and emergency switchboards and, additionally, from the standby accumulator battery.

At least two external sources of power for all EPP generators shall be provided.

17.4.3 Electric propulsion motor excitation

17.4.3.1 The exciter shall be supplied directly from the same main switchboard section supplying the stator winding.

17.4.3.2 Excitation systems and automatic control systems shall be so designed that electric propulsion motors are protected from overspeeding in the event of the propeller breaking down or working clear of water.

17.5 ELECTROMAGNETIC COMPATIBILITY (EMC)

17.5.1 The EPP shall operate without malfunctions and failures being exposed to electromagnetic interference, and comply with the requirements of 2.2.

17.5.2 Equipment producing transient voltage, frequency and current variations shall not cause malfunctions and failures of other equipment on board, neither by conduction, induction or radiation.

17.5.3 If a total harmonic distortion value of 10 per cent is exceeded when operating the propulsion plant, the appropriate filtering and interference-free operation of any consumers shall be ensured.

17.6 PRIME MOVERS OF EPP GENERATORS

17.6.1 Permissible speed deviations

17.6.1.1 If electric propulsion plant generators are also used for supplying the ship network, frequency deviations with the relevant load variations shall meet the requirements specified in 2.11.3, Part IX "Machinery".

17.6.1.2 Where the speed control of the propeller requires speed variation of prime movers of the electric propulsion plant generators, the governors shall be provided with means for local control as well as for remote control.

17.6.1.3 The prime movers rated power and overload capacity shall be adequate to supply the power needed during transitional changes in operating conditions of the electrical equipment, as well as the electric propulsion plant load variations due to manoeuvring, at sea, including severe weather conditions.

17.6.2 Parallel operation

In case of parallel operation of generators, the control system used shall ensure stable proportional distribution of loads over the entire output range of the prime movers as specified in 3.2.2.

17.6.3 Reverse power

17.6.3.1 When manoeuvring from full ahead running to full speed astern the prime movers shall be capable of absorbing a proportion of the recuperated work without tripping due to overspeed (without tripping of the overspeed protective device as specified in 2.11.6, Part IX "Machinery") or reverse power.

17.6.3.2 To absorb a proportion of the recuperated work and to retard the speed of the electric propulsion motor in reverse, braking resistors may be used ensuring the necessary limits on the prime movers and electrical machines speed. The amount of recuperated work shall be limited by the automated control system of the EPP.

17.7 EPP GENERATORS

17.7.1 General

17.7.1.1 Generators operating with semiconductor converters shall be designed for the expected harmonics of the system.

A sufficient output reserve shall be provided to compensate the generator temperature rise, compared with the sinusoidal load.

17.7.1.2 Stator windings of generators with rated power output above 500 kVA shall be provided with temperature sensors.

17.7.1.3 EPP generators shall be fitted with cooling air cleaning filters for open-circuit and closed-circuit ventilation.

For alternating current brushless generators with closed-circuit ventilation the cooling air cleaning filters are not mandatory.

Ventilation ducts shall be arranged so as to prevent water ingress into the machine.

17.7.1.4 EPP generators may be used for supplying auxiliary electrical machinery and services provided voltage and frequency are stable under all conditions, including manoeuvring, in compliance with the requirements of 2.1.3.

17.7.1.5 No circuit breakers shall be fitted in excitation circuits of generators except those which remove excitation of machinery at short circuits or damages in the main current circuit.

17.7.1.6 Means of protection of generators shall comply with the requirements specified in 8.2.

17.7.2 Generator bearings and lubrication

17.7.2.1 Sliding bearing shells shall be easily replaceable.

Provision shall be made for checking the bearing lubrication. Adequate lubrication shall be provided even at the maximum potential trim. Provision shall be made for relevant seals to prevent oil ingress inside the generator.

17.7.2.2 In case of bearings with forced lubrication (under pressure), the following alarms, as a minimum, shall be provided at control stations:

.1 failure of lubricating system (failure of lubrication pump, loss of pressure in the lubrication pipe; no flow of lubricating oil, etc.);

.2 maximum temperature of each bearing.

17.7.2.3 Generators shall be fitted with backup (emergency) devices for bearings lubrication which, in the event of malfunction or failure of the main (working) lubricating system, provide adequate lubrication until the machine full stop.

17.7.2.4 To avoid damage to bearings, provision shall be made to ensure that no currents can flow between the bearing and the shaft for which purpose one of the bearings shall be galvanically isolated from the machine housing.

17.7.3 Generators cooling

17.7.3.1 In addition to thermometers, temperature sensors of cooling air shall be provided which shall initiate an alarm with the excess of a permissible temperature.

17.7.3.2 For machines with a closed circuit cooling and heat exchanger, the flow of primary and secondary coolants shall be monitored. An alarm shall be initiated with the flow failure.

17.7.3.3 Leakage-water and condensed moisture shall be kept away from the machine windings. Provision shall be made for an alarm to monitor leakage.

17.8 EPP SWITCHBOARDS

17.8.1 Electric propulsion plant switchboards shall meet the requirements of 4.6 and 18.6.

17.8.2 EPP system shall be fitted with an arrangement for insulation resistance monitoring (refer to 2.11).

17.8.3 Switches for routine switching in de-energized circuits of the electric propulsion plant shall be provided with an interlocking device to prevent their tripping under voltage, or false switching.

17.9 EPP POWER TRANSFORMERS

17.9.1 General

17.9.1.1 Transformers and reactors shall meet the requirements of Section 11 and 18.4.

17.9.1.2 Provision shall be made for at least two independent power transformers for the EPP. Only transformers with separate windings shall be used.

17.9.1.3 The winding temperatures of transformers used in electric propulsion plants shall be monitored with a sensor and indicator system.

17.9.1.4 For EPP transformers, ammeters on the main switchboard on the primary side in each phase shall be provided.

17.9.1.5 Each EPP transformer shall have overcurrent and short circuit protection on the primary and secondary side.

For protection on the secondary side, EPP semiconductor converter may be used.

17.9.2 Liquid cooled EPP transformers

17.9.2.1 Windings of liquid cooled transformers shall be completely covered by liquid, even for inclinations up to and including 22,5 °.

17.9.2.2 Transformers shall be provided with the necessary collecting and accumulating arrangements for coolant leaks.

Fire detectors and fire-fighting equipment shall be installed in the vicinity of the transformer.

The fire-fighting equipment may be manually operated.

17.9.2.3 Transformers shall be fitted with protection against gassing of coolant.

17.9.2.4 The coolant temperature shall be monitored with a sensor system.

A pre-alarm shall be actuated before the maximum permissible temperature is attained. When the maximum permissible temperature limit is reached, a separate sensor shall activate protection which switches off the transformer.

17.9.2.5 The coolant level shall be monitored by two sensors, one of them shall actuate an alarm and the other set up to the maximum permissible level shall switch off the transformer.

17.9.3 Air cooled EPP transformers

17.9.3.1 The operation of fans for transformers cooling, as well as the cooling air temperature shall be monitored with a sensor system.

An alarm shall be given at the excess of temperature or fan failure.

17.9.3.2 Where a closed circuit cooling air system with an air cooler is used, in addition to the requirements of 17.9.3.1, the following shall be monitored:

.1 the minimum flow of primary and secondary coolants (air and water);

.2 heat exchanger leakage to be alarmed.

The heat exchanger shall be so installed that water leakages and condensed moisture are kept away from the windings.

17.10 EPP SEMICONDUCTOR CONVERTERS

17.10.1 General

17.10.1.1 Converters shall meet the requirements of Section 12.

17.10.1.2 At least two entirely independent separate semiconductor converters shall be provided for the EPP.

17.10.1.3 Each converter shall be provided with a separate control system.

17.10.1.4 Two galvanically isolated speed sensors shall be provided for each control system. Common housing of both sensors is permitted.

17.10.1.5 If the converter feeds a permanently excited electric propulsion motor, a switch disconnector shall be fitted in the main "motor-converter" circuit which opens automatically in case of an inverter (rectifier) fault.

Devices shall be provided for such faults diagnosis.

17.10.1.6 EPP converters shall be designed for the nominal torque of the drive (nominal torque at a propeller shaft). Short-term overloads and speed variations (dips) resulting from overloads shall not lead to the activation of converter protection.

17.10.1.7 The cabinets for semiconductor converters shall meet the requirements of 4.6 and Section 18.

17.10.1.8 The cabinets for semiconductor converters shall provide for the quick exchange of power components. This can be achieved by use of modular design for separate thyristors, single phase thyristors or by another way.

17.10.2 Cooling of semiconductor converters

17.10.2.1 If converters are fitted with a forced-cooling system, means for its monitoring shall be provided.

In case of a failure of the cooling system, measures shall be taken to prevent the overheat and failure of the converter.

17.10.2.2 The cooling system shall be provided with an alarm system.

The alarm signal shall be generated by the reducing of a coolant flow and by high temperature of semiconductors.

17.10.2.3 Single failures in the converter cooling system shall not result in tripping all converters of the ship's electric propulsion plant.

17.10.3 Protection of semiconductor converters

17.10.3.1 Operational overvoltages in a supply system of converters shall be limited by suitable devices to prevent damage (breakdown) of thyristors.

17.10.3.2 A suitable control system shall ensure that the rated current of semiconductor elements is not exceeded under all normal and most severe conditions.

17.10.3.3 Power semiconductors shall not be damaged by direct short circuit at the terminals.

Protection by fuses against short-circuit currents is permitted.

The relevant feedbacks of the converter shall control (limit) the current in such a way, that no components are damaged when the converter is switched on to a blocked motor.

17.11 HARMONIC FILTERING

17.11.1 Line filters shall be used to ensure the required harmonic distortion on the main switchboard busbars at any step of propulsion.

17.11.2 Each individual filter circuits shall be protected against overcurrents and short-circuit currents.

The fuses in filter circuits shall be monitored.

Any fuse burnout shall be alarmed.

17.11.3 When designing and using line filters, their layout shall be designed for any conceivable line constellations.

In particular, self-resonance shall be excluded under any load conditions and operating generators constellations.

17.11.4 In case of several parallel filter circuits, the current symmetry shall be monitored.

An unsymmetrical current distribution in the individual filter circuits and the failure of the filter shall be alarmed.

17.12 ELECTRIC PROPULSION MOTORS

17.12.1 General

17.12.1.1 Stator windings of a.c. motors and interpole, mainpole and compensation windings of d.c. motors of electric machines with a capacity above 500 kW, shall be provided with temperature sensors.

17.12.1.2 Regarding the design and lubrication of electric propulsion motor (EPM) bearings, the requirements of 17.7.2 shall be met.

17.12.2 EPM cooling

17.12.2.1 The cooling system shall ensure sufficient cooling under all load and speed conditions.

17.12.2.2 EPMs shall be fitted with built-in temperature sensors which shall give an alarm signal with the excess of a permissible temperature.

17.12.2.3 For machines with a closed circuit cooling system and a heat exchanger, the flow of primary and secondary coolants shall be monitored.

17.12.2.4 Provision shall be made for an alarm to monitor leakage.

The heat exchanger shall be so installed that water leakages and condensed moisture are kept away from the windings.

17.12.2.5 If the cooling system of the propulsion motor fails, the emergency operation mode to ensure ship's manoeuvring under heavy navigating conditions shall be provided. Interventions by an operator for opening of emergency air flaps are permitted.

17.12.2.6 Air-cooled EPM shall be fitted with two forced-air fans, each having a capacity sufficient for normal operation of the electric motor. A visual signal indicating fans operation and an alarm on their shutdown shall be provided.

17.12.2.7 A liquid cooling system for multi-armature machines shall be independent for each armature.

17.12.3 Protection of EPP

17.12.3.1 Over-current protection in the main and excitation circuits shall be set sufficiently high so that there is no possibility of its operating due to the overcurrents caused by ship's manoeuvring, operation in heavy seas or in broken ice.

17.12.3.2 Short-circuit and over-current protection may be provided by the converter. Different electric propulsion motor designs (d.c., synchronous, induction and permanent-magnet excitation motors) shall be taken into consideration.

17.12.3.3 For electric propulsion d.c. motors provision shall be made for an independent overspeed (runaway) protection device as required in 2.11, Part IX "Machinery".

The EPM shall be capable to withstand overspeed up to the limit reached in accordance with the characteristics of the overspeed protection device at its specified operational setting.

17.12.3.4 The motor shall be capable to withstand a sudden short-circuit currents at its terminals under nominal load without damage.

Steady state short-circuit current of a permanent excited motor shall not cause thermal damages of the motor and the current carrying components (e. g. slip rings, cables, feeders or busducts).

17.13 SPECIAL REQUIREMENTS FOR PODDED DRIVES

17.13.1 General

17.13.1.1 If the space, where an electrical machine and other equipment are located, is inaccessible during operation and associated with special environmental conditions (high temperature, humidity, etc.), special measures shall be taken like use of highly reliable materials and components, adequate number of sensors, as well as special means for protection of components against flooding and damages.

17.13.1.2 The components, e.g. controls, sensors, slip rings, cable connections and auxiliary drives shall withstand undamaged the strength of vibration, of at least 4 g from 3 Hz to 100 Hz.

17.13.2 Sensors

17.13.2.1 Sensors which can only be changed during dry docking shall be constructed as double sensors, i. e. two sensor elements in one housing.

17.13.3 Bearings

17.13.3.1 Oil filling levels in bearing housings shall be monitored during operation and standstill.

Any oil leakage shall activate an alarm.

This applies to circulated lubrication systems as well. These systems shall additionally be equipped with lubricating oil flow monitoring. A flow level monitoring alarm shall be independent from the EPM control system.

17.13.3.2 The temperature of shaft bearings shall be monitored by an alarm and protection system.

The alarm shall be carried out in two steps: alarm and engine stop.

The protection system shall be independent from the temperature indication system for shaft bearings, and the alarm system.

17.13.4 Bilges in a pod housing

17.13.4.1 The water level in pod bilges and associated spaces shall be monitored with level sensors.

In addition to high level sensors in bilges operating for an alarm system, independent sensors to monitor a high emergency level shall be provided which prevent false operations and automatically stop the propulsion.

17.13.5 Fire detection system

An effective fire detection system with the adequate number of sensors of the relevant type shall be provided. The general requirements for such systems are specified in 7.5.

17.13.6 Accessible spaces (in a pod housing)

Sufficient illumination and ventilation shall be provided for accessible spaces of the pod housing where regular maintenance work and equipment inspection are carried out.

17.13.7 Protection of podded drives

17.13.7.1 Motors of more than 1 MW and all permanent excited motors shall be provided with protection against internal

faults that also monitors the connections between the semiconductor converter and the motor.

The power supply to the defective equipment shall be interrupted with an appropriate time delay and an alarm shall be given.

17.13.7.2 Humidity shall be monitored for motors with closed air cooling systems. The excess of the permissible humidity level shall be alarmed.

17.13.8 Motor supply lines

17.13.8.1 Cables operated at high temperature limits shall be installed separate from other cables. If required, splitters shall be provided to prevent contacts between cable sheaths.

17.13.8.2 IP protection for all terminals, cable glands and busbar connections shall be equal to motor protection, however, at least IP44. These requirements also apply to control cables.

17.13.9 Slip rings

17.13.9.1 Where data from feedback sensors, controlled variable sensors, etc. are transmitted via a data bus of slip rings, the busbar shall be duplicated.

Failure of each single busbar shall be alarmed.

17.13.9 Slip rings unit fitted with external forced cooling system shall be capable of operation without a cooling system for a certain period of time. The cooling system failure shall be alarmed.

17.13.10 Azimuth drive

17.13.10.1 Azimuth drive shall meet the requirements for steering gear in accordance with 5.5.

17.13.10.2 The single failure localization principle shall be ensured for all electrical and hydraulic components.

Safe operation of the ship shall be ensured independently of the rudder angle and ship's speed at any time a failure occurs.

The designer shall develop and submit for approval the "Failure Mode Effect Analyses" (FMEA).

17.13.10.3 The position of the azimuth drive shall be mechanically indicated on a scale at the drive location (steering compartment).

17.13.10.4 At least two independent electric drives shall be provided for each azimuthal unit for turn. One drive shall be supplied from the main switchboard and the other, from the emergency switchboard.

17.13.10.5 Azimuth electric drives shall be protected against overcurrent (by converter, if applicable) and short circuit.

They shall be able to supply 160 per cent of the torque necessary for the rated speed of movement in accordance with the requirements of 7.2.3, Part VII "Machinery Installations".

Azimuth drives with different design, e. g. hydraulic, shall also be able to fulfil the above requirements.

17.13.10.6 The thrust azimuth angle shall be limited to ± 35 °.

At low propulsion power rating and thus low ship's speed or crash-stop manoeuvre these limits may be disabled with the control system.

17.13.10.7 The thrust azimuth angle shall be limited related to the steps of the set ship's speed that the safety of the ship is not endangered (due to excessive thrust while turning).

The limitation (interlock) shall be provided redundantly and independently of the control of the azimuth angle (pod turning).

17.13.10.8 Reaching or exceeding the permissible limitations of the azimuth angle shall be alarmed. After triggering the limitation, it shall be possible to move the azimuth drive back to the permitted angles of the drive turn without manual reset.

17.13.10.9 The operation and indication equipment of the azimuth drive shall be arranged in such a way that the set direction of the propeller thrust or the direction of the ship's moving is clearly indicated.

It shall be clear to the operator whether the direction of the ship's moving or the direction of the propeller thrust of the electric propulsion plant was chosen.

17.13.10.10 The local control station for azimuthal unit shall be equipped with the following:

.1 ammeters for each supply system of each load component;

.2 azimuth angle (turn angle) indicators for each drive;

.3 power supply system readiness for operation indicators for each drive;

.4 power supply system disturbance indicators for each drive;

and provide for the following:

.5 power limitation (from converter);

.6 control from the main machinery control room;

.7 control from the navigation bridge;

.8 control from local control station;

.9 running indication for the associated propulsion drive.

The local control station can be activated locally at any time and shall have the highest priority.

17.14 EPP CONTROL SYSTEMS

17.14.1 EPP powerplant control systems

17.14.1.1 For power supply systems of electric propulsion plants with generators operating in parallel, the automated powerplant control system shall be provided which will ensure adequate power generation being consistent with the needs of specific operational modes of the electric propulsion plant, in transit/manoeuvre including.

Automatic load based disconnection of generators in manoeuvre mode is not permitted.

17.14.1.2 In case of under-frequency on main switchboard busbars, overcurrent or overload and reverse power, the propulsion power shall be automatically limited (to prevent de-energizing of main switchboard busbars).

17.14.1.3 If generators are running in parallel and one of them is tripping by protection system, the automated powerplant control system shall automatically reduce the electric propulsion plant load to protect the remaining generators against unacceptable overloads and ensure their operation at permissible loads.

The same requirement applies to the main switchboard busbars tiebreakers.

17.14.1.4 Tripping of the main switchboard busbars tiebreaker shall not lead to any malfunction of the system. It is not necessary that the powerplant control system remains in the automatic mode if the power supply system is split.

Any loss of the control system automatic functions shall be alarmed.

17.14.2 Location of the EPP control stations

17.14.2.1 EPP control stations may be located at any convenient place according to the ship's purpose.

Where control stations are arranged outside the machinery space, i. e. on the bridge or in other locations, control stations in the machinery space or main machinery control room shall be provided as well.

17.14.2.2 The local control station has a priority and shall be located in the vicinity of the drive or semiconductor converters.

Changes of EPP modes generated at this station shall be displayed by the system indicating a preset and executed commands.

17.14.2.3 Where several control stations are available, a control stations switch in the control station having a priority shall be provided. Such switch shall provide switching of any, but only one control station (central and wing stations on the navigation bridge are considered as one control station).

17.14.2.4 Each control station shall have an emergency stop device independent of the control system and the active (in "on" condition) control station.

17.14.3 Main and local control stations

17.14.3.1 At least two mutually independent main and local control stations shall be provided for EPP.

17.14.3.2 In case of damage, malfunctioning or loss of power supply of the main station control system, a local control station of the electric propulsion plant converters shall be provided.

17.14.3.3 The bridge shall be fitted with control systems such that the steering (azimuth thrust change) control system can operate independently of the speed and electric propulsion plant EPM reverse control system.

17.14.3.4 All electric propulsion plant alarms shall be acknowledged at the local control station.

Alarms which do not require any further intervention of the personnel can be acknowledged at the main control station (on the navigation bridge) with the mandatory follow-up acknowledgement at the local control station.

17.14.3.5 Restart of the EPP shall be possible from both (main and local) control stations, depending on which one has been preselected.

After the main switchboard de-energizing it shall be possible to restart the EPP at the main control station.

17.14.3.6 If the EPP is controlled from a panel or desk with the use of electric, pneumatic or hydraulic drive, the failure of any of these shall not result in EPP tripping, and each control station at the panel or desk shall be immediately ready for manual operation.

17.14.3.7 Mechanically linked control stations installed in the wheelhouse (on the navigation bridge) for their synchronous operation are permitted.

17.14.3.8 The remote control system of the EPP shall be so designed that no time delay is needed for the personnel to move a control handle at a control station to a new position.

17.14.3.9 The EPP control system shall be provided with an interlock to prevent the EPP activation with a shaft turning gear engaged.

17.14.3.10 Each control station shall have a visual indication on the control system being alive.

17.14.4 Measuring, indicating and monitoring equipment

17.14.4.1 Failures in measuring, monitoring and indicating equipment shall not result in failure of the EPP control system, e. g., failure of the actual value (speed) sensor or of the reference speed

value sensor shall not cause an excessive increase of propeller speed.

17.14.4.2 The local (active) control station shall be equipped with the following:

.1 ammeter for each power supply line of each load component (stator current of each winding, etc.), and also in the excitation circuit (for adjustable-excitation systems);

.2 voltmeter for each power supply line of each load component, and also for power supply of the excitation system (for adjustable-excitation systems);

.3 speed indicator for each shaft;

.4 "Powerplant ready for electric propulsion plant operation" indicator;

.5 "Powerplant disturbed" indicator;

.6 "Electric propulsion plant power limited" (from converter) indicator;

.7 "Control from the main machinery control room" indicator;

.8 "Control from the navigation bridge" indicator;

.9 "Control from the local control station" indicator.

17.14.4.3 The main control station (on navigation bridge) shall be equipped with the following:

.1 speed indicator for each shaft;

.2 each shaft power meter;

.3 "Powerplant ready for switching on" (additional generators) indicator;

.4 "Powerplant ready for electric propulsion plant operation" indicator;

.5 "Powerplant disturbed" indicator;

.6 "Electric propulsion plant power limited" indicator;

.7 "Request to reduce power" indicator – if not automatically controlled or "override" button pushed (cancellation of the plant automated control);

.8 "Control from the main machinery control room" indicator;

.9 "Control from the navigation bridge" indicator;

.10 "Control from the local control station" indicator;

.11 indication of the generators operating at the EPP;

.12 indication of power reserve (recommended).

17.14.4.4 When two or more control stations are provided for change of speed and angle of turn of CPP blades, both speed change and angle of turn of CPP blades indicators shall be provided at each control station.

17.14.4.5 The main machinery control room shall be equipped with the following:

.1 speed indicator for each shaft;

.2 each shaft power meter;

.3 "Powerplant ready for switching on" (additional generators) indicator;

.4 "Powerplant ready for electric propulsion plant operation" indicator;

.5 "Powerplant disturbed" indicator;

.6 "Electric propulsion plant power limited" indicator;

.7 "Request to reduce power" indicator – if not automatically controlled or "override" button pushed;

.8 "Control from the main machinery control room" indicator;

.9 "Control from the local control station" indicator.

.10 "Control from the navigation bridge" indicator;

.11 indication of the generators operating at the EPP;

The list of parameters controlled by the alarm system is given in Tables 17.14.4.5-1 and 17.14.4.5-2.

Table 17.14.4.5-1 **Controlled parameters of EPPs with a.c. electric propulsion motors (EPM): synchronous, permanently excited and asynchronous**

Controlled parameter	Limit value max./min.	Local meter	Alarm system, main machin. contr. room display	Load reduction	Automatic stop	Main contr. station (bridge), Gener. alarm sys.[1]
1	2	3	4	5	6	7
EPM						
Lubrication system	failure	gauge glass	X	X	X	X
Bearings temperature	max.	thermometer	X			X
Stator windings temperature	max.		X	X		X
Slip rings (synchronous EPM)	failure (arc)	sight hole	X			X
Water/air cooling system	failure		X			X
Inlet cooling air temperature	max.	thermometer	X			X
Cooling liquid	leakage		X			X
Speed	max.		X		X	X
Voltage regulation sys. (synchronous EPM)	breakdown		X		X	X
Stator and feeder insulation resistance	min.		X			X
Excitation sys., feeder insul. resistance (synchronous EPM)	min.		X			X
Transformers						
Windings temperature	max.		X	X		X
Cooling liquid	leakage		X			X
Cooling system	failure		X			X

End of Table 17.14.4.5-1

1	2	3	4	5	6	7
Converters						
Power system	failure		X		start	X
Cooling system	failure		X	X		X
Power section temperature	max.		X max. 1		X max. 2	X
Coolant flow	min.		X			X
Cooling liquid	leakage		X			X

Pre-alarm						X
Accident, breakdown			X		X	X
Rotor speed and position sensor (synchronous EPM)	failure		X			X
Emergency stop (converter off)			X		X	X
Semiconductor fuse	failure		X		X	X
Semiconductor temperature	max.		X	torque reduction		X
Voltage (d.c. link)	max.		X		X	X
Current (d.c. link)	max.		X		X	X
Converter outlet current	max.		X		X	X
EPM power system, ship's electric system:						
Harmonic filter	accident, damage		X			X

[1] General alarm system

17.14.5 Fail-safety of EPP control systems

17.14.5.1 EPP control systems with the use of processors shall comply with the requirements of Section 7, Part XV "Automation".

17.14.5.2 The loss of power or malfunctioning of any other control and monitoring systems shall not result in loss of propulsion and EPP control, ship's steering or azimuth drive.

17.14.5.3 Electric propulsion plant, azimuth drives and their control systems shall have self-check system and an alarm system to detect failures quickly.

17.14.5.4 The most probable failures, e. g. loss of power, wire failure or cable and wire short circuits, etc. shall result in the least critical of all possible new conditions of the ship (fail to safety).

Table 17.14.4.5-2 **Controlled parameters of EPPs with d.c. electric propulsion motors (EPM):**

Controlled parameter	Limit value max./min.	Local meter	Alarm sys., main machin. contr. room display	Load reduction	Automatic stop	Main contr. station (bridge), Gener. alarm sys.[1]
1	2	3	4	5	6	7
EPM						
Lubrication system	failure	gauge glass	X	X	X	X
Bearings temperature	max.	thermometer	X			X
Mainpole temperature	max.		X	X		X
Interpole and compensation windings	max.		X	X		X

temperature						
Water/air cooling system	failure		X			X
Inlet cooling air temperature	max.	thermometer	X			X
Cooling liquid	leakage		X			X
Speed	max.		X		X	X
Commutator and brushes	failure (arc)	sight hole	X			X
Armature current	max.		X		X	X
Armature circuit and feeder insulation resistance	min. (earth fault)		X			X
Transformers						
Windings temperature	max.		X	X		X
Cooling liquid	leakage		X			X
Cooling system	failure		X			X
Converters						
Power system	failure		X		restart	X
Cooling system	failure		X	X		X

End of Table 17.14.5-2

1	2	3	4	5	6	7
Power section temperature	max.		X max. 1		X max. 2	X
Coolant flow (direct cooling)	min.		X			X
Cooling liquid	leakage		X			X
Pre-alarm						X
Accident, breakdown			X		X	X
Armature speed sensor	failure		X			X
Emergency stop (converter off)			X		X	X
Semiconductor fuse	failure		X		X	X
EPM power system, ship's electric system						
Harmonic filter	accident, damage		X			X

[1] General alarm system

17.15 ELECTRIC COUPLINGS

17.15.1 General

17.15.1.1 Electric couplings shall be designed so that they are dismantled without the disassembly of a driving motor or reduction gear.

The design and location of couplings shall ensure free access for their maintenance, brush replacement and air gap measurements without dismantling the couplings.

17.15.1.2 Enclosures and end shields shall be made of steel or material of equivalent strength (refer also to 10.1.1).

17.15.1.3 The rotating parts of couplings, as well as their windings shall be designed and secured so that they do not get damaged in the event of a sudden stop.

Electric couplings shall not cause axial forces.

Balance ratio of electric couplings shall meet the requirements of 4.1.2, Part IX "Machinery".

17.15.1.4 The maximum torque under excitation forcing conditions shall not exceed the twofold rated torque of the coupling.

The requirements of this Subsection also apply to electric couplings fitted in other systems.

17.15.2 Protection and interlocking

The design of the coupling connection system or the interlock used shall be such that the coupling excitation during the main propulsion engine starting and reversing is prevented.

Where several driving motors operate on a common transmission, in order to prevent the simultaneous start of driving motors rotating in opposite directions, the interlock in the coupling excitation system shall be used.

17.15.3 Electric couplings excitation

Excitation windings of electric couplings shall be protected against overvoltage.

The excitation circuit of electric couplings shall include:

.1 a two-pole switch;

.2 a magnetic field discharging device;

.3 short-circuit protection.

18. ADDITIONAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT DESIGNED FOR A VOLTAGE IN EXCESS OF 1,000 V UP TO 15 KV

18.1 GENERAL

18.1.1 The requirements apply to three-phase a.c. systems with the rated voltage in excess of 1 kV where the rated voltage means the voltage between phases.

Unless otherwise specified in this Section, the requirements for design and installation for low-voltage equipment (up to 1,000 V) given in other sections of this Part also apply to high-voltage equipment.

18.1.2 Electrical equipment for a voltage over 1,000 V shall not be housed in the same casing (enclosure) with low-voltage equipment, unless the relevant segregation is provided or appropriate measures ensuring safe access for low-voltage equipment maintenance are taken.

18.1.3 Insulating materials used for electrical equipment shall ensure the insulation resistance of 1,500 ohms per 1 V rated voltage, but at least 2 megohms during the unit operation.

18.1.4 For monitoring of insulation status the systems for each feeder insulation monitoring shall be used. Such systems shall show direction to the damaged area and have visible and audible alarm at decrease of the monitored value below the specified level.

It is recommended to complete feeder monitoring systems with portable devices for search of insulation fault location.

18.1.5 At the entrance to special electrical spaces, a warning notice shall be provided indicating the voltage.

Enclosures of electrical equipment installed outside special electrical spaces shall be provided with warning notices indicating the voltage.

18.2 SYSTEM DESIGN

18.2.1 Distribution design

18.2.1.1 The following power distribution systems may be used for **three-phase a.c.** high-voltage plants:

insulated three-wire system;

three-wire system with the neutral earthed to the ship's hull through a high-capacity resistor or reactor;

four-wire system with the deadly earthed neutral.

18.2.1.2 Configuration of network for ensuring uninterruptible power supply.

The main switchboard design shall provide for the possibility of its separation into, as a minimum, two independent parts by means of a circuit breaker or disconnector.

Each part of sections shall be connected to at least one generator.

Where two independent main switchboards interconnected by cable jumpers are provided, circuit breakers shall be fitted at its both ends.

All the duplicated electrical drives shall be supplied from different main switchboards or its split sections.

18.2.1.3 Systems with earthed neutral.

18.2.1.3.1 Neutral points of generators running in parallel may be connected to a common bus before an earthing resistor or reactor fitted in a switchboard or immediately at the generators.

18.2.1.3.2 In case of an earth fault, the leakage current shall not exceed the rated current of the largest generator or the total rated current of a relevant main switchboard section and shall not be less than the triple minimum current required for earth-fault protection activation.

18.2.1.3.3 When the system is energized, at least one neutral earthing point shall be closed.

The electrical equipment in systems with a deadly earthed neutral connected to the hull through a high capacity resistor or reactor shall bear without damage the single phase-to-earth fault current during the time needed for protection device activation.

18.2.1.4 Neutral opening.

In the neutral wire of each generator, provision shall be made for a disconnector, which may cut out the neutral from earthing for insulation resistance measurements and generator maintenance.

18.2.1.5 Connections to the earthing impendance housing.

18.2.1.5.1 All earthing impedances of neutral points shall be connected to the hull.

The connection to the hull shall be so arranged that any circulating currents in the earth connections do not interfere with radio, radar, intercommunication and control equipment circuits.

18.2.1.5.2 It is allowed to connect all resistors or reactors to the common earthing busbar, which shall be connected to the ship's hull at least at two points.

18.2.1.6 Divided systems

18.2.1.6.1 Neutral connections to the hull shall be provided for each split group of main switchboard sections in divided systems with an earthed neutral.

18.2.2 Degrees of enclosures protection

18.2.2.1 General

Each part of electrical equipment shall have shielding enclosures corresponding to its location and environmental effect.

The requirements of IEC 60092-201 may be considered as minimum.

18.2.2.2 Electrical machines

A degree of protection by enclosure for electrical machines shall be at least IP23.

The degree of protection of machines lead boxes shall be at least IP44.

Motors installed in spaces accessible to unqualified personnel shall have the degree of protection of at least IP4X to prevent touching of live and rotating parts.

18.2.2.3 Transformers

A degree of protection by enclosure for transformers shall be at least IP23.

Transformers installed in spaces accessible to unqualified personnel shall have the degree of protection of at least IP4X.

The requirements of 18.7.1 apply to transformers without enclosures.

18.2.2.4 Switchgear, control panels and converters

A degree of metal **enclosures** protection for switchgear, control panels, static converter cabinets shall be at least IP32.

Switchgear installed in spaces accessible to unqualified personnel shall have the degree of protection of at least IP4X.

18.2.3 Insulation clearances

18.2.3.1Air clearances

Air clearances between live parts with different potentials or between live parts and earthed metal parts or the casing shall not be less than specified in Table 18.2.3.1

Minimum **clearances** for intermediate values of working voltages are assumed as for the next larger value of a standard voltage.

When selecting lesser **clearances**, special high-voltage impulse tests shall be performed to confirm admissibility of such an option.

Table 18.2.3.1

Rated voltage, kV	Minimum air clearance, mm
3(3.3)	55
6(6.6)	90
10(11)	120
15	160

18.2.3.2 Creepage distances

Creepage distances between live parts with different potentials and between live parts and the hull shall be selected on the basis of national and international standards.

For non-standard equipment parts within the busbar section of a switchgear assembly, the minimum **creepage** distances shall be at least 25 mm/kV, and behind current limiting devices, 16 mm/kV.

18.2.4 Protective devices

18.2.4.1 Faults on the generator side

In addition to the types of protection specified in 8.2, generators shall be provided with protection devices against an interphase fault in the cables connecting the generator and main switchboard, and against tum-to-tum faults inside the generator.

When this protection device is activated, the generator shall be shut off from the main switchboard and its excitations shall automatically be removed.

In distribution systems with deadly earthed neutral, the earth fault of a generator phase shall also result in the activation of protection.

18.2.4.2 Faults to earth

18.2.4.2.1 An audible and visual alarm shall be activated in a system in case of any earth faults.

18.2.4.2.2 Protection automatically disconnecting[3] a faulted circuit in case of earth faults shall be activated in low-impedance (deadly-earthed) systems.

18.2.4.2.3 In high-impedance earthed systems (systems with a neutral earthed through a high- resistance resistor), where the feeders outgoing from the main switchboard can not be disconnected at an earth fault, the insulation of electrical equipment supplied from these feeders shall be designed for the line voltage of the system.

18.2.4.3 Power transformers

Power transformers shall be protected against short circuit and overloading with circuit breakers.

Where the transformers are intended for running in parallel, the activation of protection on the primary side shall cause their automatic disconnection on the secondary side as well.

18.2.4.4 Voltage transformers for control systems and instruments

Transformers intended for supply of control circuits and instruments shall be protected against overloading and short circuits on the secondary side.

18.2.4.5 Fuses

Protective fuses shall be used for short-circuit protection.

No fuses for overload protection are allowed.

18.2.4.6 Low-voltage systems

Low-voltage distribution systems (up to 1,000 V) supplied from high-voltage transformers (systems) shall be protected against overvoltages associated with the ingress of a high voltage on the secondary (low voltage) side.

This may be achieved by:

earthing of the low voltage system;

appropriate neutral voltage limiters;

earthed screen between the primary and secondary windings of the transformer.

18.2.4.7 Protective earthing

Metal enclosures of electrical equipment shall be earthed by external flexible copper conductors having a cross-sectional area designed for a single-phase short-circuit current, but not less than 16 mm^2.

Earthing wires shall be marked.

Earthing conductors may be connected by welding or by bolts of at least 10 mm in diameter.

18.3 ELECTRICAL MACHINES

18.3.1 Stator windings of generators

Generator stator windings shall have accessible both phase and neutral ends to ensure the installation of the differential protection.

18.3.2 Temperature detectors

Electrical machines shall be fitted with built-in temperature detectors in their stator windings to actuate an audible and visual alarm whenever the temperature exceeds the permissible limit.

For built-in temperature detectors, means shall be provided to protect measurement circuits against overvoltage.

18.3.3 Tests.

In addition to the tests required for all electrical machines, high-frequency testing

1. The systems to be classified as effectively earthed (low impedance) if a coefficient of earthing is below 0.8, and ineffectively earthed (high impedance), 0.8 and over.

2. The factor of earthing means a ratio between a voltage "phase – earth" in a healthy, i. e. intact system, and a line ("phase – phase") voltage.

voltage tests, in accordance with IEC 60034-15, of individual phase windings (coils) of the machine shall be provided to demonstrate a satisfactory level of resistance to tum-to-turn faults caused by step-fronted switching surges.

18.3.4 Design

18.3.4.1 A machine casing, bearing shields, guards of air intakes and outlets shall be made of steel alloys.

Aluminium alloys for the above parts are not allowed.

18.3.4.2 A draining arrangement readily accessible for maintenance shall be provided in the lower part of a machine casing for removal of condensate.

Vertically-designed motors shall be fitted on their top with a rigidly secured canopy preventing the ingress of water and foreign objects inside the machine. A lower end shield shall be shaped so as to prevent accumulation of water in way of a bearing.

18.3.4.3 Lead boxes of machines shall be dimensioned so as to ensure:

necessary insulation distances between current-carrying parts and the casing;

necessary insulation distances between the phases;

a sufficient space for arrangement of connecting cable terminations and windings ends;

an opportunity to change the location of supply cable entries up to four positions at an angle of 90 °.

An individual terminal box shall be provided for instrument current transformers, heating anticondensation elements, temperature detectors, etc.

18.3.4.4 The leads of stator winding phases shall enter a separate terminal box, which is different from the ones for lower voltages, through a sealing gasket.

A separate terminal box may be provided for neutral leads.

Terminals for earthing cable cores shall be provided inside terminal boxes.

In this case, a reliable electrical connection between a machine casing and box body shall be ensured.

18.3.4.5 Motors having the rated power 1,000 kW and over shall be fitted with differential protection devices. For this purpose, a separate lead box shall be provided on a motor casing, located on the opposite side from the main box, in which a sufficient space for three current transformers and leads of neutral winding ends shall be provided.

18.3.4.6 Bearings temperature of motors with power of 1,000 kW and over shall be controlled by local indicators (devices).

Temperature detectors for remote control shall also be provided for each bearing.

18.3.4.7 In order to prevent the harmful effect of bearing currents, the bearing on the side opposite to a drive shall be electrically isolated from a casing.

Measuring the insulation resistance of an isolated bearing without its disassembly shall be made possible.

18.3.4.8 The design of plain bearings shall include:

local indicators of the lube oil level;

separate pump with a local pipeline, tank, cooler, filter and flow rate indicator when forced circulating lubrication is used;

possible fitting of instruments for vibration control, including pertinent cable lines, as well as of instruments for bearing wear measurements;

possible use of the motor starting interlock when lubrication fails.

18.4 POWER TRANSFORMERS

18.4.1 General.

18.4.1.1 Dry-type transformers shall meet the requirements of IEC 60076-11.

Dry-transformers in use shall have earthed screens between high and low voltage windings.

Liquid-cooled transformers shall meet the requirements of IEC 60076.

Oil-immersed transformers shall, as a minimum, be provided with the following alarms and protections:

"minimum liquid level" – alarm and automatic trip;

"maximum liquid temperature" – alarm and automatic trip or load reduction;

"high gas pressure in enclosure" – automatic trip.

18.4.1.2 Transformers located in spaces accessible to unqualified personnel shall have **a degree** of protection provided by enclosure of at least IP4X.

18.4.1.3 Where the low-voltage side of transformer has an insulated neutral point, a spark fuse shall be inserted between the neutral point of each transformer and ship's hull.

The fuse shall be rated for not more than 80 per cent of the minimum test voltage of services fed through the given transformer.

18.4.1.4 The equipment for monitoring the condition of insulation on the lower-voltage side of the unit or for detecting locations of this insulation damages may be connected to the fuse in parallel.

This equipment shall not interfere with the reliable operation of the fuse.

18.4.1.5 Effective means (e. g. heating) shall be provided to prevent condensation and moisture accumulation inside the transformers when de-energized.

18.5 CABLES

18.5.1 General

18.5.1.1 Cables shall be constructed in accordance with the requirements of IEC 60092-353 and 60092-354 or other equivalent standards.

18.5.1.2 For three-phase cable systems, triple-core cables with multiwire cores shall be used.

The cross-sectional area of the cable conductor for power circuits shall be at least 10 mm^2.

18.5.1.3 The construction, type and permissible current loads of the cables used are subject to the special consideration by the Register in each case.

18.6 SWITCHGEAR AND CONTROL GEAR ASSEMBLIES

18.6.1 General

Switchgear and control gear assemblies shall be constructed according to IEC 62271-200 and the following additional requirements.

18.6.2 Design

18.6.2.1 Mechanical construction

18.6.2.1.1 Switchgear shall be of the metal-enclosed type in accordance with the requirements of IEC 62271-200, or of the insulation-enclosed type in accordance with the requirements of IEC 60466, or in accordance with the requirements of national standards.

18.6.2.1.2 Switchboards shall be locked with a special key other than for lower-voltage switchboards and switchgear.

Opening of doors and withdrawal of separate part shall be possible only after disconnection of the panel or switchboard from the electric network.

18.6.2.1.3 Passageways for a switchboard and electrical equipment

inspection at least 800 mm wide and 1,000 mm wide between the bulkhead and switchboard, and between parallel switchboard sections respectively, shall be provided along the switchboards.

Where intended for maintenance, their width shall be increased up to 1,000 mm and 1,200 mm respectively.

The specified width of these passageways is required irrespective of the applied means of protection against contact, like doors, a net or insulated guardrails.

The doors, continuous bulkheads and net screens shall be at least 1,800 mm high.

The perforated bulkheads or net screens shall ensure a degree of protection not below IP2X.

Two insulated guardrails shall be fitted along the switchboard at the heights of 600 mm and 1,200 mm.

18.6.2.1.4 Live parts of electrical installation shall be located at a distance specified in Table 18.6.2.1.4.

18.6.2.2 Locking facilities

Withdrawable circuit breakers used in switchboards shall be provided with mechanical locking facilities in both service and disconnected positions.

For maintenance purposes, key locking of withdrawable circuit breakers and other equipment and fixed disconnectors shall be provided.

Withdrawable circuit breakers shall be located in the service position so that there is no relative motion between fixed and moving portions.

Table 18.6.2.1.4

Rated voltage, kV	Minimum aisle	Minimum distances of live elements from safety enclosures of different types, mm		
	height, mm	continuous doors and bulkheads	doors and net screens	insulated handrails
3(3.3)	2,500	100	180	600
6(6.6)	2,500	120	200	600
10(11)	2,500	150	220	700
15	2,500	160	240	800

18.6.2.3 Shutters

The fixed current-carrying contacts of withdrawable circuit breakers shall be automatically covered by insulating shutters when the circuit breaker is drawn out.

18.6.2.4 Earthing and interphase fault devices

In order to ensure the safe maintenance of high- voltage switchgear, an adequate number of devices for forced busbar fault and earthing for busbars and outgoing feeders shall be provided.

The device shall be designed for a maximum short-circuit current, and may be portable subject to special consideration by the Register.

18.6.3 Auxiliary supply system

18.6.3.1 Source **of supply**

Where a separate auxiliary electrical or another source of power is required for operation of circuit breakers and other switches, and also for protection devices, in addition to such a main source, a standby one, with energy supply shall be sufficient for at least two operations of all the components, shall be provided.

However, the circuit breaker releases activated due to overload, short-circuit or undervoltage shall be independent of any electrical sources of power.

The requirements does not preclude the use of releases activated by an operating voltage, provided that the control of tripping circuits and their supply system integrity

(continuity) is ensured, i. e. if the integrity of the circuits is broken or their supply system is faulty (fails), an alarm is activated.

18.6.3.2 Number of supply sources

At least one independent stand-by source of power supply for split main switchboards (refer to 18.2.1.1) for operation of circuit breakers and other switches, in addition to their own supply sources each fed from its own busbar system, shall be provided.

Where necessary, an emergency source of electrical power intended for activation of the machinery installation from fully de-energized or dead ship condition may be used for this purpose.

18.6.4 High-voltage tests

Every main and other switchboards shall be **tested** by high voltage of standard frequency.

The test **procedure** and voltage **values** shall meet the requirements of an appropriate national standard or IEC 62271-200.

18.7 INSTALLATION

18.7.1 Electrical equipment

18.7.1.1 Where high-voltage **equipment** is not contained but a special room forms the enclosure of the equipment, the access doors shall be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

At the entrance of the rooms or spaces where high-voltage equipment **is installed,** caution notes shall be placed, which indicate high voltage.

18.7.1.2 Electrical equipment shall be installed in special electrical spaces and shall have **a degree of protection** at least IP23 (refer also to 18.6).

When justified, the equipment may be installed **outside** the above spaces provided **its degree of protection** is at least IP44 and access to current-carrying parts of the **equipment** is only possible when the voltage is off and special tools are used.

18.7.1.3 A diagram of connections and a drawing of electrical equipment arrangement shall be available in the special **electrical space**.

18.7.2 Cables

18.7.2.1 Cable run laying

Cables shall not run through accommodation spaces. However, when required due to technological reasons, such laying is allowed in special enclosed transit systems (structures).

18.7.2.2 Segregation

High-voltage cables shall be segregated from cables for voltage below 1,000 V.

In particular, they shall not be run in the same cable bunch, nor in the same ducts or pipes, or in the same boxes with cables for a voltage 1,000 V and below.

Where high-voltage cables of different voltage ratings are installed on the same cable tray, the insulation distances between the cables shall not be less than those specified for a high-voltage cable as per 18.2.3.1.

18.7.2.3 Installation of cables

High-voltage cables shall be laid in earthed metallic pipes or metallic ducts, or shall be protected by earthed metallic enclosures.

Open installation of cables (on carrying pressed panels) is allowed if they have a continuous metallic armour, which shall be reliable and repeatedly earthed.

18.7.2.4 Cable terminations

Terminations in all conductors of high-voltage cables shall be effectively covered with a suitable insulating material.

In terminal boxes, if conductors are not insulated, phases shall be separated from earth and from each other by durable barriers of a suitable insulating material.

High-voltage cables, having a conductive layer between phases to control the electric field within the insulation, shall have terminations which provide electric stress control.

Terminations shall be of a type compatible with the insulation and jacket material of the cable and shall be provided with the means for earthing all metallic shielding components (metallic tapes, wires, etc.).

18.7.2.5 Marking

High-voltage cables shall be readily identifiable by suitable marking.

18.7.2.6 **Tests** after installation[4]

Before putting into service of a new high-voltage cable network or after its updating (repair or additional cables installation), each cable and its accessories (terminations, earthing ends, etc.) shall be tested by high voltage.

Tests shall be carried out after an installation resistance measurement.

When a d.c. voltage withstand test is carried out, the test voltage shall not be less than:

$1.6\ (2.5U_o + 2$ kV) for cables of a rated voltage U_o up to and including 3.6 kV; and

$4.2U_o$ for higher rated voltages,

where U_o is the rated power frequency voltage between each conductor and earth or a metallic screen, for which the cable is designed.

The test voltage shall be maintained for at least 15 min.

After completion of the test, the conductors shall be connected to earth for a sufficient time period in order to remove any trapped electric charge.

An insulation resistance measurement is then repeated.

When an a.c. voltage withstand test of high- voltage cable insulation is carried out (according to the manufacturer's recommendations), the test voltage shall not be less than the rated one, and applied voltage shall be maintained for at least 24 hours.

[4] Tests performed in accordance with IEC 60502 shall be recognized equivalent to the tests listed below by the Register.

19. REQUIREMENTS FOR ELECTRICAL EQUIPMENT PROCEEDING FROM SHIP PURPOSE

These requirements shall be considered amendments or supplements to the respective requirements as set forth in 1–18 of this Part of the Rules.

19.1 PASSENGER SHIPS

19.1.1 Supply and signalling

19.1.1.1 Electric drives of sea-water pumps, air compressors and control-and-signalling devices of automatic sprinkler systems shall be supplied directly from the main and the emergency distribution boards through separate feeders.

The feeders shall be connected to an automatic switch fitted near the pump of the sprinkler system. Normally, the switch shall be connected to the feeder from the main distribution board, and in case of supply failure it shall automatically switch over to the supply feeder from the emergency distribution board.

At the main and the emergency distribution boards, the switches of the feeders shall be clearly marked off and shall be permanently in the "on" position. No other switches shall be fitted to these feeders.

19.1.1.2 Supply cables of sea-water pumps, air compressors and control-and-signalling devices of automatic sprinkler systems shall not run through machinery casings, galleys and other enclosed spaces of high fire hazard, except where the above devices and machinery are installed in the spaces in question.

19.1.1.3 In saloons, in the way of stairs, passages and ladders to the boat deck, the lighting fixtures shall be supplied through two independent feeders at least (refer also to 6.2.3).

19.1.1.4 The supply systems of essential ship gear shall be so designed that a fire in one of the main vertical fire zone does not damage the above service supply systems in another main vertical fire zone.

This requirement may be considered satisfied where the main and emergency supply feeders of the services running through any such zone are as distant from each other as possible both vertically and horizontally.

19.1.1.5 General alarm system shall consist of two independent groups: one for passengers and the other for the crew.

A special alarm, operated from the navigation bridge or fire control station, shall be fitted to summon the crew. The alarm may be part of the ship's general alarm system the requirements for which are specified in 7.4.

In passenger ships with a low-power electrical plant or with a number of passengers less than 36, one group of general alarms is permitted.

19.1.1.6 A fixed fire detection and fire alarm system shall meet the following requirements (in addition to those set forth in 7.5):

.1 be capable of remotely and individually identifying each detector and manually operated call point;

.2 one section of automatic and manual detectors shall not be located in more than one main vertical zone;

.3 automatic detectors located within cabins, when activated, shall also sound or

enable sounding of an audible alarm in spaces they are installed in.

The audible alarm shall not be muted from the alarm panel.

19.1.2 Supply from emergency sources of electrical power

19.1.2.1 In passenger ships of unrestricted service and of restricted area of navigation **R1** and marked **A**, **A-R1**, the emergency sources of electrical power shall simultaneously supply, during 36 hours, the following services:

.1 emergency lighting:

of muster and embarkation stations for boarding life-saving appliances and spaces overboard where life-saving appliances are launched according to 2.3.4 and 2.7.7, Part II "Life-Saving Appliances" of the Rules for the Equipment of Sea-Going Ships;

of indicators of exits to the boat deck and notice- plates at the life-saving appliances;

of exits from the spaces where a large number of passengers, special personnel or crew members can gather simultaneously;

of alleyways, stairways and exits to the open deck in all accommodation and service spaces as well as passenger lift cars;

of machinery spaces and generator rooms with their local control stations;

of all control stations as well as main and emergency switchboards;

of emergency diesel generator spaces;

of a wheelhouse;

of a chartroom and radioroom;

of stowage positions for emergency and fireman's outfit and positions where manual fire alarms are fitted;

of steering gear compartments;

of positions of attendance upon emergency fire and bilge pump, sprinkler pump and starting positions of their motors;

of helicopter hangars and landing areas;

of a gyrocompass space;

of a medical space;

.2 navigation lanterns, lanterns of "Vessel not under command" signal and other lanterns required by Part III "Signal Means" of the Rules for the Equipment of Sea-Going Ships;

.3 radio equipment and navigational equipment according to the requirements of Parts IV "Radio Equipment" and V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships;

.4 internal communication, announcing and general alarm systems;

.5 fire detection and alarm systems, fire door control devices and indicators showing the position of fire doors specified in 2.2.3.3, Part VI "Fire Protection";

.6 daylight signalling lamps, sound signal means (whistles, gong, etc.), manual summoning signals and other signals as required under emergency conditions;

.7 one of the fire pumps, a pump of the automatic sprinkler system, an electric-driven pump of the pressure water-spraying system referred to in 3.4.7, Part VI "Fire Protection", as well as electrical equipment used to ensure operation of foam generators referred to in 3.7.3.7, Part VI "Fire Protection";

.8 emergency bilge pump and equipment essential for operation of remote-controlled bilge valves;

.9 services listed in 7.3.6 and 7.3.8, Part VI "Fire Protection" for Class **INF2** and **INF3** ships in accordance with classification given in 7.3.2, Part VI "Fire Protection", regardless of the area of navigation and tonnage of the ship;

.10 other systems, which operation will be considered by the Register to be vital for ensuring the safety of the ship and persons on board.

The services indicated in 19.1.2.1.3 to 19.1.2.1.6 may be fed from their own accumulator batteries located according to 9.2 and having a capacity sufficient for their supply for a period of 36 hours.

For ships of restricted areas of navigation **R2**, **R2-S**, **R2-RS**, **R3-S**, **R3-RS**, **R3**, **and R3-IN,** the period of 36 h may be reduced to 12 h;

.11 On ships marked **B-R3-S**, **B-R3-RS**, **C-R3-S**, **C-R3-RS**, **D-R3-S**, **and D-R3-RS,** the time required for simultaneous supply of services listed under 19.1.2.1.1 to 19.1.2.1.8 and 19.1.2.1.10 may be reduced at least up to:

12 h for ships marked **B-R3-S**, **and B-R3-RS**;

6 h for ships marked **C-R3-S**, **and C-R3-RS**;

3 h for ships marked **D-R3-S**, and **D-R3-RS**.

19.1.2.2 Emergency sources of electrical power shall ensure the supply of steering gear in accordance with 5.5.6.

19.1.2.3 Emergency sources of electrical power shall supply, for a period of 30 min, the following services:

.1 electrical drives of watertight doors together with their indicators and warning signals. Sequential operation of the doors may be permitted provided all doors are closed in 60 s;

.2 emergency electric drives of passenger lifts. Passenger lifts may be operated sequentially;

.3 supplementary lighting shall be provided in all cabins to clearly indicate the exit. Such lighting may be connected to an emergency source of power or have a self-contained source of electrical power in each cabin.

19.1.2.4 Where a generator serves as the emergency source of electrical power, it shall be:

.1 driven by an internal combustion engine (refer to 2.2.5, Part IX "Machinery");

.2 automatically started upon failure of the electrical supply from the main source of electrical power and automatically connected to the emergency switchboard; consumers stipulated under 19.1.2.7 shall be automatically supplied by the emergency generator.

The total time for starting and carrying the board by the generator shall not exceed 45 s;

.3 for an emergency, a transitional source of electrical power shall be provided, which shall be activated immediately upon de-energizing.

19.1.2.5 Where an accumulator battery is used as the emergency source of electrical power, it shall:

.1 operate without recharging and with voltage across its terminals within 12 per cent of rated voltage during the whole discharge period, where voltage variations across the terminals of accumulator battery connected to an electronic voltage converter are determined by the permissible range of voltage variation across the terminals of the converter;

.2 be automatically connected to the busbars of the emergency distribution board in case of supply failure and supply at least the services listed under 19.1.2.7 during the time stipulated by 19.1.2.1.

.3 on ships marked **C-R3-S**, **C-R3-RS**, **D-R3-S,** and **D-R3-RS**, less than 24 m long, separate consumers may be supplied from their own accumulator batteries properly arranged, with an adequate capacity for supply of the consumers during the period stipulated under 19.1.2.1.11.

19.1.2.6 For the emergency

transitional source of electrical power required by 19.1.2.4.3, an accumulator battery shall be used, which shall operate without recharging and with voltage across its terminals within 12 per cent of rated voltage during the whole discharge period.

Voltage variations across the terminals of accumulator battery connected to an electronic voltage converter are determined by the permissible range of voltage variation across the terminals of the converter, which shall not be above values specified in 2.1.3.1.

19.1.2.7 The capacity of the battery serving as a transitional source of electrical power shall be sufficient for supplying the services listed below during 30 min:

.1 lighting and necessary navigation lights according to 19.1.2.1.1 and 19.1.2.1.2;

.2 internal communication and announcing systems required in an emergency;

.3 general alarm system, fire detection and alarm systems, control devices of fire doors and indicators showing the position of fire doors specified in 2.2.3.3, Part VI "Fire Protection";

.4 daylight signalling lamps, sound signal means (whistles, gong, etc.), and other signals as required under emergency conditions;

.5 arrangements for closing watertight doors, their position indicators and signals warning of their closing.

Sequential closing is permitted;

.6 ship's security alarm system and AIS installation required by Part IV "Radio Equipment" and Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships.

Services listed under 19.1.2.7.2 to 19.1.2.7.6 may be supplied from their own accumulator batteries, which shall ensure their supply during the time necessary.

19.1.3 Electrically powered low-location lighting (refer to 8.5.5, Part III "Equipment, Arrangements and Outfit and Outfit")**.**

19.1.3.1 The low-location lighting system shall be connected to the busbars of the emergency switchboard so as to be powered by the main source of electrical power under normal circumstances and also by the emergency source of electrical power when the latter is in operation.

The low-location lighting system shall function at all times**.**

19.1.3.2 Where an accumulator battery is the emergency source of electrical power, its capacity shall be sufficient for powering the low-location lighting system for at least 60 min.

19.1.3.3 The additional emergency lighting required by 19.3.3 may be accepted to form partly or wholly the low-location lighting system, provided that such system complies with the requirements of 19.1.3.

19.1.3.4 The electrically powered low-location lighting system shall ensure the following minimum standards of luminance:

.1 for luminous surface of the planar source – 10 cd/m^2, the light band being not less than 15 mm in width;

.2 for the point source – 35 mcd in the directions of approach and viewing, while:

the direction of viewing for the sources located on a horizontal plane, i. e. on the deck, shall be within a cone with an angle of 60°, the axis of which is inclined at 30° (refer to Fig. 19.1.3.4.2-1);

the direction of viewing for the

sources located on a vertical plane, i. e. on the bulkheads (e. g. for marking of the door handles) shall be within a cone with an angle of 60°, the axis of which is perpendicular to the source installation plane (refer to Fig. 19.1.3.4.2-2);

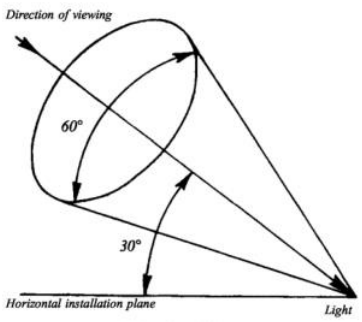


Fig. 19.1.3.4.2-1

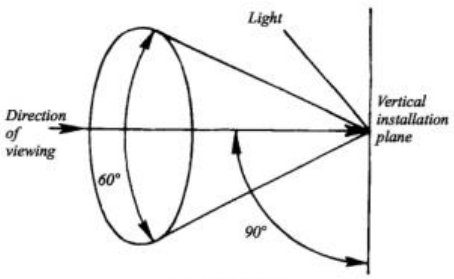


Fig.19.1.3.4.2-2

spacing between sources shall not exceed 300 mm.

19.1.3.5 Power supply of the LLL system shall be such that a failure of any single light or fire in one fire zone or on one deck does not result in lighting and escape route marking in another fire zone being ineffective.

19.1.3.6 Failure or damage, other than short circuit, of any single light, shall not result in loss of visible delineation of the escape route at a length of more than 1 m.

19.1.3.7 The electrical equipment (lights) shall be provided with a minimum degree of ingress protection of IP55.

19.1.4 Additional requirements for passenger ships having a safety centre

19.1.4.1 Internal communication shall comply with the requirements of 2.2.8.3 and 2.2.8.5, Part VI "Fire Protection".

19.1.4.2 General alarm shall comply with the requirements of 2.2.8.6.4, Part VI "Fire Protection".

19.1.4.3 Indication of closing watertight and fire doors shall comply with the requirements of 2.2.8.6.3, Part VI "Fire Protection".

19.1.4.4 Flooding detection system shall comply with the requirements of 2.2.8.6.8, Part VI "Fire Protection".

19.1.4.5 Indication of closing doors on passenger ro-ro ships shall meet the requirements of 2.2.8.6.7, Part VI "Fire Protection".

19.1.5 Additional requirements for passenger ships having length, as defined in 1.2.1 of the Load Line Rules for Sea-Going Ships, of 120 m or more, or having three or more main vertical zones

19.1.5.1 Steering systems and steering-control systems shall comply with the requirements of 2.2.6.7.2 and 2.2.6.8, Part VI "Fire Protection".

19.1.5.2 Lighting of safety areas shall comply with the requirements of 2.2.6.13.7, Part VI "Fire Protection".

19.1.5.3 Lighting along escape routes, at assembly stations and at embarkation stations of life-saving appliances, shall comply with the requirements of 2.2.7.4.2, Part VI "Fire Protection".

19.1.5.4 Internal communication shall additionally comply with the requirements

of 2.2.6.7.6, 2.2.6.8 and 2.2.7.4.4, Part VI "Fire Protection".

19.1.5.5 Flooding detection system shall comply with the requirements of 2.2.6.7.7 and 2.2.6.8, Part VI "Fire Protection".

19.1.6 Emergency lighting shall be provided at all cabins for clear exit identification for cabin occupants.

Such lighting powered from an emergency power supply or from its own power source at each cabin shall switch on automatically in the event of loss of power by the regular cabin lighting, and shall remain on for at least 30 min.

19.2 OIL TANKERS AND OIL RECOVERY SHIPS

19.2.1 General.

The requirements of the Subsection cover the electrical equipment of oil tankers and oil recovery ships intended for the carriage of petroleum products having a flash point 60 °C and below and petroleum products having a flash point 60 °C and above, which require heating up to a temperature less than 15 °C below the flash point.

The electrical equipment of oil tankers (> 60°C) and oil recovery ships (> 60°C) is covered by the requirements of 19.2.3.2.3.2, 19.2.5, 19.2.6.2 (refer also to 9.6.5, Part VIII "Systems and Piping").

The requirements of this Subsection specify the boundaries of dangerous zones, the division of ship's spaces and areas into zones, the installation of electrical equipment in hazardous spaces and areas in compliance with IEC 60092-502 "Electrical Installations in Ships – Tankers – Special Features".

19.2.2 Distribution of electrical power

19.2.2.1 For distribution of electrical power on board the ship, only the following systems may be used:

.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 voltage above 1,000 but not in excess of 11,000 Va.c.);

.4 three-wire system with neutral earthed through a high-value resistor for voltages above 1,000 but not in excess of 11,000 Va.c., provided that any possible resulting current does not flow directly through any dangerous spaces and areas.

19.2.3 Dangerous zones, spaces and areas

19.2.3.1 Classification of dangerous zones.

Classification of dangerous zones:

.1 Zone 0, in which an explosive gas/air mixture is continuously present or present for long periods.

.2 Zone 1, in which an explosive gas/air mixture is likely to occur in normal operation.

.3 Zone 2, in which an explosive gas/air mixture is not likely to occur, and if it occurs it will only exist for a short time.

19.2.3.2 Division of spaces and areas into zones.

19.2.3.2.1 Zone 0:

.1 internal areas of cargo compartments and tanks, cargo piping and transfer systems of recovered oil;

.2 open areas lying at a height up to 1 m from oil-covered water surface (for ships operating in the oil spill).

19.2.3.2.2 Zone 1:

.1 cofferdams and segregated ballast tanks adjoining cargo tanks as well as the forepeak, if served by a system connected

to ballast tanks installed in the cargo area;

.2 enclosed or semi-enclosed spaces containing cargo pumps or cargo piping, provided the latter is not all-welded;

.3 enclosed and semi-enclosed spaces above the deck of cargo compartments and tanks, which have their bulkheads above or level with the bulkheads of the cargo compartments and tanks;

.4 enclosed and semi-enclosed spaces immediately above cargo pump rooms and also above vertical cofferdams adjoining cargo compartments and tanks unless separated by a gastight deck and provided with mechanical ventilation;

.5 areas and spaces other than cofferdams adjoining cargo compartments and tanks and located below cargo compartment and tank top;

.6 areas and semi-enclosed spaces on the open deck within 3 m of any outlets other than ventilation outlets, cargo tank manholes and hatches, pump rooms and cofferdams adjoining cargo tanks, of cargo valves and cargo piping flanges, as well as areas on open deck within 3 m of open ends of vent pipes mentioned in 12.4.6, Part VIII "Systems and Piping"; Areas within breather valve outlets and gas outlet pipes of gas-extraction systems in accordance with 9.7, Part VIII "Systems and Piping";

.7 areas on open deck, or semi-enclosed spaces on open deck, according to 9.7.11, Part VIII "Systems and Piping", arranged in the vicinity of any cargo gas outlet equipped with high-speed devices to ensure the passage of large volumes of gas or vapour mixture at the rate of 30 m/s at least during cargo loading and ballasting or during discharging, 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;

.8 areas on open deck, or semi-enclosed spaces on open deck, within 1.5 m of cargo pump room entrances, cargo pump room ventilation inlet, openings into cofferdams or other zone 1 spaces;

.9 areas on open deck within spillage coamings and trays surrounding cargo manifold valves and 3 m beyond these, up to a height of 2.4 m above the deck;

.10 areas on the open deck above cargo compartments and tanks over the full breadth of the ship and 3 m fore and aft of their boundary bulkheads up to a height of 2.4 m above the deck as well as enclosed and semi-enclosed spaces within this area. For ships operating in the oil spill, this area is extended to cover the whole length of the ship;

.11 storage spaces for cargo hoses and equipment for collecting spilt oil (oil collectors);

.12 enclosed and semi-enclosed spaces having direct access or other openings into one of the above areas and spaces;

.13 spaces and areas above cofferdams adjoining cargo compartments and tanks, which are not divided by oil- and gastight bulkheads and decks, not adequately ventilated and entered from an upper deck.

19.2.3.2.3 Zone 2:

.1 areas above zone 1 over the full breadth and length of the ship to a height of 6 m above the deepest load waterline (for ships operating in the oil spill);

.2 internal areas of cargo compartments and tanks, slop tanks, cargo piping, transfer systems of recovered petroleum products having a flash point > 60 °C and their ventilation systems;

.3 areas on open deck or semi-enclosed spaces 4 m beyond the cylinder and 4 m beyond the sphere with the radius

of 6 m specified in 19.2.3.2.2.7.

.4 areas or spaces within 4 m of the areas specified in 19.2.3.2.2.6.

19.2.3.2.4 Spaces and areas not included in zones 0, 1 and 2 are considered safe.

19.2.3.3 Enclosed spaces having direct access to or other openings into areas listed under 19.2.3.2.2.10 are not regarded as dangerous if provision is made for appropriate self-closing gastight doors forming an air lock and, additionally, for mechanical supply ventilation with air suction from locations outside the dangerous zones.

19.2.3.4 In the case of ships operating in the oil spill, entrances, ventilation openings (both for suction and discharge) and other openings of safe spaces such as accommodation, service spaces and machinery spaces, control stations and wheelhouse, which have no gastight closures, shall not be located more than 6 m below the deepest waterline and, under all circumstances, shall be outside dangerous zones.

Entrances to safe spaces lying more than 6 m below the deepest waterline or within dangerous zones shall be provided with air locks. In such spaces, openings more than 6 m below the waterline shall bear gastight closures when operating in the oil spill.

19.2.4 Electrical equipment in hazardous spaces and areas

19.2.4.1 Only the following electrical equipment may be considered for zone 0 spaces:

.1 certified intrinsically-safe apparatus of category (*ia*);

.2 simple electrical apparatus and components (for example, thermocouples, photocells, strain gauges, junction boxes, switching devices, included in intrinsically-safe circuits of category (*ia*), not capable of storing or generating electrical power or energy for ignition of explosive mixture even in case of disconnection, short circuit or earth fault in the intrinsically-safe circuit;

19.2.4.2 Only the following electrical equipment may be considered for zone 1 spaces:

.1 any type that may be considered for zone 0;

.2 certified intrinsically-safe apparatus of category (*ib*);

.3 simple electrical apparatus and components (for example, thermocouples, photocells, strain gauges, junction boxes, switching devices, included in intrinsically-safe circuits of category (*ib*), not capable of storing or generating electrical power or energy for ignition of explosive mixture under normal conditions;

.4 certified flameproof type (*d*);

.5 certified pressurized type (*p*). In this case automatic shutdown is required when values of overpressure fall below minimum prescribed values;

.6 certified increased safety type (*e*);

.7 echo sounder transducers and their cables in compliance with the requirements of Part V "Navigational Equipment" of the Rules for the Equipment of Sea-Going Ships, cables of an impressed current cathodic protection system, housed within corrosion-resistant steel pipes with gastight connections up to the upper deck and not located adjacent to a cargo tank bulkhead (refer also to 16.8.4.2);

.8 through runs of cables.

19.2.4.3 The electric motors driving the arrangements located in pump rooms shall be installed in adjacent flameproof spaces (refer also to 4.2.5, Part VII "Machinery Installations").

The electric motors shall be fitted with remote shut-down devices located outside the spaces where the motors are installed and above the cargo tank deck (refer also to 9.4.4, Part VIII "Systems and Piping").

19.2.4.4 Lighting in pump rooms shall be interlocked with ventilation of these spaces in such a way as to ensure the possibility of the lighting switching on with ventilation in operation only. Failure of the ventilation system shall not result in the lighting switching off.

Emergency lighting, if fitted, shall not be interlocked with ventilation.

19.2.4.5 Only the following electrical equipment may be considered for zone 2 spaces:

.1 any type that may be considered for zone 1;

.2 tested specially, for example type (*n*) protection;

.3 the type which ensures the absence of sparks and arcs and of "hot spots" during its normal operation.

19.2.5 Portable electrical equipment used for collecting spilt oil

19.2.5.1 Portable equipment for collecting and transfer of oil shall be of safe type.

19.2.5.2 Distribution boards and socket outlets for supplying portable oil-collecting and transfer equipment on deck shall be permanently fitted in such a way that a cable connected to them would not pass through door coamings or other closed openings serving as a boundary of dangerous spaces and zones.

The design of such distribution devices and socket outlets shall provide for an interlock that would rule out the possibility of the portable electrical equipment being connected to them when energized and ensure protection from short-circuit currents and overvoltage in each phase.

19.2.5.3 Flexible cables for connection of portable electrical equipment used for collecting spilt oil shall have a metallic braid (screen) covered by an external proof sheathing of an oil-resistant material.

19.2.6 Installation of cables

19.2.6.1 On the decks of oil tankers and oil recovery ships, cables shall run on flying bridges in suitable conduits (grooves). Single cables may be laid in pipes. Where the flying bridges are within zone 1, cables in compliance with the requirements of 2.9.11 shall only be installed.

Cases not covered by this paragraph are subject to special consideration by the Register.

19.2.6.2 When cables are installed in conduits (grooves), the following requirements shall be met:

.1 cables in conduits (grooves) shall be loosely laid in rows on separators of non-metallic materials; in this case, the possibility of lateral displacement of the row (cable) shall be excluded. It is permitted to use methods of fixed pipeless installation of cables (in cable hangers, under clips), which shall be approved by the Register from the viewpoint of the design features; in case of fixed installation cables shall be laid in not more than two rows;

.2 cables shall not be in contact with metal parts of the conduit (groove);

.3 cables shall not be subjected to constant or variable tensions due to deformation of the ship’s hull and shall be protected from this deformation, especially in way of detachable or sliding connections between the gangway or platform and superstructures. In way of detachable or sliding connections of the gangway or platform provision shall be made for

expansion loops having the inside radius of not less than 10 diameters of the thickest cable;

.4 cables shall be protected from direct exposure to solar radiation, sea waves, oil products carried on board the ship and from mechanical damage;

.5 cables shall be separated from sources of heat by a distance specified in 16.8.4.1;

.6 cable runs on the passageway platform or in pipes inside spaces within zone 1, as well as expansion loops shall not be located below 300 mm from the cargo tank deck;

.7 metal sheaths or armours of cables shall be earthed at both ends. For final subcircuits earthing of the metal sheath may be effected only at the supply end.

19.2.6.3 In systems with voltages specified in 19.2.2.1.4, only cables having copper screens with additional insulation covering may be used. The cross-sectional area of a screen shall be at least the cross-sectional area of a conductor.

19.2.7 Integrated cargo and ballast systems

19.2.7.1 These requirements are applicable to integrated cargo and ballast systems on tankers, irrespective of the size or type of the tanker.

Within the scope of these requirements, integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps (including active control and safety systems and excluding passive components, e. g. piping).

19.2.7.2 Measures shall be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems.

19.2.7.3 The emergency stop circuits of the cargo and ballast pumps shall be independent from the circuits for the control systems.

A single failure in the control system circuits or the emergency stop circuits shall not render the integrated cargo and/or ballast system inoperative.

19.2.7.4 Manual emergency stops of the cargo pumps shall be arranged in a way that they do not cause the stop of the power pack making ballast pumps inoperable.

19.2.7.5 The control systems shall be provided with a duplicate power supply from the main switchboard.

The failure of any power supply shall provide audible and visible alarm activation at each pump control location.

19.2.7.6 In the event of failure of the automatic or remote control systems, a secondary means of control shall be made available for the operation of the integrated cargo and ballast system. This can be achieved by manual overriding and/or redundant arrangements within the control systems.

19.3 SHIPS INTENDED FOR CARRIAGE OF MOTOR VEHICLES WITH FUEL IN THEIR TANKS FOR THEIR PROPULSION

19.3.1 General

19.3.1.1 The requirements of this Subsection apply to electrical equipment of holds and other spaces and areas intended for the carriage of motor vehicles with fuel in their tanks necessary for their propulsion.

19.3.1.2 The holds and spaces specified in 19.3.1.1 belong to the category of dangerous spaces and zones.

19.3.1.3 Cables shall be protected

against mechanical damage. Cables installed horizontally shall be positioned at a distance not less than 450 mm above the continuous deck or platform preventing a free propagation of gases in the downward direction. The sealings where cables penetrate bulkheads and deck shall be gastight.

19.3.1.4 Electrical equipment installed in ventilation ducts shall be of the following safe types: increased safety (*Exe*) or with flameproof enclosure (*Exd*).

19.3.1.5 The lighting system in holds and spaces specified in 19.3.1.1 shall be arranged at least in two groups, each supplied separately from an independent circuit.

19.3.2 Installation of electrical equipment in holds and spaces intended for carriage of motor vehicles with fuel in their tanks in passenger ships and ferries

19.3.2.1 In holds and compartments, in spaces located at a height of more than 450 mm above the cargo deck or platform preventing free penetration of gases downwards, it is allowed to install electrical equipment:

with the degree of protection at least IP55 provided the ventilation system ensures at least 10 air changes per hour;

specially designed for use in Zone 2.

19.3.2.2 In holds and spaces above the bulkhead deck, in zones less than 450 mm above the deck or platform preventing free propagation of gases in the downward direction, electrical equipment installed shall be of the following safe types: intrinsically safe (*Exi*), with pressurized enclosure (*Exp*), with flameproof enclosure (*Exd*) or increased safety (*Exe*).

19.3.2.3 In holds and spaces below the bulkhead deck all the electrical equipment shall be of the following safe types: intrinsically safe (*Exi*), with pressurized enclosure (*Exp*), with flameproof enclosure (*Exd*) or increased safety (*Exe*).

19.3.3 Special requirements for passenger ships having ro-ro cargo spaces

19.3.3.1 In passenger ships with roll-on/roll-off cargo spaces or special-category spaces as mentioned under 1.5, Part VI "Fire Protection", apart from emergency lighting required by 19.1.2.1.1, additional emergency lighting shall be provided in all public spaces and corridors, that shall serve for 3 h at least under any heel of the ship and when all other electrical power sources fail.

This lighting shall make the escape routes clearly visible (or ensure an illumination intensity of 0.5 lx). Any damage to a lighting fixture shall be clearly visible.

19.3.3.2 As electrical power sources for this additional lighting, accumulator batteries shall serve fitted in lighting fixtures, continuously recharged from the emergency distribution board and replaced within the period established by the manufacturer with regard to their service conditions.

19.3.3.3 In each corridor of crew spaces, in crew recreation rooms and in each space where the crew members generally work, a hand lamp (lantern) shall be provided supplied from an accumulator unless additional emergency lighting stipulated by 19.3.3.1 and 19.3.3.2 is installed in the space.

19.3.4 Installation of electrical equipment in holds and spaces intended for carriage of motor vehicles with fuel in their tanks in cargo ships

19.3.4.1 In holds and compartments, in spaces located at a height of more than

450 mm above the cargo deck or platform preventing free penetration of gases downwards, it is allowed to install electrical equipment:

with the degree of protection at least IP55 provided the ventilation system ensures at least 10 air changes per hour;

specially designed for use in Zone 2.

19.3.4.2 In holds and compartments located at a height of more than 450 mm above the cargo deck or platform preventing free penetration of gases downwards, electrical equipment installed shall be of the following safe types: intrinsically safe (*Exi*), with pressurized enclosure (*Exp*), with flameproof enclosure (*Exd*) or increased safety (*Exe*).

19.4 SPECIAL PURPOSE SHIPS

19.4.1 Supply of essential services

In special purpose ships carrying more than 60 persons, the power supply of essential services shall comply with 19.1.1.4.

19.4.2 Emergency sources of electrical power

19.4.2.1 In special purpose ships carrying not more than 60 persons, the emergency source of electrical power shall comply with 9.3.

Ships with a length above 50 m shall additionally comply with 19.1.2.3.1.

19.4.2.2 In ships carrying more than 60 persons, the emergency source of electrical power shall comply with 19.1.2.

19.4.3 Electrical equipment in storerooms for explosives

19.4.3.1 Except for lighting fixtures in glass hoods and protection gratings, and cables in gastight pipes, no electrical equipment shall be installed in storerooms for explosives specified in 6.2.2, Part VI "Fire Protection".

19.4.3.2 Switches of lighting circuits shall be fitted outside storerooms for explosives and shall be provided with light signals to indicate the presence of voltage in the lighting fixtures.

19.4.3.3 In storerooms for explosives, the devices for connection of portable electrical equipment to the ship's mains shall be provided with nameplates indicating the rated electrical parameters and shall have a protective enclosure not below IP56 type.

19.4.4 Ships used for processing the living resources of the sea and not engaged in their catching

19.4.4.1 Survey of electrical equipment

In addition to the requirements of 1.3.2, the electrical equipment of processing machinery (catch processing) is subject to survey on board the ship (refer also to 1.3.2.4.1).

19.4.4.2 Survey during manufacture of electrical equipment

The electrical equipment of processing machinery specified in 19.4.4.1 is subject to survey during manufacture in addition to that listed in 1.3.3.1.

Use of electrical equipment specified in 19.4.4.1, which does not fully meet the requirements of sections 1 to 18, is subject to special consideration by the Register.

19.4.4.3 Structural requirements and protection of electrical equipment of processing machinery and refrigerating plants

19.4.4.3.1 The electrical equipment installed in catch processing spaces shall be resistant to seawater and fish processing products or shall be adequately protected.

19.4.4.3.2 The electric motors of the processing refrigerating compressors, fans

of the refrigerated holds and freezing apparatus and, where justified, the electrical equipment of other processing machinery shall be provided with heating arrangements to maintain a temperature which is at least 3 °C higher than the ambient temperature.

19.4.4.3.3 Distribution gear and start, control and protection devices of electrical equipment specified in 19.4.4.3.1 shall be installed in special electrical spaces.

19.4.4.3.4 Cables installed in spaces subjected to prolonged influence of salt and other products of fish processing shall be provided with sheaths resistant to such influence or be adequately protected.

19.4.4.4 Composition and capacity of main electrical power source

19.4.4.4.1 The composition and capacity of the main source of electrical power shall be determined with regard to the following operating conditions of the ship:

running conditions;

manoeuvring;

in case of fire, hole in the ship's hull or other conditions affecting the safety of navigation, with the main source of electrical power in operation;

processing.

19.4.4.4.2 The capacity of generators composing the main electrical power source shall be such that if any of them fails, the rest will ensure power supply of electrical equipment necessary under conditions specified in 19.4.4.4.1 as well as minimal habitable conditions to persons on board.

19.4.4.5 Distribution of electrical power

19.4.4.5.1 Where the main electrical power source incorporates shaft generators not intended for operation in parallel with the independently driven generators, the machinery and systems ensuring propulsion, manoeuvrability and safety of navigation shall be supplied from the busbars of independently driven generators, while the electrical equipment of processing refrigerating plant and machinery shall be supplied from the busbars of shaft generators.

19.4.4.5.2 The electric drives of processing refrigerating compressors shall be supplied by separate feeders from the busbars of the main switchboard. These drives may be fed from a separate switchboard supplied by two feeders connected to different sections of the main switchboard.

19.4.4.5.3 Electrical circuit for supplying switchboards of the processing machinery (catch processing) shall be separated electrically (galvanically) from the ship's mains.

19.4.4.5.4 If provision is made for electrical power transmission to other ships, a power transmission switchboard separated electrically (galvanically) from the ship's mains shall be installed.

19.4.4.5.5 Where portable tools and movable mechanization facilities not permanently installed, are supplied from a circuit of more than 50 V, a safety isolation device in combination with a separating transformer shall be used for each consumer. Such device shall interrupt power supply if the hull leakage current exceeds 30 mA.

19.4.4.6 Lighting

19.4.4.6.1 Catch processing spaces and refrigerating machinery rooms shall be illuminated by stationary lighting fixtures, which shall be supplied and arranged in accordance with 6.2.3.

19.4.4.6.2 Fish storage holds shall be illuminated with stationary lighting fixtures,

which shall be supplied in accordance with 6.2.7.

19.4.4.7 Signalling

A "Man-in-hold" signal push-button shall be located inside the refrigerated holds at each exit to actuate signal at the wheelhouse or another permanently attended space.

19.4.4.8 Emergency electrical installations

19.4.4.8.1 The emergency source of electrical power shall comply with the requirements of 9.3.

19.4.4.8.2 In addition to the requirements of 9.3.1.1, the emergency source of electrical power shall supply the emergency lighting for the catch processing spaces and their exits as well as for the deck in way of fishing machinery.

19.4.4.8.3 Where a diesel generator is used as the emergency source of electrical power, an emergency transitional source of electrical power (accumulator battery) shall be provided, with the capacity sufficient to supply the consumers specified in 9.3.7 and 19.10.8.2 for 30 min.

19.5 CONTAINER SHIPS

19.5.1 General

The requirements of this Subsection apply to the electrical equipment of ships intended for the carriage of thermal containers.

19.5.2 Supply and distribution of electrical power

19.5.2.1 Prescribed power of electrical equipment of thermal containers shall be taken as their rated power. The consumed power of the electrical equipment of thermal container shall not exceed 15 kW (18.75 kVA) under rated operating conditions.

The application of correction factors is subject to special consideration by the Register in each case.

19.5.2.2 The overload protective device of sources of electrical power prescribed in 8.2.3 shall ensure disconnection of thermal containers from the main switchboard last (refer also to 20.2.1).

19.5.2.3 The electrical circuit supplying the equipment of thermal containers shall be separated from the ship's mains by transformers with separate windings, fed from the main switchboard.

19.5.2.4 The electrical installations of thermal containers shall be fed from special distribution gear energized by separate feeders.

19.5.2.5 Socket outlets installed in cargo holds or on open decks in areas of stowage of thermal containers shall be supplied by separate outgoing feeders from the special distribution gear (switchboards) specified in 19.5.2.4 and 19.5.3.3.

19.5.2.6 The electrical circuit of socket outlets intended for supply of the electrical installations of thermal containers shall be rated for 220/380 V at 3-phase alternating current, 50 Hz, or for 240/440 V at 3-phase alternating current, 60 Hz.

19.5.2.7 For each isolated network of sockets monitoring of insulation resistance shall be provided (refer to 2.11).

19.5.3 Distribution gear and transformers

19.5.3.1 The distribution gear (switchboards) of thermal containers, electrical converters, if any, and transformers with separate windings shall be installed in special electrical spaces.

19.5.3.2 The secondary winding of transformers with separate windings shall have an isolated zero point.

19.5.3.3 Each distribution gear

(switchboard) shall be equipped with appliances, which ensure:

.1 visual signalling to indicate the presence of voltage;

.2 connection and disconnection of each outgoing feeder supplying the socket outlets;

.3 short-circuit protection at the outgoing feeders supplying the socket outlets;

.4 measuring of insulation resistance with visible and audible alarm at the main machinery control room at decreasing of the controlled value below the specified level.

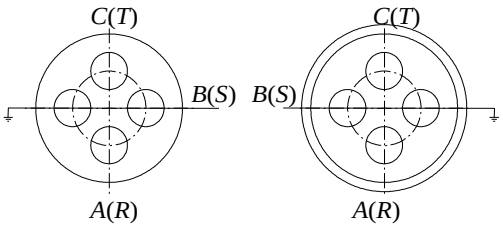
19.5.4 Socket outlets

19.5.4.1 In holds containing thermal containers it is allowed to install socket outlets used only for power supply of containers with the degree of protection not less than IP55 type, and on open decks – IP56 type.

When the electrical systems of remote control over temperature, humidity, ventilation and other characteristics of thermal containers are used, it is permitted to install additional socket outlets for connection of these control devices in holds or on decks.

19.5.4.2 Socket outlets for power supply of the electrical equipment of thermal containers shall, in addition to requirements of 6.6, be fitted with an isolating switch interlocked so that the plug cannot be inserted or withdrawn while the switch is in the "on" position. A nameplate indicating the voltage shall also be fitted.

19.5.4.3 The electrical installation of thermal containers shall be supplied from the ship's mains at the direct sequence of phases *A*(*R*), *B*(*S*), *C*(*T*) according to the scheme given in Fig. 19.5.4.3.



Plug (front view) Socket (front view)

Fig. 19.5.4.3

19.5.4.4 Socket outlets intended for supply of the electrical installations of thermal containers shall be rated at the following currents:

63 A for voltage of 220 V, 50 Hz or 240 V, 60 Hz;

32 A for voltage of 380 V, 50 Hz or 440 V, 60 Hz;

19.5.4.5 Socket outlets shall be designed so as to prevent connection of plugs rated for one voltage to socket outlets rated for another voltage.

19.5.4.6 Design and dimensions of plugs and sockets shall correspond to international standards.

19.5.5 Protection earthing

The receptacle intended for connection of the earthing conductor in the flexible cable of the thermal container shall be grounded through the earthing conductor in the supply feeder, where the distribution gear (switchboard) is installed for supply of socket outlets of thermal containers.

19.6 CATAMARANS

19.6.1 In each hull of the ship at least one generator being a part of the main source of electrical power shall be provided.

19.6.2 A main distribution board shall be installed in each hull. One of the boards may be installed above the bulkhead deck.

19.6.3 The busbars supplying the ship hulls shall be sectioned.

19.6.4 The emergency services of each hull shall be supplied from the emergency source of electrical power through separate feeders.

19.6.5 The disconnecting switches of electrical equipment specified in 5.7.1, 5.7.2, 5.8.1, 5.8.2 and 5.8.3 shall be grouped separately for each hull.

19.7 FLOATING CRANES AND CRANE SHIPS

19.7.1 Where systems similar to those mentioned in Section 17 are used for crane machinery of floating cranes and crane ships, the requirements of this Section being also applicable to the electric drives of crane machinery, such systems fall, as far as practicable, under the relevant requirements of this Section.

19.7.2 For self-driven floating cranes, the capacity of the main source of electrical power shall be sufficient for the selective operation of the crane both underway and during cargo-handling operations.

19.7.3 Accumulator rooms, accumulator boxes and spaces containing emergency sources of electrical power may be located below the bulkhead deck, provided all the requirements of 9.2 and 13.2 are satisfied.

19.7.4 To produce sound signals during cargo handling operations, a sound-signal means shall be fitted on the crane, activated from the operator's cabin.

19.8 FLOATING DOCKS

19.8.1 General

The requirements of this Subsection cover the electrical equipment of steel floating docks in addition to the relevant requirements set forth in Sections 1 to 18.

19.8.2 Survey of electrical equipment

19.8.2.1 In addition to requirements of 1.3.2.1, the following types of equipment, systems and devices are subject to survey on board the floating dock:

.1 electric drives with systems of control and monitoring of the mechanisms ensuring submersion and emersion of the dock;

.2 earthing of the docked ship.

19.8.2.2 All types of electrical equipment used in steel floating docks and listed under 1.3.3.1 and 19.8.2.1 are subject to survey during manufacture.

In particular cases, for machinery and gear of non-autonomous docks, it is allowed to use the electrical equipment manufactured out of full conformity with Sections 1 to 18 and without the Register survey, subject to special agreement with the Register.

19.8.3 Protective enclosures of electrical equipment

Protective enclosures of the electrical equipment shall be in compliance with Table 2.4.4.2 considering that dry compartments of the dock wing walls refer to the spaces of increased humidity, and dry compartments of pontoons, tunnels in pontoons and other similar spaces refer to the extra humid category.

19.8.4 Earthing

19.8.4.1 Each docked ship shall be earthed to the dock hull through at least two special flexible cable connectors having a cross-sectional area not less than 70 mm^2 each, and devices for connection thereof to the dock hull shall be provided at the dock.

19.8.4.2 To connect the dock hull to the shore earthing system, it is necessary to provide at least two flexible copper cables, having a cross-sectional area not less than 70 mm^2 each, and also a device for connection of these cables to the dock hull.

No metal earthing of the dock hull is needed if a system of cathodic protection from corrosion is applied, and circuits of the dock are electrically separated from the shore circuits.

19.8.4.3 All sections of the dock hull, pontoons, wing walls and similar structures shall be electrically connected by reliable means.

19.8.5 Number and output of sources of electrical power

19.8.5.1 Main sources of electrical power for docks may be as follows:

.1 for autonomous docks – intrinsic generators;

.2 for non-autonomous docks – shore electrical power system.

19.8.5.2 At least two generators and, in addition, a shore electrical power system, if necessary, shall be provided as main sources of electrical power on autonomous docks.

For non-autonomous docks only a shore electrical power system may be used.

19.8.5.3 The power of main generators of autonomous docks or the power available from a shore electrical power system shall be sufficient to ensure the following operating conditions of the dock:

.1 submersion of the dock;

.2 docking of ships;

.3 emersion of the dock;

.4 emergency condition;

.5 other conditions in accordance with the dock's purpose.

19.8.5.4 The power of main generators of the autonomous dock shall be such that in case of failure of any generator the rest of the generators ensure safe submersion and emersion of the dock as well as docking and undocking of ships.

19.8.6 Distribution of electrical power

19.8.6.1 The following systems of electrical power distribution are allowed for use in docks in addition to those specified in 4.1.1:

.1 three-phase four-wire alternating current system with earthed neutral wire;

.2 one-wire system, both alternating and direct current, with dock's hull return only for welding circuit (refer also to 19.8.4), and also for devices of monitoring and measurement of insulation resistance.

19.8.6.2 In addition to 4.3.1 the following consumers shall be supplied by separate feeders from the main switchboard busbars energized directly by the generators proper or through the transformer, or by the shore electrical power system:

.1 system of monitoring, signalling and control of the dock submersion and emersion;

.2 switchboards for electric drives of the ballast system sluice valves associated with safe operation of the dock;

.3 switchboards for supply of welding outfit;

.4 switchboards for supply of the docked ship.

Note. Power supply of essential services from the main busbar conduit in each case is subject to the special consideration by the Register.

19.8.6.3 Essential consumers and electric drives of machinery situated at the wing wall where no source of electrical power is installed shall be supplied from the switchboard located therein. This switchboard shall be considered as a separate part of the main switchboard and shall be fed from the main switchboard by two feeders. The cross-section of each feeder shall be sufficient for supply of the wing wall essential consumers in case of failure of one feeder. The supply feeders shall run between wing walls in different spaces if it is permitted by the dock design.

In separate cases, installation of both feeders in one space may be allowed.

19.8.6.4 The side, bow and stem lights may be supplied from lighting switchboards.

19.8.6.5 In case of high-voltage electrical power supply of the non-autonomous dock from the shore electrical power system, in addition to the high-voltage feeder a device shall be fitted for connection of the low-voltage supply feeder.

This device shall be designed for continuous transmission of electrical energy required at the idle dock when no repairs are carried out. In this case, provision shall be made for continuous supply of at least one electric drive of maximum capacity fire pump when fully loaded and also for supply of all electric motors of sluice valve drives and lighting of main spaces.

When high-voltage electrical power is supplied to the non-autonomous dock by two independent feeders, a low-voltage supply feeder need not be provided.

19.8.6.6 When the dock is supplied from the shore low-voltage electrical power system, two feeders and two devices are required for reception of electrical power, one of them supplying the consumers specified in 19.8.6.2 and the other – at least the consumers referred to in 19.8.6.5.

19.8.6.7 Arrangement and design of devices for connection of cables used for power supply from the shore electrical power system shall be such as to ensure:

.1 installation of cables at an adequate distance from one another to prevent simultaneous damage of high-voltage and low-voltage feeders;

.2 absence of mechanical stresses in cables during submersion and emersion of the dock;

.3 prevention of transmission of mechanical stresses to the terminals intended for connection of cables or wires.

It is recommended that the devices for reception of electrical power from the shore electrical power system are located on different wing walls of the dock.

19.8.6.8 A bright and clear warning inscription indicating the voltage shall be made on the hull in a prominent position or on the door of the external supply switchboard.

19.8.6.9 The maximum permissible level of the short-circuit power shall be determined for each dock, which may be supplied from the shore electrical power system. This level shall be marked on the warning inscription of the external supply switchboard.

19.8.6.10 The docked ships shall be fed from the stationary supply switchboards installed in the dock.

19.8.6.11 Each supply switchboard of the docked ship shall be fitted with:

.1 switchgear and protective devices, terminals or plug and socket connectors for flexible cables connected to the docked ship. All switchboard terminals shall bear a mark indicating a phase or pole;

.2 a pilot lamp indicating the presence of voltage across switchboard terminals;

.3 a nameplate indicating the nominal voltage, nature of current, its permissible value and frequency.

19.8.6.12 At the supply switchboard of the docked ship provision shall be made for the device for fastening the ends of the flexible cable feeding the docked ship.

19.8.6.13 Cross-sectional area of the flexible supply cable of the docked ship shall be chosen for rated current of the protection setting fitted in the outgoing feeders of the supply switchboard of the docked ships.

19.8.7 Transformers

In floating docks one transformer of adequate power may be used for supply of the lighting circuit and circuits of essential consumers. In this case, it is recommended to provide for possible reserve supply of these consumers from the transformer intended for feeding the docked ships.

19.8.8 Lighting

19.8.8.1 In addition to provisions of 6.6.1, socket outlets for portable lighting fixtures shall be installed at least:

.1 in dry compartments of wing walls where equipment and outfit for the system of submersion and emersion of the dock is located;

.2 in spaces of safety deck where the equipment for the system of submersion and emersion of the dock is located;

.3 in the space where the central control console of the dock submersion and emersion is located;

.4 in the area of location of the mooring machinery electric drives.

19.8.9 Service telephone communication

19.8.9.1 In the absence of other types of voice communication provision shall be made for telephones of the ship's control group, which ensure clear two-way communication between the following spaces:

.1 warping capstans;

.2 emergency diesel generator space;

.3 main switchboard space;

.4 main diesel generator space;

.5 high-voltage transformer space;

.6 spaces for location of hand drives for sluice valves of the dock submersion and emersion system;

.7 fire-extinguishing station.

Besides, two-way independent voice communication shall be provided between the main machinery control room and the machinery space.

19.8.9.2 In docks provision shall be made for connection of at least one telephone set to the shore telephone system.

19.8.10 General alarm system

General alarm system shall be actuated from the main machinery control room and from the space intended for the personnel on watch, if such a space is provided.

19.8.11 Installation of cables

19.8.11.1 If the pontoon deck is illuminated with lighting fixtures of submersible type and if the cables used are not tight, they shall run to the lighting fixtures in water- and gastight pipes.

The pipes and pipe packings shall be selected with regard to operation under pressure not less than the permissible pressure of submersible lighting fixtures.

19.8.11.2 On special agreement with the Register, cables may be installed on tray plates (saddles) welded directly to the dock plating.

19.8.12 Distribution of electrical power and cabling with the use of one-wire system

19.8.12.1 Relevant terminals of sources and consumers of electrical power shall be reliably connected to the dock hull. This connection shall not be made in pipelines, tanks and cylinders containing compressed gases, petrol and oil.

19.8.12.2 For direct-current circuit the insulated wire shall be connected to the positive poles and terminals of sources and consumers of electrical power.

Instruments, switchgear and protective devices shall be set to the positive pole.

19.8.12.3 Conductors used for connection of terminals of the electrical equipment and the dock hull shall be equal

in cross-sectional area to the conductors isolated from the hull.

19.8.12.4 Points of connection of conductors to the steel hull of the dock shall be situated in areas and positions readily accessible for control and maintenance of contacts.

These points shall be located on structures, which are reliably joined by welding to the dock hull.

19.8.12.5 Working earthing conductors shall be joined in such a manner that reliable electrical connection to the hull is ensured.

It is recommended to use high-power busbars, which are connected to the dock hull in several points.

19.8.12.6 Regardless of the system of electrical power distribution used for welding circuit, the welding station in the docked ship shall be supplied by two-wire system from the welding circuit of the dock.

Hull return system of the docked ship is not permitted.

19.8.12.7 When carrying out welding operations on the hull of the docked ship, a cable with a potential opposite to that of the electrode shall be connected to the hull as close to the part being welded as possible.

19.8.13 Busbar conduits

19.8.13.1 The use of busbar conduits is allowed for floating docks. The degree of protection of busbar conduits depending on the place of installation shall comply with the requirements of 2.4.4.2.

19.8.13.2 Busbar conduits shall be designed for adequate load and shall withstand, along with insulators and holders, mechanical stresses resulting from short-circuit current directly at busbars.

19.8.13.3 At alternating current exceeding 1,500 A, provision shall be made for reduction of the current loss in busbar holders, fixtures, insulators and structures which results from the influence of magnetic fields.

19.8.13.4 All protective devices and switchgear connected immediately to the busbar conduit shall be installed in places accessible for inspection and repair.

Cables and busbars connecting the protection devices and the busbar conduit shall not be more than 2 m in length.

19.8.13.5 Busbar conduits with the degree of protection IP20 and below shall be installed at a height not less than 2.5 m above the floor level.

19.8.13.6 Warning inscriptions indicating the voltage shall be made on the protective enclosure of the busbar conduit at 3 to 5 m intervals throughout the whole length.

19.8.14 Emergency electrical installations

19.8.14.1 Each floating dock shall be provided with an emergency source of electrical power ensuring power supply of all the necessary consumers for not less than 3 hours.

19.8.14.2 Emergency source of electrical power shall ensure supply of consumers as per 9.3.1, which are installed on board the dock, and also supply of the following consumers:

.1 electrical drives essential for sluice valves of the system of dock submersion and emersion (at least 2 closings and openings of the sluice valves);

.2 indication and control circuits of the system of dock submersion and emersion;

.3 command service communication.

19.8.14.3 If a diesel generator with an automatic starting system is used as the emergency source of electrical power, provision shall be made for local starting of the diesel generator.

19.8.14.4 All the emergency

consumers shall be supplied from the emergency switchboard.

Where justified, the emergency diesel generator and emergency switchboard may be installed in different spaces, and one section of the main switchboard may be used as an emergency switchboard, provided the main switchboard is located above the level of the margin line of the dock.

19.8.15 Electric drives of submersion and emersion system of the dock

19.8.15.1 Electric drives for sluice valves of the submersion and emersion system shall not hinder manual opening and closing of sluice valves. Interlocking device shall be also provided to prevent the electric drive from operation in case of sluice valve change-over to manual control.

19.8.15.2 Electric drives for sluice valves shall be fitted with local and remote-controlled (in the main machinery control room, etc.) indicators of sluice valve limit positions. For electric drives of sluice valves intended for water distribution in the pontoon compartments it is also recommended to provide for devices indicating the extent to which the sluice valve is open.

19.8.15.3 For sluice valves intended for water distribution in the pontoon compartments it is recommended to provide for separate control of each sluice valve, as well as for group control of port and starboard sluice valves.

19.8.15.4 Control circuit for electric drives of the drain (ballast) pump shall provide for local and remote control from the main control station with indication of the pump operation or control of electric motor load on the ammeter.

19.8.16 Connection of electrical power supply sources

When generators of the autonomous dock or transformers of the shore power supply are connected directly to the distribution busbar conduit, and the main switchboard is not installed, provision shall be made for a common control desk fitted with control gear for circuit breakers of generators or transformers and with instruments and devices of control, signalling and protective systems.

These instruments and devices are listed in 4.6.

19.8.17 High-voltage electrical installation of the dock

19.8.17.1 High-voltage electrical installation of the dock shall comply with the requirements of national standards and rules applicable to the shore electrical installations.

19.8.17.2 High-voltage electrical installation of the dock shall be located in separate special electrical spaces.

19.9 BERTH-CONNECTED SHIPS

19.9.1 For berth-connected ships, the following sources may be used as main sources of electrical power:

.1 generators;

.2 shore electrical power system.

19.9.2 On independent berth-connected ships, provision shall be made for at least two generators as main sources of electrical power.

In addition, the ship mains may be supplied from the shore electrical power system.

Berth-connected ships that are not independent may be supplied from the shore electrical-power system only.

19.9.3 On independent berth-connected ships, the power of generators of the main power source or the power

supplied by the shore electrical power system shall be sufficient for the operation of services in accordance with the ship purpose, in case of fire, hull leakage or other circumstances adversely affecting the safety of the berth-connected ship while the main source of electrical power is in operation.

19.9.4 The main generator power of an independent berth-connected ship shall be sufficient to ensure operation in accordance with 19.9.3 in the case of failure of any of the generators.

19.9.5 In floating hotels and hostels, power supply and signalling functions of essential systems and gear shall be effected in conformity with 19.1.1.1 to 19.1.1.4.

The side, bow and stem lights may be supplied from lighting switchboards.

19.9.6 Each floating hotel or hostel shall be provided with an independent emergency source of electrical power to ensure the operation of services in accordance with 19.1.2.1 during 12 h, as well as the operation of services in accordance with 19.1.2.3 during 30 min.

For other types of berth-connected ships, provision of an emergency power source is subject to the special consideration by the Register in each case.

19.9.7 As regards the automatic starting of the emergency source of electrical power and provision of an emergency transitional source in floating hotels and hostels, the requirements of 19.1.2.4 to 19.1.2.7 shall be complied with.

19.10 FISHING VESSELS

19.10.1 Survey of electrical equipment

19.10.1.1 In addition to the requirements of 1.3.2 the following kinds of equipment, systems and devices are subject to survey on board the ship (refer also to 1.3.2.4.2):

.1 electrical equipment of fishing machinery;

.2 electrical equipment of processing machinery (catch processing).

19.10.2 Survey during manufacture of electrical equipment.

19.10.2.1 The electrical equipment of processing machinery specified in 19.10.1.1 is subject to survey during manufacture in addition to that listed in 1.3.3.1.

Use of electrical equipment specified in 19.10.1.1.2, which doesn't fully meet the requirements of Sections 1 to 18, is subject to special consideration by the Register.

19.10.3 Structural requirements and protection of electrical equipment of fishing and processing machinery

19.10.3.1 The electrical equipment installed in catch processing spaces shall be resistant to seawater and fish processing products or shall be adequately protected.

19.10.3.2 Distribution gear and start, control and protection devices of electrical equipment specified in 19.10.3.1 shall be installed in special electrical spaces.

19.10.3.3 Cables installed in spaces subjected to prolonged influence of salt and other products of fish processing shall be provided with sheaths resistant to such influence or be adequately protected.

19.10.4 Composition and capacity of main electrical power source

19.10.4.1 The composition and capacity of the main source of electrical power shall be determined with regard to the following operating conditions of the ship:

.1 running conditions;

.2 manoeuvring;

.3 in case of fire, hole in the ship's hull or other conditions affecting the safety of navigation, with the main source of

electrical power in operation;

.4 fishing.

19.10.4.2 The capacity of generators composing the main electrical power source shall be such that if any of them fails, the rest will ensure power supply of electrical equipment necessary under conditions specified in 19.10.4.1 as well as minimal habitable conditions to persons on board.

Where justified, in vessels of less than 500 gross tonnage the capacity necessary to ensure fishing operations and/or catch processing may be neglected.

19.10.5 Distribution of electrical power

19.10.5.1 Where the main electrical power source incorporates shaft generators not intended for operation in parallel with the independently driven generators, the machinery and systems ensuring propulsion, manoeuvrability and safety of navigation shall be supplied from the busbars of independently driven generators, while the electrical equipment of fishing and processing machinery shall be supplied from the busbars of shaft generators.

19.10.5.2 The electric drives of refrigerating compressors shall be supplied by separate feeders from the busbars of the main switchboard. Electric drives of refrigerating compressors may be fed from a separate switchboard supplied by two feeders connected to different sections of the main switchboard.

19.10.5.3 Where portable tools and movable mechanization facilities not permanently installed, are supplied from a circuit of more than 50 V, a safety isolation device in combination with a separating transformer shall be used for each consumer.

Such device shall interrupt power supply if the hull leakage current exceeds 30 mA.

19.10.6 Lighting

19.10.6.1 Catch processing spaces and refrigerating machinery rooms shall be illuminated by stationary lighting fixtures, which shall be supplied and arranged in accordance with 6.2.3.

19.10.6.2 Fish storage holds shall be illuminated with stationary lighting fixtures, which shall be supplied in accordance with 6.2.7.

19.10.7 Signalling

A "Man-in-hold" signal push-button shall be located inside the refrigerated holds at each exit to actuate signal at the wheelhouse or another permanently attended space.

19.10.8 Emergency electrical installations

19.10.8.1 The emergency source of electrical power shall comply with the requirements of 9.3.

19.10.8.2 In addition to the requirements of 9.3.1.1, the emergency source of electrical power shall supply the emergency lighting for the catch processing spaces and their exits as well as for the deck in way of fishing machinery.

19.10.8.3 Where a diesel generator is used as the emergency source of electrical power, an emergency transitional source of electrical power (accumulator battery) shall be provided, with the capacity sufficient to supply the consumers specified in 9.3.7 and 19.10.8.2 for 30 min.

19.11 SHIPS CARRYING DANGEROUS GOODS

19.11.1 General

19.11.1 The requirements of this Subsection, in addition to the requirements of 7.2, Part VI "Fire Protection", apply to the electrical equipment of ships and cargo spaces

intended for the carriage of dangerous goods, the classification of which is presented in 1.2, Part VI "Fire Protection".

19.11.2 Dangerous zones, spaces and areas

19.11.2.1 Classification of dangerous zones:

Zone 1, in which an explosive gas/air mixture is likely to occur in normal operation;

Zone 2, in which an explosive gas/air mixture is not likely to occur, and if it occurs it will only exist for a short time.

Typical examples of arrangement of the dangerous zones are given in Table 19.11.2.1

19.11.2.2 For **packaged dangerous goods**, Class 1, except for subclass 1.4S, the **dangerous zones** encompass **the** following spaces and areas classified as Zone 1:

.1 enclosed spaces **of** cargo compartments/holds as well as open or **enclosed ro-**ro cargo spaces;

.2 integral storerooms for the ship's stock of explosives.

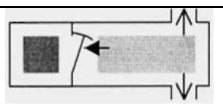
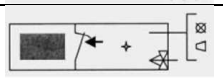
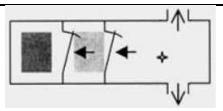
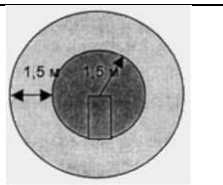
19.11.2.3 For **dangerous goods carried in bulk**, Class 4.1, 4.2, 9 and MHB (Materials Hazardous in Bulk) capable of producing explosive dust**/air** mixtures**, the dangerous zones** encompass **the following** spaces and areas classified as Zone 1:

.1 enclosed spaces **of cargo** compartments/holds;

.2 air ducts of ventilation systems **for spaces of cargo** compartments/holds specified in 19.11.2.3.1.

19.11.2.4 For **dangerous goods carried in bulk**, Class 4.3, capable of producing explosive dust**/air** mixtures**, the dangerous zones** encompass **the following** spaces and areas:

Table 19.11.2.1. **Dangerous zones for dangerous cargo**

Items	Typical examples	Notes
19.11.2.2 19.11.2.3.1, 19.11.2.4.1.1 19.11.2.5.1.1		-
19.11.2.3.2 19.11.2.4.1.2 19.11.2.5.1.2		-
19.11.2.4.1.4 19.11.2.5.1.4		-
19.11.2.4.2.1 19.11.2.5.2.1		*
		**
19.11.2.4.2.1 19.11.2.5.2.1 - for air locks only		*
19.11.2.4.1.3 19.11.2.5.1.3, 19.11.2.4.2.2 19.11.2.5.2.2		

* Natural ventilation

** Pressurized spaces, visual and audible alarm at control stations in case of pressure drop

	Self-locking gastight doors
	Safe space
	Dangerous zone 1
	Dangerous zone 2

19.11.2.4.1 Zone 1:

.1 enclosed spaces **of cargo** compartments/holds;

.2 air ducts of ventilation systems **for spaces of cargo** compartments/holds specified in 19.11.2.4.1.1.

.3 areas on open deck or semi-enclosed spaces **on** open deck within 1.5 m of any ventilation outlets of **cargo** compartments/holds specified in 19.11.2.4.1.1;

.4 enclosed or semi-enclosed **spaces** having direct access to or other openings into **spaces** and areas specified in 19.11.2.4.1.1, 19.11.2.4.1.2, unless appropriate measures are taken to prevent the explosive mixture **from** penetration into **these spaces**;

.5 air ducts of ventilation systems, pipelines of bilge systems, etc. where open ends of this piping directly face **dangerous** Zone 1.

19.11.2.4.2 Zone 2:

.1 enclosed or semi-enclosed **spaces** with natural ventilation, having direct access to or other openings into **spaces** and areas specified in 19.11.2.4.1.1, 19.11.2.4.1.2, and separated from these **spaces** by gastight self-closing doors, as well as directly within air lock, if any;

.2 areas within 1.5 m of **areas** or spaces on open deck specified in 19.11.2.4.1.3;

.3 closed spaces (e. g. pipe tunnels, pump rooms with bilges, etc.) with piping specified in 19.11.2.4.1.5 along with their flanges, valves, pumps, **etc**. except cases when special methods of pressure buildup approved by the Register are used in those spaces.

19.11.2.5 For **packaged dangerous goods**, Class 2.1, and also Classes 3.1, 3.2, 6.1 and 8 (liquids with $T_{flash} \leq 23$ °C)**, the dangerous zones** encompass **th**e following spaces and areas.

19.11.2.5.1 Zone 1:

.1 enclosed spaces **of cargo** compartments/holds;

.2 air ducts of ventilation systems **for spaces of cargo** compartments/holds specified in 19.11.2.5.1.1.

.3 areas on open deck or semi-enclosed spaces **on** open deck within 1.5 m of any ventilation outlets of **cargo** compartments/holds specified in 19.11.2.5.1.1;

.4 enclosed or semi-enclosed **spaces** having direct access to or other openings into **any of the** spaces specified in 19.11.2.5.1.1 and 19.11.2.5.1.2, unless appropriate measures are taken to prevent the explosive mixture **from** penetration into **these spaces**;

19.11.2.5.2 Zone 2:

.1 enclosed or semi-enclosed **spaces** with natural ventilation, having direct access to or other openings into **spaces** and areas specified in 9.11.2.5.1.1 and 19.11.2.5.1.2, and separated from these **spaces** by gastight self-closing doors, as well as directly within air lock, if any;

.2 areas within 1.5 m of **areas** or spaces on open deck specified in 19.11.2.5.1.3;

19.11.3 Electrical equipment in hazardous spaces and areas.

19.11.3.1 Electrical equipment installed in **spaces and areas** where only explosive dust is likely to occur due to bulk cargoes, shall comply with the following minimum requirements, unless otherwise specified (refer to Table 19.11.3.3):

.1 protection level IP55 and the maximum surface temperature of 200 °C or,

.2 certified safe type with temperature class T3 and protection level IP55.

19.11.3.2 Electrical equipment installed in **spaces and areas** gas atmosphere is likely to occur shall be of certified safe type and comply with the

following minimum requirements, unless otherwise specified (refer to Table 19.11.3.3):

.1 temperature class T3;

.2 subgroup **of equipment** IIB.

The certified safe-type electrical equipment shall be at least with protection suitable for operation in Zone 1.

19.11.3.3 Electrical equipment installed in **spaces and areas** where only solid bulk cargoes and MHB (Materials Hazardous in Bulk) are carried shall comply with the requirements of 19.11.3.1, 19.11.3.2 and the minimum requirements of Table 19.11.3.3

19.11.3.4 Electrical equipment installed in **spaces and areas** where explosive gas atmosphere and dust are likely to occur shall comply with the requirements of 19.11.3.1, 19.11.3.2.

Table 19.11.3.3 **Requirements for electrical equipment based on specific bulk cargoes**

Dangerous cargo	IMO class	Major risk factor[1]	Explosive dust protection class	Explosive gas atmosphere protection class	
				Subgroup A	Temperature class
1	2	3	4	5	6
Aluminium dross	4.3	Hydrogen	—	IIC	T2
Aluminium ferrosilicon, powder	4.3	Hydrogen	—	IIC	T2
Aluminium silicon powder, unprotected	4.3	Hydrogen	—	IIC	T2
Ammonium nitrate fertilizers:		See footnote[2]			
A type	5.1		—	—	—
B type	9		—	—	—
Coal	MHB[3]	Dust, methane	IP55	IIA	T4
DRI iron	MHB	Hydrogen	—	IIC	T2
Ferrophosphorus (non-palletized)	MHB	Hydrogen	—	IIC	T1
Ferrosilicon	4.3	Hydrogen	—	IIC	T1
Iron oxide. Spongy iron	4.2	Dust	IP55	IIA	T2
Oil cake, press residues	4.2	Hexane	—	IIA	T3
Silicon manganese	MHB	Hydrogen	—	IIC	T1
Sulphur	4.1	Inherent properties	IP55	—	T4
Zinc dross, residues, dezincification	4.3	Hydrogen	—	IIC	T2

[1] This column specifies substances that may be released and effect electrical plants and cables.

[2] All electrical circuits with terminations in cargo spaces shall be disconnected in accordance with the provisions of 2.9.9.

[3] MHI - Materials Hazardous in Bulk.

19.11.3.5 Electrical equipment installed in **spaces and areas** where dangerous goods **of** Class 1, except for Class 1.4S, are likely to be carried, shall comply with the following requirements:

.1 protection level IP65;

.2 maximum surface temperature — 100 °C.

19.11.3.6 Electrical equipment installed in dangerous zone of category 2 shall be:

.1 of a type suitable for use in adjacent **spaces** in accordance with 19.11.3.1 to 19.11.3.5; or

.2 of special design for protection class "*n*" and appropriate temperature class, sub-group and protection level in accordance with 19.11.3.1 to 19.11.3.5; or

.3 of design that does not generate arcs or

sparks in service and which surfaces do not reach unacceptable high temperatures under normal conditions.

19.11.3.7 Portable electrical equipment shall, in general, have its own independent source of electrical power (except for intrinsically safe electric circuits) and be of certified safe type with protection suitable for operation in Zone 1.

19.12 REQUIREMENTS FOR ELECTRICAL EQUIPMENT IN SHIPS UTILIZING GAS AS FUEL FOR PROPULSION PLANT

19.12.1 General

19.12.1.1 Electrical equipment of systems and pipelines utilizing gas as fuel for propulsion plant shall meet the requirements of Part VII "Electrical Equipment" of the Rules for the Classification and Construction of Ships Carrying Liquefied Gases in Bulk. Dangerous zones shall be classified in accordance with 19.12.2.

19.12.2 Classification of dangerous zones, spaces and areas

19.12.2.1 Dangerous zones shall be classified in accordance with IEC 60079-10 and IEC 60092-502. In case any dangerous area is not covered by 19.12.2.2, the above standards shall apply.

19.12.2.2 Zone 0:

the interior of vessels for gas fuel storage, gas fuel pipelines, pipelines from safety valves of vessels for gas fuel storage, as well as any air ducts from gas-containing equipment.

19.12.2.3 Zone 1:

− storage spaces for gas fuel vessels;

− gas compressor spaces;

− areas on open deck and semi-enclosed spaces on open deck within 3 m from any gas outlets from safety valves, caps and filling necks of gas fuel vessels on open deck, as well as its sounding pipes, flanges and valves of fuel supply pipes and other gas fittings, inlets and ventilation outlets to compressor and pump spaces or gas fuel vessel storage spaces;

− areas on open deck and semi-enclosed spaces on open deck within 1.5 m from entrances to gas compressor and pump spaces, from ventilation intakes and outlets serving the above spaces or any other spaces classified as Zone 1;

− areas on open deck within the coaming, around the fuel oil filling station and within 3 m of the coaming at a hight of 2.4 m;

− enclosed and semi-enclosed areas around gas fuel pipes and adjacent air ducts;

− gas-hazardous machinery spaces shall be regarded as safe in normal operation as Zone **1** following gas leakage alarm activation.

19.12.2.4 Zone 2:

areas on open deck within 1.5 m around Zone 1.

20. REQUIREMENTS FOR ELECTRICAL EQUIPMENT OF REFRIGERATING PLANTS

20.1 GENERAL

20.1.1 The requirements of the Section cover the electrical equipment of classed refrigerating plants.

The requirements of 20.2.3, 20.2.4, 20.3.1 and 20.4 apply to unclassed refrigerating plants as well.

20.2 POWER SUPPLY AND

SWITCHING

20.2.1 The electric drives of refrigerating plants shall be powered through separate feeders from the switchboard of the refrigerating plant.

The electric drives of refrigerating compressors may be supplied directly from the main switchboard.

The refrigerating fans may be supplied from the switchboard of the refrigerating plant or another switchboard energized directly from the main switchboard.

For each method of power supply it shall be provided that in case of generator overload the refrigerating plant electric drives are disconnected last.

The emergency ventilation system shall be supplied through a separate feeder from the switchboard energized from the main switchboard or directly from the main switchboard.

20.2.2 Power supply of electric drives of thermal containers shall comply with the requirements of 19.5.2.

20.2.3 When using the refrigerants of Group II according to Table 2.2.1, Part XII "Refrigerating Plants", a device shall be provided for emergency remote disconnection of the refrigerating plant switchboard operated from the following locations:

.1 from the permanent control post of the refrigerating plant in the refrigerating machinery room;

.2 from a location outside the space that may be contaminated with the refrigerant of Group II in case of breakdown in the refrigerating machinery room;

.3 outside, next to every exit from the refrigerating machinery room.

The device for emergency remote disconnection shall be installed in such a manner that it cannot be actuated inadvertently.

20.2.4 The device for emergency remote disconnection of the switchboard of the refrigerating plant working with Group II refrigerant shall simultaneously switch off the electric drives of refrigerating compressors if they are fed from the main switchboard (refer to 20.2.1), main lighting of the refrigerating machinery compartment and switch on the emergency ventilation, water screens and reserve lighting.

Additionally, next to the device for emergency remote disconnection of the refrigerating plant switchboard at locations stated in 20.2.3.1 and 20.2.3.2, devices shall be installed for remote starting in any sequence of emergency ventilation, water screens, and reserve lighting, without disconnection of the refrigerating plant switchboard.

20.2.5 It is recommended that the electrical heating appliances for hatches and doors to refrigerated spaces and freezing chambers shall be supplied at safety voltage.

20.3 VENTILATION

20.3.1 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, shall be of safe type.

20.3.2 The electric motors of fans located in the stream of air coming from the refrigerated cargo spaces shall have a degree of protection not below IP55.

20.4 LIGHTING

20.4.1 If the refrigerant of Group II is used, safe-type reserve lighting fixtures shall be installed in the refrigerating machinery room in addition to the main lighting fixtures.

The reserve lighting fixtures shall be

powered separately from the electrical equipment and main lighting fixtures installed in the refrigerating machinery room.

21. SPARE PARTS

21.1 GENERAL

21.1.1 Each ship shall be provided with spare parts to an extent that is not less than required by this Section.

For ships of restricted navigation areas, the amount of spare parts carried on board may be reduced on agreement with the Register.

21.1.2 The range and the amount of spare parts for EPPs, electrical couplings, generator self-excitation and automatic voltage regulation systems, as well as automatic systems for icebreakers and ships equipped with ice category **Ice6,** as well as for ships with electrical equipment of a type not stipulated in Table 21.2, is subject to special consideration by the Register in each case.

21.1.3 The spare parts shall be properly secured in easily accessible places, marked and efficiently protected against impacts of environment.

21.1.4 Every ship shall be supplied with a set of appropriate tools and appliances necessary for dismantling and assembling of the electrical equipment in service conditions.

It is recommended to provide the ships with the materials necessary for the service of accumulators, cables and wires, fuse links of all sizes for safety fuses, as well as with materials as may be used in the repair of electrical equipment malfunctions.

21.1.5 Spare parts are not required for electrical drives of auxiliary machinery, if a double amount of such machinery is installed, it serves only its direct purpose and has sufficient capacity.

Spare parts are not required for onboard electrical power plant generators, provided that generators of appropriate capacity are installed in the amount in excess of the requirements of this Part of the Rules.

21.1.6 Spare parts shall be included in the Spare Parts List provided for in Sect. 4, Part I "Classification", as agreed upon with the Register, and the amount of spare parts carried on board shall be at least equal to that indicated in this list.

21.2 REQUIRED MINIMUM OF SPARE PARTS

Every ship shall be supplied with spare parts specified in Table 21.2.

Table 21.2. **Required minimum of spare parts for onboard electrical equipment**

Appliances	Spare parts	Number of spare parts	Note
1	2	3	4
Rotary generators and exciters	Brushes Brush holders Bearings	1 set 1 pc. 1 set	For 3 generators and 3 exciters of the same type
Static exciters	Thyristors and power circuit diodes	1 pc of each type	For 3 exciters of the same type It is recommended to have 1 spare exciter assembly instead of separate spare parts
Electric motors	Brushes Brush holders Bearings	1 set 1 pc. 1 set	For 6 motors of the same type
V-belt drives	V-belts	1 set	For each drive

End of Table 21.2.

1	2	3	4
Steering gear	Brushes Brush holders Bearings	1 set 1 pc. 1 set	For each motor
	Armature with a shaft and half-coupling Excitation coils of each type	1 pc. 1 pc.	Optional for d.c. steering gear with one motor
	Packaged electric motor	1 pc.	For a.c. steering gear with one motor only
Main, emergency and auxiliary switchboards, control panels etc. (for the entire ship)	Disconnecting switches, packet switches and installed automatic circuit breakers rated for up to 63 A	2 pc.	Each type
	Automatic circuit breakers rated for over 63 A	1 set	Each type
	Voltage coils	1 pc.	
	Arc chutes	1 pc.	
	Fuse assemblies	2 pc.	
Starting, control and switching devices	Wearable contacts	1 set	Each type for 6 similar devices
	Voltage coils	1 pc.	
Emergency lighting	Incandescent lamps	1 set	If supply voltage is different from the ship mains voltage
Navigation lanterns	Incandescent lamps	Refer to 2.2.6.2, Part III "Signal Means " of the Rules for the Equipment of Sea-Going Ships	
Navigation light switchboard	Relays Pilot lamps	2 pc. 1 set	
Portable measuring instruments	Insulation tester	1 pc.	Multipurpose instrument is recommended
	Ammeter	1 pc.	
	Voltmeter	1 pc.	
	Ohmmeter	1 pc.	
Ventilators of refrigerated spaces of classed refrigerating plants	Armature assembly	1 pc.	For 6 d.c. motors of the same type, where no spare motors are available
	Coils set	1 set	
	Stator assembly	1 pc.	For 6 a.c. motors of the same type, where no spare motors are available