RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

PART VIII
ELECTRICAL INSTALLATIONS AND CONTROL SYSTEMS

July
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GDAŃSK

RULES FOR CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS developed and edited by Polish Register of Shipping* consist of the following Parts:

Part I – Classification Regulations
Part II – Hull
Part III – Hull Equipment
Part IV – Stability and Subdivision
Part V – Fire Protection
Part VI – Ship and Machinery Piping Systems
Part VII – Main and Auxiliary Machinery and Equipment
Part VIII – Electrical Installations and Control Systems
Part IX – Materials and Welding.

Part VIII – Electrical Installations and Control Systems – July 2025 was approved by the PRS Board on 23 June 2025 and enters into force on 1 July 2025.
From the entry into force, the requirements of *Part VIII* apply, within the full scope, to new ships.
For existing ships, the requirements of *Part VIII* are applicable within the scope specified in *Part I – Classification Regulations.*

The requirements of this *Part VIII* are extended by the following Publications:

Publication 9/P – Computer Based Systems,
Publication 10/P – Safety requirements for sea-going fishing vessels
Publication 11/P – Environmental Tests on Marine Equipment,
Publication 12/P – Safety requirements for sea-going ships carrying industrial personnel
Publication 15/P – Current Rating Tables for Cables, Wires and Bus-bars in Marine Installations,
Publication 25/P – Technical Requirements for Shipboard Power Electronic Systems,
Publication 35/P – One Man Bridge Operated (OMBO) Ships,
Publication 72/P – Safety Requirements for Ships Using Low-flashpoint Gases as Fuel,
Publication 73/P – Safety Requirements for Ships Using Methyl or Ethyl Alcohol as Fuel,
Publication 79/P – Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment,
Publication 90/P – Safe Return to Port and Orderly Evacuation and Abandonment of the Ship,
Publication 100/P – Safety Requirements for Sea-going Passenger Ships and High-speed Passenger Craft Engaged in Domestic Voyages,
Publication 102/P – EU RO Mutual Recognition of Type Approval,
Publication 103/P – Guidelines for energy efficiency of ships,
Publication 106/P – Eco Class Rules,
Publication 116/P – Bunkering Guidelines for LNG as Marine Fuel.
Publication 120/P – Requirements for Vessels and Units with Dynamic Positioning (DP) Systems,
Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships,
Publication 125/P – Ship's Cyber Security,

Publication 5/I – Guidelines for the performance of periodical classification surveys of electrical explosion-proof equipment onboard ships in operation other than tankers and on tankers,
Publikacja 9/I – Materiały elektroizolacyjne (available in Polish only).

External documents referred to in this *Part VIII* (IMO Resolutions and Circulars, IACS Resolutions, international standards, etc.) – see *List of external reference documents* at the end of this *Part VIII.*

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CHAPTER 1

1 GENERAL PROVISIONS

1.1 Application and explanation

1.1.1 *Part VIII – Electrical Installations and Control Systems* of the *Rules* contains requirements for various types of ship's electrical installations and control systems and applies to all types of ships to be assigned the main symbol ✳**KM** or ✳**K** of PRS class. Additional requirements for the assignment of additional marks in the symbol of class relating to a specific type of ship, specific structures, systems or equipment, are given in *Chapters 21* and *22* of this *Part VIII*.

1.1.2 Requirements of this *Part VIII* cover the installation's and systems' components (cables, conductors, fittings, protective devices, automation elements, etc.), associated machines and equipment (generators, transformers, storage batteries, switchboards, motors, heating devices, lights, etc.), as well as protection/shielding of the installations and systems, where required.

1.1.3 In addition to the requirements of this *Part* of the *Rules*, the electrical equipment shall fulfil the requirements of the national or international standards indicated by PRS.

1.1.4 Requirements for fire detection and alarm systems are given in *Part V – Fire Protection*.

1.1.5 If relaxation from some requirements of this *Part VIII* can be granted due to restricted or special service of a ship, relevant information can be found in particular paragraphs.

1.1.6 Requirements of external documents implemented into the *Rules* are marked with dedicated colours (see 1.1.7, 1.1.9 and 1.11.10) and provided with identification of the source material they came from. PRS' text is always in black colour.

1.1.7 Latest editions of IACS resolutions (Unified Requirements – UR, Unified Interpretations – UI and Recommendations – REC.) concerning systems are incorporated and cited in this *Part VIII* in their original version where appropriate. Whenever the term Classification Society or Society appears in IACS resolutions it should be read as PRS. Unless explicitly provided otherwise IACS Recommendations are non-mandatory.

1.1.8 IACS UIs will be applied by PRS to ships whose flag Administrations have not issued definite instructions on the interpretation of the IMO regulations concerned.

1.1.9 Statutory technical requirements of SOLAS Convention as well as of related IMO resolutions and circulars concerning installations, systems and equipment are incorporated and cited in this *Part VIII* in their original version where appropriate. Only the latest version of statutory requirements is cited.

1.1.10 Relevant provisions of EU legal documents (Directives, Regulations, Decisions) concerning installations, systems and equipment are incorporated and cited in this *Part VIII* in their original version where appropriate.

1.1.11 If some parts of the cited IACS resolutions or statutory technical requirements have been omitted due to their irrelevance in particular context, the omitted text is marked with (...). Where necessary, relevant PRS notes or additional requirements are inserted in the cited text in black colour.

1.1.12 Statutory technical requirements incorporated into the *Rules* will be applied to ships as stipulated in the Conventions they come from. For ships of less than convention size for which the flag Administration has not defined its own national "statutory" requirements, PRS will apply requirements of these *Rules* as far as reasonable and practicable to ensure appropriate level of safety and environment protection taking into account both the type and service area of the ship.

1.1.13 Statutory technical requirements cited in the *Rules* will not be considered as the condition for class assignment if PRS provides statutory services and certification to the ship on behalf of her flag Administration.

1.1.14 If following the provisions of a Convention flag Administration exempts a ship from any of the Convention technical requirements or accepts equivalent arrangements PRS will not demand compliance with the Convention original technical requirements cited in these *Rules*.

1.1.15 Whenever Conventions leave some technical arrangements to the satisfaction of flag Administrations PRS, acting as RO on behalf of a flag Administration, will make relevant decisions following provisions of Agreement with the Administration, otherwise will accept decisions made by the RO acting on behalf of the flag Administration. If the flag Administration of a newbuilding is unknown (not decided yet) PRS will make relevant decisions on its own.

1.1.16 PRS, when accepting alternative design and arrangements to those required by IMO instruments and this *Part VIII* will act in accordance with SOLAS regulation II-1/55 and related MSC.1/Circ.1212/Rev.1 and MSC.1/Circ.1455 as may be amended. Necessary engineering analysis shall be submitted to PRS for evaluation and approval while examinations/tests required for the purpose of such analysis shall be witnessed by PRS Surveyor.

1.2 Definitions

The following definitions apply mainly for the purpose of this *Part VIII*. For definitions of other terms used in this *Part* see either *Part I* or the relevant referenced *Parts* of the *Rules.*

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

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

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

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

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

.6 ***Auxiliary steering gear*** is the equipment other than any part of the main steering gear necessary to steer the ship in the event of failure of the main steering gear but not including the tiller, quadrant or components serving the same purpose. (SOLAS, Reg. II-1/3.4)

.7 ***A cargo ship*** is any ship which is not a passenger ship. (SOLAS, Reg. I/2g)

.8 ***Cargo area*** is that part of the ship that contains cargo holds, cargo tanks, slop tanks and cargo pump-rooms including pump-rooms, cofferdams, ballast and void spaces adjacent to cargo tanks and also deck areas throughout the entire length and breadth of the part of the ship over the above-mentioned spaces. (SOLAS, Reg. II-2/3.6)

.9 ***Cargo spaces*** are spaces used for cargo, cargo oil tanks, tanks for other liquid cargo and trunks to such spaces. (SOLAS, Reg. II-2/3.8)

.10 ***Closed ro-ro spaces*** are ro-ro spaces which are neither open ro-ro spaces nor weather decks. (SOLAS, Reg. II-2/3.12)

.11 ***Closed vehicle spaces*** are vehicle spaces which are neither open vehicle spaces nor weather decks. (SOLAS, Reg. II-2/3.13)

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

.13 ***Contracted for construction*** – whenever the term appears in any IACS PR it shall be understood as the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of "contract for construction", refer to IACS PR29.

.14 ***Control stations*** are those spaces in which the ship' s radio or main navigating equipment or the emergency source of power is located or where the fire recording or fire control equipment is centralized. (SOLAS, Reg. II-1/3.18)

.15 ***Dead ship condition*** is the condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power. (SOLAS, Reg. II-1/3.8) The absence of power means the starting battery discharge, the absence of starting air needed for restoring the operation of the main propulsion plant, boilers and auxiliaries.

.16 ***Earthing*** – metallic connection of equipment terminal with the ship metal hull.

.17 ***Emergency condition*** is a condition under which any services needed for normal operational and habitable conditions are not in working order due to failure of the main source of electrical power. (SOLAS, Reg. II-1/3.6)

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

.19 ***Emergency services*** – services which in case of emergency shall be supplied from the emergency switchboard to maintain safety of the ship

.20 ***Emergency source of electrical power*** is a source of electrical power, intended to supply the emergency switchboard for distribution of power to all the essential consumers on board the ship in the event of a failure of the supply from the main source of electrical power. (SOLAS, Reg. II-1/3.12)

.21 ***Emergency switchboard*** is a switchboard which in the event of failure of the main electrical power supply system is directly supplied by the emergency source of electrical power or the transitional source of emergency power and is intended to distribute electrical energy to the emergency services. (SOLAS II-1/3.11)

.22 ***Engine control room (ECR)*** – enclosed space which contains: a central control station of main engines and auxiliary machinery and of controllable pitch propellers or thrusters, control devices, instrumentation, alarms giving warning of reaching the limits of the permissible assumed parameters, alarms announcing the activation of automatic protection devices, means of communication.

.23 ***Engine room*** – machinery space where main engines and auxiliary machinery are fitted.

.24 ***Essential services*** are those services essential for propulsion and steering, and safety of the ship, which are made up of "Primary Essential Services" and "Secondary Essential Services". Definitions and examples of such services are given (in 2 and 3) below.

Primary Essential Services are those services which need to be in continuous operation to maintain propulsion and steering. Examples of equipment for primary essential services are as follows:

- Steering gears
- Pumps for controllable pitch propellers
- 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
- 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
- Oil burning installations for steam plants on steam turbine ships and for auxiliary boilers where steam is used for equipment supplying primary essential services
- Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps
- Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps
- Electric generators and associated power sources supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Viscosity control equipment for heavy fuel oil
- Control, monitoring and safety devices/systems for equipment to primary essential services
- Fire pumps and other fire extinguishing medium pumps *
- Navigation lights, aids and signals *
- Internal safety communication equipment; and *
- Lighting system *

Note:

* Classification of essential services according to IACS UI SC134 differs from the above IMO classification – services listed in the above last four bullets as primary are classified by IACS as secondary.

Secondary Essential Services are those services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the vessel's safety. Examples of equipment for secondary essential services are as follows:

- Windlass
- Fuel oil transfer pumps and fuel oil treatment equipment

- Lubrication oil transfer pumps and lubrication oil treatment equipment
- Pre-heaters for heavy fuel oil - Starting air and control air compressors
- Bilge, ballast and heeling pumps
- Ventilating fans for engine and boiler rooms
- Services considered necessary to maintain dangerous spaces in a safe condition
- Fire detection and alarm system
- Electrical Equipment for watertight closing appliances
- Electric generators and associated power sources supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Control, monitoring and safety systems for cargo containment systems
- Control, monitoring and safety devices/systems for equipment to secondary essential services. (MSC.1/Circ.1572/Rev.2, Sec. 5)

.25 ***Fire-retardant insulating material*** – material satisfying the requirements specified in *Publication 11/P – Environmental Tests on Marine Equipment*.

.26 ***Hazardous area*** – an area in which an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use ofelectrical apparatus (see also .66 Zones). Hazardous area covers hazardous rooms and spaces.

.27 ***IGF Code*** means the *International Code of safety for ships using gases or other low-flashpoint fuels* as adopted by the Maritime Safety Committee of the Organization by resolution MSC.391(95), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the annex other than chapter I. (SOLAS, Reg. II-1/2.28)

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

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

.30 ***Lightning protection zone*** – zone protected against direct lightning stroke.

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

.32 ***Machinery spaces*** are all machinery spaces of category A and all other spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces. (SOLAS, Reg. II-1/3.16)

.33 ***Machinery spaces of category A*** are those spaces and trunks to such spaces which contain:

.1 internal combustion machinery used for main propulsion;
.2 internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or
.3 any oil-fired boiler or oil fuel unit. (SOLAS, Reg. II-1/3.17)

.34 ***Main generating station*** is the space where the main source of electrical power is situated. (SOLAS, Reg. II-1/3.9, IACS UI SC151)

.35 ***Main source of electrical power*** is a source intended to supply electrical power to the main switchboard for distribution to all services necessary for maintaining the ship in normal operational and habitable condition. (SOLAS, Reg. II-1/3.7, IACS UI SC151)

.36 ***Main steering gear*** is the machinery, rudder actuators, steering gear, power units, if any, and ancillary equipment and the means of applying torque to the rudder stock (e.g. tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions. (SOLAS, Reg. II-1/3.2)

.37 ***Main switchboard*** is a switchboard which is directly supplied by the main source of electrical power and is intended to distribute electrical energy to the ship' s services. (SOLAS, Reg. II-1/3.10, IACS UI SC151)

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

.39 ***Normal operational and habitable condition*** is a condition under which the ship as a whole, the machinery, services, means and aids ensuring propulsion, ability to steer, safe navigation, fire and flooding safety, internal and external communications and signals, means of escape, and emergency boat winches, as well as the designed comfortable conditions of habitability are in working order and functioning normally. (SOLAS, Reg. II-1/3.5)

.40 ***Open deck spaces*** are:

Open deck spaces and enclosed promenades clear of lifeboat and liferaft embarkation and lowering stations. To be considered in this category, enclosed promenades shall have no significant fire risk, meaning that furnishings shall be restricted to deck furniture. In addition, such spaces shall be naturally ventilated by permanent openings.

and

Air spaces (the space outside superstructures and deckhouses). (SOLAS, Reg. II-2/9.2.2.3.2.(5))

.41 ***Open ro-ro spaces*** are those ro-ro spaces that are either open at both ends or have an opening at one end, and are provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides. (SOLAS, Reg. II-2/3.35)

.42 ***Open vehicle spaces*** are those vehicle spaces either open at both ends, or have an opening at one end and are provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides. (SOLAS, Reg. II-2/3.36)

.43 ***A passenger ship*** is a ship which carries more than twelve passengers. (SOLAS, Reg. I/2f)

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

.45 ***Power actuating system*** is the hydraulic equipment provided for supplying power to turn the rudder stock, comprising a steering gear power unit or units, together with the associated pipes and fittings, and a rudder actuator. The power actuating systems may

share common mechanical components (i.e. tiller, quadrant and rudder stock) or components serving the same purpose. (SOLAS, Reg. II-1/3.13)

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

.47 ***Ro-ro passenger ship*** means a passenger ship with ro-ro spaces or special category spaces. (SOLAS, Reg. II-2/3.42)

.48 ***Ro-ro spaces*** are spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction. (SOLAS, Reg. II-2/3.41)

.49 ***Safety centre*** is a control station (see .14) dedicated to the management of emergency situations. Safety systems' operation, control and/or monitoring are an integral part of the safety centre. (SOLAS, Reg. II-2/3.52)

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

- 50 V between conductors for direct current,
- 50 V between conductors or between the hull and the phase for alternating current.

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

.52 ***Service spaces*** are those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, storerooms, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces. (SOLAS, Reg. II-2/3.45)

.53 ***Services for habitability*** are those services which need to be in operation for maintaining the vessel's minimum comfort conditions for the crew and passengers. Examples of equipment for maintaining conditions of habitability are as follows:

- Cooking
- Heating
- Domestic refrigeration
- Mechanical ventilation
- Sanitary and fresh water
- Electric generators and associated power sources supplying the above equipment (IACS, UI SC134, para 4, MSC.1/Circ.1572/Rev.2, Sec. 5)

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

.55 ***Special category spaces*** are those enclosed vehicle spaces above and below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be accommodated on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m. (SOLAS, Reg. II-2/3.46)

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

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

.58 ***Steering gear control system*** is the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables. (SOLAS, Reg. II-1/3.1)

.59 ***Steering gear power unit*** is:

.1 in the case of electric steering gear, an electric motor and its associated electrical equipment;

.2 in the case of electrohydraulic steering gear, an electric motor and its associated electrical equipment and connected pump; or

.3 in the case of other hydraulic steering gear, a driving engine and connected pump. (SOLAS, Reg. II-1/3.3)

.60 ***A tanker*** is a cargo ship constructed or adapted for the carriage in bulk of liquid cargoes of an inflammable* nature. (SOLAS, Reg. I/2h)

* "Inflammable" has the same meaning as "flammable"

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

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

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

.64 ***Vehicle spaces*** are cargo spaces intended for carriage of motor vehicles with fuel in their tanks for their own propulsion. (SOLAS, Reg. II-2/3.49)

.65 ***Weather deck*** is a deck which is completely exposed to the weather from above and from at least two sides. (SOLAS, Reg. II-2/3.50)

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

Zone 0 – a hazardous area in which an explosive gas atmosphere is present continuously or is present for long periods. In Zone 0, only the following explosion-proof electrical equipment may be installed:

- intrinsically safe apparatus (Exia);
- simple electrical apparatus (thermocouples, photocells, strain gauges, junction boxes, switching devices), not capable of storing or generating electrical power;
- electrical apparatus certified for use in Zone 0;
- submersible electrically-driven pumps, having at least two independent methods of shutting down automatically in the event of low liquid level.

Zone 1 – an area, in which an explosive gas atmosphere is likely to occur in normal operation. In Zone 1, the following explosion-proof electrical equipment may be installed:

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

Zone 2 – an area in which an explosive gas atmosphere is not likely to occur in normal operation and if it does occur, it is likely to do so infrequently and will exist for a short period of time. In Zone 2, the following explosion-proof electrical equipment may be installed:

- any electrical equipment that may be considered for Zone 1;
- tested specially for Zone 2 (Exn);
- pressurized, accepted by PRS;
- having an enclosure filled with a liquid dielectric or encapsulated, accepted by PRS;
- the type which ensures the absence of sparks and arcs and of "hot spots" during its normal operation.

1.3 Technical documentation of ship

1.3.1 Classification documentation of a ship under construction

1.3.1.1 Prior to the commencement of ship construction, documentation listed in 1.3.1.2 to 1.3.1.4, shall be submitted to PRS Head Office for consideration and approval.

1.3.1.2 Classification documentation of electrical equipment:

.1 principle diagrams of power generation and distribution circuits of the main and emergency electric power sources: power circuits, lighting circuits (up to branch circuit board) and navigation light circuits;

.2 specification of data on the circuits with indication of current values, the applied protective devices, as well as the types and cross-sectional areas of cables;

.3 principle diagrams and a general view of the main and emergency switchboards, ship navigation control and monitoring console and other devices of non-standard design;

.4 calculation results of electric power plant output necessary to provide operation of the ship in conditions specified in 3.1.6, as well as the basis for the choice of the number and output of generators and the calculation of power of electric power emergency sources;

.5 principle or detailed diagrams of main, excitation, control, monitoring, signalization, protection and interlocking circuits of the ship electric propulsion plant machines;

.6 calculation results of the ship electric propulsion plant generators output necessary to provide operation in all conditions;

.7 calculation results of short-circuit currents on the main switchboard busbars and in the other points of electric network – as the basis for the choice of switching and protecting apparatus of generators and consumers, as well as for checking electrodynamic and thermal loads to which apparatus, wiring and busbars of main switchboard and other

distribution equipment shall correspond – together with the selection of protective devices;

.8 results of calculation of illumination intensity for important compartments and open locations for information;

.9 diagrams of internal communication and signalling;

.10 principle diagrams of electric drives according to 1.5.2.1.5;

.11 diagram of lubricating and air cooling systems of main propulsion el. motors;

.12 diagrams of protective earthing, drawings and if necessary, calculation of lightning conductors for tankers, gas carriers and combined ships;

.13 principle diagram of cable passages with indication of compartments through which they pass;

.14 results of capacity calculations of accumulator batteries supplying emergency lighting, navigation lights, general alarm and fire detection systems;

.15 data on electrical equipment in spaces where explosion hazard exists;

.16 diagrams of remote switching-off ventilation, fuel pumps and lubricating pumps;

.17 arrangement plans of main and emergency generators, main and emergency switchboards, accumulator batteries, equipment of explosion-proof execution;

.18 maintenance schedule for accumulator batteries intended for the supply of essential and emergency services (for details see paragraph 13.8.1);

.19 detailed risk assessment document for steering gear (demonstrating that in the case of any single failure in the steering gear, control system and power supply to the ship steering is maintained).

1.3.1.3 When classed refrigerating installation is foreseen, documentation listed in 1.3.1.2 shall include data concerning electrical equipment of refrigerating installation.

1.3.1.4 Classification documentation of shipboard automated machinery:

.1 technical description including: specification of parameters covered by alarm, safety and automatic control systems, information concerning continuity of lubrication of cylinders and machinery of main engine, supply of fuel, steam, etc. and other means necessary for execution of unattended operation, as well as accepted method of repair and maintenance of particular units or elements of automatic systems, data concerning reliability of particular systems or their units;

.2 functional diagrams of particular automatic systems with regard to the respective equipment, machinery and installations, giving information concerning: method of supply, functional features, structure, eventual connections with other systems as well as the kind and limit values of parameters covered by these systems;

.3 drawings of particular units of automatic systems such as desks, consoles, showing their elevation and arrangement of internal components, as well as their location on board the ship;

.4 in the case of applying computer systems for control or checking the machinery and installations, the above documentation shall be supplemented according to *Publication 9/P – Computer Based Systems*, paragraph 1.4.

1.3.2 Workshop documentation of a ship under construction

In the case of approval of the classification documentation listed in 1.3.1, the following workshop documentation shall be submitted to the relevant PRS Branch Office or Survey Station for agreement:

.1 drawings of cabling and cable fastening;

.2 diagrams of final circuits of emergency switchboard and emergency lighting;

.3 diagrams of final circuits of lighting switchboards;
.4 test programme for ship electrical equipment and automated machinery performed alongside the quay and at sea.

1.3.3 Classification documentation of a ship under alteration or reconstruction

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

1.3.3.2 Where new machinery or arrangements, covered by the requirements of the *Rules*, are installed, or machinery installed differs substantially from those initially fitted, additional documentation, within the scope required for a new ship, shall be submitted to the PRS Head Office (see 1.3.1).

1.4 Technical documentation of equipment

1.4.1 Prior to the commencement of supervising the manufacture of electrical equipment or control systems, the following documentation shall be submitted to PRS for consideration:

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

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

1.5 Scope of survey

1.5.1 General

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

1.5.2 Survey of electrical installation in ship

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

.1 electrical propulsion plant;
.2 main and emergency, including transitional, sources of electric power;
.3 power and lighting transformers and electric power converters used in equipment listed in 1.5.2.1;
.4 distribution gear and control and monitoring panels;
.5 electric drives for:

- machinery essential for the operation of propulsion engines,
- steering gear and all devices for active steering of the ship,
- controllable pitch propellers,
- windlasses, mooring and towing winches,
- boat winches,
- starting air compressors and air compressors for sound signals,
- bilge and ballast pumps as well as cargo pumps on tankers;
- watertight doors and fire doors,
- pumps and compressors of the smothering system,
- ventilating fans in machinery spaces, cofferdams, cargo holds and hazardous rooms and spaces;

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

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

1.5.2.3 Electrical equipment intended for domestic, living and technological application shall be surveyed by PRS within the following scope:

.1 influence of this equipment operation on the ship electric network parameters;
.2 choice of cable types, cable sections and the ways of running the cables;
.3 means of protection, insulation and earthing.

1.5.3 Survey of electrical equipment manufacture

1.5.3.1 The following items of electrical equipment intended for systems and devices, specified in 1.5.2.1, are subject to PRS survey during manufacture:

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

1.5.3.2 Each explosion-proof electrical equipment shall be surveyed (with respect to its explosion proofness) by a special body recognised by PRS for this purpose, irrespective of whether or not this equipment is subject to survey according to the requirements specified in 1.5.3.1.

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

1.5.3.4 Products mentioned in 1.5.3.1 shall have either *Test Certificate* or *Type Approval Certificate* issued by PRS. All PRS certificates should be accompanied by the manufacturer's documents specifying the results of performed tests and additionally in the case of type approved products be provided with the manufacturer statement confirming compliance of the product with the approved type. See also 1.5.3.7 and 1.5.3.8.

1.5.3.5 In lieu of *Type Approval Certificate* issued by PRS, PRS may accept *Type Approval Certificate* issued by any European Union Recognised Organisation (EU RO) in accordance with the provisions of *Publication 102/P – European Union Recognized Organizations Mutual Recognition Procedure for Type Approval*.

1.5.3.6 Products other than those mentioned in 1.5.3.1 should have documents issued by the manufacturer specifying the results of performed tests and/or confirming compliance with the approved type as appropriate.

1.5.3.7 In ships which are certified according to SOLAS and MARPOL Convention and which fly the flag of an EU Member State, the below specified marine equipment is subject to the conformity assessment procedures as regards its design, construction and performance requirements and to testing standards set out in Commission Implementing Regulation (EU) 2022/1157, laying down rules for the application of Directive 2014/90/EU (so called MED Directive):

.1 Public Address and General Alarm Systems (PAGA) (MED/1.44a, 1.44b);
.2 Low-location lighting systems (components only) (MED/3.40);
.3 Transmitting heading device THD (magnetic method) (MED/4.2);
.4 Heading control system (HCS) (MED/4.16);
.5 Rudder angle indicator (MED/4.20);
.6 Propeller revolution indicator (MED/4.21);
.7 Pitch indicator (MED/4.22);
.8 Navigation lights (MED/6.1);
.9 Water level detectors (MED/8.1);
.10 Public address & general emergency alarm system (when used as fire alarm device item MED/3.53 shall apply) (MED/9/1.5).

1.5.3.8 For ships of less than 500 gross tonnage and for passenger ships not engaged on international voyages, as well as for ships flying the flag of non-EU Member State, the equipment specified in 1.5.3.7, shall be of a type approved by PRS (should have *Type Approval Certificate*).

In lieu of *Type Approval Certificate*, the above-mentioned equipment may have *EC Declaration of Conformity* with the MED Directive.

CHAPTER 2

2 GENERAL REQUIREMENTS

2.1 Electrical installations – general (SOLAS, Reg. II-1/40)

2.1.1 Electrical installations shall be such that:

.1 all electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions will be ensured without recourse to the emergency source of electrical power;

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IACS and IMO interpretation

(...) For the purposes of these regulations (i.e. .1), the services as included in paragraphs 2 to 4 (i.e. defined in 1.2.24 and 1.2.53) are to be considered. (IACS UI SC134 para 5, MSC.1/Circ.1464/Rev.1, Sec.4 and MSC.1/Circ.1572/Rev.2, Sec.5)

.2 electrical services essential for safety will be ensured under various emergency conditions; and

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IACS and IMO interpretation

(...) For the purposes of this regulation (i.e. .2), the services as included in paragraphs 2 and 3 (i.e. defined in 1.2.24) and the services in the Regulation II-1/42 (i.e. services supplied from emergency source of electrical power in passenger ships – see 21.1.3.6) or II-1/43 (i.e. services supplied from emergency source of electrical power in cargo ships – see 9.3.5), as applicable, are to be considered. (IACS UI SC134 para 6, MSC.1/Circ.1464/Rev.1, Sec. 4 and MSC.1/Circ.1572/Rev.2, Sec.5)

.3 the safety of passengers, crew and ship from electrical hazards will be ensured. (SOLAS, Reg. II-1/40.1)

2.1.2 The Administration shall take appropriate steps to ensure uniformity in the implementation and application of the provisions of this Part (i.e. Reg. II-1/41 to II-1/46) in respect of electrical installations*. (SOLAS, Reg. II-1/40.2)

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* Refer to the recommendations published by the International Electrotechnical Commission and, in particular, publication IEC 60092, *Electrical Installations in Ships*.

2.2 Operating conditions

When designing, selecting and arranging electrical equipment, the operating conditions specified in 2.2.1 to 2.2.4 shall be taken into account.

2.2.1 Climatic hazards

2.2.1.1 Ambient conditions – Temperatures

IACS UR M40

2.2.1.1.1 The ambient conditions specified under 2.2.1.1.2 (M40.2) are to be applied to the layout, selection and arrangement of all shipboard machinery, equipment and appliances as to ensure proper operation. (M40.1)

2.2.1.1.2 Temperatures (M40.2)

Air (unrestricted service)

Installations, components	Location, arrangement	Temperature range (°C)
Machinery and electrical installations 1)	In enclosed spaces	0 to +45 2)
	On machinery components, boilers, In spaces subject to higher and lower temperatures	According to specific local conditions
	On the open deck	–25 to +45 2

Water (unrestricted service)

Coolant	Temperature (°C)
Seawater	+32 2)
Charge air coolant inlet to charge air cooler	see UR M28 3)

NOTES

1) Electronic appliances are to be suitable for proper operation even with an air temperature of +55°C. For electrical machines located in machinery space, maximum air temperature equal to +50°C shall be taken.
2) The Classification Society may approve other temperatures in the case of ships not intended for unrestricted service. (see 2.2.1.1.3)
3) UR M28 – see *Part VII*, para 2.1.4.
4) Electronic equipment and components intended to be installed in switchboards, desks and enclosures shall be capable of correct operation at the ambient air temperature of up to 55°C. The temperature of up to 70°C should not cause damage to components, equipment and systems.

END OF IACS UR M40

2.2.1.1.3 The temperature values, specified below, shall be taken as the rated ambient air and cooling water temperatures for electrical equipment of ships of restricted service outside the tropic. The use of electrical equipment for other temperature ranges is subject to PRS consideration in each particular case.

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

Notes:

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

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

2.2.1.3 Ambient Temperatures for Electrical Equipment installed in environmentally controlled spaces

IACS UR E19

2.2.1.3.1 Where electrical equipment is installed within environmentally controlled spaces the ambient temperature for which the equipment is to be suitable may be reduced from 45°C and maintained at a value not less than 35°C provided:

- the equipment is not for use for emergency services.
- temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit(s) is capable of satisfactorily maintaining the design temperature.
- the equipment is able to be initially set to work safety within a 45°C ambient temperature until such a time that the lesser ambient temperature may be achieved; the cooling equipment is to be rated for a 45°C ambient temperature.
- audible and visual alarms are provided, at a continually manned control station, to indicate any malfunction of the cooling units. (1.)

2.2.1.3.2 In accepting a lesser ambient temperature than 45°C, it is to be ensured that electrical cables for their entire length are adequately rated for the maximum ambient temperature to which they are exposed along their length. (2.)

2.2.1.3.3 The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with UI SC134 (see 1.2.24) and to be subject to survey in accordance with the requirements of the relevant Society. (3.)

END OF IACS UR E19

2.2.2 Mechanical hazards

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

- at a frequency from 2 Hz to 13.2 Hz with displacement amplitude ±1.0 mm;
- at a frequency from 13.2 Hz to 100 Hz with acceleration amplitude ±0.7 g.

Electrical equipment intended to be installed in locations in which specific severe vibration conditions prevail (e.g. internal combustion engines, compressors) or to be installed in the steering gear compartment shall be capable of correct operation at vibrations with a frequency of 2 Hz to 100 Hz, as follows:

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

2.2.2.2 Main propulsion machinery and all auxiliary machinery essential to the propulsion and the safety of the ship shall, as fitted in the ship, be designed to operate when the ship is upright and when inclined at any angle of list up to and including 15° either way under static conditions and 22.5° under dynamic conditions (rolling) either way and simultaneously inclined dynamically (pitching) 7.5° by bow or stern. The Administration may permit deviation from these angles, taking into consideration the type, size and service conditions of the ship. (SOLAS, Reg. II-1/26.6)

2.2.2.3 Ambient conditions – inclinations

IACS UR M46

2.2.2.3.1 General (M46.1)

The ambient conditions specified under 2.2.2.3.2 and 2.2.2.3.3 (M46.2 and M46.3) are to be applied to the layout, selection and arrangement of shipboard machinery, equipment and appliances (addressed in this UR) to ensure proper operation.

2.2.2.3.2 Inclinations (M46.2)

Inclinations applied to respective components are as follows.

Installations, components	Angle of inclination [°][2]			
	Athwartships		Fore-and-aft	
	static	dynamic	static	dynamic
Main and auxiliary machinery	15	22.5	5[4]	7.5
Safety equipment, e.g. emergency power installations, emergency fire pump and their devices Switch gear, electrical and electronic appliances[1] and remote control systems	22.5[3]	22.5[3]	10	10

Notes:

1. No undesired switching operations or operational changes are to occur.
2. Athwartships and fore-and-aft inclinations may occur simultaneously.
3. In ships for the carriage of liquefied gases and of chemicals the emergency power supply must also remain operable with the ship flooded to a final athwartships inclination up to maximum of 30°.
4. Where the length of the ship exceeds 100 m, the fore-and-aft static angle of inclination may be taken as $500/L$ degrees where L = length of the ship, in metres, as defined in UR S2 i.e.:

L – the Rule length L is the distance, in metres, measured on the waterline at the scantling draught from the fore side of the stem to the after side of the rudder post, or the centre of the rudder stock if there is no rudder post. L is not to be less than 96%, and need not be greater than 97%, of the extreme length on the waterline at the scantling draught. In ships without rudder stock (e.g. ships fitted with azimuth thrusters), the Rule length L is to be taken equal to 97% of the extreme length on the waterline at the scantling draught. In ships with unusual stern and bow arrangement the Rule length L will be specially considered. (IACS UR S2, para. S2.1)

The Society may consider deviations from these angles of inclination, taking into consideration the type, size and service conditions of the ship.

2.2.2.3.3 Shipboard accelerations (M46.3)

2.2.2.3.3.1 Main propulsion and steering machinery and auxiliary machinery that is essential to the propulsion and steering, and the safety of the ship shall be capable of operation under the effects of acceleration and motions. (3.1)

2.2.2.3.3.2 The requirements in 2.2.2.3.4 to 2.2.2.3.6 (M46.4 to M46.6) apply where documented evidence of equipment suitability is specifically required by other relevant URs for such equipment or requested by the Classification Society. (3.2)

2.2.2.3.4 Documentation (M46.4)

2.2.2.3.4.1 For ships subject to the SOLAS Convention, ship builders are to identify and document the ship accelerations and motions periods to which machinery and equipment might be subjected to. The expected accelerations and ship motions periods are to be within machinery and equipment manufacturers requirements. The estimations are to consider vessel type, machinery or equipment location and expected service conditions. (4.1)

2.2.2.3.5 Evaluation of equipment suitability (M46.5)

2.2.2.3.5.1 Machinery and equipment manufacturers are to submit evidence to the Classification Society that their machinery or equipment can operate under the required static and dynamic conditions stated in 2.2.2.3.2 (M46.2) and at least at the levels of shipboard accelerations as stated in 2.2.2.3.4 (M46.4) and/or specified in the relevant URs. Documentation of satisfactory performance shall take the form of:

.1 Report of testing under representative conditions; or

.2 Report of theoretical verification using recognised computational techniques accompanied by detailed and relevant validation data: or
.3 Historical data which provides relevant demonstration of satisfactory experience in service. (5.1)

2.2.2.3.6 Installation and operation (M46.6)

2.2.2.3.6.1 Machinery and equipment manufacturers are to submit details of the requirements/recommendations for installation of the machinery and equipment onboard to ensure satisfactory operation in service under the required static and dynamic conditions as described in 2.2.2.3.2 (M46.2) and at least at the levels of shipboard accelerations as stated in 2.2.2.3.4 (M46.4) and/or specified in the relevant URs. (6.1)

Note:
Consideration should be given for positioning machinery in order to minimize the dynamic load on bearings due to ship motion.

2.2.2.3.6.2 Shipbuilders are to submit details demonstrating that the installation of the machinery and equipment onboard is in accordance with manufacturer's requirements/ recommendations. (6.2)

END OF IACS UR M46

2.2.2.4 Electrical equipment shall have adequate mechanical strength and shall be so located that it is not exposed to a risk of mechanical damage (see also 2.7.4).

2.2.3 Voltage and frequency variations

IACS UR E5

2.2.3.1 All electrical appliances supplied from the main or emergency systems are to be so designed and manufactured that they are capable of operating satisfactorily under the normally occurring variations in voltage and frequency. (1.)

2.2.3.2 Unless otherwise stated in the national or international standards, all equipment should operate satisfactorily with the variations from its rated value shown in the Tables 1 to 3 on the following conditions.

(a) For alternative current components, voltage and frequency variations shown in the Table 1 are to be assumed.
(b) For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table 2 are to be assumed.
(c) For direct current components supplied by electrical batteries, voltage variations shown in the Table 3 are to be assumed. (2.)

2.2.3.3 Any special system, e.g. electronic circuits, whose function cannot operate satisfactorily within the limits shown in the Table should not be supplied directly from the system but by alternative means, e.g. through stabilized supply. (3.)

Table 1: Voltage and frequency variations for a.c. distribution systems

Quantity in Operation	Variations	
	Permanent	Transient
Frequency	±5%	±10% (5 sec)
Voltage	+6%, -10%	±20% (1.5 sec)

Table 2: Voltage variations for d.c. distribution systems

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

Table 3: Voltage variations for battery systems

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

END OF IACS UR E5

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

2.2.4 Electromagnetic interference

2.2.4.1 Electrical and electronic shipborne equipment shall be resistant to the following interference:

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

The test parameters are specified in *Publication 11/P – Environmental Tests on Marine Equipment* and in IEC 60092-504.

2.2.4.2 Ship electrical and electronic equipment shall not emit excessive electromagnetic, radiated and conducted interferences.

The test parameters are specified in *Publication 11/P – Environmental Tests on Marine Equipment* and in IEC 60092-504.

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

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

2.2.4.5 All signal, control and information cables shall be screened. Metallic screens of these cables shall be earthed appropriately to the number of screens. In the case of using double-screened cables and appearance of high frequency field interference, internal and external screens

shall be earthed on both sides and connected to equipment earthing. Internal cable screens may be earthed on one side if low frequency interference occurs. The above-mentioned principles do not concern screened concentric cables.

2.2.4.6 In all cases, the electrical continuity of all cable sheaths shall be provided, i.e. in cable junction and connecting boxes, as well as at the point of cable penetration of bulkheads.

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

2.2.4.8 To prevent contacts with the ship hull, screens of signal conductors shall be covered with an insulated outer sheath.

2.2.4.9 The screens and enclosures of electrical equipment placed on the navigation bridge shall be earthed.

The screens of cables and flexible cords shall be earthed in accordance with 2.5.3.5.

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

2.2.4.10 It is recommended that screened cables with pair or multipair twisted wires be used to increase their resistance to electromagnetic interference.

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

2.2.4.12 Administrations shall ensure that all electrical and electronic equipment on the bridge or in the vicinity of the bridge, (...), is tested for electromagnetic compatibility, taking into account the recommendations developed by the Organization.* (SOLAS, Reg. V/17.1)

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* Refer to the *General requirements for electromagnetic compatibility for all electrical and electronic ship's equipment* adopted by the Organization by resolution A.813(19).

2.2.4.13 Electrical and electronic equipment shall be so installed that electromagnetic interference does not affect the proper function of navigational systems and equipment. (SOLAS, Reg. V/17.2)

IACS interpretation

1. Scope

All electrical and electronic appliances installed on the bridge and vicinity of the bridge other than mandatory navigation and communication equipment having been type tested according to IEC 60945:2002, as well as loose equipment placed on board by the builders or owners shall have been EMC tested for Conducted and Radiated Emission.

Bridge and vicinity of the bridge covers deck and bridge zone, i.e.

- *the wheelhouse including bridge wings*
- *control rooms, characterized by equipment for inter-communication, signal processing, radio communication and navigation, auxiliary equipment*
- *area in close proximity to receiving and/or transmitting antennas and large openings in the metallic structure (equipment beyond 5 meters need not be considered for this purposes).*

2. Test standards

The following are acceptable test standards:

– *IEC 60945:2002*
– *IEC 60533:2015*

For the purpose of this UI, equipment need be tested for Conducted and Radiated Emission only.

Note:

Equipment having been type tested for EMC in accordance with other appropriate standards will have to be considered. In particular the level of radiated emission in the frequency band from 156 to 165 MHz and the location of the equipment shall be evaluated.

IEC 60533:2015 gives guidance to type of equipment and applicable tests.

***Passive-EM equipment**, defined below, which is excluded from the scope of the EMC since it is considered not liable to cause or be susceptible to disturbances need not to be tested but shall be provided with an exemption statement.*

Definition:

Equipment is considered a passive-EM equipment if, when used as intended (without internal protection measures such as filtering or shielding) and without any user intervention, it does not create or produce any switching or oscillation of current or voltage and is not affected by electromagnetic disturbances.

Example of equipment which include no active electronic part:

– *cables and cabling systems, cables accessories.*
– *equipment containing only resistive loads without any automatic switching device; e.g. simple domestic heaters with no controls, thermostat, or fan.*
– *batteries and accumulators.*

3. Evidence to be provided

All electrical and electronic appliances installed on the bridge and vicinity of the bridge other than mandatory navigation and communication equipment having been type tested according to IEC 60945:2002, as well as loose equipment placed on board by the builders or owners shall be listed and be provided with at least the following information. The list and the evidence of equipment are to be kept onboard.

– *equipment description*
– *manufacturer*
– *type/model*
– *evidence of EMC compatibility which may be:*
  - *type approval certificate covering EMC requirements for bridge installations;*
  - *test certificate or report/conformity statement; or*
  - *exemption statement. (IACS UI SC194)*

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

2.2.4.15 In ships constructed of non-current-carrying materials where radio equipment installation is required, all cables installed within the radius of 9 m from antenna shall be screened or otherwise effectively protected against interference.

2.3 Materials

(…) for all ships, new installation of materials which contain asbestos shall be prohibited. (SOLAS, Reg. II-1/3-5.2)

According to IACS UI SC249 the provision covers inter alia insulation material in electric equipment, thermal insulating materials, electrical cable materials, adhesives/mastics/fillers, sealing putty, electrical bulkhead penetration packing and circuit breaker arc chutes. For further guidance – see MSC.1/Circ.1374/Rev.1 and MSC.1/Circ.1379.

2.3.1 Construction materials

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

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 higher than normal humidity shall be made of corrosion-resistant materials or shall have effective corrosion-resistant covering.

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

.1 rheostat elements which shall be made of mechanically strong materials having high resistivity and capable of withstanding high temperature;
.2 rotor cages windings of asynchronous and synchronous motors which can be made of aluminium or its alloys resistant to sea conditions;
.3 carbon brushes and rings, cermet contacts and similar parts when the properties specified so require;
.4 parts of electrical equipment connected directly to the hull used as return conductor in one-wire system.

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

2.3.2 Insulating materials

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

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

2.3.2.2 Uninsulated parts of electrical equipment shall be cooled by incombustible liquids only.

2.3.2.3 The insulating materials to be used for winding insulation in machines, apparatus and other equipment for essential services shall be those specified in Table 3.1, Appendix 2. The use of insulating materials of at least 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 hardly combustible. For apparatus with increased heating, as well as those specified in Chapter 15 – of incombustible materials.

2.3.2.5 Insulating materials used for manufacturing cables shall fulfil the requirements specified in 16.3.

2.4 Design requirements and degrees of enclosures protection

2.4.1 General requirements

2.4.1.1 Parts which may require replacement while in service shall be easily dismountable.

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

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

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

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

2.4.1.6 When oil, steam or water are led to the measuring instruments used in the control desk or in the switchboard, it is necessary to undertake the preventive measures in order not to allow oil, steam or water to penetrate the live parts of the electrical equipment in case of damage of the measuring instruments or pipes.

2.4.2 Insulation clearances

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

2.4.3 Internal connections

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

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

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

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

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

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

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

2.4.4 Degrees of enclosures protection

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

2.4.4.2 The minimum degree of protection of electrical equipment installed in rooms and spaces of the ship shall be chosen in accordance with the Table below.

Item	Electrical equipment location (examples)	Conditions in equipment location	Design according to degree of protection
1 2 3 4 5 6 7	Ammonia plant rooms (refrigerating machinery) Accumulator battery rooms Lamp rooms Paint rooms Stores for welding-gas bottles Holds classified as explosion-hazardous Tunnels for pipes containing oil with a flash-point of 60°C or below	Danger of explosion	Certified safe-type (see 2.9)
8 9	Dry accommodation spaces Dry control rooms	Danger of touching live parts only	IP20
10 11 12 13 14 15 16 17	Rooms on the bridge Engine and boiler rooms above floor Steering gear rooms Refrigerating machinery rooms (excluding ammonia plant) Emergency machinery rooms General store-rooms Pantries Provision rooms	Danger of dripping liquid and/or moderate mechanical damage	IP22
18	Bathrooms and showers	Increased danger of liquid occurrence and/or mechanical damage	IP34
19 20 21 22 23 24 25	Engine and boiler rooms below floor Closed fuel oil separator rooms Closed lubricating oil separator rooms Ballast pump-rooms Refrigerated rooms Galleys and laundries Engine rooms protected by fixed water-based local application fire-fighting systems (FWBLAFFS) – see note 3)	Increased danger of liquid occurrence and mechanical damage	IP44
26 27 28	Rooms intended for fish processing Shaft or pipe tunnels in double bottom Holds	Danger of liquid spraying, cargo dust presence, serious mechanical damage, aggressive fumes	IP55
29	Open decks	Danger of occurrence of liquids in large quantities	IP56
30	Equipment intended to work under the conditions of continuous submersion, (e.g.: sensors in forward dry spaces of bulk carriers)	Submersion	IPX8

Notes:

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

2) For crude oil tankers, combined ships, ships intended or adapted for operation in the area of oil spillage – see 21.4.4.

3) **Installation of electrical and electronic equipment in engine rooms protected by fixed water-based local application fire-fighting systems (FWBLAFFS)**

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Definitions:

Protected space:

– Is a machinery space where a FWBLAFFS is installed.

Protected areas:

– Areas within a protected space which is required to be protected by FWBLAFFS.

Adjacent areas:

– Areas, other than protected areas, exposed to direct spray.
– Areas, other than those defined above, where water may extend.

See also Fig. 1

Electrical and electronic equipment enclosures located within areas protected by FWBLAFFS and those within adjacent areas exposed to direct spray are to have a degree of protection not less than IP44, except where evidence of suitability is submitted to and approved by the Society.

The electrical and electronic equipment within adjacent areas not exposed to direct spray may have a lower degree of protection provided evidence of suitability for use in these areas is submitted taking into account the design and equipment layout, e.g. position of inlet ventilation openings, cooling airflow for the equipment is to be assured.

Note

1. Additional precautions may be required to be taken in respect of:
   a. tracking as the result of water entering the equipment
   b. potential damage as the result of residual salts from sea water systems
   c. high voltage installations
   d. personnel protection against electric shock

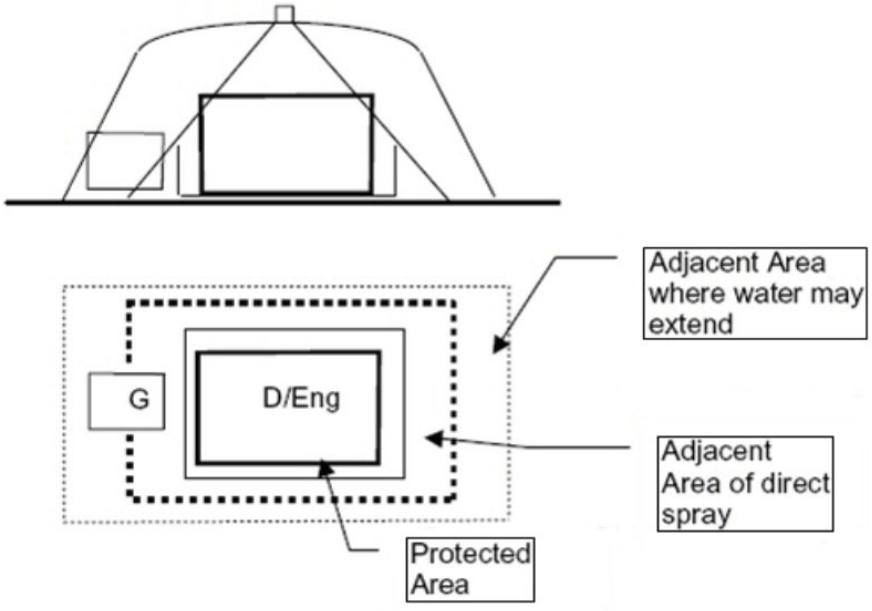

Figure 1

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2.5 Earthing of non-current-carrying metal parts

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

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

For guidance – see IACS REC.178 *Overall Earthing System: Protective Earthing, System Earthing – Guidelines.*

2.5.1 Parts subject to earthing

2.5.1.1 Exposed metal parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live shall be earthed unless the machines or equipment are:

- **.1** supplied at a voltage not exceeding 50 V direct current or 50 V, root mean square between conductors; auto-transformers shall not be used for the purpose of achieving this voltage; or
- **.2** supplied at a voltage not exceeding 250 V by safety isolating transformers supplying only one consuming device; or
- **.3** constructed in accordance with the principle of double insulation. (SOLAS, Reg. II-1/45.1.1)

2.5.1.2 The Administration may require additional precautions for portable electrical equipment for use in confined or exceptionally damp spaces where particular risks due to conductivity may exist. (SOLAS, Reg. II-1/45.1.2)

2.5.1.3 All electrical apparatus shall be so constructed and so installed as not to cause injury when handled or touched in the normal manner. (SOLAS, Reg. II-1/45.1.3)

2.5.1.4 Apart from the machines and equipment listed in 2.5.1.1, protective earthing against electric shock hazard is not required for:

- **.1** metal parts of electrical equipment fastened in an insulating material or passing through it and isolated from the earthed and live parts in such a manner that under normal operating conditions these parts cannot happen to be live or get in contact with the earthed parts;
- **.2** cages of specially insulated bearings;
- **.3** lamp bases, lamp holders and fasteners for luminescent lamps, lamp shades and reflectors, covers fastened to lamp holders or to lighting fixtures made of an insulating material or screwed into such a material;
- **.4** cable hangers and brackets;

2.5.1.5 The screens and metal sheaths of cables shall be earthed.

2.5.1.6 The secondary windings of all measuring current and voltage transformers shall be earthed.

2.5.2 Earthing of aluminium superstructures in steel ships

Superstructures of aluminium alloys fastened to the ship steel hull, but insulated from it, shall be earthed with a special conductor having a cross-section not less than 16 mm^2 which shall be

corrosion-resistant and such that will not start electrolytic corrosion at the point of contact of the superstructure with the hull.

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

2.5.3 Earthing terminals and earthing wires

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

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

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

For the purpose of earthing effected with an external earthing wire, copper wire shall be used. A wire of another corrosion-resistant metal may also be used, provided the resistance of this wire does not exceed that of the required copper wire.

The cross-section of copper earthing wire shall not be less than that specified in the Table below.

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

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

2.5.3.3 Earthing of the movable and portable appliances shall be effected through the earthed jack of a socket outlet or other earthed connecting elements and through the earthed copper core of the feeding cable. Cross-section of the earthing core shall not be less than the nominal cross-section of the core in the flexible feeding cable for cables up to 16 mm^2 and at least half the cross-section of the core in the flexible feeding cable, but not less than 16 mm^2 for cables over 16 mm^2.

2.5.3.4 Earthing wires or earthing conductors of cables in fixed equipment shall not be disconnected.

2.5.3.5 Earthing of screens and metal sheaths of cables shall be effected by one of the following methods:

.1 by a copper earthing wire having a cross-section not less than 1.5 mm^2 for cables with a cross-section up to 25 mm^2 and not less than 4 mm^2 for cables with a cross-section over 25 mm^2;
.2 by a suitable fastening of the metal sheath or armour of cables to the metal hull of the ship;
.3 by means of rings in the cable glands, provided they are corrosion-resistant, well conducting and resilient.

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

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

2.5.3.7 Cargo tanks and their process plant, including piping systems, shall have relevant connection with the ship hull. Resistance between them and hull of the ship shall not exceed 1 MΩ. In the case of lack of stable connection with the hull, bonding straps shall be used.

2.5.3.8 In the case of application of bonding straps, they shall be:

- clearly visible (in order to immediate verification of their failures);
- designed and installed in such way that they are protected against possible mechanical failures and corrosive atmosphere/products;
- easy for installation and replacement.

2.6 Lightning protection

2.6.1 General requirements

2.6.1.1 The ship shall be fitted with a lightning protection, whose protection zone will comprise all arrangements required for protection against lightning.

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

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

2.6.2 Spike

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

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

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

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

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

2.6.3 Lightning conductor

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

2.6.3.2 Lightning conductors shall be led on the outer side of the mast and superstructures and as straight as possible with a minimum number of bends which shall be smooth and have the largest possible radii.

2.6.3.3 Lightning conductors shall not pass through explosion-hazardous spaces.

2.6.4 Earthing

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

2.6.4.2 Provision shall be made for earthing the lightning conductors or the ship steel hull to an efficient earth on shore when the ship is in a dry dock or on a slipway.

2.6.5 Connections in the lightning installation

2.6.5.1 Connections in the lightning installation shall be welded, clamped, riveted or bolted with clamps.

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

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

2.6.6 Earthing installation

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

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

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

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

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

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

2.7 Arrangement of equipment

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

2.7.2 The horizontal-shaft electric machines shall be so installed that the shaft is situated parallel to the fore-and-aft plane of the ship. Placing of such machines with the shaft situated in another direction is permitted only in those cases when the construction of the machine will ensure its normal operation under conditions specified in 2.2.2.3.

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

2.7.4 The electrical equipment placed in locations subject to vibrations and shocks (heavier than those specified in 2.2.2.1) which are impossible to eliminate shall be so designed as to be capable of normal operation under such conditions or shall be installed on shock absorbers.

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

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

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

2.8 Special electrical spaces

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

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

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

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

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

2.9 Electrical equipment in hazardous areas

2.9.1 The requirements of the present subchapter apply to electrical equipment installed on all ships where in enclosed and semi-enclosed rooms and spaces explosive mixtures of vapour, gases and dust with air may accumulate – specified in items 1 to 7 of Table in para 2.4.4.2.

Additional requirements for the installation of electrical equipment in crude oil tankers, combined ships, ships intended or adapted for operation in the area of oil spillage are specified in 21.4,

whereas the requirements for the installation of electrical equipment in ships having holds and other spaces for carrying vehicles with fuel in their tanks, as well as tank cars and tank trucks carrying cargoes subject to explosion hazards are specified in 21.1.10 and 21.2.

2.9.2 No electrical equipment shall be installed in any space where flammable mixtures are liable to collect, e.g. in compartments assigned principally to accumulator batteries, in paint lockers, acetylene stores or similar spaces, unless the Administration is satisfied that such equipment is:

.1 essential for operational purposes;
.2 of a type which will not ignite the mixture concerned;
.3 appropriate to the space concerned; and
.4 appropriately certified for safe usage in the dusts, vapours or gases likely to be encountered. (SOLAS, Reg. II-1/45.10)

2.9.3 The electrical installations in hazardous spaces and rooms shall be made in accordance with IEC 60092-506.

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

The installation of electrical equipment in paint stores and spaces leading to paint stores shall fulfil the requirements specified in 2.9.4.

The installation of electrical equipment in accumulator battery rooms shall fulfil the requirements specified in 13.6.

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

2.9.4 Electrical Equipment allowed in paint stores and in the enclosed spaces leading to paint stores

IACS UR E12

2.9.4.1 General (1.)

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

Certified safe type equipment of the following type is acceptable;

a. intrinsically safe Exi
b. flameproof Exd
c. pressurised Exp
d. increased safety Exe
e. special protection Exs

Cables (through-runs or terminating cables) of armoured type or installed in metallic conduits are to be used.

2.9.4.2 Minimum Requirements (2.)

The minimum requirements for the certified safe type equipment are as follows:

– explosion group II B
– temperature class T3

Footnote:
The paint stores and inlet and exhaust ventilation ducts under 2.9.4.1 (Clause 1) are classified as Zone-1 and areas on open deck under 2.9.4.3.2 (Clause 4) as Zone 2, as defined in IEC 60092-502:1999.
A watertight door may be considered as being gastight.

2.9.4.3 Special requirements (3.)

2.9.4.3.1 Switches, protective devices, motor control gear of electrical equipment installed in a paint store are to interrupt all poles or phases and preferably are to be located in non-hazardous space. (3.1)

2.9.4.3.2 In the areas on open deck within 1m of inlet and exhaust ventilation openings or within 3 m of exhaust mechanical ventilation outlets, the following electrical equipment may be installed:

- electrical equipment with the type of protection as permitted in paint stores;
- equipment of protection class Exn;
- appliances which do not generate arcs in service and whose surface does not reach unacceptably high temperature;
- appliances with simplified pressurised enclosures or vapour-proof enclosures (minimum class of protection IP55) whose surface does not reach unacceptably high temperature; or
- cables as specified in 2.9.4.1 (clause 1). (3.2)

2.9.4.3.3 The enclosed spaces giving access to the paint store may be considered as nonhazardous, provided that:

- the door to the paint store is a gastight door with self-closing devices without holding back arrangements,
- the paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area, and
- warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids. (3.3)

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

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

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

2.9.6 Lighting fixtures of explosion-proof construction shall be so installed that, except the fastening points, free space of at least 100 mm is left around.

2.9.7 All devices, except fire detection devices, installed in hazardous areas, shall be fitted with switches, protection devices or starters capable of switching off all poles or phases located outside hazardous areas.

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

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

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

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

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

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

2.9.11 In hazardous spaces and rooms, only cables intended for electrical equipment located in these spaces and rooms shall be installed.

Cables passing through the above-mentioned rooms and spaces may be installed, provided the requirements specified in 2.9.12 to 2.9.16 are met.

2.9.12 Cables installed in hazardous areas shall be sheathed with one of the following:

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

2.9.13 Cables passing through hazardous areas shall be protected against mechanical damage.

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

2.9.15 Cables associated with intrinsically safe circuits shall be used for one device only and shall be separated from other cables.

2.9.16 No cables of portable electrical equipment shall pass through hazardous areas, except cables associated with intrinsically safe circuits.

2.10 Carriage of dangerous goods

Where goods having a flash-point lower than 23°C (Class 3, 6.1 or 8) are being carried in cargo spaces, the electrical equipment in such spaces and in the spaces containing bilge water systems

with such components as flanges, valves and pumps shall fulfil the requirements specified in *Part V,* 7.2.2.

2.11 Ship's cyber security

Ships shall comply with the requirements of *Publication 125/P – Ship's Cyber Security*. It is recommended that ships also comply with the IACS REC.166 – *Recommendation on Cyber Resilience.*

CHAPTER 3

3 MAIN SOURCE OF ELECTRIC POWER

3.1 General requirements

3.1.1 A main source of electrical power of sufficient capacity to supply all those services mentioned in 2.1.1.1 (regulation 40.1.1) shall be provided. This main source of electrical power shall consist of at least two generating sets. (SOLAS, Reg. II-1/41.1.1)

Note:
Interpretation under 2.1.1.1 applies also to this paragraph.

3.1.2 The capacity of these generating sets shall be such that in the event of any one generating set being stopped it will still be possible to supply those services necessary to provide normal operational conditions of propulsion and safety. Minimum comfortable conditions of habitability shall also be ensured which include at least adequate services for cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water. (SOLAS, Reg. II-1/41.1.2)

IACS and IMO interpretation

(...) For the purposes of this regulation (i.e. 3.1.2), the services as included in paragraphs 2 to 4 (i.e. defined in 1.2.26 and 1.2.54), except for those also listed in UI SC2 (i.e. thrusters not forming part of the main propulsion, moorings, cargo handling gear, cargo pumps, refrigerators for air conditioning those which are not necessary to establish a minimum condition of habitability), are to be considered. (IACS UI SC134 para 7, MSC.1/Circ.1464/Rev.1, Sec.4 and MSC.1/Circ.1572/Rev.2, Sec.5)

Note:
Although UI SC2 was deleted in 2003 its provisions mentioned above still apply under MSC.1/Circ.1572/Rev.2, Sec.6.

3.1.3 The capacity of these generating sets shall also be such that, even if any one generating set is stopped it will still be possible to start the electric motor with a maximum starting current under the most severe starting conditions. There must be no drop in voltage or frequency that could cause the generator prime mover to fall out of synchronism, stop of, or switch off the running machines and apparatus.

3.1.4 The arrangements of the ship' s main source of electrical power shall be such that the services referred to in 2.1.1.1 (regulation 40.1.1) can be maintained regardless of the speed and direction of rotation of the propulsion machinery or shafting. (SOLAS, Reg. II-1/41.1.3)

IACS and IMO interpretation

Generators and generator systems, having the ship's main propulsion machinery as their prime mover (i.e. shaft generators), may be accepted as part of the ship's main source of electrical power, provided:

***1.** They are to be capable of operating under all weather conditions during sailing and during manoeuvring, also when the vessel is stopped, within the specified limits for the voltage variation in IEC 60092-301:1980 and the frequency variation in 2.2.3 (UR E5).*

***2.** Their rated capacity is safeguarded during all operations given under 1, and is such that in the event of any other one of the generators failing, the services given under 3.1.2 (Regulation 41.1.2 of SOLAS Chapter II-1 as amended by IMO resolutions up to MSC.436(99)) can be maintained.*

***3.** The short circuit current of the generator/generator system is sufficient to trip the generator/generator system circuit-breaker taking into account the selectivity of the protective devices for the distribution system.*

Protection is to be arranged in order to safeguard the generator/generator system in case of a short circuit in the main bus bar. The generator/generator system is to be suitable for further use after fault clearance.

4. Standby sets are started in compliance with the paragraph 2.2 of SC157 (see 4.3.7). (IACS UI SC1, MSC.1/Circ.1572/Rev.2, Sec.6)

3.1.5 If a shaft generator is used instead of one of the generating sets mentioned in 3.1.1, the shaft generator shall run with a constant rotary speed at variable rotational speed of the main engine or propeller shaft.

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

3.1.6 In addition, the generating sets shall be such as to ensure that with any one generator or its primary source of power out of operation, the remaining generating sets shall be capable of providing the electrical services necessary to start the main propulsion plant from a dead ship condition. The emergency source of electrical power may be used for the purpose of starting from a dead ship condition if its capability either alone or combined with that of any other source of electrical power is sufficient to provide at the same time those services required to be supplied by 21.1.3.6.1 to 21.1.3.6.3 (Regulations 42.2.1 to 42.2.3) for passenger ships and 9.3.5.1 to 9.3.5.4 (43.2.1 to 43.2.4) for cargo ships. (SOLAS, Reg. II-1/41.1.4)

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

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

3.1.9 (...) load shedding or other equivalent arrangements shall be provided to protect the generators required by 3.1.1 (this regulation) against sustained overload; (SOLAS, Reg. II-1/41.5.1.2)

IACS and IMO interpretation

(...) For the purposes of this regulation (i.e. 3.1.9), the following interpretations are applicable.

***10.1** Services in paragraph 2 (i.e. primary essential services as defined in 1.2.24) are not to be included in any load shedding or other equivalent arrangements.*

***10.2** Services in paragraph 3 (i.e. secondary essential services as defined in 1.2.24) may be included in the automatic load shedding or other equivalent arrangement provided disconnection will not:*

(a) cause immediate disruption of systems required for safety, e.g.:

- *Lighting systems,*
- *Navigation lights, aids and signals,*
- *Internal safety communication equipment.*

(b) prevent services required for safety being immediately available when the power supply is restored to normal operating conditions, e.g.:

- *Fire pumps, and other extinguishing medium pumps,*
- *Bilge pumps,*
- *Ventilating fans for engine and boiler rooms.*

Examples of equipment in the paragraph 3 (i.e. secondary essential services as defined in 1.2.24), for which the automatic load shedding or other equivalent arrangement is normally allowed, includes:

– *Fuel oil transfer pumps and fuel oil treatment equipment*
– *Lubrication oil transfer pumps and lubrication oil treatment equipment*
– *Pre-heaters for heavy fuel oil*
– *Starting air and control air compressors (except for control air compressors for propulsion control and its safety systems)*
– *Services listed in UI SC2 (see interpretation and note under 3.1.2).*

10.3 *Services for habitability in the paragraph 4 (i.e. services for habitability as defined in 1.2.53) may be included in the automatic load shedding or other equivalent arrangement. (IACS UI SC134 para 10, MSC.1/Circ.1464/Rev.1, Sec.4 and MSC.1/Circ.1572/Rev.2, Sec.5)*

IACS and IMO interpretation

(…)

2.3.1 *The load shedding should be automatic.*

2.3.2 *The non-essential services, service for habitable conditions may be shed and where necessary, additionally the secondary essential services, sufficient to ensure the connected generator set(s) is/are not overloaded. (IACS UI SC157, MSC.1/Circ.1572/Rev.2, Sec.6)*

3.1.10 The number and the capacity of the main source of electric power shall be determined taking account of the following operating conditions of the ship:

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

3.1.11 Each hull of a catamaran shall be provided with at least one generating set.

3.1.12 In ships of 300 gross tonnage and downward (except passenger ships), accumulator batteries may be used as main source of power subject to special consideration and approval by PRS. If the main source of electric power are accumulator batteries, their capacity shall be sufficient to satisfy the requirements specified in 3.1.2 for 8 hours without recharging.

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

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

3.2 Electric generating sets

3.2.1 General requirements

3.2.1.1 Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative. Special consideration shall be given to the malfunctioning of:

.1 a generating set which serves as a main source of electrical power;
(…)
.10 (…) electrical means for control in main propulsion machinery including controllable pitch propellers.

However, the Administration, having regard to overall safety considerations, may accept a partial reduction in propulsion capability from normal operation. (SOLAS, Reg. II-1/26.3)

3.2.1.2 Engines designed for use as generator prime movers shall fulfil the requirements specified in *Part VII*, Chapter 2 and additionally with the requirements of the present subchapter.

3.2.1.3 Generating sets shall be designed for continuous duty, taking into account the power drop of the prime movers during the operation of the ship under the conditions specified in 2.2.1.1 and 2.2.1.2.

3.2.1.4 In the event of short-circuit in the ship network, the generators shall be capable of maintaining the design short-circuit current of the value sufficient for the operation of protective devices.

3.2.1.5 Generators of the generating sets shall be provided with voltage regulation within the limits specified in 10.6 and 10.7, as well as with frequency regulation within the limits specified in 2.2.3.

3.2.1.6 For alternating current generators, the difference between the actual value of voltage curve and the corresponding value of the 1st harmonic shall not exceed 5% of the 1st harmonic peak value.

3.2.2 Load sharing between generating sets running in parallel

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

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

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

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

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

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

3.2.3 Shaft generators

3.2.3.1 Shaft generators used as main source of electric power for shipboard electrical network shall be provided with devices for voltage regulation within the limits specified in 10.6 and 10.7 and for frequency regulation within the limits specified in 2.2.3.

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

3.2.3.2 The use of shaft generators designed to supply individual consumers with voltage and frequency parameters different from those specified in 2.2.3 will be specially considered by PRS in each particular case.

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

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

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

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

3.2.3.7 When shaft generators connect to the ship network, visual signalling shall automatically switch on warning on the navigation bridge that a change of the rotational speed of the main propulsion may result in a change of the ship network parameters exceeding the limits specified in 10.6, 10.7 and 2.2.3.

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

3.2.3.9 Generators and generator systems, having the ship's propulsion machinery as their prime mover, not forming part of the ship's main source of electrical power
IACS UR E17

Generators and generator systems, having the ship's propulsion machinery as their prime mover but not forming part of the ship's main source of electrical power[1] may be used whilst the ship is at sea to supply electrical services required for normal operational and habitable conditions provided that:

1. there are sufficient and adequately rated additional generators fitted, which constitute the main source of electrical power required by 3.1.1, 3.1.2, 3.1.4 and 3.1.6 (SOLAS), meeting the requirements of IEC 60092-201:2019 paragraph 8.1.1.
2. arrangements are fitted to automatically start one or more of the generators, constituting the main source of electrical power required by SOLAS, in compliance with paragraph 2.2

of SC157 (see 4.3.7) and also upon the frequency variations exceeding ± 10% of the limits specified below.

3. within the declared operating range of the generators and/or generator systems the specified limits for the voltage variations in IEC 60092-301:1980/AMD2:1995 and the frequency variations in 2.2.3 (UR E5) can be met.
4. the short circuit current of the generator and/or generator system is sufficient to trip the generator/generator system circuit-breaker taking into account the selectivity of the protective devices for the distribution system.
5. where considered appropriate, load shedding arrangements are fitted to meet the requirements of paragraph 2.3 of SC157 (see 3.1.9).
6. on ships having remote control of the ship's propulsion machinery from the navigating bridge means are provided, or procedures be in place, so as to ensure that supplies to essential services are maintained during manoeuvring conditions in order to avoid a blackout situation[2].

Footnotes:

1. Such generator systems are those whose operation does not meet the requirements of IEC 60092-201:2019, paragraph 8.1.1.
2. A 'blackout situation' means that the main and auxiliary machinery installations, including the main power supply, are out of operation but the services for bringing them into operation (e.g. compressed air, starting current from batteries etc.) are available.

END OF IACS UR E17

3.2.4 Requirements for AC generating sets

Note:
These requirements are applicable to AC generating sets driven by reciprocating internal combustion engines irrespective of their types (i.e. diesel engine, dual-fuel engine, gas-only engine), except for those sets consisting of a propulsion engine which also drives power take off (PTO) generator(s).

3.2.4.1 The generating set shall show torsional vibration levels which are compatible with the allowable limits for the alternator, shafts, coupling and damper.

3.2.4.2 The coupling selection for the generating set shall take into account the stresses and torques imposed on it by the torsional vibration of the set. The torsional vibration calculations are to be submitted to PRS for approval when the engine power is 110 kW or above.

3.2.4.3 The rated power shall be appropriate for the actual use of the generator set.

3.3 Number and power of transformers

3.3.1 Where transformers constitute an essential part of the electrical supply system required by 3.1.1 to 3.1.6 (this paragraph), the system shall be so arranged as to ensure the same continuity of the supply as is stated in 3.1.1 to 3.1.6 (this paragraph). (SOLAS, Reg. II-1/41.1.5)

IACS and IMO interpretation

(...) For the purposes of this regulation (i.e. 3.3.1), the services as included in paragraphs 2, 3 and 4 (i.e. defined in 1.2.24 and 1.2.53) are to be considered. See also UI SC83 – below. (IACS UI SC134 para 8, MSC.1/Circ.1464/Rev.1, Sec.4 and MSC.1/Circ.1572/Rev.2, Sec.5)

IACS interpretation

The number, capacity and arrangement of power transformers supplying auxiliary electrical systems are to be such that with any one transformer not in operation, the remaining transformer(s) is (are) sufficient to ensure the safe operation of those

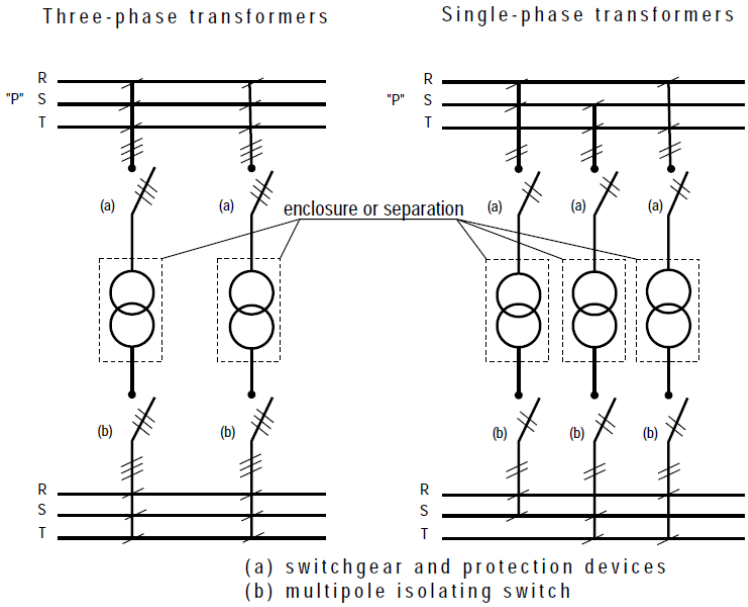
services necessary to provide normal operational conditions of propulsion, safety and minimum comfortable conditions of habitability are also to be ensured, which include at least adequate services for cooking, heating domestic refrigeration, mechanical ventilation, sanitary and fresh water.

Each transformer required is to be located as a separate unit with separate enclosure of equivalent, and is to be served by separate circuits on the primary and secondary sides. Each primary circuit is to be provided with switch-gear and protection devices in each phase.

Each of the secondary circuits is to be provided with a multipole isolating switch.

Transformers supplying bow thruster are excluded.

EXAMPLES:



(IACS UI SC83)

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

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

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

3.4 Power supply from an external source of electric power

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

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

3.4.3 In ships with a low-rated electrical installation, it is permitted to connect the cable supplying the ship network from an external source of electric power directly to the main switchboard.

3.4.4 The terminal for power supply from an external source of electric power shall be provided with:

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

3.5 Connection of supply sources

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

3.5.2 Compound-wound generators designed for parallel operation 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 stand-by manual synchronizer shall be provided.

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

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

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

3.5.6 (...) where the main source of electrical power is necessary for propulsion of the ship or where the total output of generators running in parallel is over 1000 kW (kVA), the main busbar shall be subdivided into at least two parts which shall normally be connected by circuit breakers or other approved means; so far as is practicable, the connection of generating sets and other duplicated equipment shall be equally divided between the parts (...)(SOLAS, Reg. II-1/41.5.1.3) See also 4.5.2.1

IACS and IMO interpretation

Other approved means can be achieved by:

- *circuit breaker without tripping mechanism; or*
- *disconnecting link or*
- *switch*

by which bus bars can be split easily and safely.

Bolted links, for example bolted bus bar sections, are not to be accepted. *(UI SC136, MSC.1/Circ.1572/Rev.2, Sec.6)*

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

CHAPTER 4

4 DISTRIBUTION OF ELECTRIC POWER

4.1 Distribution systems

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

.1 for voltages up to 1000 V alternating current:
- **.1.1** three-phase three-wire insulated system;
- **.1.2** three-phase three-wire system with neutral earthed;

.2 in addition, for voltages up to 500 V alternating current:
- **.2.1** three-phase four-wire system with neutral earthed but without hull return;
- **.2.2** single-phase two-wire insulated system;
- **.2.3** single-phase two-wire system with one wire earthed;

.3 for direct current:
- **.3.1** two-wire insulated system;
- **.3.2** single-wire system with hull return, for voltages of up to 50 V only, under the following conditions:
  - in ships of less than 1600 gross tonnage,
  - in ships of 1600 gross tonnage and upwards in restricted and locally earthed systems (e.g. in the starting system of internal combustion engines);
- **.3.3** two-wire system with one pole earthed;
- **.3.4** three-wire system with neutral earthed.

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

4.1.2 The hull return system of distribution shall not be used for (...) power, heating, or lighting in any (...) ship of 1,600 gross tonnage and upwards. (SOLAS, Reg. II-1/45.3.1)

4.1.3 The requirement of paragraph 4.1.2 (3.1) does not preclude under conditions approved by the Administration the use of:

.1 impressed current cathodic protective systems;
.2 limited and locally earthed systems; or
.3 insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions. (SOLAS, Reg. II-1/45.3.2)

4.1.4 (...), the requirement of paragraph 4.1.2 (3.1) does not preclude the use of limited and locally earthed systems, provided that any possible resulting current does not flow directly through any dangerous spaces. (SOLAS, Reg. II-1/45.3.2-1)

4.1.5 Where the hull return system is used, all final subcircuits, i.e. all circuits fitted after the last protective device, shall be two-wire and special precautions shall be taken to the satisfaction of the Administration. (SOLAS, Reg. II-1/45.3.3)

IACS interpretation

1. *All final sub-circuits should consist of two insulated wires, the hull return being achieved by connecting to the hull one of the busbars of the distribution board from which they originate.*

2. Earth wires should be in accessible locations to permit their ready examination and to enable their disconnection for testing of insulation. (IACS UI SC8)

4.1.6 When a distribution system, whether primary or secondary, for power, heating or lighting, with no connexion to earth is used, a device capable of continuously monitoring the insulation level to earth and of giving an audible or visual indication of abnormally low insulation values shall be provided. (SOLAS, Reg. II-1/45.4.2)

IACS interpretation

By "insulation level monitoring devices" is meant a device or devices to continuously monitor the values of electrical insulation to earth and to give an audible or visual indication in case of abnormally low insulation values. (IACS UI SC9)

4.1.7 All lighting and power circuits terminating in a bunker or cargo space shall be provided with a multiple pole switch outside the space for disconnecting such circuits. (SOLAS, Reg. II-1/45.8)

4.2 Permissible voltages

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

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

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

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

Table 4.2.2

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

Table 4.2.3

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

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

4.3 Power supply to essential services

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

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

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

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

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

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

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

4.3.6 Power supply to automatic systems shall fulfil the requirements specified in 20.3.

4.3.7 (...) where the main source of electrical power is necessary for propulsion and steering of the ship, the system shall be so arranged that the electrical supply to equipment necessary for propulsion and steering and to ensure safety of the ship will be maintained or immediately restored in the case of loss of any one of the generators in service; (SOLAS, Reg. II-1/41.5.1.1)

IACS and IMO interpretation

2.1 *Where the electrical power is normally supplied by more than one generator set simultaneously in parallel operation, provision of protection, including automatic disconnection of sufficient non-essential services and if necessary secondary essential services and those provided for habitability (see 1.2.24 and 1.2.53), should be made to ensure that, in case of loss of any of these generating sets, the remaining ones are kept in operation to permit propulsion and steering and to ensure safety.*

2.2 *Where the electrical power is normally supplied by one generator provision shall be made, upon loss of power, for automatic starting and connecting to the main switchboard of stand-by generator(s) of sufficient capacity with automatic restarting of the essential auxiliaries, in sequential operation if required. Starting and connection to the main switchboard of the stand-by generator is to be preferably within 30 seconds, but in any case not more than 45 seconds, after loss of power.*

The time of taking over the load by a stand-by generator shall be short enough to delay the starting of the emergency source of electric power.

Where prime movers with longer starting time are used, this starting and connection time may be exceeded upon approval from the society.

Note:
IMO interpretation – para 2 below, differs in some aspects from IACS interpretation – para 2.2 above, therefore both are cited. For the purpose of class only IACS interpretation can be applied, for statutory purposes IMO interpretation will be applied, for both purposes – the more stringent i.e. IMO.

2 *Where Administrations permit electrical power to be normally supplied by one generator, provision should be made, upon loss of power, for automatic starting and connecting to the main switchboard of stand-by generator(s) of sufficient capacity with automatic restarting of the essential auxiliaries, in sequential operation if required. Starting and connection to the main switchboard of one generator should be as rapid as possible, preferably within 30 seconds after loss of power. Where prime movers with longer starting time are used, this starting and connection time may be exceeded upon approval from the Administration.*

(...) (IACS UI SC157, MSC.1/Circ.1572/Rev.2, Sec.6)

4.4 Power supply to ship navigation control and monitoring consoles

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

4.4.2 It is permitted to supply the equipment specified in 4.3.1 from the switchboards built into ship navigation control and monitoring console, provided the requirements of 4.4.3 to 4.4.7 are met (see also 9.4.3).

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

4.4.4 In addition, the switchboards of control and monitoring console 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 or on any other technical reasons.

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

4.4.6 Each consumer specified in 4.3.1 supplied from the switchboard of control and monitoring console shall be supplied by a separate feeder (see also 9.5.3).

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

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

4.5 Distribution switchboards

4.5.1 Switchboard constructions

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

4.5.1.2 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.

4.5.1.3 Switchboards shall be at least 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 (see also 4.5.6.3).

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

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

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

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

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

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

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

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

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

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

4.5.2 Busbars and bare conductors

4.5.2.1 Where the total installed electrical power of the main generating sets is in excess of 3 MW, the main busbars shall be subdivided into at least two parts which shall normally be connected by removable links or other approved means; so far as is practicable, the connexion of generating sets and any other duplicated equipment shall be equally divided between the parts. Equivalent arrangements may be permitted to the satisfaction of the Administration. (SOLAS, Reg. II-1/41.4) See also 3.5.6.

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

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

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

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

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

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

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

4.5.2.8 Busbars and bare conductors of different polarity shall be marked with the following distinguishing colours:

.1 red for the positive pole;
.2 blue for the negative pole;
.3 black or yellow and green transverse bands for earth connections;
.4 light-blue for the middle wire.

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

4.5.2.9 Busbars and bare 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 green-yellow transverse bands for earth connections.

4.5.2.10 Busbar connections shall be so made as to preclude corrosion in places of connection.

4.5.3 Selection of apparatus and short-circuit currents calculation

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

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

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

Calculation of the minimum short-circuit current shall be performed only if it is necessary for estimation of the system.

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

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

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

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

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

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

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

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

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

- big motors (power above 100 kW):
  - $I''_M = 6.25\ I_{rM}$
  - $I_{acM} = 4I_{rM}$, $t = \mathrm{T}/2$
  - $I_{pM} = 10I_{rM,}$
- small motors:
  - $I''_M = 5I_{rM}$
  - $I_{acM} = 3.2I_{rM}$, $t = \mathrm{T}/2$
  - $I_{pM} = 8I_{rM}$

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

Calculation shall be performed for all cases of short-circuit necessary for obtaining the system characteristics.

4.5.4 Arrangement of apparatuses and measuring instruments

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The above given scale limits may be changed subject to PRS consent in each particular case.

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

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

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

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

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

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

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

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

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

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

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

4.5.4.20 Flexible stranded conductors shall be used for connection of instruments located on movable or drawn-out parts.

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

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

4.5.5 Visual signals

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

Table 4.5.5.1

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

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

4.5.6 Arrangement of switchboards

4.5.6.1 Main and emergency switchboards shall be so arranged as to give easy access as may be needed to apparatus and equipment, without danger to personnel. The sides and the rear and, where necessary, the front of the switchboards shall be suitably guarded. Exposed live parts having voltages to earth exceeding a voltage* to be specified by the Administration shall not be installed on the front of such switchboards. Where necessary, non-conducting mats or gratings shall be provided at the front and rear of the switchboard. (SOLAS, Reg. II-1/45.2)

IACS interpretation

* *Voltage values as stated in 2.5.1.1.1 (Regulation 45.1.1.1). (IACS UI SC7)*

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

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

4.5.6.4 If switchboards with the degree of protection IP10 and lower are located in a special space, cabinet or recess, such spaces shall be made of non-combustible material or shall have a

lining of such material. If the switchboards are located in a space having a deck area of less than 4 m^2, such space is treated as space of category (5) – see *Part V,* subchapter 2.2.2.

4.5.6.5 The arrangement of pipelines and tanks near the electrical equipment shall conform to the requirements specified in *Part VI,* 1.10.6, 1.10.9, 1.10.11 and 1.10.12.

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

4.5.6.7 The main switchboard (see 1.2.37) shall be so placed relative to one main generating station (see 1.2.34) that, as far as is practicable, the integrity of the normal electrical supply may be affected only by a fire or other casualty in one space. An environmental enclosure for the main switchboard, such as may be provided by a machinery control room situated within the main boundaries of the space, is not to be considered as separating the switchboards from the generators. (SOLAS, Reg. II-1/41.3)

IACS interpretation

(...)

***"Machinery space"**, for the purpose of this UI, is to be taken as extending from the moulded base line to the margin line and between the extreme main transverse watertight bulkheads, bounding the spaces containing the main and auxiliary propulsion machinery, boilers serving the needs of propulsion, and all permanent coal bunkers. In the case of unusual arrangements, the Administration may define the limits of the machinery space.*

The main generating station is to be situated within the machinery space, i.e. within the extreme main transverse watertight bulkheads.

Any bulkhead between the extreme main transverse watertight bulkheads is not regarded as separating the equipment in the main generating station provided that there is access between the spaces.

The main switchboard is to be located as close as practicable to the main generating station, within the same machinery space and the same vertical and horizontal A60 fire boundaries.

Where essential services for steering and propulsion are supplied from section boards these and any transformers, converters and similar appliances constituting an essential part of electrical supply system are also to satisfy the foregoing. (IACS UI SC151)

4.5.6.8 In catamarans, the main switchboard shall be installed in each hull.

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

4.5.7 Access to switchboards

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

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

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

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

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

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

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

CHAPTER 5

5 ELECTRICALLY DRIVEN MACHINERY AND EQUIPMENT

5.1 General requirements

5.1.1 The control stations and automatic features of the drives shall fulfil the relevant requirements specified in 20.1, while the power supply of electrical automation systems shall fulfil the requirements specified in 20.3.

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

5.1.3 The equipment provided with automatic remote and manual control shall be so designed that the automatic or remote control is switched off when changing over to the manual control. The manual control shall be independent of automatic or remote control.

5.2 Interlocking of machinery operation

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

5.2.2 If mutual dependence of machinery operation or machinery operation in a certain sequence is required, the appropriate interlocking device 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 accidental switching off the interlocking. An informative inscription shall be placed in close proximity to this device indicating its application and forbidding using it by unauthorized personnel. Such a device shall not be used for machinery specified in 5.2.1.

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

5.3 Safety devices

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

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

These safety switches shall be protected from accidental, unintended use.

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

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

5.4 Switchgear and machine control gear

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

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

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

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

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

If the requirements concerning the location of machine control gear stated above are not fulfilled, the following shall be provided:

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

5.5 Electric and electrohydraulic steering gear

5.5.1 In addition to the requirements specified in *Part III,* subchapter 2.6, and in *Part VII,* subchapter 6.2, steering gears shall fulfil the requirements of this subchapter.

Notes:
1. For hydraulic installation of steering gear – see relevant requirements in *Part VI*, subchapter 10.3.
2. For a ship fitted with multiple steering-propulsion units (e.g. azimuth trusters, water jets) – see *Part III*, subchapter 2.6.1.

5.5.2 Main and auxiliary steering gear power units shall be:

.1 arranged to re-start automatically when power is restored after a power failure; and
.2 capable of being brought into operation from a position on the navigating bridge. In the event of a power failure to any one of the steering gear power units, an audible and visual alarm shall be given on the navigating bridge. (SOLAS, Reg. II-1/29.5)

5.5.3 Steering gear control shall be provided:

.1 for the main steering gear, both on the navigating bridge and in the steering gear compartment;
.2 where the main steering gear is arranged in accordance with paragraph 6 (i.e. comprises two or more identical power units operating the rudder as required – see *Part III* subchapter 2.6), by two independent control systems, both operable from the navigating bridge. This does not require duplication of the steering wheel or steering lever. Where the control system consists of an hydraulic telemotor, a second independent system need not be fitted, except in a tanker, chemical tanker or gas carrier of 10,000 gross tonnage and upwards;*

.3 for the auxiliary steering gear, in the steering gear compartment and, if power operated, it shall also be operable from the navigating bridge and shall be independent of the control system for the main steering gear.* (SOLAS, Reg. II-1/29.7)

**** IACS interpretation***

1. Scope

The interpretation applies to steering gear control systems, as defined in 1.2.58 (SOLAS regulation II-1, 3/1), for the main and auxiliary steering gear, operable from the navigation bridge, for which SOLAS stipulates two steering gear control systems independent of each other (SOLAS II-1, Reg. 29/6.1– see 2.6 of Part III, 29/7.2, 29/7.3– see above , Reg. 29/15 and Reg. 29/16 – see 6.2 of Part VII).

Following requirements of:

- 1.2.58, 1.2.59, 1.2.45 and 5.5.1 to 5.5.11 (SOLAS Chap. II-1, Reg. 3/1, 3/3, 3/13 and Reg. 29)

have been considered, as far as containing requirements for the independency of the control systems.

2. Basic Requirements

Two independent steering gear control systems shall be provided and shall be so arranged that a mechanical or electrical failure in one of them will not render the other one inoperative.

The term "Steering gear control system" as defined in 1.2.58 (SOLAS Part A, Regulation 3/1 (UR M42 Appendix item 1)) shall be understood to cover "the equipment required to control the steering gear power actuating system".

3. Separation of Control Systems and Components

***3.1** General*

Wires, terminals and the components for duplicated steering gear control systems installed in units, control boxes, switchboards or bridge consoles shall be separated as far as practicable.

Where physical separation is not practicable, separation may be achieved by means of a fire retardant plate.

***3.2** Steering wheel or steering lever*

All electric components of the steering gear control systems shall be duplicated. This does not require duplication of the steering wheel or steering lever.

***3.3** Steering mode selector switch*

If a joint steering mode selector switch (uniaxial switch) is employed for both steering gear control systems, the connections for the circuits of the control systems shall be divided accordingly and separated from each other by an isolating plate or by air gap.

***3.4** Follow-up amplifier*

In the case of double follow-up control (see Annex, example 2), the amplifiers shall be designed and fed so as to be electrically and mechanically separated. In the case of non-follow-up control and follow-up control, it shall be ensured that the follow-up amplifiers are protected selectively (see Annex, example 3).

***3.5** Additional control systems*

Control circuits for additional control systems, e.g. steering lever or autopilot shall be designed for all – pole disconnection (see Annex, examples 1, 2 and 3).

***3.6** Feed-back units and limit switches*

The feed-back units and limit switches, if any, for the steering gear control systems shall be separated electrically and mechanically connected to the rudder stock or actuator separately.

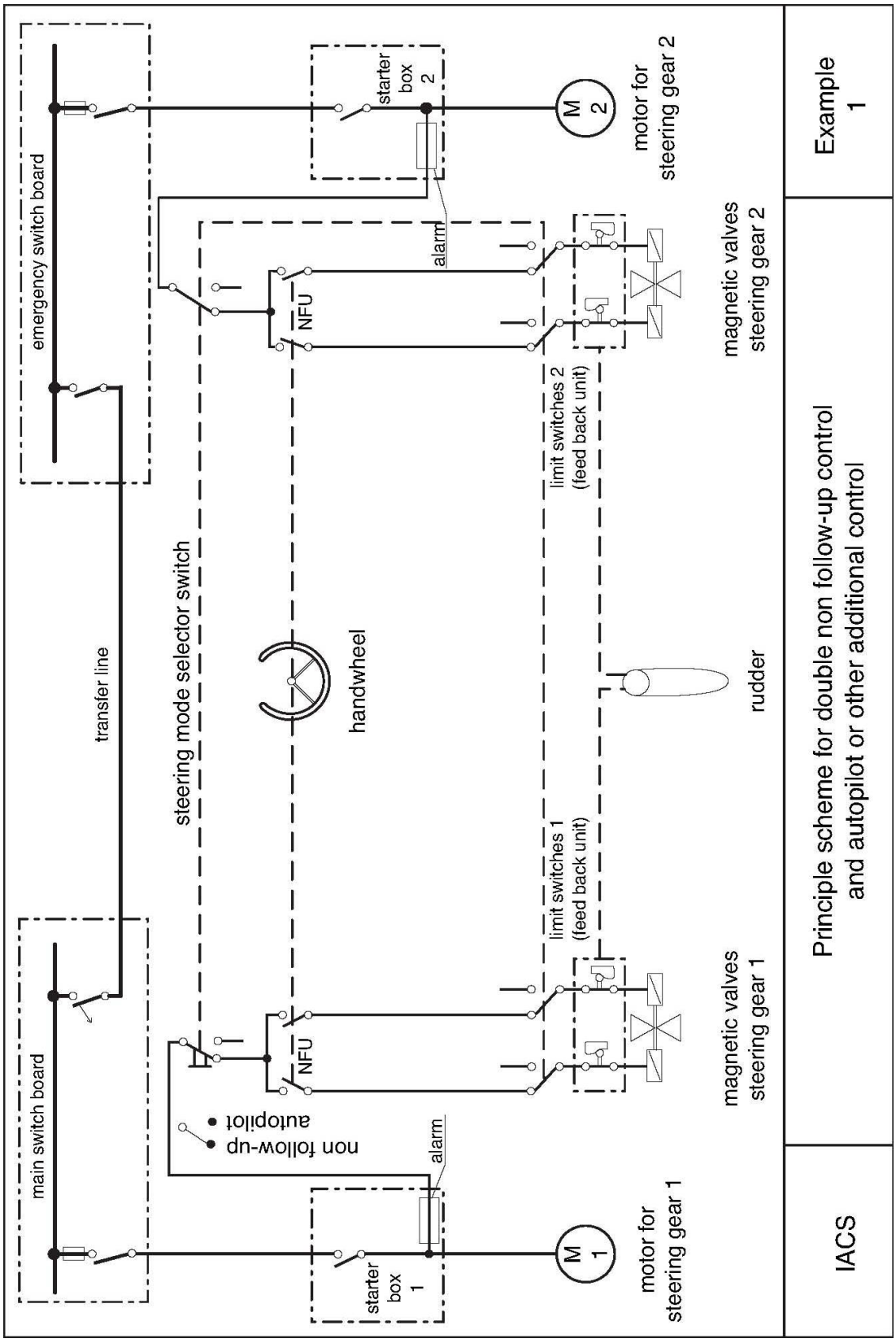
***3.7** Hydraulic control components – although 3.7 is relevant to Part VII, it has been retained here for consistency.*

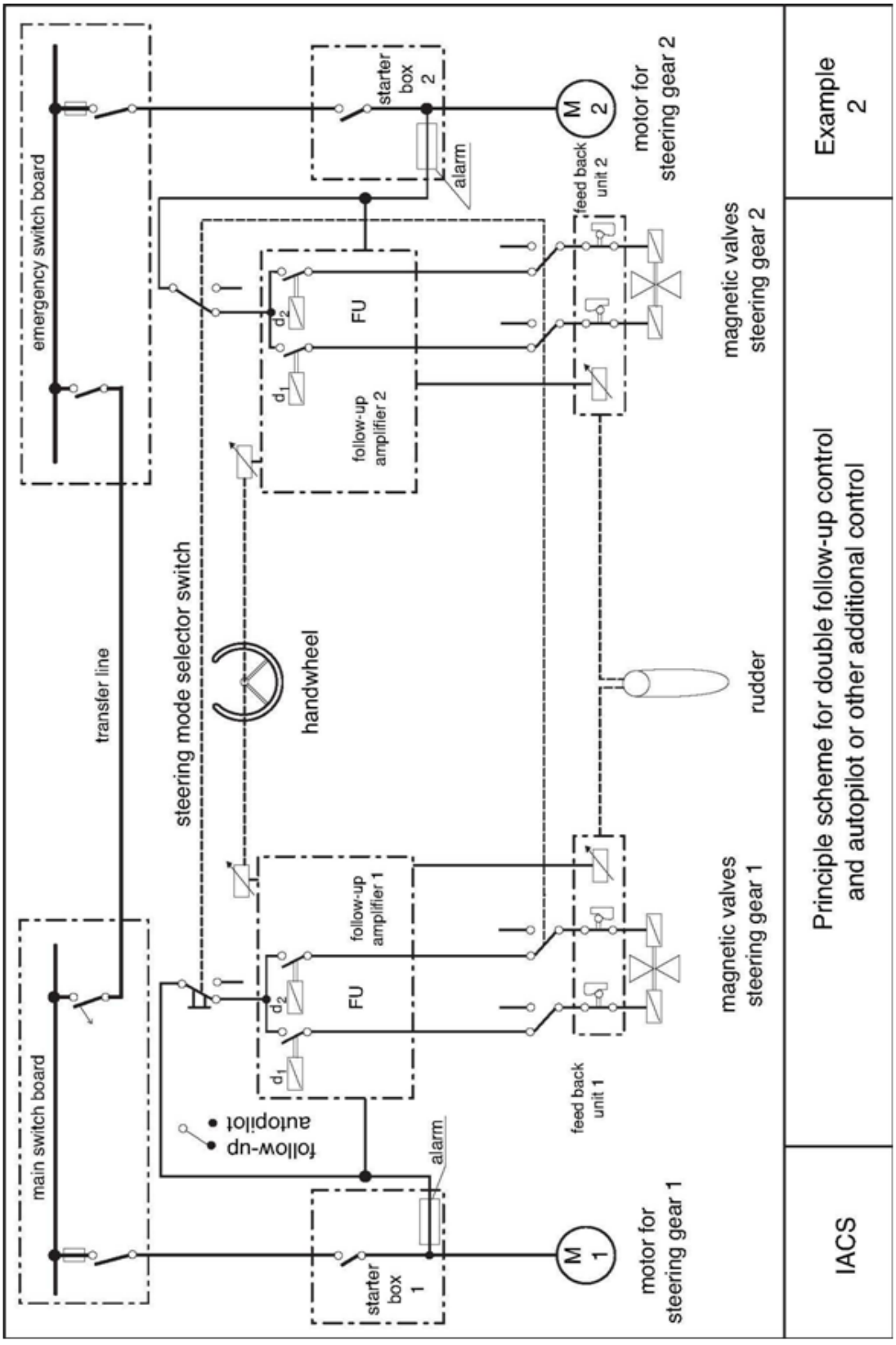
Hydraulic system components in the power actuating or hydraulic servo systems controlling the power systems of the steering gear (e.g. solenoid valves, magnetic valves) are to be considered as part of the steering gear control system and shall be duplicated and separated.

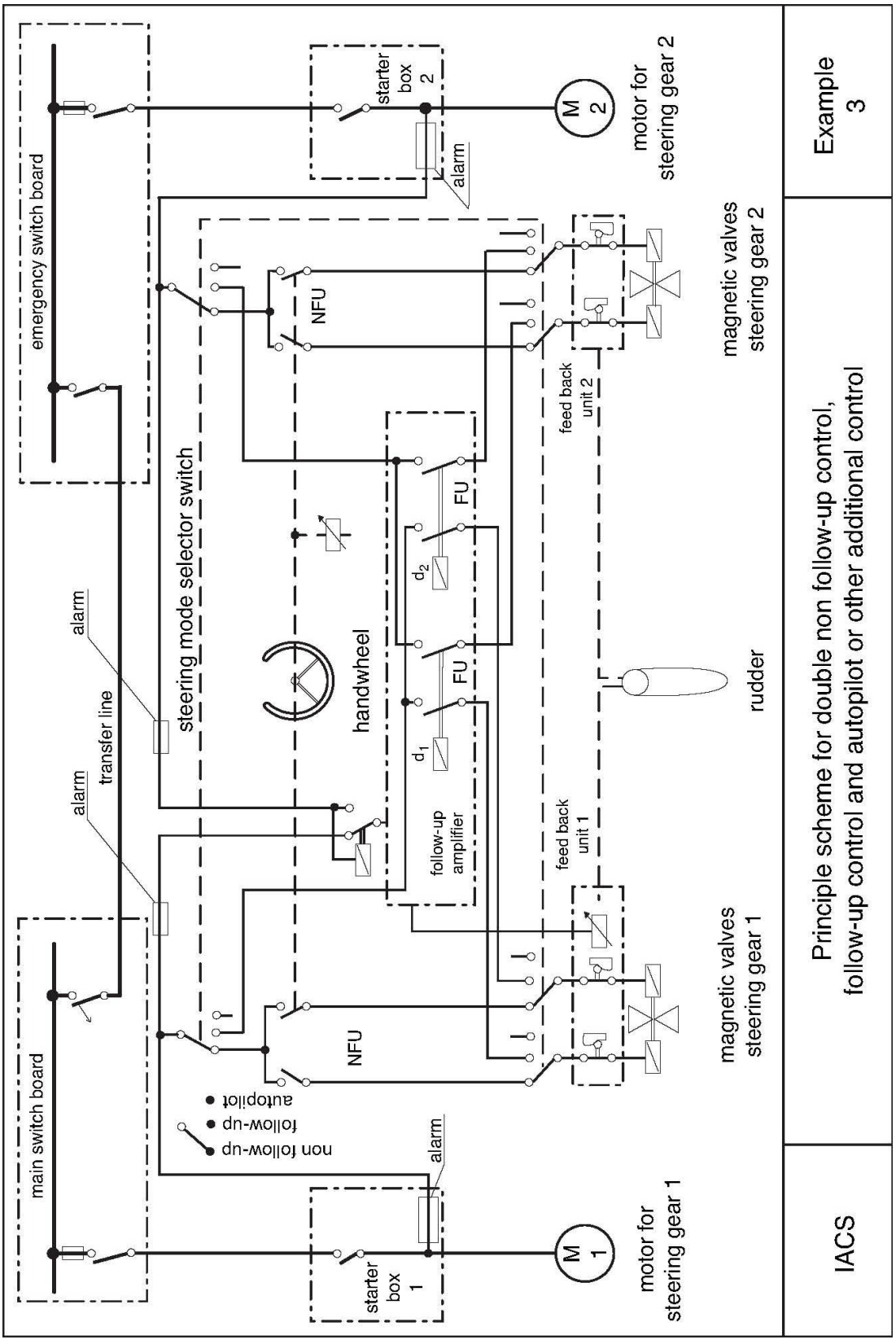
Hydraulic system components in the steering gear control system that are part of a power unit may be regarded as being duplicated and separated when there are two or more separate power units provided and the piping to each power unit can be isolated.

4. Annex

Reference should be made to examples 1, 2 and 3, which can be regarded as basic design.


Example 1
Principle scheme for double non follow-up control and autopilot or other additional control
IACS
emergency switch board
main switch board
transfer line
steering mode selector switch
handwheel
rudder
NFU
NFU
alarm
alarm
starter box 2
starter box 1
M 2
M 1
motor for steering gear 2
motor for steering gear 1
magnetic valves steering gear 2
magnetic valves steering gear 1
limit switches 2 (feed back unit)
limit switches 1 (feed back unit)
non follow-up
autopilot


Example 2
Principle scheme for double follow-up control and autopilot or other additional control
IACS
emergency switch board
main switch board
transfer line
starter box 2
starter box 1
alarm
alarm
M 2
M 1
motor for steering gear 2
motor for steering gear 1
feed back unit 2
feed back unit 1
magnetic valves steering gear 2
magnetic valves steering gear 1
FU
follow-up amplifier 2
follow-up amplifier 1
d2
d1
steering mode selector switch
handwheel
rudder
follow-up
autopilot


Example 3
Principle scheme for double non follow-up control, follow-up control and autopilot or other additional control
IACS
emergency switch board
main switch board
starter box 2
starter box 1
alarm
motor for steering gear 2
motor for steering gear 1
M 2
M 1
NFU
FU
steering mode selector switch
handwheel
follow-up amplifier
feed back unit 2
feed back unit 1
magnetic valves steering gear 2
magnetic valves steering gear 1
rudder
transfer line
non follow-up
follow-up
autopilot

(IACS UI SC94)

5.5.4 Any main and auxiliary steering gear control system operable from the navigating bridge shall comply with the following:

.1 if electric, it shall be served by its own separate circuit supplied from a steering gear power circuit from a point within the steering gear compartment, or directly from switchboard busbars supplying that steering gear power circuit at a point on the switchboard adjacent to the supply to the steering gear power circuit;

.2 means shall be provided in the steering gear compartment for disconnecting any control system operable from the navigating bridge from the steering gear it serves,

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IMO interpretation

Such means for disconnecting shall be operable by a single person without the need for tools. (MSC/Circ.736)

.3 the system shall be capable of being brought into operation from a position on the navigating bridge;

.4 in the event of a failure of electrical power supply to the control system, an audible and visual alarm shall be given on the navigating bridge, and

.5 short circuit protection only shall be provided for steering gear control supply circuits. (SOLAS, Reg. II-1/29.8)

5.5.5 The electric power circuits and the steering gear control systems with their associated components, cables and pipes required by 5.5.1 to 5.5.6 (this regulation) and by 5.5.9 to 5.5.12 (regulation 30) shall be separated as far as is practicable throughout their length. (SOLAS, Reg. II-1/29.9) See also 16.8.4.12.

5.5.6 A means of communication shall be provided between the navigating bridge and the steering gear compartment. (SOLAS, Reg. II-1/29.10)

5.5.7 The angular position of the rudder shall:

.1 if the main steering gear is power operated, be indicated on the navigating bridge. The rudder angle indication shall be independent of the steering gear control system;

.2 be recognizable in the steering gear compartment. (SOLAS, Reg. II-1/29.11)

5.5.8 Where the rudder stock is required to be over 230 mm diameter* in way of the tiller, excluding strengthening for navigation in ice, an alternative power supply, sufficient at least to supply the steering gear power unit which complies with the requirements of paragraph 4.2 (i.e. puts the rudder from one side to another within required time– see *Part VII*, 6.2.1.2) and also its associated control system and the rudder angle indicator, shall be provided automatically, within 45 seconds, either from the emergency source of electrical power or from an independent source of power located in the steering gear compartment. This independent source of power shall be used only for this purpose. In every ship of 10,000 gross tonnage and upwards, the alternative power supply shall have a capacity for at least 30 minutes of continuous operation and in any other ship for at least 10 minutes. (SOLAS, Reg. II-1/29.14)

*** Note:**
Regarding calculation of rudder stock diameter – see *Part III*, subchapter 2.6.1 which includes SOLAS requirement and IACS interpretation SC15,

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IACS and IMO interpretation

This interpretation is valid to the steering propulsion units having a certain proven steering capability due to vessel speed also in case propulsion power has failed.

Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative power supply, sufficient at least to supply the steering arrangements which complies with the requirements of SOLAS regulation II-1/29.4.2 (i.e. puts the rudder from one side to another within required time– see Part VII, 6.2.1.2) and also its associated control system and the steering gear response indicator, shall be provided automatically, within 45 s, either from the emergency source of electrical power or from an independent source of power located in the steering gear compartment. This independent source of power shall be used only for this purpose. In every ship of 10,000 gross tonnage and upwards, the alternative power supply shall have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (IACS UI SC242, MSC.1/Circ.1416/Rev.1)

5.5.9 Means for indicating that the motors of electric and electrohydraulic steering gear are running shall be installed on the navigating bridge and at a suitable main machinery control position. (SOLAS, Reg. II-1/30.1)

5.5.10 Each electric or electrohydraulic steering gear comprising one or more power units shall be served by at least two exclusive circuits fed directly from the main switchboard; Where sectionalised busbars are used in the main switchboard, each circuit shall be connected to a different section of the busbars. however, one of the circuits may be supplied through the emergency switchboard. An auxiliary electric or electrohydraulic steering gear associated with a main electric or electrohydraulic steering gear may be connected to one of the circuits supplying this main steering gear. The circuits supplying an electric or electrohydraulic steering gear shall have adequate rating for supplying all motors which can be simultaneously connected to them and may be required to operate simultaneously. (SOLAS, Reg. II-1/30.2)

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

IACS and IMO interpretation

For a ship fitted with multiple steering systems, the requirements in 5.5.10 (SOLAS II-1/30.2) are to be applied to each of the steering systems. (IACS UI SC242, MSC.1/Circ.1416/Rev.1)

5.5.11 Short circuit protection and an overload alarm shall be provided for such circuits and motors. Protection against excess current, including starting current, if provided, shall be for not less than twice the full load current of the motor or circuit so protected, and shall be arranged to permit the passage of the appropriate starting currents. Where a three-phase supply is used an alarm shall be provided that will indicate failure of any one of the supply phases. The alarms required in this paragraph shall be both audible and visual and shall be situated in a conspicuous position in the main machinery space or control room from which the main machinery is normally controlled and as may be required by 22.1.6.2 (regulation 51). (SOLAS, Reg. II-1/30.3)

IACS interpretation

Steering gear motor circuits obtaining 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 protection against excess current, including starting current, of not less than twice the full load current of the motor. The required overload alarm is to be set to a value not greater than the normal load [1] of the electronic converter.

[1] *Normal load is the load in normal mode of operation that approximates as close as possible to the most severe conditions of normal use in accordance with the manufacturer s operating instructions. (IACS UI SC187)*

5.5.12 When in a ship of less than 1,600 gross tonnage an auxiliary steering gear which is required (...) to be operated by power is not electrically powered or is powered by an electric motor primarily intended for other services, the main steering gear may be fed by one circuit from

the main switchboard. Where such an electric motor primarily intended for other services is arranged to power such an auxiliary steering gear, the requirement of 5.5.11 (paragraph 3) may be waived by the Administration if satisfied with the protection arrangement together with the requirements of 5.5.2.1 and 5.5.2.2 (regulation 29.5.1 and .2) and 5.5.3.3 (29.7.3) applicable to auxiliary steering gear. (SOLAS, Reg. II-1/30.4)

5.5.13 The electric and electro-hydraulic drive for the steering gear shall ensure:

.1 putting the rudder over from one side to the other side within the time and angle specified in *Part VII,* subchapter 6.2.1;
.2 continuous putting the rudder over from one side to the other side during 30 minutes for each set with the rudder fully immersed and at maximum ahead speed corresponding to such draught;
.3 continuous operation during one hour at the maximum service speed ahead with putting the rudder over through an angle so as to ensure 350 put-overs per hour;
.4 possible stalling of the electric motor in ”on” position at the rated supply for one minute from hot state (only for rudders fitted with the direct electric drive);
.5 sufficient strength of electric drive in the presence of mechanical forces arising at maximum speed astern; it is recommended that a possibility of putting the rudder over at the average speed astern be provided.

5.5.14 Failure detection and response of all types of steering gear control systems

IACS UR E25

5.5.14.1 Application (1.)

5.5.14.1.1 This UR applies to Steering Gear Control System as defined in UR M42 Appendix 1 Item 1. (1.1)

i.e.

> ***Steering gear control system*** means the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables. Steering gear control system is also understood to cover “the equipment required to control the steering gear power actuating system”.

Note:
Compare with definition in 1.2.58.

5.5.14.2 Failure detection (2.)

5.5.14.2.1 The most probable failures that may cause reduced or erroneous system performance shall be automatically detected and at least the following failure scenarios shall be considered:

(a) Power supply failure (in the supply circuits of: power units, control system)
(b) Earth fault on AC and DC circuits
(c) Loop failures in closed loop systems, both command and feedback loops (normally short circuit, broken connections and earth faults)
(d) Data communication errors
(e) Programmable system failures (Hardware and software failures)
(f) Deviation between rudder order and feedback* (2.1)
(g) The low level of hydraulic oil in any service tank

* Deviation alarm shall be initiated if the rudder's actual position does not reach the set point within acceptable time limits for the closed loop control systems (e.g. follow-up control and autopilot). Deviation alarm may be caused by mechanical, hydraulic or electrical failures.

5.5.14.2.2 All failures detected shall initiate audible and individual visual alarm on the navigation bridge. (2.2)

Alternatively to alarms, required in 5.5.14.2.1 (c), (d) and (e) depending on rudder characteristic, critical deviations between rudder order or response shall be indicated visually and audibly as steering failure alarm on the navigation bridge. In the deviation analysis, the following parameters shall be considered: delay – the rudder actual position reaches set position within acceptable time limits and accuracy – the end actual position of the rudder shall correspond to the set value within the design offset tolerances.

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

5.5.14.3 System response upon failure (3.)

5.5.14.3.1 The failures (as defined but not limited to those in 5.5.14.2.1 (2.1)) likely to cause uncontrolled movements of rudder are to be clearly identified. In the event of detection of such failure, the rudder is to stop in the current position without manual intervention or, subject to the discretion of the Classification Society, is to return to the midship/neutral position. For mechanical failures such as sticking valves and failure of static components (pipes, cylinders), the system response without manual intervention is not mandatory, and the operator can follow instructions on the signboard in case of such failures, in accordance with UR M42.13 (3.1)

i.e.

> **13. Operating instructions**
>
> Where applicable, following standard signboard should be fitted at a suitable place on steering control post on the bridge or incorporated into operating instruction on board:
>
> CAUTION
>
> IN SOME CIRCUMSTANCES WHEN 2 POWER UNITS ARE RUNNING SIMULTANEOUSLY THE RUDDER MAY NOT RESPOND TO HELM. IF THIS HAPPENS STOP EACH PUMP IN TURN UNTIL CONTROL IS REGAINED.
>
> The above signboard is related to steering gears provided with 2 identical power units intended for simultaneous operation, and normally provided with either their own control systems or two separate (partly or mutually) control systems which are/may be operated simultaneously.

Note:
For hydraulic locking failure, refer also to UR M42.12.2

i.e.

> 12.2 Where hydraulic locking, caused by a single failure, may lead to loss of steering, an audible and visual alarm, which identifies the failed system, shall be provided on the navigating bridge.
>
> NOTE: This alarm should be activated whenever:

- position of the variable displacement pump control system does not correspond with given order; or
- incorrect position of 3-way full flow valve or similar in constant delivery pump system is detected.

and 42.13. (see above)

END OF IACS UR E25

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

The direction of rotation of the rudder wheel or the direction of the movement of the control gear handle shall correspond to the direction of putting the rudder over.

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

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

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

Heading control systems shall fulfil the requirements of ISO 11674:2019. The use of other solutions is subject to PRS consideration in each particular case.

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

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

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

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

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

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

.2 malfunction of the heading control system;

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

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

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

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

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

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

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

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

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

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

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

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

5.5.32 The automatic pilot shall be provided with a device capable of changing the predetermined ship course to any other course by manual operation within the limits of at least ±15° under automatic control without switching over to manual control specified in 5.5.15.

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

The value of the rapid change of the ship course shall be possible up to the complete circulation. The remote control stations intended for manual control shall be so arranged as to ensure the

return of the ship to the predetermined course and further functioning of the automatic control system after the control handle (push-button) of the station is set in neutral position.

5.5.34 Adaptive automatic pilot shall fulfil the following requirements:

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

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

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

5.6 Electric drives for anchor and mooring machinery

5.6.1 In addition to the requirements specified in *Part VII*, subchapters 6.3 and 6.4, the drives of windlasses, anchor and mooring capstans and mooring winches shall fulfil the requirements of this subchapter.

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

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

After stalling conditions, the temperature rise shall not exceed 130% of the permissible value for the insulation used.

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

5.6.4 The power supply of windlass electric drives shall fulfil the requirements of paragraphs 4.3.1 and 4.3.3.

5.7 Electric drives for pumps

5.7.1 The electric motors of fuel and lubricating oil transfer pumps, as well as of oil separators shall be provided with remote switching devices located outside the spaces in which these pumps are located and outside the machinery casing, but in direct vicinity of the exits from these spaces. See also *Part VI,* 8.7.8 to 8.7.10.

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

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

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

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

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

5.8 Electric drives for fans

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

It is recommended that such switching devices be installed in one place together with the switching devices mentioned in 5.7.1.

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

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

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

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

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

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

5.8.6 Positions of all the remote switching devices mentioned in paragraphs from 5.8.1 to 5.8.5 shall not be readily cut off the access in the event of fire in the area/space being served.

5.9 Electric drives for boat winches

5.9.1 A lifeboat launching appliance shall be capable of recovering the lifeboat with its crew. (LSA Code , 6.1.1.8)

5.9.2 Each rescue boat launching appliance shall be fitted with a powered winch motor capable of raising the rescue boat from the water with its full rescue boat complement of persons and equipment at a rate of not less than 0.3 m/s. (LSA Code , 6.1.1.9)

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

5.9.4 A switch in the main current of electric motors shall be installed near the boat winch control station.

5.10 Electric drives for watertight and fireproof doors

5.10.1 The electric drives of watertight doors shall fulfil the requirements of *Part III,* 7.13.2, and 21.2.1.7, and the requirements of the present subchapter.

5.10.2 Power supply of electric drives, alarm, control and indication circuits of the watertight doors shall be separately distributed from the main switchboard through the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically switched to the transitional source of electric power in the event of failure of either the main or emergency source of electric power, in accordance with the requirements specified in 4.3.1.21, 21.1.3.6.6 and 21.1.3.9.2.

5.10.3 The electric drives of the devices keeping the fire doors in the open position shall:

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

CHAPTER 6

6 LIGHTING

6.1 General requirements

6.1.1 A main electric lighting system which shall provide illumination throughout those parts of the ship normally accessible to and used by passengers or crew shall be supplied from the main source of electrical power. (SOLAS, Reg. II-1/41.2.1)

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

The list of rooms, spaces and locations in which, in addition to the main lighting, fixtures of emergency lighting shall be installed, is contained in 9.3.5.1, 9.3.5.2 and 21.1.3.6.1.

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

6.1.4 Lighting fittings shall be so arranged as to prevent temperature rises which could damage the cables and wiring, and to prevent surrounding material from becoming excessively hot. (SOLAS, Reg. II-1/45.7)

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

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

6.1.7 In rooms, locations and spaces lighted with discharge lamps which do not ensure the continuity of lighting at the voltage variations specified in 2.2.3.3, lighting fixtures with incandescent lamps shall be provided.

6.1.8 Battery compartments and other explosion-hazardous spaces shall be illuminated with lighting fixtures located in adjacent safe spaces through gastight windows or with explosion-proof lighting fixtures installed inside such spaces (see also 2.9).

6.1.9 Ergonomic Considerations

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

6.1.9.2 Detailed recommendations in this respect are contained in IACS REC.132 – *Human Element Recommendations for structural design of lighting, ventilation, vibration, noise, access and egress arrangements.*

6.2 Supply to the lighting circuits

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

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

6.2.2 The protections of the lighting final circuits of spaces shall be designed for the rated current not exceeding 16 A and the total circuit current shall not exceed 80% of the rated current of the applied protection.

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

Table 6.2.2

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

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

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

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

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

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

As far as possible, the lighting feeders shall be so installed that a fire in one zone cannot damage the feeders supplying the lighting circuits in other zones.

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

6.2.6 The arrangement of the main electric lighting system shall be such that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, the main switchboard and the main lighting switchboard, will not render the emergency electric lighting system required by 21.1.3.6.1 and 21.1.3.6.2 (Regulations 42.2.1 and 42.2.2) for Passenger Ships and 9.3.5.1 and 9.3.5.2 (43.2.1 and 43.2.2) for Cargo Ships inoperative. (SOLAS, Reg. II-1/41.2.2)

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

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

6.3 Emergency lighting

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

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

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

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

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

6.3.4 The arrangement of the emergency electric lighting system shall be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render the main electric lighting system required by this regulation inoperative. (SOLAS, Reg. II-1/41.2.3)

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

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

6.4 Switches in lighting circuits

6.4.1 All lighting (...) circuits terminating in a bunker or cargo space shall be provided with a multiple pole switch outside the space for disconnecting such circuits. (SOLAS, Reg. II-1/45.8)

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

6.4.3 Permanently installed ship external lighting fixtures shall be provided with central switches located on the navigation bridge or in any other permanently attended place situated on upper deck.

6.4.4 The switches of lighting circuits of fire-extinguishing stations shall be located outside these spaces.

6.4.5 The lighting switches behind free-standing switchboards shall be installed near each entry behind the switchboard.

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

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

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

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

6.5 Fluorescent and gas discharge lamps

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

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

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

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

6.6 Socket outlets and plugs

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

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

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

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

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

6.7 Illumination intensity

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

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

Table 6.7.1

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

6.8 Navigation lights

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

6.8.2 The NLC shall be supplied by two circuits:

.1 one circuit from the emergency switchboard, which is supplied in accordance with paragraph 9.4.1;
.2 the second circuit from the section switchboard, which is not supplied from the emergency switchboard only.

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

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

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

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

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

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

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

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

The power supply of signals shall be taken:
– from a circuit or a source other than used for the power supply of the NLC, or
– from an accumulator battery.

6.8.7 Provision shall be made for possibility of the NLC indicators' illumination intensity adjustment without the possibility of their switching off.

6.8.8 The NLC shall enable the use of a bi-directional communication interface in accordance with the requirements of IEC 61162.

6.8.9 The lamp holders and lamps used in navigation lights shall fulfil the requirements of the COLREG Convention (these requirements are also specified in *Part III – Signal Means* of the *Rules for Statutory Survey of Sea-going Ships*, subchapter 3.1.7).

CHAPTER 7

7 INTERNAL COMMUNICATION AND SIGNALLING

7.1 General requirements

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

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

7.1.3 Alarm indicating devices shall be arranged such as to ensure attention of the responsible duty officer, e.g. machinery alarm indicating devices, located in the normal working areas of the machinery space. Several suitably placed low volume audible signal units should be used rather than a single unit for the whole area. A combination of audible signals and blinking light signals may be of advantage.

7.2 Electric engine-room telegraphs

7.2.1 In addition to the compliance with the requirements of this subchapter, the electric engine-room telegraphs shall fulfil the requirements specified in *Part VII*, 1.16.1.

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

7.2.3 The engine-room telegraphs installed on the navigation bridge shall be provided with scale lighting to allow for adjustment of the illumination intensity adjustment without the possibility of their switching off.

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

7.2.5 The engine-room telegraph transmitter on the navigation bridge shall be so installed that in the case of transmitting commands concerning the running of the ship, the handle of the transmitter is set in accordance with the direction of the ship running. The vertical position of the handle shall correspond to the command STOP.

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

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

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

7.2.8 Each engine-room telegraph shall be provided with an audible signal, on the navigation bridge and in the machinery space, operating at communicating orders and switching off after receiving a correct response. When the response is incorrect, the audible signal shall remain operating.

7.3 Internal service communication

7.3.1 Internal communication

7.3.1.1 At least two independent means shall be provided for communicating orders from the navigating bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled: one of these shall be an engine-room telegraph which provides visual indication of the orders and responses both in the machinery spaces and on the navigating bridge. Appropriate means of communication shall be provided from the navigating bridge and the engine-room to any other position from which the speed or direction of thrust of the propellers may be controlled. (SOLAS, Reg. II-1/37.2)

IACS interpretation

SOLAS regulation II-1/37 (old version of this regulation) requires that at least two independent means be provided for communicating orders from the navigating bridge to the position in the machinery space or in the control room from which the engines are normally controlled: one of these shall be an engine-room telegraph which provides visual indication of the orders and responses both in the machinery space and on the navigating bridge.

Appropriate means of communication shall be provided to any other positions from which the engines may be controlled.

The interpretation is that the telegraph is required in any case, even if the remote control of the engine is foreseen, irrespective of the fact that the engine room is attended or not. (IACS UI SC95)

7.3.1.2 A means of communication shall be provided between the navigating bridge and the steering gear compartment. (SOLAS, Reg. II-1/29.10)

7.3.1.3 For bunkering operations, a means of voice communication is to be provided between the bunkering stations and the machinery spaces controlling and monitoring the receiving and transferring of fuel oil.

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

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

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

7.3.1.6 A damage or disconnection of any telephone set shall not affect the working ability of the other sets.

7.3.1.7 The telephones prescribed by 7.3.1.1 for two-way telephone communication between the navigation bridge and closed central control stand or between the navigation bridge and main engine and machinery local control stand shall be provided with audible and visual calling signalisation both in the closed central control stand and in the machinery space.

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

7.3.2 Public address system

7.3.2.1 Every passenger ship and every cargo ship shall be fitted with public address system for the purpose of notifying crew and passengers of a fire for safe evacuation.

7.3.2.2 The public address system shall be a loudspeaker installation enabling the broadcast of messages into all spaces where crew members or passengers, or both, are normally present, and to muster stations. It shall allow for the broadcast of messages from the navigation bridge and such other places on board the ship as the Administration deems necessary. It shall be installed with regard to acoustically marginal conditions and not require any action from the addressee. It shall be protected against unauthorized use. (LSA Code, 7.2.2.1)

7.3.2.3 With the ship underway in normal conditions, the minimum sound pressure levels for broadcasting emergency announcements shall be:

.1 in interior spaces 75 dB (A) and at least 20 dB (A) above the speech interference level; and
.2 in exterior spaces 80 dB (A) and at least 15 dB (A) above the speech interference level. (LSA Code, 7.2.2.2)

IACS Interpretation

1. *With respect to spaces where a public address system is/may not be required in 7.3.2.2 (7.2.2.1), these may be spaces such as under deck passage way, bosun's locker, hospital, pump room.*

2. *With respect to cabin/state rooms, the sound pressure levels as stated in 7.3.2.3.1 (7.2.2.2.1) shall be attained as required inside the cabin/state room, during sea trials.*

3. *Where an individual loudspeaker has a device for local silencing, an over-ride arrangement from the control station(s), including the navigating bridge, shall be in place. (UI SC145)*

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

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

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

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

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

7.3.2.8 Loudspeakers installed in accommodation spaces shall be fitted with volume controllers or switches. Plugs shall not be used.

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

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

7.3.2.11 The public address system shall be supplied from the main source of electrical power, the emergency source of electrical power and transitional source of electrical power, if required in Chapter 9 or 21. Cabling for public address system in ro-ro passenger ships shall comply with 21.1.6.6.

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

.1 all requirements for those alerts specified in the *LSA Code*, *FSS Code* and the *SOLAS Convention*, as amended, are fulfilled;
.2 all the relevant requirements for alerts, specified in the *Code on Alerts and Indicators, 2009* are fulfilled;
.3 the public address system automatically overrides: any other input system when an emergency alarm is required and any volume controls provided to give the required output for the emergency mode when an emergency alarm is required;
.4 the public address system is arranged to prevent feedback or other interference; and
.5 the public address system is arranged to minimize the effect of a single failure.

7.4 General emergency alarm system

7.4.1 Every cargo ship and every passenger ship shall be provided with a general emergency alarm system for the purpose of notifying crew and passengers of a fire.

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

7.4.2 A general emergency alarm system complying with the requirements of 7.4.4 to 7.4.6 (paragraph 7.2.1 of the LSA Code) shall be provided and shall be used for summoning passengers and crew to muster stations and to initiate the actions included in the muster list. The system shall be supplemented by either a public address system complying with the requirements of 7.3 (paragraph 7.2.2 of the LSA Code) or other suitable means of communication. Entertainment sound systems shall automatically be turned off when the general emergency alarm system is activated. (SOLAS, Reg. III/6.4.2)

7.4.3 The general emergency alarm system shall be audible throughout all the accommodation and normal crew working spaces. On passenger ships, the system shall also be audible on all open decks. (SOLAS, Reg. III/6.4.3)

7.4.4 The general emergency alarm system shall be capable of sounding the general emergency alarm signal consisting of seven or more short blasts followed by one long blast on the ship' s whistle or siren and additionally on an electrically operated bell or klaxon or other equivalent warning system, which shall be powered from the ship' s main supply and the emergency source of electrical power (...). The system shall be capable of operation from the navigation bridge and, except for the ship' s whistle, also from other strategic points. The alarm shall continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system. (LSA Code, 7.2.1.1)

7.4.5 The minimum sound pressure levels for the emergency alarm tone in interior and exterior spaces shall be 80 dB (A) and at least 10 dB (A) above ambient noise levels existing during normal equipment operation with the ship underway in moderate weather. (LSA Code, 7.2.1.2)

7.4.6 The sound pressure levels at the sleeping position in cabins and in cabin bathrooms shall be at least 75 dB (A) and at least 10 dB (A) above ambient noise levels.* (LSA Code, 7.2.1.3)

In no case should audible alarm levels in a space exceed 120 dB(A).

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* Refer to the *Code on Alarms and Indicators, 1995*, adopted by the Organization by resolution A.830(19).

Note:
Resolution A.830(19) has been revoked by resolution A.1021(26) *Code on Alerts and Indicators, 2009*.

7.4.7 Signalling 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;
.5 in processing spaces;
.6 in vehicle spaces.

7.4.8 The general emergency alarm system shall be supplied from the main source of electrical power and from the emergency sources of electrical power in accordance with the requirements of paragraphs 9.3.1.3 or 21.1.3.6.3. Cabling for emergency alarm system in ro-ro passenger ships shall comply with 21.1.6.6.

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

7.4.9 The general emergency alarm system shall be power supplied continuously, irrespective of the accumulator battery being set in position for charging or discharging.

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

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

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

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

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

7.4.13 No switching devices shall be incorporated into the circuits of the general emergency alarm system other than the switch specified in 7.4.12. However, if it is necessary to install switches in the general emergency alarm system switchboards, they shall be interlocked in the closed position or shall be otherwise protected from access thereto by unauthorized persons.

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

7.4.14 Signalling devices, switches and distribution boxes of the general emergency alarm system shall be provided with readily visible distinctive marking.

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

7.5 Fire detection system

Fixed fire detection and fire alarm systems shall comply with the applicable requirements specified in *Part V,* chapter 4.

7.6 Warning signalisation of gas fire-extinguishing systems activation

The warning system before activation of a fixed gas fire extinguishing system in a room where people may be present shall comply with the applicable requirements specified in *Part V,* subchapter 3.6.

7.7 Indication of closing watertight and fire doors

The indication of closing watertight doors shall fulfil the requirements of *Part III* paragraphs 7.4.8, 7.5.6, 7.13.2, 7.13.3 and 21.2.1.8, and the indication of the fire doors position shall fulfil the requirements of *Part V,* 6.1.8.3.

7.8 Alarm system in the accommodation spaces for engineering personnel

An engineer' s alarm shall be provided to be operated from the engine control room or at the manoeuvring platform as appropriate, and shall be clearly audible in the engineers' accommodation. (SOLAS Reg. II-1/38)

7.9 Water level detectors on single hold cargo ships other than bulk carriers

7.9.1 Ships having a length (*L*) of less than 80 m, (...) and a single cargo hold below the freeboard deck or cargo holds below the freeboard deck which are not separated by at least one bulkhead made watertight up to that deck, shall be fitted in such space or spaces with water level detectors*. (SOLAS Reg. II-1/25.2)

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* Refer to the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers* (resolution MSC.188(79)) – see *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships*

Note:

Length (*L*) is the length as defined in the *International Convention on Load Lines* in force. (SOLAS, Reg. II-1/2.5)

7.9.2 The water level detectors required by 7.9.1 (paragraph 2) shall:

.1 give an audible and visual alarm at the navigation bridge when the water level above the inner bottom in the cargo hold reaches a height of not less than 0.3 m, and another when such level reaches not more than 15% of the mean depth of the cargo hold; and

.2 be fitted at the aft end of the hold, or above its lowest part where the inner bottom is not parallel to the designed waterline. Where webs or partial watertight bulkheads are fitted above the inner bottom, Administrations may require the fitting of additional detectors. (SOLAS Reg. II-1/25.3)

7.9.3 The water level detectors shall be of a type approved by PRS, complying with the requirements specified in *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships*.

7.9.4 The water level detectors required by 7.9.1 (paragraph 2) need not be fitted in ships complying with regulation XII/12 (see 21.9.1), or in ships having watertight side compartments each side of the cargo hold length extending vertically at least from inner bottom to freeboard deck. (SOLAS Reg. II-1/25.4)

7.9.5 Ships of subdivision length *Ls* ≥ 80 m for which it will not be revealed that they fulfil regulations regarding subdivision and damage stability (fulfilment of regulations of relevant requirements specified in *Part IV*) shall fulfil requirements specified in subchapter 21.9.

Note:

Subdivision length (*Ls*) of the ship is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision draught. (SOLAS, Reg. II-1/2.1)

7.10 Water level detectors on multiple hold cargo ships other than bulk carriers

7.10.1 Multiple hold cargo ships other than bulk carriers and tankers (...) shall be fitted with water level detectors * in each cargo hold intended for dry cargoes. Water level detectors are not required for cargo holds located entirely above the freeboard deck. (SOLAS Reg. II-1/25-1.1)

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* Refer to the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers* (resolution MSC.188(79)), as may be amended – see *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships*.

7.10.2 The water level detectors required by 7.10.1 (paragraph 1) shall:

.1 give audible and visual alarms at the navigation bridge, one when the water level above the bottom of the cargo hold reaches a height of not less than 0.3 m, and another at a height not less than 15% of the depth of the cargo hold but not more than 2 m; and

.2 be fitted at the aft end of the cargo holds. For cargo holds which are occasionally used for water ballast, an alarm overriding device may be installed. The visual alarms shall clearly discriminate between the two different water levels detected in each hold. (SOLAS Reg. II-1/25-1.2)

7.10.3 The water level detectors shall be of a type approved by PRS, complying with the requirements specified in *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships*.

7.10.4 As an alternative to the water level detector at a height of not less than 0.3 m as per 7.10.2.1 (sub-paragraph 2.1), a bilge level sensor* serving the bilge pumping arrangements

required by *Part VI,* subchapter 2.3 (SOLAS regulation 35-1) and installed in the cargo hold bilge wells or other suitable location is considered acceptable, subject to:

.1 the fitting of the bilge level sensor at a height of not less than 0.3 m at the aft end of the cargo hold; and

.2 the bilge level sensor giving audible and visual alarm at the navigation bridge which is clearly distinctive from the alarm given by the other water level detector fitted in the cargo hold. (SOLAS Reg. II-1/25-1.3)

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* Refer to the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers* (resolution MSC.188(79)), as may be amended – see *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships*.

7.11 Alert management system on navigation bridge

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

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

7.11.3 Alert management system shall be divided into the following priorities:

- emergency alarms;
- alarms;
- warnings;
- cautions.

7.11.4 Prioritised groups mentioned in 7.11.3 shall be established according to the following criteria:

a) emergency alarm:
   - alarm indicating immediate danger to human life or to the ship and its machinery exists and that immediate action has to be taken, as specified in the *Code on Alerts and Indicators, 2009*.

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

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

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

7.11.5 Alerts shall be divided into the following three categories:

- category A – additional information related to the given alert is required to be displayed by the system, i.e. detailed case description (serious hazard, e.g. collision, stranding);
- category B – additional information related to the given alert is not required to be displayed;

– category C – alerts which cannot be confirmed in the navigation bridge but they require information on their status (e.g. cancellation), such as alerts related to the machinery installations.

7.11.6 The system shall also present alerts by their status:
– confirmed;
– unconfirmed.

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

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

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

7.11.9 Unconfirmed warning shall gradually:

a) be repeated as a warning within 5 minutes;
b) convert into an alarm within further 5 minutes;

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

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

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

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

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

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

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

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

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

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

CHAPTER 8

8 PROTECTIVE DEVICES

8.1 General requirements

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

Where circuit overload is not likely to occur, the circuit may be protected against short-circuits only. Each separate circuit shall be protected against short circuit and against overload, except as permitted in 5.5.4.5 and 5.5.11 (Regulations 29 and 30) or where the Administration may exceptionally otherwise permit. (SOLAS, Reg. II-1/45.6.1)

IACS interpretation

The Administration may permit:

1. *When it is impracticable, for example engine starting battery circuit.*
2. *When by design the circuit is incapable of developing overload, for example control transformers.*
3. *For essential motors which are duplicate and thruster motors, the overload protection may be replaced by an overload alarm. (IACS UI SC13)*

8.1.2 The rating or appropriate setting of the overload protective device for each circuit shall be permanently indicated at the location of the protective device. (SOLAS, Reg. II-1/45.6.2)

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

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

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

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

8.1.5 Overload protection shall be provided in:

.1 not less than one phase or positive pole in a two-wire system;
.2 not less than two phases in an insulated three-wire three-phase alternating-current system;
.3 all phases in a three-phase four-wire alternating-current system.

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

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

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

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

8.1.8 For guidance on testing of protection devices for generators and large consumers on board – see IACS REC.49.

8.2 Protection of generators

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

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

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

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

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

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

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

8.2.3 Load shedding, as a protection of generators against overload, shall be provided in accordance with 3.1.9.

The equipment for which the automatic load shedding is not allowed includes all primary essential services (examples specified in 4.3.1.1 to 4.3.1.6 and 4.3.1.8).

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

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

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

Table 8.2.4

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

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

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

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

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

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

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

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

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

8.2.10 Electronic or computerised protection devices for generators and consumers with load current higher than 30% of the rated current shall be provided with:

– arrangements to readily identify the final settings, if they are adjustable;
– facilities and instructions for testing on board the settings and functions.

8.3 Protection of electric motors

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

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

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

Motor overload protective devices may be permitted to be replaced by audible and visual signals subject to PRS consent in each particular case.

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

8.4 Protection of steering gear motors and control systems

8.4.1 Protection shall be provided for electric motors and control systems of electric and electro-hydraulic steering gear in accordance with 5.5.4.5 and 5.5.11.

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

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

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

8.4.3 The electric motors of active means of steering the ship shall have short-circuit and overload protection. Overload protection shall give audible and visual signals and shall cause the disconnection of the electric motor within the range required by 8.3.2. Short-circuit protection shall fulfil the requirements of 8.4.2.

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

8.5 Protection of transformers

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

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

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

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

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

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

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

8.6 Protection of storage batteries

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

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

8.7 Protection of pilot lamps, voltmeters, capacitors and voltage coils of apparatus

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

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

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

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

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

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

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

8.8 Protection of power-electronic equipment

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

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

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

8.9 Protection of emergency circuits

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

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

CHAPTER 9

9 EMERGENCY SOURCES OF ELECTRICAL POWER AND EMERGENCY SOURCES' POWER DISTRIBUTION

9.1 General requirements

9.1.1 Each ship with self-propulsion shall be provided with the emergency source of electrical power. Specific requirements for cargo ships are provided in subchapter 9.3 while for passenger ships in subchapter 21.1.3.

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

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

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

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

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

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

9.2 Spaces of emergency sources of electrical power

9.2.1 The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power. (SOLAS, Reg. II-1/43.5.1)

9.2.2 Where the emergency source of electrical power is a generator, the emergency switchboard shall be located in the same space unless the operation of the emergency switchboard would thereby be impaired. (SOLAS, Reg. II-1/43.5.2)

This space shall also contain all the starting, charging and energy storing devices intended for starting the emergency set.

9.2.3 The space of the emergency generating set shall be provided with heating arrangements to ensure appropriate temperature for ready starting of the set. The space shall also be ventilated in accordance with requirements of *Part VI,* 7.6.3.

9.2.4 Where the emergency source of electrical power is an accumulator battery, the space where it is installed shall fulfil the requirements specified in 13.2.

9.2.5 No accumulator battery fitted in accordance with this regulation shall be installed in the same space as the emergency switchboard. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries

constituting either the energy source of electrical power or the transitional source of electrical power referred to in 9.3.6.2 or 9.3.8 (paragraph 3.2 or 4) are being discharged. (SOLAS, Reg. II-1/43.5.3)

9.3 Emergency sources of electrical power in cargo ships

9.3.1 A self-contained emergency source of electrical power shall be provided. (SOLAS, Reg. II-1/43.1.1)

9.3.2 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck. They shall not be located forward of the collision bulkhead, except where permitted by the Administration in exceptional circumstances. (SOLAS, Reg. II-1/43.1.2)

9.3.3 The location of the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Administration that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard, or in any machinery space of category A will not interfere with the supply, control and distribution of emergency electrical power.

As far as practicable the space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard shall not be contiguous to the boundaries of machinery spaces of category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard. (SOLAS, Reg. II-1/43.1.3)

Where such an arrangement is impracticable, decks and bulkheads separating the spaces shall fulfil the requirements for control stations, set forth in *Part V*.

Note:
For the purpose of this paragraph definition of machinery space of category A as per SOLAS II-2/3.31 applies (MSC/Circ.736) i.e.:

Machinery spaces of category A are those spaces and trunks to such spaces which contain either:
.1 internal combustion machinery used for main propulsion;
.2 internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or
.3 any oil-fired boiler or oil fuel unit, or any oil-fired equipment other than boilers, such as inert gas generators, incinerators, etc. (SOLAS, Reg. II-2/3.31)

9.3.4 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally*, and for short periods, to supply non-emergency circuits. (SOLAS, Reg. II-1/43.1.4)

Note:
For the purpose of starting from dead ship condition, see 3.1.4 (Regulation II-1/41.1.4) (MSC/Circ.736)

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* ***IACS interpretation***

Exceptionally, whilst the vessel is at sea, is understood to mean conditions such as:

1. *blackout situation*
2. *dead-ship situation*

3. routine use for testing
4. short-term parallel operation with the main source of electrical power for the purpose of load transfer

Unless instructed otherwise by the Administration, the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements of UI SC152 (see following interpretation) are complied with. (IACS UI SC3)*

*** *IACS interpretation***

1. General

Unless instructed otherwise by the Administration the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements as per items 2 and 3 below are complied with.

2. Requirements

2.1 To prevent the generator or its prime mover from becoming overloaded when used in port, arrangements are to be provided to shed sufficient non-emergency loads to ensure its continued safe operation.

2.2 The prime mover is to be arranged with fuel oil filters and lubrication oil filters, monitoring equipment and protection devices as required for the prime mover for main power generation and for unattended operation.

2.3 The fuel oil supply tank to the prime mover is to be provided with a low level alarm, arranged at a level ensuring sufficient fuel oil capacity for the emergency services for the period of time as required by SOLAS.

2.4 The prime mover is to be designed and built for continuous operation and should be subjected to a planned maintenance scheme ensuring that it is always available and capable of fulfilling its role in the event of an emergency at sea.

2.5 Fire detectors are to be installed in the location where the emergency generator set and emergency switchboard are installed.

2.6 Means are to be provided to readily change over to emergency operation.

2.7 Control, monitoring and supply circuits, for the purpose of the use of the emergency generator in port are to be so arranged and protected that any electrical fault will not influence the operation of the main and emergency services.

When necessary for safe operation, the emergency switchboard is to be fitted with switches to isolate the circuits.

3. Operation Instructions are to be provided on board to ensure that when the vessel is under way all control devices (e.g. valves, switches) are in a correct position for the independent emergency operation of the emergency generator set and emergency switchboard.*

** These instructions are also to contain information on required fuel oil tank level, position of harbour/sea mode switch if fitted, ventilation openings etc. (IACS UI SC152)*

9.3.5 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation: (SOLAS, Reg. II-1/43.2)

.1 For a period of 3 h, emergency lighting at every muster and embarkation station and over the sides as required by regulations III/11.4 and III/15.7. (SOLAS, Reg. II-1/43.2.1)

.2 For a period of 18 hours, emergency lighting:

.1 in all service and accommodation alleyways, stairways and exits, personnel lift cars and personnel lift trunks;
.2 in the machinery spaces and main generating stations including their control positions;
.3 in all control stations, machinery control rooms, and at each main and emergency switchboard;
.4 at all stowage positions for firemen' s outfits;
.5 at the steering gear;

.6 at the fire pump referred to in 9.3.5.5 (paragraph 2.5), at the sprinkler pump, if any, and at the emergency bilge pump, if any, and at the starting positions of their motors; and

.7 in all cargo pump-rooms of tankers (...). (SOLAS, Reg. II-1/43.2.2)

.3 For a period of 18 hours:

.1 the navigation lights and other lights required by the *International Regulations for Preventing Collisions at Sea* in force;

.2 (...) the VHF radio installation required by regulation IV/7.1.1 and IV/7.1.2; and, if applicable:

- the MF radio installation required by regulations IV/9.1.1, IV/9.1.2, IV/10.1.2, and IV/10.1.3;
- the ship earth station required by regulation IV/10.1.1; and
- the MF/HF radio installation required by regulations IV/11.1.1 and IV/11.1.2. (SOLAS, Reg. II-1/43.2.3)

.4 For a period of 18 hours:

.1 all internal communication equipment as required in an emergency;

.2 the shipborne navigational equipment as required by regulation V/19; where such provision is unreasonable or impracticable the Administration may waive this requirement for ships of less than 5,000 gross tonnage;

.3 the fire detection and fire alarm system; and

.4 intermittent operation of the daylight signalling lamp, the ship' s whistle, the manually operated call points, and all internal signals that are required in an emergency;

unless such services have an independent supply for the period of 18 hours from an accumulator battery suitably located for use in an emergency. (SOLAS, Reg. II-1/43.2.4)

.5 For a period of 18 hours one of the fire pumps required by regulation II-2/10.2.2.2 and II-2/10.2.2.3; if dependent upon the emergency generator for its source of power. (SOLAS, Reg. II-1/43.2.5)

.6 For the period of time required by 5.5.8 (regulation 29.14) the steering gear where it is required to be so supplied by that Regulation. (SOLAS, Reg. II-1/43.2.6.1)

.7 In a ship engaged regularly in voyages of short duration, the Administration if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 18 hour period specified in 9.3.5.2 to 9.3.5.5 (paragraphs 2.2 to 2.5) but not less than 12 hours. (SOLAS, Reg. II-1/43.2.6.2)

IACS interpretation

Dispensation to the reduced period of availability of the emergency source of power can be given to:

*1 Vessels with a class notation "Coastal Service" i.e. additional marks **II** and **III***

2 Vessels engaged in voyages where the route is no greater than 20 nautical miles offshore. (IACS UI SC72)

For ships of less than 300 gross tonnage of unrestricted service and the restricted service **I**, the required period of 18 hours may be reduced to 6 hours; for ships of less than 300 gross tonnage of restricted service **II** and **III** – to 3 hours.

9.3.6 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the following: (SOLAS II-1/43.3)

9.3.6.1 Where the emergency source of electrical power is a generator, it shall be:

.1 driven by a suitable prime-mover with an independent supply of fuel, having a flashpoint (closed cup test) of not less than 43°C;

.2 started automatically upon failure of the main source of electrical power supply unless a transitional source of emergency electrical power in accordance with 9.3.6.1.3 (paragraph 3.1.3) is provided; where the emergency generator is automatically started, it shall be automatically connected to the emergency switchboard; those services referred to in 9.3.8 (paragraph 4) shall then be connected automatically to the emergency generator; and

.3 provided with a transitional source of emergency electrical power as specified in 9.3.8 (paragraph 4) unless an emergency generator is provided capable both of supplying the services mentioned in that paragraph and of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 seconds. (SOLAS II-1/43.3.1)

9.3.6.2 Where the emergency source of electrical power is an accumulator battery it shall be capable of:

.1 carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12 percent above or below its nominal voltage;

IACS interpretation

Where the emergency and/or transitional emergency loads are supplied from a battery via an electronic converter or inverter the maximum permitted d.c. voltage variations are to be taken as those on the load side of the converter or inverter.

Where the d.c. is converted into a.c. the maximum variations are not exceed those given in 2.2.3 (UR E5). (UI SC186)

.2 automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

.3 immediately supplying at least those services specified 9.3.8 (paragraph 4). (SOLAS II-1/43.3.2)

9.3.7 For ships (...), where electrical power is necessary to restore 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. (SOLAS II-1/43.3.4)

Note:
Below UI SC124 together with UI SC3 and UI SC152 under 9.3.4 contains equivalent provisions to IMO interpretations of SOLAS II-1/43.3.4 in MSC.1/Circ.1572/Rev.2, Sec.7. Consequently the IMO interpretations have not been cited here.

IACS interpretation

"Blackout" as used in 21.1.3.8.3 and 9.3.7 (Regulation II-1/42.3.4 and II-1/43.3.4) is to be understood to mean a "deadship" condition.

"Deadship" condition, for the purpose of 21.1.3.8.3 and 9.3.7 (Regulation II-1/42.3.4 and II-1/43.3.4), is to be understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation and in restoring the propulsion, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxilaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout/dead ship condition as defined above. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

For steam ships, the 30 minute time limit given in SOLAS can be interpreted as time from blackout/dead ship condition defined above to light-off of the first boiler. (IACS UI SC124)

9.3.8 The transitional source of emergency electrical power where required by 9.3.6.1.3 (paragraph 3.1.3) shall consist of an accumulator battery suitably located for use in an emergency which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 percent above or below its nominal voltage and be of sufficient capacity and shall be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the following services if they depend upon an electrical source for their operation:

IACS interpretation

Where the emergency and/or transitional emergency loads are supplied from a battery via an electronic converter or inverter the maximum permitted d.c. voltage variations are to be taken as those on the load side of the converter or inverter.

Where the d.c. is converted into a.c. the maximum variations are not exceed those given in 2.2.3 (UR E5). (UI SC186)

.1 the lighting required by 9.3.5.1, 9.3.5.2 and 9.3.5.3.1 (paragraphs 2.1, 2.2 and 2.3.1). For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

.2 all services required by 9.3.5.4.1, 9.3.5.4.3 and 9.3.5.4.4 (paragraphs 2.4.1, 2.4.3 and 2.4.4) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency. (SOLAS II-1/43.4)

9.3.9 The emergency generator and its prime-mover and any emergency accumulator battery shall be so designed and arranged as to ensure that they will function at full rated power when the ship is upright and when inclined at any angle of list up to 22.5 degrees or when inclined up to 10 degrees either in the fore or aft direction, or is in any combination of angles within those limits. (SOLAS II-1/43.6) See also 2.2.2.3.2.

9.3.10 Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements. (SOLAS II-1/43.7)

9.3.11 During transition from the main to emergency power supply, services requiring continuous power supply shall be supplied from uninterruptible power system (UPS) in accordance with the requirements of subchapter 9.6.

9.3.12 Uninterruptible power systems used as battery or transitional emergency sources of power supply, required in 9.3.6.1.3 and 9.3.6.2, shall additionally fulfil the requirements of subchapter 9.5.

9.4 Distribution of electric power from emergency sources

9.4.1 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system

is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short circuit. (SOLAS II-1/43.5.4)

9.4.2 In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that electrical power shall be available automatically to the emergency circuits. (SOLAS II-1/43.5.5)

9.4.3 The consumers, listed in 9.3.5.2 and 21.1.3.6, shall be supplied with electric power by separate circuits directly from the busbars of the emergency switchboard fitted with suitable protection devices and switches. The consumers, listed in 9.3.5.3 and 9.3.5.4 or in 21.1.3.6.2 and 21.1.3.6.3, may be supplied from the ship navigation control and monitoring console located on the navigation bridge and supplied in accordance with 4.4.2.

9.4.4 Where a transitional source of electric power is fitted, the consumers listed in 9.3.8 or 21.1.3.9.1 shall be supplied through a special switchboard. The circuits of the switchboard shall not be fitted with switches.

9.4.5 Cables supplying the emergency consumers shall be so led as to ensure the electric power supply to the remaining emergency consumers in case the emergency consumers located below the bulkhead deck are flooded.

9.4.6 The switchboards of the emergency consumers shall be located above the bulkhead deck, behind the collision bulkhead.

9.5 Starting arrangements for emergency generating sets

9.5.1 Emergency generating sets shall be capable of being readily started in their cold condition at a temperature of 0°C. If this is impracticable, or if lower temperatures are likely to be encountered, provision acceptable to the Administration shall be made for the maintenance of heating arrangements, to ensure ready starting of the generating sets. (SOLAS, Reg. II-1/44.1)

9.5.2 Each emergency generating set arranged to be automatically started shall be equipped with starting devices approved by the Administration with a stored energy capability of at least three consecutive starts. (SOLAS, Reg. II-1/44.2)

9.5.3 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 an additional three starts within 30 minutes unless manual starting can be demonstrated to be effective. (SOLAS, Reg. II-1/44.2.1)

9.5.4 The stored energy shall be maintained at all times, as follows:

.1 electrical and hydraulic starting systems shall be maintained from the emergency switchboard;

.2 compressed air starting systems may be maintained by the main or auxiliary compressed air receivers through a suitable non-return valve or by an emergency air compressor which, if electrically driven, is supplied from the emergency switchboard;

.3 all of these starting, charging and energy storing devices shall be located in the emergency generator space; these devices are not to be used for any purpose other than the operation of the emergency generating set. This does not preclude the supply to the air receiver of the emergency generating set from the main or auxiliary compressed air system through the non-return valve fitted in the emergency generator space. (SOLAS, Reg. II-1/44.3)

9.5.5 Where automatic starting is not required, manual starting is permissible, such as manual cranking, inertia starters, manually charged hydraulic accumulators, or powder charge cartridges, where they can be demonstrated as being effective. (SOLAS, Reg. II-1/44.4.1)

9.5.6 When manual starting is not practicable, the requirements of 9.5.2 to 9.5.4 (paragraphs 2 and 3) shall be complied with except that starting may be manually initiated. (SOLAS, Reg. II-1/44.4.2)

9.5.7 Where the emergency generating set is arranged to be started by means of electric starting system with its own accumulator battery only, the second accumulator battery serving as a reserve source of power with stored energy meeting the requirements of paragraph 9.5.2 and 9.5.3 shall be provided.

9.6 Requirements for uninterruptible power system (UPS) units

IACS UR E21

9.6.1 Application (1.)

9.6.1.1 These requirements apply to UPS units, for the following cases:

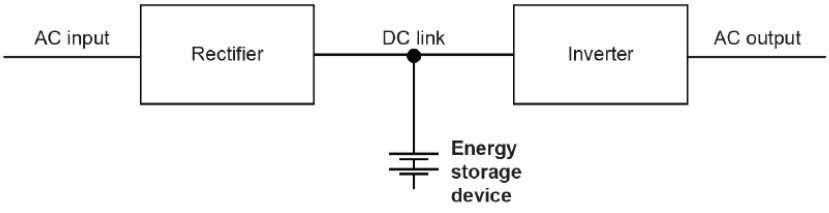
- **.1** when providing an alternative power supply as an accumulator battery in terms of being an independent power supply for the emergency services defined in 21.1.3.6.3 (SOLAS II-1/42.2.3) or 9.3.5.4 (SOLAS II-1/43.2.4),
- **.2** when providing an alternative power supply or transitional power supply to any other emergency services as defined in 21.1.3 (SOLAS II-1/42) or 9.3 (SOLAS II-1/43),
- **.3** where required, constituting a means of continuous and uninterruptible power supply to essential services as defined in 2.1.1.2 and 3.1.2 (IACS UI SC134 for SOLAS II-1/40 and SOLAS II-1/41), or
- **.4** when providing power supply in accordance with conditions specified and mandated by *FSS Code* Chapter 9, 2.2.2 to 2.2.4. (1.1)

9.6.1.2 These requirements may be referenced to UPS units for other cases than above in 9.6.1.1 (1.1), and the application of requirements is at the discretion of the Society. (1.2)

9.6.2 Definitions (2.)

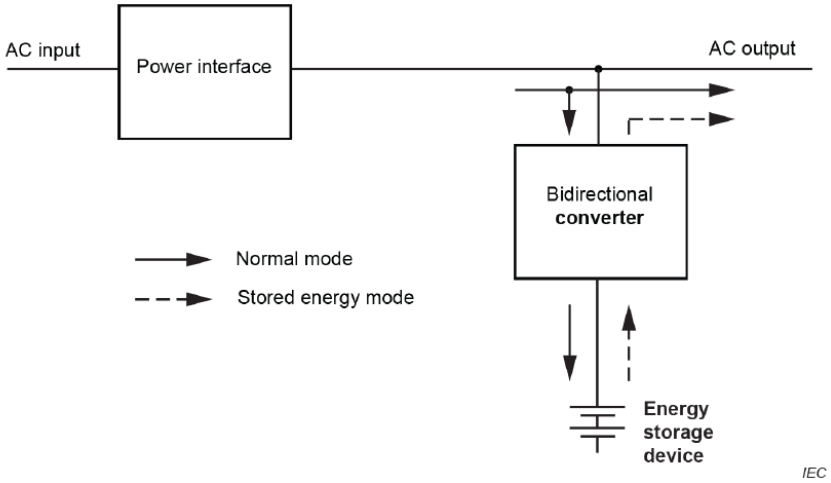
Uninterruptible Power System (UPS)
Combination of converters, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of AC input power failure [IEC 62040-3:2021]

Double Conversion topology
A UPS topology comprises an AC to DC converter, generally a rectifier, and a DC to AC converter, generally an inverter. When the AC input power is out of UPS pre-set tolerances, the UPS enters stored energy mode. (Refer to Annex B to IEC 62040-3:2021)



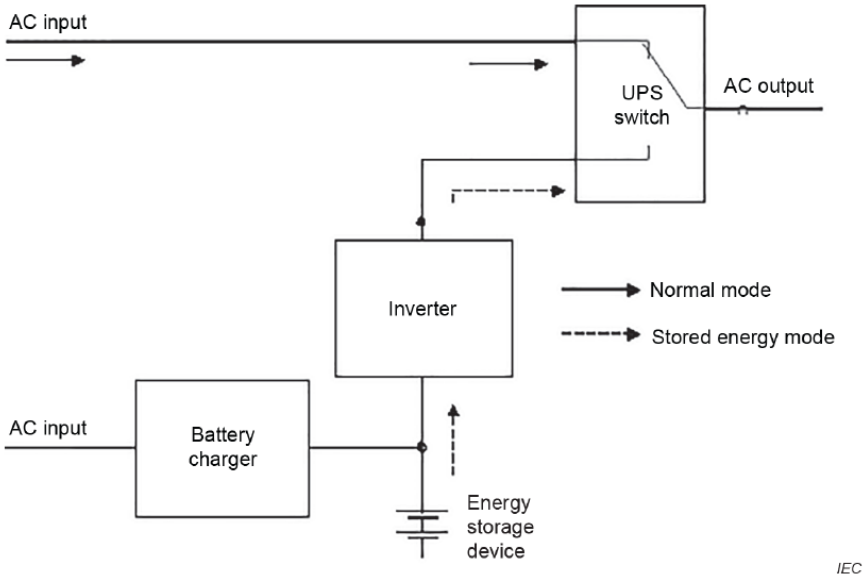
Line interactive topology

A UPS topology comprises bidirectional AC to DC power conversion, generally through a bidirectional converter and an AC power interface. When AC input power voltage or frequency is out of UPS pre-set tolerances, the UPS runs in stored energy mode. (Refer to Annex B to IEC 62040-3:2021)



Standby topology

A UPS topology comprises a battery charger, a DC to AC converter, generally a unidirectional inverter and a UPS switch. When the AC input power is out of UPS pre-set tolerances, the UPS operates in stored energy mode. (Refer to Annex B to IEC 62040-3:2021)



Energy storage device

System consisting of a single or multiple devices designed to provide power to the UPS inverter/converter. [IEC 62040-3:2021]

AC input power failure

Variation in the AC input power which could cause the UPS to operate in stored energy mode. [IEC 62040-3:2021]

Bidirectional converter
Converter which has the functions of both a rectifier and an inverter, and which can reverse the flow of power from AC to DC and vice-versa. [IEC 62040-3:2021]

9.6.3 Design and construction (3.)

9.6.3.1 UPS units are to be constructed in accordance with IEC 62040-1:2017+AMD1:2021+ AMD2:2022, IEC 62040-2:2016, IEC 62040-3:2021, IEC 62040-4:2013 and/or IEC 62040-5-3:2016, as applicable, or an acceptable and relevant national or international standard. (3.1)

9.6.3.2 The operation of the UPS is not to depend upon external services. (3.2)

9.6.3.3 The configuration and topology of UPS unit employed is to be appropriate to the power supply requirements of the connected load equipment. (3.3)

9.6.3.4 When external bypass is provided, bypass transfer switch is to be arranged to protect the load against power disturbances or interruption arising from inrush or fault current. (Refer to Annex C to IEC 62040-3:2021) (3.4)

9.6.3.5 The UPS unit is to be monitored and audible and visual alarm is to be given in continuously manned station(s) for:

- power supply failure (voltage and frequency) to the connected load,
- earth fault,
- operation of battery protective device,
- when the battery is being discharged,
- when the bypass is in operation in case an external bypass is provided, and
- any other fault and abnormal conditions of the UPS unit, as applicable. (3.5)

9.6.4 Location (4.)

9.6.4.1 The UPS unit for emergency services in 9.6.1.1.1 and 9.6.1.1.2 (1.1.1 and 1.1.2) is to be suitably located for use in an emergency. (4.1)

9.6.4.2 UPS units utilising valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC 62040-1:2017+AMD1:2021+ AMD2:2022, IEC 62040-2:2016, IEC 62040-3:2021, IEC 62040-4:2013 and/or IEC 62040-5-3:2016, as applicable, or an acceptable and relevant national or international standard. (4.2)

9.6.5 Performance (5.)

9.6.5.1 The output power is to be maintained for the duration required for the connected equipment as stated in 21.1.3 and 9.3 (SOLAS II-1/42 or SOLAS II-1/43). (5.1)

9.6.5.2 No additional circuits are to be connected to the UPS unit without verification that the UPS unit has adequate capacity. The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in the regulations. (5.2)

9.6.5.3 On restoration of the input power, the rating of the charge unit shall be sufficient to recharge the batteries while maintaining the output supply to the load equipment. (5.3)

9.6.6 Testing and survey (4.)

9.6.6.1 UPS units of 50 kVA and over are to be surveyed by the Society during manufacturing and testing, in accordance with 9.6.6.2 (paragraph 6.2). (6.1)

9.6.6.2 Appropriate testing is to be carried out to demonstrate that the UPS unit is suitable for its intended environment. This is expected to include as a minimum the following tests:

- Functionality, including operation of alarms in 9.6.3.5 (paragraph 3.5);
- Temperature rise;
- Ventilation rate;
- Battery capacity. (6.2)

9.6.6.3 Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical test. (6.3)

END OF IACS UR E21

CHAPTER 10

10 ELECTRIC MACHINES

10.1 General requirements

10.1.1 Electric propulsion generators and electric propulsion motors or, where justified, also machines of other designation, shall have heating arrangements to maintain their temperature at least 3°C above the ambient air temperature.

10.1.2 Shaft generators shall have a possibility for the stator to be axially shifted in relation to the rotor to ensure an access to the winding. If such shifting is impossible, a split stator and split bearing discs shall be provided.

Such shaft generators shall have an air-gap precluding the possibility of mechanical contact of the stator with the rotor in the most unfavourable service conditions.

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

.1 generators, converters, electric couplings and brakes: 120% of the rated speed;
.2 series-wound motors: 120% of the permissible speed as indicated on the rating plate, however not less than 150% of the rated speed;
.3 all motors other than those mentioned above: 120% of the maximum no-load speed.

10.1.4 Where a machine is so designed that at the point of installation on board its lower part is situated below the floor level, ventilating air intake shall not be effected through the bottom part of the machine.

10.2 Rings, commutators and brushes

10.2.1 Direct-current machines for driving the propulsion plants and direct-current machines rated at 200 kW and above shall be provided with sight holes to permit observation of the commutator and brushes without removing the lids.

10.2.2 The permissible amount of wear of commutator segments or slip rings shall be indicated on their face side. It shall be taken equal to at least 20% of the commutator segment or ship ring height.

10.2.3 For rotor of a mass of more than 1000 kg, possibility of reconditioning the commutator without removing the rotor from the machine shall be provided.

10.2.4 A flexible copper shall be used for drawing 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.

Direct-current machines shall be so constructed as to be capable of working with fixed brush setting under all conditions.

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

No sparking shall be possible at the specified overloads, reversals or starts, to such an extent as to cause damage to brushes or commutators.

10.3 Bearings

10.3.1 Bearings 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 Sliding bearings shall be fitted with overflow holes enabling outflow of oil excess and an oil level inspection lid. Oil level indicators shall be provided on machines rated at 100 kW (kVA) or more.

10.3.3 Pressure lubrication systems shall incorporate pressure indicators for oil supplied to a bearing.

10.3.4 Where reasonable, measures shall be taken to prevent flow of shaft stray currents through machinery bearings.

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

10.4 Temperature sensors

10.4.1 Stators of alternating-current machines rated at over 500 kVA or having an axial core length of more than 1000 mm, shall be provided with temperature sensors installed in places where the highest temperatures may be expected.

10.4.2 Embedded temperature sensors are recommended for short-time-rated and intermittent-rated electric motors.

10.4.3 It is recommended that embedded temperature sensors be used for the windlass drive electric motors. The sensors shall be so selected that the protection system disconnects the motor when the temperature rise limit for the insulation employed is exceeded by more than 30%.

The terminals of sensors leads shall be so located as to 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 such as specified in Table 10.5.1

Table 10.5.1

Item	Type of generator	Overcurrent [%]	Duration of overcurrent [s]
1	A.C. generator	50	120
2	D.C. generator	50	15

10.5.2 Electric motors shall be so designed as to be capable of developing, without stopping or sudden speed changes, increased torque such as specified in Table 10.5.2.

Table 10.5.2

Item	Type of motor	Overload by torque [%]	Duration of overload [s]	Testing conditions
1	Polyphase synchronous motors, as well as squirrel-cage motors with starting current less than 4.5 times the rated current	50	15	Frequency, voltage and excitation to be maintained at rated levels
2	Polyphase induction motors for continuous and intermittent duties	60	15	Frequency and voltage to be maintained at rated levels
3	Motors as specified in 2, but for short-time and continuous duty with varying load	100	15	As above
4	Direct-current motors	50	15	Voltage to be maintained at rated level

10.6 Alternating-current generators

10.6.1 General requirements

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

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

10.6.1.3 Alternating-current generators shall have excitation margin sufficient to maintain for 2 minutes the rated voltage with a tolerance up to 10%, with generator's overload equal to 150% of the rated current and power factor equal to 0.6.

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

10.6.1.5 Peak value of the three-phase short-circuit current of synchronous generators during operation at rated value shall not exceed fifteen-fold peak value of rated current.

10.6.2 Voltage regulation

10.6.2.1 Alternating-current generators shall have voltage regulation system so adjusted to the regulation characteristics of the prime movers that the rated voltage is maintained within ±2.5% (up to ±3.5% for emergency sets) at load changes from no-load to the rated load at rated power factor.

Main generators may have their voltage maintained within ±3.5% of the rated value at all power factor values from 0.6 to 0.9 except for the rated power factor.

The above requirement applies to a set operating at the rated speed and load of the generator.

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

Following such a change, the generator voltage shall be restored within not more than 1.5 seconds to the rated value with a tolerance of ±3%. For emergency sets, these values may be increased, respectively, to 5 seconds and ±4% of rated voltage.

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

10.7 Direct-current generators

10.7.1 General requirements

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

10.7.2 Voltage regulation

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

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

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

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

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

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

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

10.7.2.6 Direct-current sets comprising shunt-wound generators shall have such external generator characteristics and such automatic voltage regulators that voltage is maintained within ± 2.5% 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 becomes de-energized.

10.8.2 A 30% voltage fall 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 can be safe from damage at overvoltages such as occur when they are disconnected.

10.9 Test requirements for rotating machines

IACS UR E13

10.9.1 General (1.)

All machines are to be tested by the manufacturer.

Manufacturer's test records are to be provided for machines for essential services, for other machines they are to be available upon request.

All tests are to be carried out according to IEC 60092-301:1980/AMD2:1995.

All machines of 100 kW and over, intended for essential services, are to be surveyed by the Society during test and, if appropriate, during manufacturing.

Note:
An alternative survey scheme may be agreed by the Society with the manufacturer whereby attendance of the Surveyor will not be required as required above.

10.9.2 Shaft Material (2.)

Shaft material for electric propulsion motors and for main engine driven generators where the shaft is part of the propulsion shafting is to be certified by the Society.

Shaft material for other machines is to be in accordance with recognised international or national standard.

10.9.3 Tests (3.)

Type tests are to be carried out on a prototype machine or on the first of a batch of machines, and routine tests carried out on subsequent machines in accordance with Table 1.

Note:
Test requirements may differ for shaft generators, special purpose machines and machines of novel construction.

Table 1

No.	Tests	A.C. Generators		Motors	
		Type test[1)]	Routine test[2)]	Type test[1)]	Routine test[2)]
1.	Examination of the technical documentation, as appropriate and visual inspection	X	X	X	X
2.	Insulation resistance measurement	X	X	X	X
3.	Insulation resistance measurement	X	X	X	X
4.	Verification of the voltage regulation system	X	X[3)]		
5.	Rated load test and temperature rise measurements	X		X	
6.	Overload/overcurrent test	X	X[4)]	X	X[4)]
7.	Verification of steady short circuit conditions[5)]	X			
8.	Overspeed test	X	X	X[6)]	X[6)]

9.	Dielectric strength test	X	X	X	X
10.	No-load test	X	X	X	X
11.	Verification of degree of protection	X		X	
12.	Verification of bearings	X	X	X	X

1) Type tests on prototype machine or tests on at least the first batch of machines.
2) The report of machines routine tested is to contain the manufacturer's serial number of the machine which has been type tested and the test result.
3) Only functional test of voltage regulator system.
4) Only applicable for machine of essential services rated above 100kW.
5) Verification of steady short circuit condition applies to synchronous generators only.
6) Not applicable for squirrel cage motors.

10.9.4 Description of the test (4.)

10.9.4.1 Examination of the technical documentation, as appropriate and visual inspection (4.1)

10.9.4.1.1 Examination of the technical documentation (4.1.1)

Technical documentation of machines rated at 100 kW and over is to be available for examination by the Surveyor.

10.9.4.1.2 Visual inspection (4.1.2)

A visual examination is to be made of the machine to ensure, as far as is practicable, that it complies with technical documentation.

10.9.4.2 Insulation resistance measurement (4.2)

Immediately after the high voltage tests the insulation resistances are to be measured using a direct current insulation tester between:

a) all current carrying parts connected together and earth,

b) all current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accessible.

The minimum values of test voltages and corresponding insulation resistances are given in Table 2. The insulation resistance is to be measured close to the operating temperature, or an appropriate method of calculation is to be used.

Table 2

Related Voltage Un (V)	Minimum Test Voltage (V)	Test Minimum Insulation Resistance (MΩ)
Un ≤ 250	2 x Un	1
250 < Un ≤ 1000	500	1
000 < Un ≤ 7200	1000	(Un / 1000) + 1
7200 < Un ≤ 15000	5000	(Un / 1000) + 1

10.9.4.3 Winding resistance measurement (4.3)

The resistances of the machine windings are to be measured and recorded using an appropriate bridge method or voltage and current method.

10.9.4.4 Verification of the voltage regulation system (4.4)

The alternating current generator, together with its voltage regulation system shall, at all loads from no-load running to full load, be able to keep rated voltage at the rated power factor under steady conditions within ± 2.5%. These limits may be increased to ± 3.5% for emergency sets.

When the generator is driven at rated speed, giving its rated voltage, and is subjected to a sudden change of symmetrical load within the limits of specified current and power factor, the voltage is not to fall below 85% nor exceed 120% of the rated voltage.

The voltage of the generator is then to be restored to within plus or minus 3% of the rated voltage for the main generator sets in not more than 1.5 s. For emergency sets, these values may be increased to plus or minus 4% in not more than 5 s, respectively.

In the absence of precise information concerning the maximum values of the sudden loads, the following conditions may be assumed: 60% of the rated current with a power factor of between 0.4 lagging and zero to be suddenly switched on with the generator running at no load, and then switched off after steady - state conditions have been reached. Subject to Classification Society's approval, such voltage regulation during transient conditions may be calculated values based on the previous type test records, and need not to be tested during factory testing of a generator.

10.9.4.5 Rated load test and temperature rise measurements (4.5)

The temperature rises are to be measured at the rated output, voltage, frequency and the duty for which the machine is rated and marked in accordance with the testing methods specified in IEC 60034-1:2017, or by means of a combination of other tests.

The limits of temperature rise are those specified in the relevant table of IEC 60034-1:2017 adjusted as necessary for the ambient reference temperatures specified in 2.2.1.1 (UR M40).

10.9.4.6 Overload/overcurrent tests (4.6)

Overload test is to be carried out as a type test for generators as a proof of overload capability of generators and excitation system, for motors as a proof of momentary excess torque as required in IEC 60034-1:2017. The overload test can be replaced at routine test by the overcurrent test. The over current test shall be the proof of current capability of windings, wires, connections etc. of each machine. The overcurrent test can be done at reduced speed (motors) or at short circuit (generators).

10.9.4.7 Verification of steady short-circuit conditions (4.7)

It is to be verified that under steady-state short-circuit conditions, the generator with its voltage regulating system is capable of maintaining, without sustaining any damage, a current of at least three times the rated current for a duration of at least 2 s or, where precise data is available, for a duration of any time delay which will be fitted in the tripping device for discrimination purposes.

In order to provide sufficient information to the party responsible for determining the discrimination settings in the distribution system where the generator is going to be used, the generator manufacturer shall provide documentation showing the transient behaviour of the short circuit current upon a sudden short-circuit occurring when excited, and running at nominal speed. The influence of the automatic voltage regulator shall be taken into account, and the setting parameters for the voltage regulator shall be noted together with the decrement curve. Such a decrement curve shall be available when the setting of the distribution system's short-circuit protection is calculated. The decrement curve need not be based on physical testing. The

manufacturer's simulation model for the generator and the voltage regulator may be used where this has been validated through the previous type test on the same model.

10.9.4.8 Overspeed test (4.8)

Machines are to withstand the overspeed test as specified in to IEC 60034-1:2017. This test is not applicable for squirrel cage motors.

10.9.4.9 Dielectric strength test (4.9)

Machines are to withstand a dielectric test as specified in IEC 60034-1:2017.

For high voltage machine an impulse test is to be carried out on the coils according to Chapter 18 (UR E11).

10.9.4.10 No load test (4.10)

Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor or if a generator it is to be driven by a suitable means and excited to give rated terminal voltage.

During the running test, the vibration of the machine and operation of the bearing lubrication system, if appropriate, are to be checked.

10.9.4.11 Verification of degree of protection (4.11)

As specified in IEC 60034-5:2000+AMD1:2006.

10.9.4.12 Verification of bearings (4.12)

Upon completion of the above tests, machines which have sleeve bearings are to be opened upon request for examination by the Classification Society Surveyor, to establish that the shaft is correctly seated in the bearing shells.

END OF IACS UR E13

CHAPTER 11

11 TRANSFORMERS

11.1 General requirements

11.1.1 The requirements of the present subchapter apply to power and lighting transformers specified in 3.3.

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

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

11.2 Overloads, voltage variations and parallel operation

11.2.1 Transformers shall be capable of withstanding 10% overloads for 1 hour and 50% overloads for 5 minutes.

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

11.2.3 Parallel-operating transformers shall have compatible vector groups, the same transformation ratios and their short-circuit voltages shall be such that the load on any transformer, at full load, does not depart from the corresponding proportional part of its power output by more than 10%.

11.2.4 Where transformers are arranged to operate in parallel, the rated power output of the smallest transformer shall not be less than half the rated power output of the largest transformer.

CHAPTER 12

12 POWER-ELECTRONIC EQUIPMENT

12.1 General requirements

12.1.1 Power-electronic equipment shall be provided with silicon semi-conductor elements. The use of other types of elements is subject to PRS consideration in each particular case.

12.1.2 Power-electronic equipment in which the power loss exceeds 500 W shall be provided with heating appliances to maintain the temperature of at least 3°C higher than the ambient temperature.

12.1.3 Power-electronic equipment shall be provided with air-cooling (natural or forced).

12.1.4 Application of liquid-cooling is subject to PRS consideration in each particular case.

12.1.5 In power-electronic equipment with forced ventilation, a protective device shall be provided to ensure reducing or switching off the load when the ventilation is switched off, as well as the actuating of the visual and audible signals when maximal permissible temperature inside equipment is exceeded.

12.1.6 Power-electronic equipment shall be provided with appropriate measuring instruments.

The maximum permissible values of parameters shall be marked on the scales of the measuring instruments. On the scales of the cooling air thermometers, in the case of forced air cooling, the maximum permissible temperature of the cooling air shall be clearly indicated.

12.2 Harmonic distortion for ship electrical distribution system including harmonic filters

IACS UR E24

12.2.1 Scope (1.)

The requirements of this UR apply to ships where harmonic filters are installed on main busbars of electrical distribution system, other than those installed for single application frequency drives such as pump motors.

12.2.2 General (2.)

The total harmonic distortion (THD) of electrical distribution systems is not to exceed 8%.

This limit may be exceeded where all installed equipment and systems have been designed for a higher specified limit and this relaxation on limits is documented (harmonic distortion calculation report) and made available on board as a reference for the surveyor at each periodical survey.

The application of the power-electronic equipment causing the voltage distortions, exceeding the given tolerance range, is subject to PRS consideration in each particular case.

The voltage distortion factor K, also known as THD, shall be determined from the following formula:

$$K = \frac{1}{U_n} \cdot \sqrt{\sum_{v=2}^{n} U_v^2} \cdot 100 \ [\%]$$

where:

U_n – effective value of the network voltage;
U_v – effective value of voltage of v-number harmonic;
v – number of higher harmonic.

12.2.3 Monitoring of harmonic distortion levels for a ship including harmonic filters (3.)

12.2.3.1 The ships are to be fitted with facilities to continuously monitor the levels of harmonic distortion experienced on the main busbar as well as alerting the crew should the level of harmonic distortion exceed the acceptable limits. Where the engine room is provided with automation systems, this reading should be logged electronically, otherwise it is to be recorded in the engine log book for future inspection by the surveyor. (3.1)

12.2.3.2 As a minimum, harmonic distortion levels of main busbar on board such existing ships are to be measured annually under seagoing conditions as close to the periodical machinery survey as possible so as to give a clear representation of the condition of the entire plant to the surveyor. Harmonic distortion readings are to be carried out when the greatest amount of distortion is indicated by the measuring equipment. An entry showing which equipment was running and/or filters in service is to be recorded in the log so this can be replicated for the next periodical survey. Harmonic distortion levels are also to be measured following any modification to the ship's electrical distribution system or associated consumers by suitably trained ship's personnel or from a qualified outside source.

Records of all the above measurements are to be made available to the surveyor at each periodical survey. (3.2)

12.2.4 Mitigation of the effects of harmonic filter failure on a ship's operation (4.)

Where the electrical distribution system on board a ship includes harmonic filters the system integrator of the distribution system is to show, by calculation, the effect of a failure of a harmonic filter on the level of harmonic distortion experienced.

The system integrator of the distribution system is to provide the ship owner with guidance documenting permitted modes of operation of the electrical distribution system while maintaining harmonic distortion levels within acceptable limits during normal operation as well as following the failure of any combination of harmonic filters.

The calculation results and validity of the guidance provided are to be verified by the surveyor during sea trials.

12.2.5 Protection arrangements for harmonic filters (5.)

Arrangements are to be provided to alert the crew in the event of activation of the protection of a harmonic filter circuit.

A harmonic filter should be arranged as a three phase unit with individual protection of each phase. The activation of the protection arrangement in a single phase shall result in automatic disconnection of the complete filter. Additionally, there shall be installed a current unbalance detection system independent of the overcurrent protection alerting the crew in case of current unbalance.

Consideration is to be given to additional protection for the individual capacitor element as e.g. relief valve or overpressure disconnector in order to protect against damage from rupturing. This consideration should take into account the type of capacitors used.

END OF IACS UR E24

12.2.6 The factor u_W, determining the maximum relative deviation of the voltage instantaneous value from the first harmonic, shall not exceed 30%.

The factor shall be determined from the following formula:

$$u_w = \frac{\Delta U_m}{\sqrt{2}U_1} \cdot 100 \ [\%]$$

where:

ΔU_m – the maximum value of the distorted voltage;
U_1 – the first harmonic effective value of voltage.

12.3 Control and signalling systems

12.3.1 Power-electronic equipment shall be provided with visual signals indicating the ”ON” and “OFF” position of the power and control circuits.

12.3.2 The power circuits shall be electrically separated from the control circuit.

12.3.3 The prolonged difference between currents in parallel branches shall not be more than 10% of the mean current value.

12.3.4 Failure of any of the rectifier valves shall not affect the operation of power-electronic equipment. An automatic control of load shall be provided to avoid exceeding the permissible loads for each of the rectifier valves. Failure of each of the rectifier valves shall be signalled by visual and audible alarms.

12.3.5 The asymmetry of control pulses of the converter control system ($\Delta\alpha$) shall be determined by the formula:

$$\Delta\alpha = \delta_k - \frac{360}{n}$$

where:

δ_k – distance between pulses of the adjacent ducts, in electric degrees;
n – number of control channels.
$\Delta\alpha$ shall not exceed ± 3 electric degrees at any point of the control range.

CHAPTER 13

13 STORAGE BATTERIES

13.1 General requirements

13.1.1 Storage batteries shall be so constructed that the loss of capacity of a fully charged battery due to self-discharge after 28 days out of operation at a temperature of 25 ± 5°C does not exceed 30% of the rated capacity for acid batteries and 25% 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 of a durable material resistant to electrolyte. The closure design shall be such as to avoid the building up of excess gas pressure inside the battery.

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

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

13.1.5 The use of non-service accumulators is subject to PRS consideration in each particular case.

13.1.6 Accumulator batteries connected in series (e.g. two 12 V batteries supplying 24 V installation) shall be of the same type and the same capacity so that voltage drop occurring on each battery will be the same.

13.2 Arrangement of accumulator batteries

13.2.1 Accumulator batteries shall be suitably housed, and compartments used primarily for their accommodation shall be properly constructed and efficiently ventilated. (SOLAS, Reg. II-1/45.9.1)

13.2.2 Electrical or other equipment which may constitute a source of ignition of flammable vapours shall not be permitted in these compartments except as permitted in 2.9.2 (paragraph 10). (SOLAS, Reg. II-1/45.9.2)

13.2.3 Accumulator batteries shall not be located in sleeping quarters except where hermetically sealed to the satisfaction of the Administration. (SOLAS, Reg. II-1/45.9.3)

13.2.4 Batteries having voltage exceeding the safety voltage, as well as batteries having a capacity of over 2 kW (computed from the maximum charging current and the rated voltage) shall be located in special battery compartments accessible from the deck or in appropriate boxes installed on the open deck. These spaces shall be special electrical spaces.

Batteries having capacity of up to 2 kW may be installed in boxes or cabinets located inside the ship hull.

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

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

Accumulator batteries having a capacity of less than 0.2 kW are permitted to be installed in any space in accordance with the requirements of *Part VI*, subchapter 7.10, except accommodation spaces, provided that they are protected from the action of water and mechanical damage and do not harmfully affect the surrounding equipment.

13.2.5 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.

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

13.2.7 The accumulator batteries, as well as the individual accumulator cells shall be effectively secured in position. When they are placed on a stillage, the distance between the deck and the plugs of the upper tier of cells shall not exceed 1500 mm.

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

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

13.3 Heating

13.3.1 The battery compartments in which temperature during operation may fall down below +5°C, with the exception of battery boxes or cabinets installed on deck, shall be heated. The heating may be effected by the heat produced in adjacent spaces, as well as with water or steam radiators located inside the battery rooms.

13.3.2 The heating system valves 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 shall have sufficient ventilation that will prevent possible formation and accumulation of explosive mixtures.

The ventilation system shall fulfil the requirements specified *Part VI,* subchapter 7.10.

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

13.5 Charging the accumulator batteries

13.5.1 Charging facilities shall be provided for charging accumulator batteries supplying essential services. These facilities shall be capable of charging a battery within a period of time not exceeding 8 hours.

If an additional battery, which replaces the battery being charged, is available, the charging time may exceed 8 hours.

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 electric power.

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

13.6 Installation of electrical equipment in battery compartments

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

Cables leading to accumulators and lighting fixtures may be run without covers, provided that they have a metal armour or braid covered by non-metallic sheath, and that the armour or the braid are effectively earthed on both ends.

13.7 Electrical starting arrangements of internal combustion engines

IACS UR M61

(…)

Note:
Preceding part of this UR M61 – mechanical starting arrangements of internal combustion engines – see *Part VI*, subchapter 12.1.

13.7.1 Where the main engine is arranged for electric starting, two separate batteries are to be fitted. The arrangement is to be such that the batteries cannot be connected in parallel. Each battery is to be capable of starting the main engine when in cold and ready to start conditions. The combined capacity of the batteries is to be sufficient without recharging to provide within 30 minutes the number of starts of main engines that are required (…) in case of air starting. (i.e. not less than 12 consecutive starts alternating between Ahead and Astern of each main engine of the reversible type, and not less than six starts of each main non-reversible type engine connected to a controllable pitch propeller or other device enabling the start without opposite torque). (M61.2.1)

13.7.2 Electric starting arrangements for auxiliary engines are to have two separate batteries or may be supplied by separate circuits from the main engine batteries when such are provided. In the case of a single auxiliary engine only one battery may be required. The capacity of the batteries for starting the auxiliary engines is to be sufficient for at least three starts for each engine. (M61.2.2)

13.7.3 The starting batteries are to be used for starting and the engine's own monitoring purposes only. Provisions are to be made to maintain continuously the stored energy at all times. (M61.2.3)

END OF IACS UR M61

13.7.4 Permanent switching of the starting system shall be provided to ensure the possibility of using any battery for starting any of the engines in the group serviced by this battery.

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

13.7.6 In ships of restricted service **III** and in ships of restricted service **II** with the low-rated electrical installation (other than passenger ships), the starting batteries may be charged only from the generator mounted on the i.c. engine.

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

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

13.8 Recording of the type, location and maintenance cycle of batteries

IACS UR E18

13.8.1 Where batteries are fitted for use for essential (UI SC134) and emergency services (see 1.2.24 and 1.2.19) a schedule of such batteries is to be compiled and maintained. The schedule, which is to be reviewed by the Society during plan approval or the newbuilding survey, is to include at least the following information regarding the battery(ies):

- Type and manufacturer's type designation.
- Voltage and ampere-hour rating.
- Location.
- Equipment and/or system(s) served.
- Maintenance/replacement cycle dates.
- Date(s) of last maintenance and/or replacement.
- For replacement batteries in storage, the date of manufacture and shelf life.[1] (1.)

13.8.2 Procedures are to be put in place to ensure that where batteries are replaced that they are of an equivalent performance type. (2.)

13.8.3 Where vented[2] type batteries replace valve-regulated sealed[3] types, it is to be ensured that there is adequate ventilation[4] and that the Society's requirements relevant to the location and installation of vented types batteries are complied with. (3.)

13.8.4 Details of the schedule and of the procedures are to be included in the ship's safety management system and be integrated into the ship's operational maintenance routine as appropriate[5] to be verified by the Society's surveyor. (4.)

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1 Shelf life is the duration of storage under specified conditions at the end of which a battery retains the ability to give a specified performance.

2 A vented battery is one in which the cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cells to atmosphere.

3 A valve-regulated battery is one in which cells are closed but have an arrangement (valve) which allows the escape of gas if the internal pressure exceeds a predetermined value.

4 The ventilation arrangements for installation of vented type batteries (...) – see *Part VI*, 7.10.5.

5 See section 10 of the IMO ISM Code.

END OF IACS UR E18

CHAPTER 14

14 ELECTRICAL APPARATUS AND ACCESSORY

14.1 Electrical apparatus

14.1.1 General requirements

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

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

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

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

14.1.2 Manually operated apparatus

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

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

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

14.1.3 Motor-operated apparatus

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

14.1.3.2 Electric motor actuators shall ensure correct closing of switchgear at control voltage varying within 85 to 110% of the rated value and at rated frequency, in the case of alternating current.

14.1.3.3 Actuator operation at 110% of the rated control voltage shall not cause mechanical damage to the switchgear or excessive rebounding of contact liable to affect the switching capacity (due to arcing or welding of contacts). As regards electromagnetic contactors, the above requirement is applicable to contactor operation at an ambient temperature of –10°C and with the coil winding cold.

14.1.3.4 At 85% of the rated control voltage, the actuator shall be capable of correctly closing the switchgear at rated making current, at an ambient temperature of +45°C and with the actuator winding heated to the rated temperature.

14.1.3.5 A fall of control voltage down to 70% of the rated value shall not cause opening or pressure decrease of movable elements below the required minimum, at an ambient temperature of +45°C and with the actuator winding hot.

14.1.3.6 Motor-actuated non-manoeuvring switchgear shall be provided with a device for manual operation.

14.1.4 Coils

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

14.1.4.2 The coils of electromagnetic apparatus shall bear notations giving particulars of their characteristics.

14.1.5 Resistance elements

14.1.5.1 Resistance elements shall be easily replaceable in sections or as a whole.

14.1.5.2 Resistors shall be so located and ventilated as not to heat other devices beyond the permissible limits.

14.1.5.3 The joints between resistor elements or between the resistor elements and terminals shall be made by welding or by mechanical press-fitting where there is no need to dismantle them. Soldering is allowed where there is no risk of temperature rise at the point of junction above the specified limits for the solder.

14.1.6 Fuses

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

14.1.6.2 Fuse elements shall be made of incombustible and non-hygroscopic insulating material.

14.2 Installation fittings

14.2.1 General requirements

14.2.1.1 Enclosures of accessories and fittings shall be constructed of corrosion-resistant or suitably protected from corrosion and at least low flame-spread materials of adequate mechanical strength. The enclosures of accessories and fittings designed for installation on weather decks, in refrigerated cargo spaces, fish processing shops, or other humid areas shall be made of brass, bronze or equivalent materials, or of plastics of suitable quality.

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

Threaded and fitted joints shall not be made in 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 that would ignite from an electric spark at a temperature up to 500°C inclusive.

14.2.1.3 The lighting fitting intended to be installed 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 lampholder shall be marked to indicate the rated voltage, as well as the permissible current or the lamp power.

14.2.3 Plug and socket connectors

14.2.3.1 The pin jacks of socket outlets 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, as the case may be.

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

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

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

14.2.3.6 Where socket outlets are not interlocked, the clearances between contacts in the air or across the insulation surface shall be such that no short-circuit is possible due to arcing over when the plug is withdrawn while carrying a load 50% 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 only one live contact pin into the socket outlet, or insert a live contact pin into the earthing contact. Besides, the design of the outlets intended for connecting the motors (or gear), the direction of rotation (or operation) of which depends on the change of the sequence of phases or poles connected, shall exclude the possibility of this change. When the plug is inserted into the socket outlet, the earthing part of the plug shall make contact with the earthing part of the socket outlet before connecting the live pins.

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

CHAPTER 15

15 HEATING APPLIANCES

15.1 General requirements

15.1.1 Only heating appliances of stationary type shall be used.

15.1.2 Heating appliances shall be supplied from the main switchboard or section switchboard adopted for this purpose, or from the lighting switchboard, with due regard paid to the requirements of paragraph 6.2.1.

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

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

15.1.5 Heating appliances shall be so designed that the temperature of their components which are to be handled by the personnel or which can be touched accidentally does not exceed the values stated in Table 15.1.5.

Table 15.1.5

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

15.2 Space heating appliances

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

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

15.2.2 The space heaters shall be installed in compliance with the requirements of *Part V,* 7.5.

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

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

15.2.5 Stationary space heating appliances rated at 380 V and admitted for use in accordance with Table 4.2.2 shall be protected against access to live parts except with the aid of special tools. The enclosures shall have notices giving the voltage value.

15.3 Cooking appliances

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

15.4 Oil and fuel heating appliances

15.4.1 The electrical heating appliances may be used for heating oil and fuel having a flash point of vapour above 60°C, provided that the requirements specified in 15.4.2 and 15.4.3 are complied with.

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

15.4.3 As required in *Part VI,* subchapter 8.4*,* the heating appliances for oil and fuel tanks shall be provided with temperature control devices for the heated medium, temperature indicators for surfaces of heating elements, minimum level sensors, as well as with means for the disconnection of power supply to the heating devices when the maximum permissible parameters have been reached.

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

15.4.4 Where steam or electric heaters are provided in fuel or lubricating oil systems, they shall be fitted with at least high temperature alarm or low flow alarm in addition to a temperature control system. These alarms are not required where the temperature dangerous for ignition of the medium cannot be reached.

The safety switch with manual re-set shall be provided for disconnecting the supply voltage when temperature above 220°C can be reached by a surface of the heating element. The safety switch shall be independent from the automatic control sensor.

Fuel and lubricating oil heaters shall be installed in accordance with the requirements specified in *Part VI,* subchapter 8.8.

CHAPTER 16

16 CABLES AND CONDUCTORS

16.1 General requirements

IACS UR E7

16.1.1 Cables are to be of a type approved by the Classification Society. (1.)

16.1.2 Cables manufactured in accordance with the relevant recommendations of IEC 60092-350:2020, 60092-352:2005, 60092-353:2016, 60092-354:2020, 60092-360:2014, 60092-370:2019 and 60092-376:2017 will be accepted by the Classification Society provided that they are tested to its satisfaction. (2.)

16.1.3 Cables manufactured and tested to standards other than those specified in 16.1.2 (2) will be accepted provided they are in accordance with an acceptable and relevant international or national standard and are of an equivalent or higher safety level than those listed in 16.1.2 (paragraph 2). However, cables such as flexible cable, fibre-optic cable, etc. used for special purposes may be accepted provided they are manufactured and tested in accordance with the relevant standards accepted by the Classification Society. (3.)

END OF IACS UR E7

16.1.4 All electric cables and wiring external to equipment shall be at least of a flame retardant type* and shall be so installed as not to impair their original flame retarding properties**. Where necessary for particular applications the Administration may permit the use of special types of cables such as radio frequency cables, which do not comply with the foregoing. (SOLAS, Reg. II-1/45.5.2)

Note:
In case of ro-ro passenger ships – see MSC.1/Circ.1615 (item 1.3) of 2019-06-26 *Interim guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships*.

IACS interpretation

* *This may be achieved by cables which have been tested in accordance with IEC 60332-1-2:2004+AMD1:2015 or a test procedure equivalent thereto.*

** *This may be achieved by:*

Method 1

Cables which have been tested in accordance with IEC 60332-3-22:2018 Category A or a test procedure for cables installed in bunches equivalent thereto.

Method 2 *(See Figures 1-4)*

2.1 *Fire stops having at least B-0 penetrations fitted as follows:*

- ***.1*** *cable entries at the main and emergency switchboard,*
- ***.2*** *where cables enter engine control rooms,*
- ***.3*** *cable entries at centralized control panels for propulsion machinery and essential auxiliaries,*
- ***.4*** *at each end of totally enclosed cable trunks; and*

2.2 *In enclosed and semi-enclosed spaces, cable runs are to comply with the following:*

- ***.1*** *to have fire protection coating applied:*
  - *to at least 1 metre in every 14 metres*
  - *to entire length of vertical runs, or*
- ***.2*** *fitted with fire stops having at least B-0 penetrations every second deck or approximately 6 metres for vertical runs and at every 14 metres for horizontal runs.*

The cable penetrations are to be installed in steel plates of at least 3 mm thickness extending all around to twice the largest dimension of the cable run for vertical runs and once for horizontal runs, but need not extend through ceilings, decks, bulkheads or solid sides of trunk. In cargo area, fire stops need only be fitted at the boundaries of the spaces.

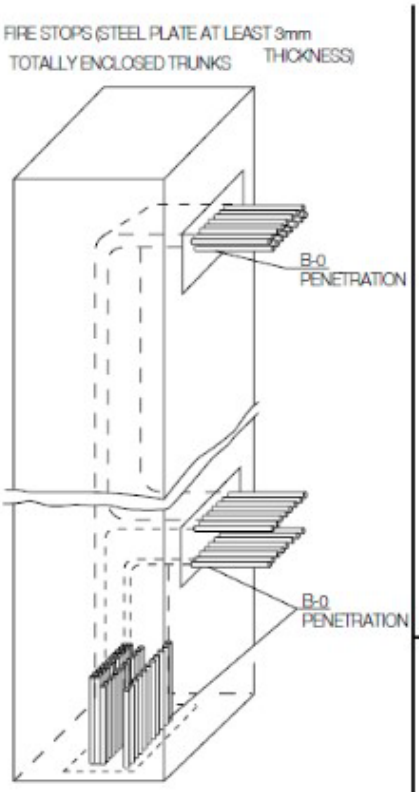

Fig. 1

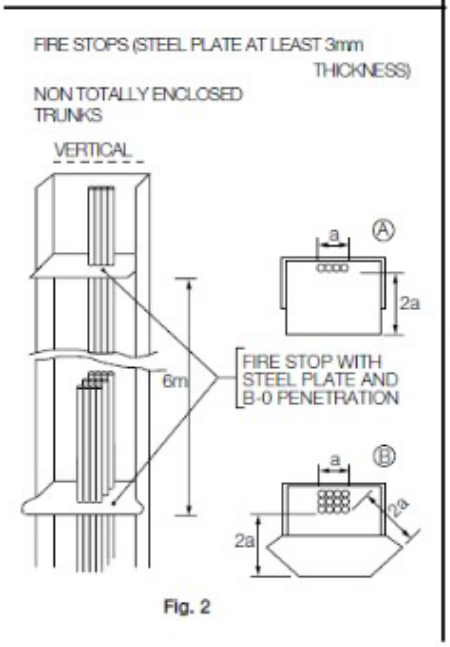

Fig. 2

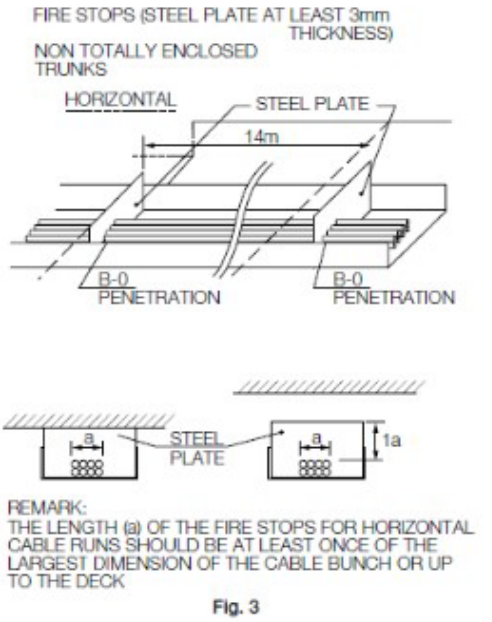

Fig. 3

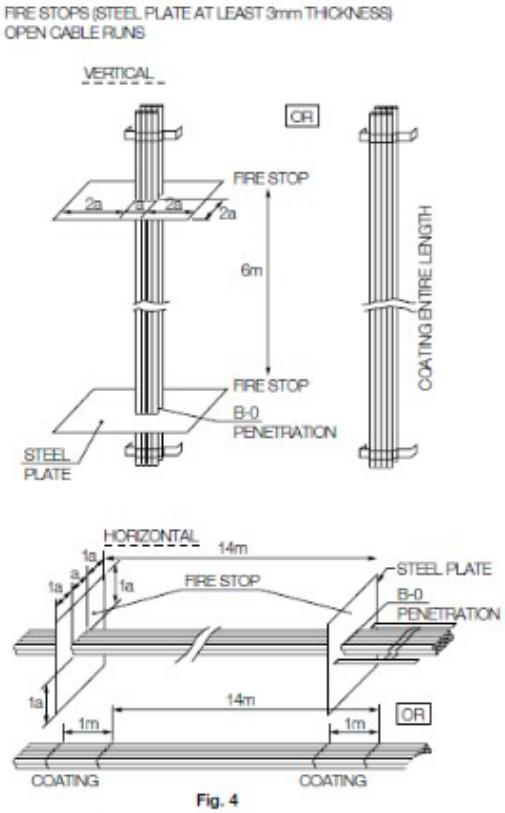

Fig. 4

(IACS UI SC10)

16.1.5 The telecommunication, telephone and coaxial cables shall fulfil the requirements of IEC: 60092-350, 60092-370:2019 and 60331-23. Optical fibre cables shall fulfil the requirements of IEC 60331-25.

16.1.6 Regarding the use of fire-resistant cables – see 16.8.12.

16.1.7 The possibility of the use of other types of cables and wires is subject to PRS consideration in each particular case.

16.1.8 The requirements of the present Chapter do not apply to power cables for the voltage over 1000 V.

16.2 Conductors

16.2.1 Cable conductors intended for supplying essential services shall be of multi-wire type. Table 16.2.1 specifies the number of wires per conductor.

Table 16.2.1

Item	Nominal cross-sectional area of conductor [mm^2]	Minimum number of wires per conductor	
		Circular non-compacted conductors	Compacted circular and shaped conductors
1	0.5 – 6	7	–
2	10 – 16	7	6
3	25 – 35	19	6
4	50 – 70	19	15
5	95	37	15
6	120 – 185	37	30
7	240 – 300	61	30

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

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

16.2.3 Separate wires of rubber-insulated copper conductors shall be tinned or coated with a suitable alloy.

Tinning or other anticorrosive coating of external wiring or of all wires of a rubber-insulated conductor may be dispensed with if the manufacturer takes measures to guarantee that the rubber insulation does not affect adversely the metal of the conductor.

No tinning is required for conductors provided with other types of insulation.

16.3 Insulating materials

16.3.1 The types of insulation that may be used for insulating current-carrying conductors in cables are listed in Table 16.3.1. The use of other types of insulation is subject to PRS consideration in each particular case.

Table 16.3.1

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

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

16.4 Cable sheaths

16.4.1 Cable and conductor sheaths may be made of materials specified in Table 16.4.1.

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

Table 16.4.1

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

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

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

16.5 Protective coverings

16.5.1 Except as permitted by the Administration in exceptional circumstances, all metal sheaths and armour of cables shall be electrically continuous and shall be earthed. (SOLAS, Reg. II-1/45.5.1)

Note:
In case of ro-ro passenger ships – see MSC.1/Circ.1615 (item 1.3) of 2019-06-26 *Interim guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships.*

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

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

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

16.5.5 Armour bedding shall be made of moisture resistant materials.

16.6 Marking

16.6.1 Rubber- or polyvinyl-chloride-insulated cables having a limiting temperature at core over 60°C shall be so marked as to allow for their identification.

16.6.2 Cable conductors shall be marked in a way that would ensure the permanence of marking.

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

16.7 Wiring

16.7.1 Insulated single-core conductors shall be used for internal wiring of switchboards and electrical devices (see also 2.4.3).

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

16.8 Cabling

16.8.1 General requirements

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

.1 1.0 mm^2 – for power, control and signalling circuits supplying the essential services and for power circuits supplying other services;
.2 0.75 mm^2 – for control and signalling circuits supplying non-essential services;
.3 0.5 mm^2 – for monitoring and indicating circuits and the circuits serving internal communication, with not less than 4 conductors in the cable.

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

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

16.8.1.3 In locations affected by the action of crude oil products and other aggressive media, the cables having a sheathing that will withstand the action of a particular medium shall be used. Cables of other types may be installed in such locations, provided they are laid in metallic pipes (see 16.8.8).

16.8.1.4 In locations where cables may be subjected to mechanical damage, they shall have 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 (see 16.8.8).

16.8.1.5 Cables and wiring servicing essential or emergency power, lighting, internal communications or signals shall so far as practicable be routed clear of galleys, laundries, machinery spaces of category A* and their casings and other high fire risk areas**. (...) Cables connecting fire pumps to the emergency switchboard shall be of a fire resistant type where they pass through high fire risk areas. Where practicable all such cables should be run in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space. (SOLAS, Reg. II-1/45.5.3)

Notes:
1. In case of ro-ro passenger ships – see MSC.1/Circ.1615 (item 1.3) of 2019-06-26 *Interim guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships*.
2. * For the purpose of this paragraph definition of machinery space of category A as per SOLAS II-2/3.31 applies – see Note in 9.3.3.

IACS interpretation

** *High fire risk areas are those considered as such in Regulation 9 of SOLAS Chapter II-2 as amended by IMO resolutions as to MSC.421(98) i.e. the following service spaces (high risk):*

Galleys, pantries containing cooking appliances, paint and lamp rooms, lockers and store-rooms having areas of 4 m^2 or more, spaces for the storage of flammable liquids, saunas and workshops other than those forming part of the machinery spaces.

(IACS UI SC11)

16.8.1.6 Where cables which are installed in hazardous areas introduce the risk of fire or explosion in the event of an electrical fault in such areas, special precautions against such risks shall be taken to the satisfaction of the Administration. (SOLAS, Reg. II-1/45.5.4)

Note:
In case of ro-ro passenger ships – see MSC.1/Circ.1615 (item 1.3) of 2019-06-26 *Interim guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships*.

IACS interpretation

Special precautions should be as follows:
.1 *Cables to be appropriately sheathed according to intended environment.*
.2 *Cables to be suitably protected against mechanical damage.*
.3 *Electrical and mechanical segregation of intrinsically safe circuits from other circuits.*
.4 *Effective earthing of metal coverings of cables.*

(IACS UI SC12)

16.8.1.7 Terminations and joints in all conductors shall be so made as to retain the original electrical, mechanical, flame retarding and, where necessary, fire resisting properties of the cable. (SOLAS, Reg. II-1/45.5.6)

Note:
In case of ro-ro passenger ships – see MSC.1/Circ.1615 (item 1.3) of 2019-06-26 *Interim guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships*.

16.8.2 Selection of cables and conductors for loads required

16.8.2.1 Permissible continuous loads on single-core cables and on conductors insulated by various materials shall be in accordance with the values specified in Table 16.8.2.1 (see also 16.8.2.6).

The values of loads specified in the Table apply to the following cases of cable installation:

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

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

Table 16.8.2.1
Permissible current ratings in continuous service of single-core cables and conductors with various insulation at the ambient temperature of 45°C

Nominal cross-sectional area of conductor [mm²]	Permissible current rating in continuous service [A]				
	Polyvinyl chloride	Polyvinyl chloride heat-resisting quality	Butyl rubber	Ethylene-propylene rubber, cross-linked polyethylene	Silicon rubber and mineral insulation
	+ 60*	+75*	+80*	+85*	+95*
1	8	13	15	16	20
1.5	12	17	19	20	24
2.5	17	24	26	28	32
4	22	32	35	38	42
6	29	41	45	48	55
10	40	57	63	67	75
16	54	76	84	90	100
25	71	100	110	120	135
35	87	125	140	145	165
50	105	150	165	180	200
70	135	190	215	225	255
95	165	230	260	275	310
120	190	270	300	320	360
150	220	310	340	365	410
185	250	350	390	415	470
240	290	415	460	490	–
300	335	475	530	560	–

* Maximum permissible temperature of conductor [°C].

16.8.2.2 The values of permissible current ratings (I) for the cross-sectional areas specified in Table 16.8.2.1, as well as for any other cross-sectional areas shall be calculated from the formula:

$$I = \alpha S^{0.625} \quad [\text{A}] \qquad (16.8.2.2)$$

where:
α – factor depending on the maximum permissible operating temperature of the conductor, determined from Table 16.8.2.2;

S – nominal cross-section of conductor, [mm²].

Table 16.8.2.2

Maximum temperature of conductor [°C]		60	65	70	75	80	85	90
Values of factor α for the nominal cross-sectional area of conductor (S)	≥ 2.5 mm²	9.5	11	12	13.5	15	18	18
	< 2.5 mm²	8	10	11.5	13	15	18	20

16.8.2.3 Permissible current ratings for two-, three- or four-core cables shall be reduced in relation to the values specified in Table 16.8.2.1, using the following correction factors:

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

16.8.2.4 Permissible current ratings for cables and conductors, installed in circuits with intermittent or short-time service, shall be determined by multiplying the value of current rating in continuous service of these cables, calculated in accordance with Table 16.8.2.1 or according to 16.8.2.3, by the correction factor taken from Table 16.8.2.4.

Table 16.8.2.4
Values of correction factors in relation to load

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

16.8.2.5 Permissible current ratings specified in Table 16.8.2.1 refer to the ambient temperature of + 45°C. For other ambient temperatures, permissible current ratings of cables and conductors shall be calculated using correction factors specified in Table 16.8.2.5.

Table 16.8.2.5
Values of correction factors in relation to the ambient temperature

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

16.8.2.6 Instead of making calculations resulting from 16.8.2.1 to 16.8.2.5, permissible current ratings for cables and conductors in relation to different maximum insulation temperature and different ambient temperatures in continuous, short-time and intermittent services may be selected according to *Publication 15/P – Current Rating Tables for Cables, Wires and Bus-bars in Marine Installations.*

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

16.8.2.8 Cables shall be so selected as to withstand the maximum short-circuit current. When choosing the cables, time-current characteristics of the applied protections, as well as the peak value of the anticipated short-circuit current in the first alternation, shall also be taken into account.

16.8.2.9 Cables installed in parallel for the same polarity or phase shall be of the same type, shall be led as close as possible to each other and shall have the same cross-sectional area of at least 10 mm^2 and the same length.

16.8.3 Selection of cable cross-sectional areas for permissible voltage drop

16.8.3.1 The voltage drop on the cables connecting the generators to the main switchboard or the emergency switchboard shall not exceed 1%.

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

For navigation light circuits, the permissible voltage drop may be limited to smaller values so as to ensure the required lighting characteristics.

At short-time service, e.g. at starting the electric motors, a greater voltage drop is permissible, provided it does not adversely affect the work of the remaining electric consumers.

16.8.3.3 Cables used for supplying the directly-started alternating-current electric motors shall be so calculated that the total drop of voltage on motor terminals at starting does not exceed 25% of the rated voltage.

The possibility of increasing the specified above voltage drop is subject to PRS consideration in each particular case.

16.8.4 Installation of cables

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

Cable runs shall not be installed closer than 100 mm to the 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 liquid fuel and lubrication oil tanks. The distance of cables from the shell plating, as well as from fire-resistant and watertight bulkheads and decks shall not be less than 20 mm.

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

16.8.4.4 In holds of dry-cargo ships intended for the carriage of dangerous cargoes, as a rule, no through runs of cables shall be installed.

Installation of cables and its methods in such holds are subject to PRS consent in each particular case.

16.8.4.5 It is recommended that no cables be installed under the flooring of machinery spaces. If such an installation is required, cables shall be installed in metallic pipes or in closed ducts (see 16.8.8).

16.8.4.6 Cables installed across expansion joints in the hull structure shall be provided with expansion loops having a radius adequate for such a joint. The inside diameter of a loop shall not be less than 12 times the outside diameter of the cable.

16.8.4.7 Installation of cables having insulation intended to withstand different maximum permissible temperatures in the common cable runs shall be so effected that the cables are not heated above their permissible temperature.

16.8.4.8 Cables with different protective coverings the less resistant of which may be damaged shall not be installed in one common pipe, one common duct or in other runs of unsupported common laying.

16.8.4.9 The current cables of the main electric propulsion machinery shall be installed separately from the cables intended for other purposes.

16.8.4.10 Conductors in multi-core cables shall not be used for supplying power and control the circuits of essential services not associated with one another.

Multi-core cable shall not be used for both the safe voltage circuits and working voltage circuits greater than the safe voltage.

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

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

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

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

16.8.4.14 Cables installed in refrigerated spaces shall be provided with protective sheathing of neoprene or of any other material resistant to the action of the refrigerant. If cables are provided with an armour, this armour shall be effectively protected against corrosion.

16.8.4.15 Cables in refrigerating spaces shall be installed on perforated panels or bridges and so fastened in position that 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 are to pass through the thermal insulation of a refrigerated space, they shall be led perpendicularly to the insulation surface in an appropriate gland packed on both ends.

16.8.4.16 The minimum internal bending radii of the cables shall not be less than those specified in Table 16.8.4.16.

Table 16.8.4.16

Item	Kind of cable		External diameter of cable *d* [mm]	Minimum bending radius
	Kind of insulation	Kind of protective covering		
1	Rubber or polyvinyl chloride	Armoured with metal tape or wire	Any	10 *d*
		Protected with braid of metal wires	Any	6 *d*
		Lead alloy and armour	Any	6 *d*
		Other sheathing	Up to 9.5	3 *d*
			9.5 to 25.4	4 *d*
			Over 25.4	6 *d*
2	Varnished cambric	Any	Any	8 *d*
3	Mineral insulation	Metal	Up to 7	2 *d*
			7 to 12.7	3 *d*
			Over 12.7	4 *d*
4	Ethylene-propylene rubber compound or cross-linked polyethylene compound	Semiconducting or metallic	25 and over	10 *d*

16.8.4.17 Cables and earthing conductors of equipment mounted on shock absorbers shall be so installed as not be damaged in service.

16.8.5 Fastening of cables

16.8.5.1 Cables and wiring shall be installed and supported in such a manner as to avoid chafing or other damage. (SOLAS, Reg. II-1/45.5.5)

Note:
In case of ro-ro passenger ships – see MSC.1/Circ.1615 (item 1.3) of 2019-06-26 *Interim guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships.*

16.8.5.2 Cables shall be properly fastened in position by means of clips, holders, hangers, etc. made of metal or other incombustible or low flame spread material.

The fastener surface shall be wide enough and shall have no sharp edges.

The fasteners shall be selected in such a manner that the cables are fastened in position securely and their protective coverings undamaged.

16.8.5.3 Distances between the cable fastening points in the case of horizontal installation shall not exceed the values specified in Table 16.8.5.3. For vertical runs of cables, these distances may be increased by 25%.

Table 16.8.5.3

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

16.8.5.4 Cables shall be so fastened that mechanical strains in cables are not transmitted to their inlet connections.

16.8.5.5 Cable runs and cables installed parallel to the shell plating shall be fastened to the hull structural members but not to the shell plating.

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

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

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

16.8.6 Cables penetrating decks, bulkheads and elements of ship structure

16.8.6.1 (...) Where penetrations of watertight bulkheads and internal decks in cargo ships are necessary for (...) electrical cables, etc., arrangements are to be made to maintain the watertight integrity. The Administration may permit relaxation in the watertightness of openings above the freeboard deck, provided that it is demonstrated that any progressive flooding can be easily controlled and that the safety of the ship is not impaired. (SOLAS, Reg. II-1/13-1.1) For penetrations of watertight boundaries in passenger ships – see 22.1

16.8.6.2 Penetration of watertight, gas-tight and fire-resisting bulkheads and decks shall be made tight. Packing where cables penetrate the mentioned bulkheads and decks shall not reduce their tightness or resistance; no force resulting from elastic deformations of the ship hull shall be transmitted to the cables.

16.8.6.3 When installing the cables through non-watertight bulkheads or elements of the ship structure not exceeding 6 mm in thickness, lining or bushings that will prevent damage to cables shall be provided.

Where bulkheads or the ship structures are more than 6 mm thick, no lining or bushing is required, but the edges of the holes shall be rounded off.

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

16.8.7 Cable compounds and packing

16.8.7.1 To fill the cable boxes in watertight bulkheads and decks, the use shall be made of packing compounds having good adhesion to the inside surfaces of cable boxes and cable sheathing, that will withstand the action of water and oil products, will not shrink and lose its tightness in continuous service under conditions specified in 2.2.1 and 2.2.2.

16.8.7.2 Packing of cable penetrations through fire-resisting bulkheads shall be so made as to withstand standard fire test required for the given type of bulkhead, specified in *Part V,* subchapter 1.2.

16.8.8 Installation of cables in pipes and conduits

16.8.8.1 Pipes and conduits in which cables are installed shall be metallic and protected from corrosion on the inside and outside surface. The inside surface of pipes and conduits shall be even and smooth. Ends of pipes 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 coating shall not be drawn into pipes.

The application of cable trays and protective casings made of plastic materials is permitted, provided they fulfil the requirements specified in subchapter 16.8.9.

16.8.8.2 Pipe and conduit bending radius shall not be smaller than the permissible radius for cable of the largest diameter installed in this pipe (see 16.8.4.16).

16.8.8.3 The sum of the cross-sectional areas of all cables as measured on their outside diameters shall not exceed 40% of the inside cross-sectional area of the pipe or conduit, in which the cables are put.

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

16.8.8.5 The pipes and conduits shall be installed in such a manner that no water can accumulate in them. When required, ventilation holes shall be provided in the pipes, in the highest

and lowest points possible, to ensure circulation of air and to prevent steam condensation. Holes in pipes are permissible only in places where they will not increase the danger of explosion or fire.

Pipes having open ends (e.g. ventilation and bilge pipes) in a hazardous area are regarded as hazardous area. Enclosed spaces containing such pipes are regarded as extended hazardous area, unless provided with overpressure ventilation, with air inlets located in non-hazardous areas.

16.8.8.6 Cable pipes and conduits installed alongside the ship hull, which can be damaged by deformation of the ship hull, shall be provided with appropriate compensation devices.

16.8.8.7 Cables running in vertical pipes and conduits shall be so protected as not to be damaged due to tension caused by their own mass.

16.8.9 Cable trays/protective casings made of plastics materials

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16.8.9.1 General requirement (1.)

Cable trays/protective casings made of plastics materials are to be type tested [1].

Note:

"***Plastics***" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fibre reinforced plastics – FRP.

"***Protective casing***" means a closed cover in the form of a pipe or other closed ducts of non-circular shape.

[1] Cable trays/protective casings made of plastic materials are to be type tested in accordance with the Type Approval Procedure applied by the Society. For guidance on testing, refer to *Publication 11/P – Environmental Tests on Marine Equipment*, subchapter 2.26 (REC 73).

16.8.9.2 Installation requirements (2.)

16.8.9.2.1 Cable trays/protective casings made of plastics materials are to 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. (2.1)

Note:
When plastics cable trays/protective casings are used on open deck, they are additionally to be protected against UV light.

16.8.9.2.2 The load on the cable trays/protective casings is to be within the Safe Working Load (SWL). The support spacing is not to be greater than the Manufacturer's recommendation nor in excess of spacing at the SWL test. In general the spacing is not to exceed 2 meters. (2.2)

Note:
The selection and spacing of cable tray/protective casing supports are to 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 .

16.8.9.2.3 The sum of the cables' total cross-sectional area, based on the cables' external diameter, is not to exceed 40% of the protective casing's internal cross-sectional area. This does not apply to a single cable in a protective casing. (2.3)

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16.8.10 Special requirements for installation of single-core alternating-current cables

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

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

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

16.8.10.3 If single-core cables rated in excess of 250 A are installed parallel to steel structures, the distance between cables and these structures shall not be less than 50 mm.

16.8.10.4 When installing single-core cables with cross-sectional areas of over 185 mm^2, cables shall inter-cross at intervals not less than 15 m. No cable inter-crossing is required in the case of cable length up to 30 m.

16.8.10.5 Multi-core cables with parallel connected cores shall be installed in the same way as single-core cables. For these cables, all requirements for single-core cables are applicable.

16.8.11 Connecting and Tapping of Cables

16.8.11.1 Ends of cables shall be packed in a manner that would prevent the entry of moisture inside the cable.

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

16.8.11.3 Connection of cables at places of tapping shall be effected in junction boxes by means of clamps.

16.8.11.4 If it is found necessary to make additional connections during installation of cables, such connections shall be effected in suitable junction boxes provided with clamps. The joint as a whole during installation of cables be protected from the influence of environmental conditions. The use of cable jointing and application of cable jointing method other than that mentioned above are subject to PRS consent in each particular case.

16.8.12 Electrical services required to be operable under fire conditions and fire resistant cables

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16.8.12.1 Electrical services required to be operable under fire conditions are as follows:

- Control and power systems to power-operated fire doors and status indication for all fire doors
- Control and power systems to power-operated watertight doors and their status indication
- Emergency fire pump

- Emergency lighting
- Fire and general alarms
- Fire detection systems
- Fire-extinguishing systems and fire-extinguishing media release alarms
- Low-location lighting
- Public address systems
- Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion (1)
- Other services required by PRS after individual consideration

16.8.12.2 Where cables for services specified in 16.8.12.1 (1) including their power supplies pass through high fire risk areas, and in addition for passenger ships, main vertical fire zones, other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone. This may be achieved by either of the following measures:

a) Cables being of a fire resistant type complying with IEC 60331-1:2018 for cables of greater than 20 mm overall diameter, otherwise IEC 60331-21:1999+AMD1:2009 or IEC 60331-2:2018 for cables with an overall diameter not exceeding 20 mm, are installed and run continuous to keep the fire integrity within the high fire risk area, see Figure 1.

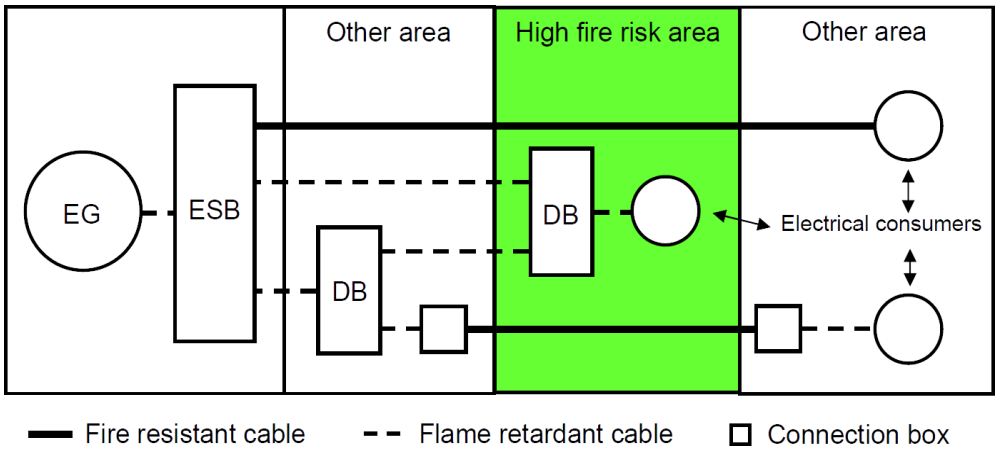

Figure 1

b) At least two-loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.
c) Systems that are self monitoring, fail safe or duplicated with cable runs as widely separated as is practicable may be exempted. (2)

16.8.12.3 The electrical cables to the emergency fire pump are not to pass through the machinery spaces containing the main fire pumps and their source(s) of power and prime mover(s). They are to be of a fire resistant type, in accordance with 16.8.12.2.a) (2 (a)), where they pass through other high fire risk areas. (3)

Electric cables supplying emergency fire pump shall comply with the requirements of *Part V,* 3.2.2.4.9.

On the outer side of the high fire risk areas the cables shall be led at a distance of not less than that specified in 16.8.4.2. In ships in which, due to their dimensions, the above requirement cannot be

satisfied, measures shall be taken to ensure effective protection of the cables running through fire-hazardous spaces.

Notes:

a) For the purpose of E15 application, the definition for "high fire risk areas" is the following:
   (i) Machinery spaces as defined by Regulation 3.30 of SOLAS Chapter II-2, as amended by IMO resolutions up to MSC.421(98) (hereinafter the same), except spaces having little or no fire risk as defined by paragraphs (10) of Regulation 9.2.2.3.2.2 of SOLAS Chapter II-2. (Including the interpretations for tables 9.3, 9.4, 9.5, 9.6, 9.7 and 9.8 given in MSC/Circ.1120 as amended by MSC.1/Circ.1436 and MSC.1/Circ.1510)
   (ii) Spaces containing fuel treatment equipment and other highly flammable substances
   (iii) Galley and Pantries containing cooking appliances
   (iv) Laundry containing drying equipment
   (v) Spaces as defined by paragraphs (8), (12), and (14) of Regulation 9.2.2.3.2.2 of SOLAS Chapter II-2 for ships carrying more than 36 passengers

b) Fire resistant type cables should be easily distinguishable.

c) For special cables, requirements in the following standards may be used:
   IEC 60331-23:1999: *Procedures and requirements – Electric data cables*
   IEC 60331-25:1999: *Procedures and requirements – Optical fibre cables*

END OF IACS UR E15

CHAPTER 17

17 SPECIAL ELECTRICAL SYSTEMS IN SHIPS

17.1 Electric propulsion plant

17.1.1 General requirements

In addition to compliance with the applicable requirements of particular Chapters of this *Part* of the *Rules*, the electrical equipment forming part of the electric propulsion plant shall fulfil the requirements specified in IEC 60092-501.

CHAPTER 18

18 UNIFIED REQUIREMENTS FOR SYSTEMS WITH VOLTAGES ABOVE 1 KV UP TO 15 KV

IACS UR E11

18.1 General (1.)

18.1.1 Field of application (1.1)

The following requirements apply to a.c. three-phase systems with nominal voltage exceeding 1kV, the nominal voltage is the voltage between phases.

If not otherwise stated herein, construction and installation applicable to low voltage equipment generally apply to high voltage equipment.

18.1.2 Nominal system voltage (1.2)

The nominal system voltage is not to exceed 15 kV.

Note:
Where necessary for special application, higher voltages may be accepted by the Society.

18.1.3 High-voltage, low-voltage segregation (1.3)

Equipment with voltage above about 1 kV is not to be installed in the same enclosure as low voltage equipment, unless segregation or other suitable measures are taken to ensure that access to low voltage equipment is obtained without danger.

18.2 System design (2.)

18.2.1 Distribution (2.1)

18.2.1.1 Network configuration for continuity of ship services (2.1.1)

It is to be possible to split the main switchboard into at least two independent sections, by means of at least one circuit breaker or other suitable disconnecting devices, each supplied by at least one generator. If two separate switchboards are provided and interconnected with cables, a circuit breaker is to be provided at each end of the cable.

Services which are duplicated are to be divided between the sections.

18.2.1.2 Earthed neutral systems (2.1.2)

In case of earth fault, the current is not to be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any device against earth fault.

It is to be assured that at least one source neutral to ground connection is available whenever the system is in the energised mode. Electrical equipment in directly earthed neutral or other neutral earthed systems is to withstand the current due to a single phase fault against earth for the time necessary to trip the protection device.

18.2.1.3 Neutral disconnection (2.1.3)

Means of disconnection are to be fitted in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance and for insulation resistance measurement.

18.2.1.4 Hull connection of earthing impedance (2.1.4)

All earthing impedances are to be connected to the hull. The connection to the hull is to be so arranged that any circulating currents in the earth connections do not interfere with radio, radar, communication and control equipment circuits.

18.2.1.5 Divided systems (2.1.5)

In the systems with neutral earthed, connection of the neutral to the hull is to be provided for each section.

18.2.1.6 Permissible voltages

Rated voltages shall not exceed the values specified in the Table below

Inter-phase rated voltage [kV]	Rated frequency [Hz]
3/3.3	50 or 60
6/6.6	50 or 60
10/11	50 or 60

18.2.2 Degrees of protection (2.2)

18.2.2.1 General (2.2.1)

Each part of the electrical installation is to be provided with a degree of protection appropriate to the location, as a minimum the requirements of IEC 60092-201:2019.

18.2.2.2 Rotating machines (2.2.2)

The degree of protection of enclosures of rotating electrical machines is to be at least IP23. The degree of protection of terminals is to be at least IP44.

For motors installed in spaces accessible to unqualified personnel, a degree of protection against approaching or contact with live or moving parts of at least IP4X is required.

18.2.2.3 Transformers (2.2.3)

The degree of protection of enclosures of transformers is to be at least IP23.

For transformers installed in spaces accessible to unqualified personnel a degree of protection of at least IP4X is required.

For transformers not contained in enclosures, see para 18.7.1 (7.1).

18.2.2.4 Switchgear, controlgear assemblies and converters (2.2.4)

The degree of protection of metal enclosed switchgear, controlgear assemblies and static convertors is to be at least IP32. For switchgear, control gear assemblies and static converters installed in spaces accessible to unqualified personnel, a degree of protection of at least IP4X is required.

18.2.3 Insulation (2.3)

18.2.3.1 Air clearance (2.3.1)

In general, for Non Type Tested equipment phase-to-phase air clearances and phase-to-earth air clearances between non-insulated parts are to be not less than those specified in Table 2.3.1.

Table 2.3.1

Nominal Voltage (kV)	Minimum air clearance (mm)
3 (3.3)	55
6 (6.6)	90
10 (11)	120
15	160

Intermediate values may be accepted for nominal voltages provided that the next higher air clearance is observed.

In the case of smaller distances, appropriate voltage impulse test must be applied.

18.2.3.2 Creepage distances (2.3.2)

Creepage distances between live parts and between live parts and earthed metal parts are to be in accordance with IEC 60092-503:2007 for the nominal voltage of the system, the nature of the insulation material and the transient overvoltage developed by switch and fault conditions.

18.2.3.3 Insulating materials used in electrical equipment of above 1000 V shall ensure, during the continuous service of the ship, the insulation resistance of at least 2000 Ω per V of rated voltage.

18.2.4 Protection (2.4)

18.2.4.1 Faults on the generator side of circuit breaker (2.4.1)

Protective devices are to be provided against phase-to-phase faults in the cables connecting the generators to the main switchboard and against interwinding faults within the generators. The protective devices are to trip the generator circuit breaker and to automatically de-excite the generator.

In distribution systems with a neutral earthed, phase to earth faults are also to be treated as above.

18.2.4.2 Faults to earth (2.4.2)

Any earth fault in the system is to be indicated by means of a visual and audible alarm. In low impedance or direct earthed systems provision is to be made to automatic disconnect the faulty circuits. In high impedance earthed systems, where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

Note:
Earthing factor is defined as the ratio between the phase to earth voltage of the health phase and the phase to phase voltage. This factor may vary between $1/\sqrt{3}$ and 1.

A system is defined effectively earthed (low impedance) when this factor is lower than 0.8. A system is defined non-effectively earthed (high impedance) when this factor is higher than 0.8.

18.2.4.3 Power transformers (2.4.3)

Power transformers are to be provided with overload and short circuit protection. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

18.2.4.4 Voltage transformers for control and instrumentation (2.4.4)

Voltage transformers are to be provided with overload and short circuit protection on the secondary side.

18.2.4.5 Fuses (2.4.5)

Fuses are not to be used for overload protection.

18.2.4.6 Low voltage systems (2.4.6)

Lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

i) direct earthing of the lower voltage system.
ii) appropriate neutral voltage limiters.
iii) earthed screen between the primary and secondary windings of transformers.

18.2.4.7 Heating arrangements

Heating arrangements shall be provided to prevent the accumulation of moisture and condensation within electric machines when they are stopped. It is recommended that such means are automatically switched on at stand-still and switched off at starting.

18.2.5 Switchboards

18.2.5.1 The switchboards shall be provided with doors locked with a special key, other than those for switchboards and electrical equipment operating at lower voltages.

Opening of the door shall be possible only when the part of main circuit located in compartment or field of swichboard which becomes accessible is disconnected from supply.

18.2.5.2 Circuit-breakers used in switchboards shall be of a withdrawable type.

Circuit-breakers or movable elements with apparatus shall have mechanical devices fixing them in the operating position, in the testing position (control circuits are connected), as well as in switching-off position (main circuits are disconnected and furthermore, there is safe, insulating clearance in poles of main circuit).

Automatic shielding shall be provided, by means of insulating barriers, of fixed contacts of plug connections in live condition when circuit-breaker or movable element is withdrawn to the testing position, switched-off position or withdrawn totally from the switchboard.

Pulling out or pulling in of the circuit-breaker or movable element to the operating position shall be possible only when switchgear is in open condition.

If electrical or other energy is required for the operation of circuit breakers and switches, a store supply of such energy shall be provided for at least two operations of all the components.

However, the tripping due to overload, short-circuit or under-voltage shall be independent of any stored electrical energy sources.

18.2.5.3 For the purpose of short-circuiting the busbars and the outgoing switchboard circuits with each other and with the ship hull, a device rated for the maximum short-circuit current shall be provided in the switchboard.

The possibility of using a portable short-circuiting device instead of a stationary one is subject to PRS consideration in each particular case.

18.2.5.4 Along the free-standing switchboards a passageway shall be provided for inspection of the switchboard and the switchgear. The width of the passageway between the switchboard and the wall shall not be less than 800 mm and that between the parallel switchboard sections – not less than 1000 mm.

If such passageways are intended for maintenance of the switchboard, their width shall be increased to 1000 mm and 1200 mm, respectively.

Such passageway widths are required, irrespective of the type of the accidental touch protection applied.

18.2.5.5 The clearances between the live parts of electrical equipment and the protective barriers and enclosures shall not be less than those specified in the Table below.

Item	Rated voltage [kV]	Minimum height of passageway [mm]	Minimum protective clearances of live parts from barriers and enclosures consisting of:	
			tight doors and barriers [mm]	insulating handrails [mm]
1	3/3.3	2500	70	600
2	6/6.6	2500	100	600
3	10/11	2500	140	700
4	15	2500	180	700

In the case of smaller distances, appropriate voltage impulse test must be applied.

18.2.5.6 Switchboards shall be provided with devices intended for reduction of overpressure to ensure the mechanical strength of enclosure in case of internal short-circuit arcs.

Devices shall be so located that the influence of hot and ionized gases would not endanger personnel and compartment, in which they are located.

18.2.5.7 Switchboards shall be provided with devices which respond to the internal overpressure of compartments or radiation of electric arcs and which cause automatic switching-off of faulty circuit during short-circuit arcs.

18.3 Rotating machinery (3.)

18.3.1 Stator windings of generators (3.1)

Generator stator windings are to have all phase ends brought out for the installation of the differential protection.

18.3.2 Temperature detectors (3.2)

Rotating machinery is to be provided with temperature detectors in their stator windings to actuate a visual and audible alarm in a normally attended position whenever the temperature exceeds the permissible limit.

If embedded temperature detectors are used, means are to be provided to protect the circuit against overvoltage.

18.3.3 Heat exchangers

Heat exchangers of rotating machinery shall be of the double tube type. In a normally attended position, a visual and audible alarm shall be given to monitor water cooler leakage.

18.3.4 Tests (3.3)

In addition to the tests normally required for rotating machinery, a high frequency high voltage test in accordance with IEC 60034-15:2009 is to be carried out on the individual coils in order to demonstrate a satisfactory withstand level of the inter-turn insulation to steep fronted switching surges.

18.4 Power transformers (4.)

18.4.1 General (4.1.)

18.4.1.1 Dry type transformers have to comply with IEC 60076-11:2018. Liquid cooled transformers have to comply with the applicable Parts of the IEC 60076 Series. Oil immersed transformers are to be provided with the following alarms and protections:

- liquid level (Low) - alarm
- liquid temperature (High) - alarm
- liquid level (Low) - trip or load reduction
- liquid temperature (High) - trip or load reduction
- gas pressure relay (High) - trip

18.4.1.2 Dry transformers having earthed screens between the windings of the high and low voltages shall be used.

The use of other types of transformers is subject to PRS consent in each particular.

The isolating of the transformer on the high voltage side shall cause the disconnection of the switch on the low voltage side.

18.4.1.3 If the voltage on the low voltage side of the transformer does not exceed 1000 V and the windings have the neutral insulated, a protective surge arrester shall be connected between the neutral of each transformer and the ship hull. Such a surge arrester shall be designed for operation at a voltage not exceeding 80% of the minimum proof voltage of the equipment supplied by the transformer in question.

18.4.1.4 Parallel to the surge arrester, insulation monitoring instruments or an insulation fault indicator in the lower voltage circuit supplied by the transformer in question may be connected. Such devices shall not interfere with the proper operation of the arrester.

18.5 Cables (5.)

18.5.1 General (5.1)

Cables are to be constructed in accordance with the IEC 60092-353:2016 and 60092-354:2020 or other equivalent Standard.

18.6 Switchgear and controlgear assemblies (6.)

18.6.1 General (6.1)

Switchgear and controlgear assemblies are to be constructed according to the IEC 62271-200:2011 and the following additional requirements.

18.6.2 Construction (6.2)

18.6.2.1 Mechanical construction (6.2.1)

Switchgear is to be of metal – enclosed type in accordance with IEC 62271-200:2011 or of the insulation – enclosed type in accordance with the IEC 62271-201:2014.

18.6.2.2 Locking facilities (6.2.2)

Withdrawable circuit breakers and switches are to be provided with mechanical locking facilities in both service and disconnected positions. For maintenance purposes, key locking of withdrawable circuit breakers and switches and fixed disconnectors is to be possible.

Withdrawable circuit breakers are to be located in the service position so that there is no relative motion between fixed and moving portions.

18.6.2.3 Shutters (6.2.3)

The fixed contacts of withdrawable circuit breakers and switches are to be so arranged that in the withdrawable position the live contacts are automatically covered.

Shutters are to be clearly marked for incoming and outgoing circuits. This may be achieved with the use of colours or labels.

18.6.2.4 Earthing and short-circuiting (6.2.4)

18.6.2.4.1 For maintenance purposes an adequate number of earthing and short-circuiting devices is to be provided to enable circuits to be worked upon with safety.

18.6.2.4.2 Metallic enclosure of switchboards shall be provided with copper conductor situated along its total length, having at least two relevant terminals for connection with the ship hull. One-second short-circuit earth current density in this conductor shall not exceed 150 A/mm^2, and the cross-section of conductor shall not be less than 30 mm^2. Casings of compartments and fields shall be connected to earthing conductor directly or by means of the metal parts of structure.

Welded and twisted connections assure proper continuity of earthing, but for twisted connections the surface of connection shall be protected against corrosion by usage of adequate anti-corrosion surfaces.

Depending on the method of the network neutral earthing and the time necessary for activation of the protection devices, maximum short-circuit current shall be taken into account for earthing connections.

18.6.2.4.3 Earthing of metal parts of withdrawable circuit-breakers or movable elements shall be effective in each fixed and intermediate position.

18.6.2.4.4 Doors of the high voltage compartments shall be connected to the earthed structure by means of copper conductor with a cross-section not less than 6 mm^2.

18.6.2.4.5 Metal enclosures of other high voltage equipment shall be earthed by means of flexible copper conductor of such cross-section that one-second short-circuit earth current density shall not exceed 150 A/mm^2, however not less than 16 mm^2.

18.6.2.4.6 The secondary windings of measuring current and voltage transformers shall be earthed by means of copper conductor with cross-section of not less than 4 mm^2.

18.6.2.4.7 The earthing conductors shall be properly marked.

18.6.2.5 Internal arc Classification (IAC) (6.2.5)

Switchgear and controlgear assemblies shall be internal arc classified (IAC).

Where switchgear and controlgear are accessible by authorized personnel only Accessibility Type A is sufficient (IEC 62271-200:2011; Annex AA; AA 2.2). Accessibility Type B is required if accessible by non-authorised personnel.

Installation and location of the switchgear and controlgear shall correspond with its internal arc classification and classified sides (F, L and R).

18.6.3 Auxiliary systems (6.3)

18.6.3.1 Source and capacity of supply (6.3.1)

If electrical energy and/or physical energy is required for the operation of circuit breakers and switches, a stored supply of such energy is to be provided for at least two operations of all the components.

However, the tripping due to overload or short-circuit, and under-voltage is to be independent of any stored electrical energy sources. This does not preclude shunt tripping provided that alarms are activated upon lack of continuity in the release circuits and power supply failures.

18.6.3.2 Number of external supply sources (6.3.2)

When external source of supply is necessary for auxiliary circuits, at least two external sources of supply are to be provided and so arranged that a failure or loss of one source will not cause the loss of more than one generator set and/or set of essential services. Where necessary one source of supply is to be from the emergency source of electrical power for the start up from dead ship condition.

18.6.4 High voltage test (6.4)

A power-frequency voltage test is to be carried out on any switchgear and controlgear assemblies. The test procedure and voltages are to be according to the IEC 62271-200:2011 section 7/ routine test.

18.7 Installation (7.)

18.7.1 Electrical equipment (7.1)

Where equipment is not contained in an enclosure but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

At the entrance of the spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed which indicates danger of high-voltage. As regard the high-voltage electrical equipment installed out-side a.m. spaces, the similar marking is to be provided. An adequate, unobstructed working space is to be left in the vicinity of high voltage equipment for preventing potential severe injuries to personnel performing maintenance activities. In addition, the clearance between the switchboard and the ceiling/deckhead above is to meet the requirements of the Internal Arc Classification according to IEC 62271-200:2011.

18.7.2 Cables (7.2)

18.7.2.1 Runs of cables (7.2.1)

In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

18.7.2.2 Segregation (7.2.2)

High voltage cables are to be segregated from cables operating at different voltage ratings each other; in particular, they are not to be run in the same cable bunch, nor in the same ducts or pipes, or, in the same box.

Where high voltage cables of different voltage ratings are installed on the same cable tray, the air clearance between cables is not to be less than the minimum air clearance for the higher voltage side in 18.2.3.1 (2.3.1). However, high voltage cables are not to be installed on the same cable tray for the cables operating at the nominal system voltage of 1 kV and less.

18.7.2.3 Installation arrangements (7.2.3)

High voltage cables, in general, are to be installed on cable trays when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth; otherwise they are to be installed for their entire length in metallic castings effectively bonded to earth.

18.7.2.4 Terminations (7.2.4)

Terminations in all conductors of high voltage cables are to be, as far as practicable, effectively covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases are to be separated from earth and from each other by substantial barriers of suitable insulating materials.

High voltage cables of the radial field type, i.e. having a conductive layer to control the electric field within the insulation, are to have terminations which provide electric stress control.

Terminations are to be of a type compatible with the insulation and jacket material of the cable and are to be provided with means to ground all metallic shielding components (i.e. tapes, wires etc).

In junction boxes and sockets, as well as terminal boxes of electrical equipment with rated voltage above 1000 V, no joints shall be installed or connection of conductors effected if such joints or conductors are rated for lower voltages.

18.7.2.5 Marking (7.2.5)

High voltage cables are to be readily identifiable by suitable marking.

18.7.2.6 Test after installation (7.2.6)

Before a new high voltage cable installation, or an addition to an existing installation, is put into service a voltage withstand test is to be satisfactorily carried out on each completed cable and its accessories.

The test is to be carried out after an insulation resistance test.

For cables with rated voltage (U_0/U) above 1.8/3 kV (U_m =3.6 kV) an a.c. voltage withstand test may be carried out upon advice from high voltage cable manufacturer. One of the following test methods to be used:

a) test for 5 min with the phase-to-phase voltage of the system applied between the conductor and the metallic screen/sheath.
b) test for 24 h with the normal operating voltage of the system.

Alternatively, a d.c. test voltage equal to 4 U_0 may be applied for 15 minutes.

For cables with rated voltage (U_0/U) up to 1.8/3 kV (U_m =3.6 kV) a d.c. voltage equal to 4 U_0 shall be applied for 15 minutes.

After completion of the test, the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge.

An insulation resistance test is then repeated.

18.7.3 Warning notices indicating danger of high-voltage and the value of voltage shall be placed at the entries to special electric spaces and on the enclosures of electric equipment located outside these spaces.

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CHAPTER 19

19 REQUIREMENTS FOR ELECTRICAL EQUIPMENT OF REFRIGERATING INSTALLATIONS

19.1 General requirements

The requirements of the present Chapter apply to the electrical equipment of classed refrigerating installations.

The requirements specified in 19.2.3, 19.2.4, 19.3.1 and 19.4 are also applicable to unclassed refrigerating installations.

19.2 Power supply

19.2.1 The electric drives of refrigerating installations shall be supplied by separate feeders from the refrigerating plant switchboard. The motors of refrigerating compressors may be supplied directly from the main switchboard. Refrigerating plant fans may be supplied from the refrigerating plant switchboard or from other switchboard supplied directly from the main switchboard.

Irrespective of the kind of power supply, the drives of refrigerating installations shall be the last to be disconnected in case of the generator overload.

The emergency ventilation shall be supplied by a separate feeder from the main switchboard or other switchboard supplied directly from the main switchboard.

19.2.2 Power supply of the electric drives of isothermal container equipment shall fulfil the requirements of subchapter 22.4.2.

19.2.3 If the refrigerant of Group II is applied (for the definition, see *Part VII,* 17.2.1), a device shall be provided for emergency remote disconnection of the refrigerating installation switchboard, operated from the below given places:

.1 from the permanent control post of the refrigerating installations in the refrigerating machinery room;
.2 from a location situated outside the space that may be contaminated with refrigerants of Group II in the case of a breakdown in the refrigerating machinery room;
.3 outside, near every exit from the refrigerating machinery room.

The apparatus for emergency remote disconnection shall be installed in such a manner that they cannot be actuated accidentally.

19.2.4 The device for emergency remote-controlled disconnection of the refrigerating installation switchboard employing the refrigerant of Group II shall disconnect simultaneously the electric drives of refrigerating compressors if they are supplied directly from the main switchboard (see 19.2.1) and simultaneously disconnect the main lighting of refrigerating machinery room, as well as to switch on the emergency ventilation, water screens and emergency lighting.

Additionally, near the devices for emergency remote disconnection of switchboard of such a refrigerating installation, at locations stated in 19.2.3.1 and 19.2.3.2, devices shall be installed for remote starting, in any sequence, of emergency ventilation, water screens and emergency lighting without disconnection of the refrigerating installation switchboard.

19.2.5 It is recommended that safe voltage power be supplied to electric heating appliances for hatches and exits from refrigerating and freezing spaces.

19.3 Ventilation

19.3.1 If the refrigerant of Group II is used, exhaust fan electric motors of the emergency ventilation in the refrigerating machinery rooms installed in the exhaust ducts shall be explosion-proof.

19.3.2 The fan electric motors located in the stream of air coming from the refrigerated cargo spaces shall have an enclosure of at least IP55.

19.4 Lighting

19.4.1 If the refrigerant of Group II is used, explosion-proof emergency lighting fittings shall be installed in the refrigerating machinery space in addition to the main lighting fittings. The emergency lighting fittings shall be supplied separately from the electrical equipment and from the main lighting fittings installed in the refrigerating machinery room.

CHAPTER 20

20 AUTOMATION AND REMOTE CONTROL SYSTEMS

20.1 Application

The requirements of the present Chapter apply to all control systems covered by PRS survey, irrespective of the extent of the ship automation.

20.2 Design requirements

20.2.1 General requirements

20.2.1.1 Computerised automatic systems shall fulfil the requirements specified in *Publication 9/P –Computer Based Systems*.

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

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

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

20.2.1.4 Main and auxiliary machinery essential for the propulsion, control and safety of the ship shall be provided with effective means for its operation and control. All control systems essential for the propulsion, control and safety of the ship shall be independent or designed such that failure of one system does not degrade the performance of another system. (SOLAS, Reg. II-1/31.1)

20.2.1.5 Control systems with global asymptotical stability features are recommended.

20.2.1.6 Where machinery space of the ship shall be continuously attended by one person, the extent of the necessary remote or automatic control is subject to PRS consideration in each particular case, having regard to the location of the control station and surveillance procedure adopted for the machinery, as well as their service requirements.

20.2.2 Requirements for components and units of automatic systems

20.2.2.1 Components and units used in automatic systems shall additionally fulfil the requirements of the relevant *Parts* of the *Rules*.

20.2.2.2 Individual components and units of systems and their external connections shall be permanently and clearly marked. The marking shall ensure an easy identification with the drawings and, in the case of sensors, shall also indicate their purpose and the set point. Analog indicators shall be marked with rated values using red colour.

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

20.2.2.4 Components and units to be installed in spaces or areas of explosion risk shall be of intrinsically safe or flame-proof type.

20.2.2.5 Control elements intended for fixing the settings shall be secured against unintentional change of the position. Their repeated securing in case of readjustment shall be possible.

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

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

20.2.2.8 Replaceable blocks (printed cards) with plug-in connections shall be so designed as to preclude the possibility of erroneous replacement. They shall also be capable of being effectively and permanently fixed in working position.

When it is necessary, due to design or functional features of the component or unit, the permanent marking of correct mounting position shall be provided or the component or unit itself shall be so designed that mounting in other than correct position is impossible.

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

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

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

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

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

20.2.2.14 Temperature sensors installed on the distribution piping for flammable liquids shall be fitted in pockets.

20.2.3 Requirements for automatic systems

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

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

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

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

20.2.3.5 Automatic systems shall be built of such components and units that their replacement with the other ones of the same type does not affect the operation of the system. If readjustment is necessary, it shall be possible by simple means.

20.2.3.6 Automatic systems shall be protected against malfunctions as a result of short time deviations of parameters due to rolling and pitching, starting or stopping of the machinery or due to other similar, normal fluctuation of parameters.

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

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

20.2.3.9 Replaceable and controllable components, as well as the test points shall be arranged with permanent and easy access.

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

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

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

20.2.3.13 Drying and filtering equipment used in automatic systems of main propulsion and electric generating sets are, as a rule, to be doubled and so arranged as to ensure the operation of one of them when the other is out of action. Double drying and filtering equipment need not be used, provided it is of self-cleaning type or of such design that quick replacement of contaminated inserts is possible without stopping the air supply.

20.2.3.14 In supply piping of pneumatic systems, safety valves shall be provided to prevent an increase of pressure by more than 10% of the working pressure.

20.2.3.15 Where hydraulic, pneumatic, electric and electronic components are situated in common desks, consoles and other similar units, they shall be so separated from each other that possible leakage of working medium does not affect the electric, electronic or pneumatic components.

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

20.2.3.16 Where components and units requiring forced cooling are used, effective means shall be provided to prevent their damage in case of cooling failure.

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

20.2.3.17 Elements intended for control shall be arranged with easy access, and shall be marked appropriately to their assignment, as well as shall be secured against self-acting change of the position.

20.3 Power supply of automatic systems

20.3.1 Where power supply to electrically driven essential machinery is required both from the main and emergency sources, electric and electronic control systems of such machinery shall also be supplied from two independent sources.

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

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

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

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

20.3.6 Alarm and monitoring system shall always be supplied from two independent power sources. Switching on of the stand-by power source shall be effected automatically.

Where the stand-by power source of the alarm system is an automatically started emergency generating set, the alarm system circuits monitoring the conditions affecting the ship manoeuvrability and parameters of generating sets prime movers shall additionally be supplied from an accumulator battery of a capacity sufficient for 30 minute operation of that part of the system.

20.3.7 Supply of automatic equipment essential for starting and operation of the emergency generating set shall be taken from starting accumulator batteries or from separate battery located in the emergency generating set compartment.

20.4 Monitoring systems

20.4.1 Alarm system

20.4.1.1 In addition to compliance with the applicable requirements of the present Chapter, alarm signalling shall fulfil, within the scope agreed with PRS, the requirements of the *Code on Alerts and Indicators, 2009.*

20.4.1.2 Depending on the extent of machinery automation, the alarm system shall give the following types of alarms:

.1 alarm to indicate that limit values of parameters have been exceeded;
.2 alarm to indicate that safety system has operated;
.3 alarm to indicate the failure of power supply to particular automatic system or that the stand-by power supply has been switched on;

.4 alarm to indicate that other values or conditions resulting from the detailed requirements of this *Part* of the *Rules* have been changed.

Alarm conditions of machinery shall be indicated in the relevant control stations. The arrangement of the alarm display shall assist in identifying the particular fault condition and its location within the machinery space.

20.4.1.3 Alarm system shall function independently of control and safety systems so that a failure or malfunction in these systems will not prevent the alarm system from operating. Possible interconnection of these systems, restricted to the source of alarm only, is subject to PRS consideration in each particular case.

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

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

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

20.4.1.7 Audible signal may be common for all types of alarms. If the possibility of switching off the audible signal is provided, the readiness of actuating new alarms from other parameters shall be maintained until the reason of previous signal has been eliminated.

In ships of 500 gross tonnage and upwards, switching off audible signals shall not switch off visual signals.

Audible signals for machinery shall be clearly distinguished from surrounding sounds and other audible signals, e.g. fire, CO_2 releasing, etc. The local switching off the audible signal on the navigation bridge and in the accommodation area, if provided, shall not stop the audible signal in the machinery space.

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

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

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

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

20.4.1.12 When visual signals are given by means of lamps, the colour of a visual signal shall be adequate to the character of this signal and the size of the system in accordance with 4.5.5.

20.4.1.13 Where it is intended to provide a dimming arrangement for alarm system annunciators on the navigation bridge, the arrangement shall be such that the total extinguishing of annunciators luminescence is impossible.

20.4.2 Safety system

20.4.2.1 Safety system of particular units of automated machinery plant shall operate automatically after exceeding limit values of the given parameters causing a failure and shall cover all foreseeable fault conditions assumed with regard to operational properties and characteristics of the machinery concerned so that:

.1 normal operating conditions are restored, or
.2 the machinery operation is temporarily adjusted to the prevailing conditions (by reducing the load of machinery), or
.3 machinery and boilers are protected from failure by stopping (in the case of machinery) or by shutting off the fuel (in the case of boilers).

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

20.4.2.3 The safety system shall operate in the event of lack or wrong reaction of the crew which may result in machinery failure.

20.4.2.4 The safety system intended for the functions specified in 20.4.2.1.3, shall be independent of all other control and alarm systems so that failure or malfunction in these systems will not prevent the safety system from operating.

For the safety system intended for functions listed in 20.4.2.1.1 and 20.4.2.1.2, complete independence of other control and alarm systems is not required.

20.4.2.5 Safety system shall have such self-monitoring properties that, with the requirements of paragraph 20.4.2.7 satisfied, alarm signal will be given at least in the case of short circuit, earth fault, broken fuse or broken circuit.

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

20.4.2.7 Safety system shall intervene after operation of the alarm system in the relevant sequence of functions.

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

20.4.2.9 When the safety system has stopped an unit, the unit shall not restart automatically, but only after a manual reset has been performed (see also 20.2.3.8).

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

20.4.3 Indicating and recording systems

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

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

20.4.3.3 Means shall be provided to ensure accurate reading of indication on indicating instruments taking into account lighting conditions at the point of their installation.

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

20.5 Main propulsion control systems

20.5.1 Where remote control of propulsion machinery from the navigating bridge is provided, the following shall apply:

.1 the speed, direction of thrust and, if applicable, the pitch of the propeller shall be fully controllable from the navigating bridge under all sailing conditions, including manoeuvring;

.2 the control shall be performed by a single control device for each independent propeller, with automatic performance of all associated services, including, where necessary, means of preventing overload of the propulsion machinery. Where multiple propellers are designed to operate simultaneously, they may be controlled by one control device;

.3 the main propulsion machinery shall be provided with an emergency stopping device on the navigating bridge which shall be independent of the navigating bridge control system;

.4 propulsion machinery orders from the navigation bridge shall be indicated in the main machinery control room and at the manoeuvring platform;

.5 remote control of the propulsion machinery shall be possible only from one location at a time, at such locations interconnected control positions are permitted. At each location there shall be an indicator showing which location is in control of the propulsion machinery. The transfer of control between the navigating bridge and machinery spaces shall be possible only in the main machinery space or the main machinery control room. This system shall include means to prevent the propelling thrust from altering significantly when transferring control from one location to another;

.6 it shall be possible to control the propulsion machinery locally, even in the case of failure in any part of the remote control system. It shall also be possible to control the auxiliary machinery, essential for the propulsion and safety of the ship, at or near the machinery concerned;

.7 the design of the remote control system shall be such that in case of its failure an alarm will be given. Unless the Administration considers it impracticable the preset speed and direction of thrust of the propeller shall be maintained until local control is in operation;

.8 indicators shall be fitted on the navigation bridge, the main machinery control room and at the manoeuvring platform, for:

8.1 propeller speed and direction of rotation in the case of fixed pitch propellers; and

8.2 propeller speed and pitch position in the case of controllable pitch propellers;

.9 an alarm shall be provided on the navigating bridge and in the machinery space to indicate low starting air pressure which shall be set at a level to permit further main engine starting operations. If the remote control system of the propulsion machinery is designed for automatic starting, the number of automatic consecutive attempts which fail to produce a start shall be limited in order to safeguard sufficient starting air pressure for starting locally.

.10 automation systems shall be designed in a manner which ensures that threshold warning of impending or imminent slowdown or shutdown of the propulsion system is given to the officer in charge of the navigational watch in time to assess navigational circumstances in an emergency. In particular, the systems shall control, monitor, report, alert and take safety action to slow down or stop propulsion while providing the officer in charge of the navigational watch an opportunity to manually intervene, except for those cases where manual intervention will result in total failure of the engine and/or propulsion equipment within a short time, for example in the case of overspeed. (SOLAS, Reg. II-1/31.2)

20.5.2 Where the main propulsion and associated machinery, including sources of main electrical supply, are provided with various degrees of automatic or remote control and are under continuous manual supervision from a control room the arrangements and controls shall be so designed, equipped and installed that the machinery operation will be as safe and effective as if it were under direct supervision; (...) (SOLAS, Reg. II-1/31.3)

20.5.3 In general, automatic starting, operational and control systems shall include provisions for manually overriding the automatic controls. Failure of any part of such systems shall not prevent the use of the manual override. (SOLAS, Reg. II-1/31.4)

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

20.5.5 The remote control from the bridge shall be limited to a single control element (lever, wheel, etc.) separate for each propeller, and all the auxiliary control functions shall be performed automatically. The protection against overloading of the propulsion and against the continuous operation of the propulsion within the forbidden speed range shall be actuated by the remote control, where necessary. Where several propellers constituting one propulsion system are provided to operate simultaneously, they may be additionally controlled by one control element.

In ships of less than 500 gross tonnage, whose propulsion system consists of non-reversible engine operating through a reversing gear or controllable pitch propeller, the arrangement with two control elements may be used, provided that the control system is so designed that an erroneous maneuver does not result in stopping the engine.

20.5.6 The remote control system shall be independent of engine room telegraph or any other means of communication used for giving the manoeuvre commands. It is permitted to use one lever for both systems.

20.5.7 Auxiliary control operations performed by the remote control system after any setting of the control system, including emergency reversing from ”full ahead”, shall proceed in the programmed sequence with the time intervals required by the main engine being respected.

The programme shall not be time-dependent only, but it shall take account of the operational parameters of the main engine auxiliary installations and signals acknowledging the performance of the sequence of actions according to the programme.

Stoppage in the programme performance shall be alarmed. A simultaneous indication of the place of interruption is recommended.

Where the main turbines are used, the control system shall be so designed that when maintaining the necessary manoeuvrability of the propulsion system, the changes of controlled parameters of

the turbine set do not cause hazardous disturbances in the operation of auxiliary machinery and installations, such as boilers, condenser installations, etc.

20.5.8 The remote control station on the navigation bridge shall be equipped with the device for stopping the main engine in case of emergency independently of the remote control system.

Such device shall be so designed that the requirements specified in 20.4.2.9 and 20.2.3.8 are satisfied.

20.5.9 Automatic interlocking of the remote starting of the main engine shall be provided, e.g. when the crankshaft turning gear is under operation or in case of lack of lubricating oil pressure.

20.5.10 In the case of the turbine main propulsion, a device for the slow turning of rotor shall be provided. It shall start automatically when the turbine stops for a longer period of time than permitted by the manufacturer. The possibility of switching off this device from the navigation bridge shall be provided. In ships with permanently attended machinery spaces, automatic starting of the turning device need not be applied.

20.5.11 The remote control system shall be so designed as to give alarm in case of failure, and the number of revolutions, as well as the direction of power screw thrust be maintained till the local station takes over the control. It especially refers to the power supply decay (electric, pneumatic and hydraulic). The decay shall not cause a serious and abrupt change in the power of the main propulsion being developed and in the direction of the propeller revolutions.

20.5.12 In the case of steering propeller (azimuth thruster, cycloidal propeller etc.) all requirements applicable to steering control specified in Chapter 5.5 are to be fulfilled. For these types of propellers see also interpretations in MSC.1/Circ.1416/Rev.1.

20.5.13 The number of the repeated starting (reversing) attempts in the case of faulty starts (reverses) shall be limited in order to preserve enough starting energy to perform manual startings. The alarm shall be given at the starting energy drop to the level indispensable to manual startings.

The minimum level of the starting energy at which the alarm starts to operate shall be such that:

.1 for starting by means of compressed air, six starts of reversible engine from the local control station and three starts of non-reversible engine could be performed;
.2 for electrical starting – three starts of non-reversible engine could be performed.

20.5.14 Simultaneous control of the main propulsion from more than one station should be excluded. The control from several conjugated control units is allowed from one control station.

20.5.15 The remote control system shall be so designed that the transfer of control from one station to another will not cause any essential change in thrust of a screw or in rotations of the main engine.

20.5.16 Each control station shall be equipped with the indicator informing which station is in charge of control.

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

20.5.17 The number, type and arrangement of the main propulsion remote control stations shall be adapted to the type of supervision over the machinery. One of such stations shall be superior with regard to others. The superior control station shall be located in the machinery

space. Only the superior control station may overtake the control from the station on the navigation bridge or from other remote control stations. The superior control station shall have monitoring facilities of all important parameters of the propulsion system and associated installations, irrespective of which control station is actually in charge.

Instructions: The adequate hardware of the remote control stations shall be provided so that the operator will have a possibility of supervising the performance of commands and controlling the parameters of the main engine operation within the range appropriate for a given station. The control stations shall be equipped with:
- indicators of number of revolutions and direction of rotation of the propeller shaft;
- indicators of number of revolutions and direction of rotation of the main engine when clutch coupling is used;
- indicators of propeller speed and direction of rotation in the case of fixed pitch propellers, if such propeller has been installed (see also 20.5.1.8.1);
- indicators of propeller speed and pitch position in the case of controllable pitch propeller, if such propeller has been installed (see also 20.5.1.8.2);
- alarm system annunciators and in particular, indicators informing about the conditions affecting the ship manoeuvrability (see also 20.5.9);
- indicators informing which station is in charge of control;
- emergency shut-down device of the main engine;
- device for switching off the slow turning of the main turbine rotor (see 20.5.7);
- switching-off device of the main engine safety system (see 20.4.2.10).

Where several conjugated control units are used at one control station, only one of them may be provided with the above-mentioned indicators of the alarm system. In the vicinity of the remaining control units, only an indicator informing about the alarm signal may be used.

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

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

20.5.20 Remote control system of two or more main propulsion engines driving one propeller shall be capable of automatic equalizing the load of operating engines.

20.5.21 Propulsion engines electronic speed governors and overspeed protective devices are to comply with requirements specified in *Part VII*, items 2.10.5 – 2.10.9.

20.6 Electrical power supply and distribution control system

20.6.1 The control system of generating set prime movers should, in case of failure of first automatic or remote starting, so limit the number of repeated automatic starting attempts of the same engine or engines driving the remaining sets that the quantity of air left in air receivers or, in the case of electric starting, the quantity of electric energy left in the battery is sufficient to perform, from the local control station, at least three starts of one of the generating sets having the highest output.

20.6.2 Failure to start the set shall be signaled by the alarm system.

20.6.3 The automatic control system of generating sets shall be provided with interlocking arrangement preventing the generating set from being automatically connected when a short-circuit occurs on the busbars of the main switchboard.

20.6.4 The alarms specified in item 2.3, Table 22.1.4.1-1 shall be indicated in the engine control room as individual alarms; where the alarm panel with individual alarms is installed on the engine or in the vicinity, common alarm in the engine control room is required.

20.7 Control systems of steam boilers

20.7.1 Control characteristics of different automatic control systems of operation of steam boilers shall be so selected as to maintain the water level, steam pressure and other controlled parameters within the predetermined limits over the entire load range of the boiler, and to ensure rapid changes of boiler load in accordance with boiler characteristics.

20.7.2 The automatic control system of boiler firing installation shall be so designed that starting of a cold boiler is only possible from the local control station.

20.7.3 The automatic control system of boiler firing installation shall be so designed that fuel supply is only possible when, additionally to the conditions specified in *Part VII,* 11.2.1, the following conditions are fulfilled:

.1 water level is normal;
.2 viscosity and temperature of fuel oil are sufficient for its proper atomisation;
.3 prepurging of the combustion chamber has been effected during at least 30 sec., and the dampers in the air ducts are fully opened;
.4 fuel supply to the burners is set for the minimum value.

20.7.4 The automatic control system of boiler firing installation shall be so designed that purging of combustion chamber always takes place after the fuel supply has been cut off, whether manually or automatically.

For the boiler fired by more than one burner, purging of the combustion chamber shall take place after switching off of the last burner.

20.7.5 Where the boiler is fired by more than one burner, the control systems of burners shall be independent of each other as far as practicable.

In any case, failure of pilot burner control system shall not disturb the operation of the main burners.

20.7.6 The automatic boiler firing installation shall be provided with safety system shutting off the fuel oil supply as specified in *Part VII,* 11.2.2, and also when the following failures occur:

.1 the ignition of the fuel fails within 5 sec. from the beginning of fuel admission;
.2 the viscosity or the temperature of fuel oil is too low;
.3 the values of parameters of atomising steam or air intended for fuel atomising fall;
.4 the water level in the boiler is below the permissible value.

20.7.7 The restarting of firing installation after the elimination of defects shall be possible from the local control station only.

The automatic control system of boiler firing installation shall be so designed that the ignition device is switched on after a certain time of purging the combustion chamber in accordance with the manufacturer's requirements.

20.8 Control systems of piping installations

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

20.8.2 The valves, specified in 20.8.1, shall be situated in places readily accessible for manual operation under all normal service conditions.

20.8.3 All components of valve control system fitted inside the double bottom shall be so designed as to be capable of normal operation when completely flooded under the water head resulting from the maximum draught of the ship.

20.8.4 Where piping systems are intended to be alternately used for different purposes (e.g. for ballast or fuel transfer), their control system shall be provided with such interlocking and protection arrangements as to meet the relevant requirements for interconnection of such piping systems specified in *Part VI*.

CHAPTER 21

21 ADDITIONAL REQUIREMENTS FOR SPECIFIC SHIP TYPES

21.1 Passenger ships – additional marks: PASSENGER SHIP, PASSENGER SHIP/FERRY

Notes:
1. Passenger ships having ro-ro spaces or special category spaces and receiving in their symbol of class supplementary mark **RO-RO,** apart from compliance with 21.1.10 shall also comply with the requirements specified in 21.2.
2. Passenger ships engaged on domestic voyages and receiving in their symbol of class supplementary mark **Class A**, **Class B**, **Class C** or **Class D** shall comply with 21.1.8.
3. Passenger ships of 120 m in length or more, or having 3 or more main vertical zones and receiving in their symbol of class additional mark **SRP** shall also comply with 21.1.9.

21.1.1 Cabling

21.1.1.1 Where (...) electric cables, etc., are carried through watertight boundaries below the bulkhead deck, arrangements shall be made to ensure the watertight integrity of the boundaries. (SOLAS, Reg. II-1/13.2.1)

21.1.1.2 (...) Where (...) electric cables, etc. are carried through internal watertight boundaries above the bulkhead deck that are immersed at any intermediate or final stage of flooding in damage cases that contribute to the attained subdivision index *A*, arrangements shall be made to ensure their watertight integrity. (SOLAS Reg. II-1/17.2)

21.1.1.3 (...) distribution systems shall be so arranged that fire in any main vertical zone as is defined in Regulation II-2/3.32 (see *Part V,* 1.2.32) will not interfere with services essential for safety in any other such zone. This requirement will be met if main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable. (SOLAS, Reg. II-1/45.12)

21.1.2 Power supply and signalling system

21.1.2.1 The power supply for pumps, air compressors and control and monitoring system of the sprinkler system shall be taken directly from the main and emergency switchboards by separate feeders. Such feeders shall run to an automatic change-over switch which in its normal position shall be connected to the feeder from the main switchboard and in the event of voltage decay automatically will change over to the feeder from the emergency switchboard. The switches of these feeders in the main and emergency switchboard shall be clearly marked and provided with a notice that they must be permanently set in the connected position. No other switches shall be installed in these feeders.

21.1.2.2 Cables supplying the sprinkler system machinery (pump, air compressor, control and monitoring system) shall not be led through the machinery spaces, galleys and other enclosed fire-hazardous spaces, except where the said machinery is installed in these spaces.

21.1.2.3 The lighting of saloons, ladders, stairs and passageways leading to the boat deck shall be supplied by not less than two independent feeders.

21.1.2.4 The lighting fixtures shall so arranged that in the event of failure of either feeder uniformity of lighting will be ensured. These feeders shall be supplied from different distribution boards which in the case of application of sectionalised lighting busbars in the main switchboard shall be connected to different sections of the busbars.

21.1.2.5 The general alarm system shall be composed of two independent groups: one for the passengers and one for the crew.

In ships with low-rated electrical installations, only one group of the general alarm system may be used.

21.1.3 Emergency sources of electric power

21.1.3.1 Emergency sources of electrical power (...) shall not be installed forward of the collision bulkhead. (SOLAS, Reg. II-1/39)

21.1.3.2 A self-contained emergency source of electrical power shall be provided. (SOLAS, Reg. II-1/42.1.1)

21.1.3.3 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck. They shall not be located forward of the collision bulkhead. (SOLAS, Reg. II-1/42.1.2)

21.1.3.4 The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency electric lighting switchboards in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Administration that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of category A will not interfere with the supply, control and distribution of emergency electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard shall not be contiguous to the boundaries of machinery spaces of category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard. (SOLAS, Reg. II-1/42.1.3)

Where such an arrangement is impracticable, decks and bulkheads separating the spaces shall fulfil the requirements for control stations, set forth in *Part V*.

21.1.3.5 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances the emergency generator may be used exceptionally*, and for short periods, to supply non-emergency circuits. (SOLAS, Reg. II-1/42.1.4)

Note:
For the purpose of starting from dead ship condition, see 3.1.4 (Regulation II-1/41.1.4) (MSC/Circ.736)

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* ***IACS interpretation***

Exceptionally, whilst the vessel is at sea, is understood to mean conditions such as:

1. *blackout situation*
2. *dead-ship situation*
3. *routine use for testing*
4. *short-term parallel operation with the main source of electrical power for the purpose of load transfer*

Unless instructed otherwise by the Administration, the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements of UI SC152 (see following interpretation) are complied with. (IACS UI SC3)*

* ***IACS interpretation***

1. *General*

Unless instructed otherwise by the Administration the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements as per items 2 and 3 below are complied with.

2. *Requirements*

2.1 *To prevent the generator or its prime mover from becoming overloaded when used in port, arrangements are to be provided to shed sufficient non-emergency loads to ensure its continued safe operation.*

2.2 *The prime mover is to be arranged with fuel oil filters and lubrication oil filters, monitoring equipment and protection devices as required for the prime mover for main power generation and for unattended operation.*

2.3 *The fuel oil supply tank to the prime mover is to be provided with a low level alarm, arranged at a level ensuring sufficient fuel oil capacity for the emergency services for the period of time as required by SOLAS.*

2.4 *The prime mover is to be designed and built for continuous operation and should be subjected to a planned maintenance scheme ensuring that it is always available and capable of fulfilling its role in the event of an emergency at sea.*

2.5 *Fire detectors are to be installed in the location where the emergency generator set and emergency switchboard are installed.*

2.6 *Means are to be provided to readily change over to emergency operation.*

2.7 *Control, monitoring and supply circuits, for the purpose of the use of the emergency generator in port are to be so arranged and protected that any electrical fault will not influence the operation of the main and emergency services.*

When necessary for safe operation, the emergency switchboard is to be fitted with switches to isolate the circuits.

3. *Operation Instructions* are to be provided on board to ensure that when the vessel is under way all control devices (e.g. valves, switches) are in a correct position for the independent emergency operation of the emergency generator set and emergency switchboard.*

* *These instructions are also to contain information on required fuel oil tank level, position of harbour/sea mode switch if fitted, ventilation openings etc.* ***(IACS UI SC152)***

21.1.3.6 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation: (SOLAS, Reg. II-1/42.2)

.1 For a period of 36 hours, emergency lighting:

- **.1** at every muster and embarkation station and over the sides as required by regulations III/11.4 and III/15.7;
- **.2** in alleyways, stairways and exits giving access to the muster and embarkation stations, as required by regulation III/11.5;
- **.3** in all service and accommodation alleyways, stairways, and exits, personnel lift cars;
- **.4** in the machinery spaces and main generating stations including their control positions;
- **.5** in all control stations, machinery control rooms, and at each main and emergency switchboard;
- **.6** at all stowage positions for firemen's outfits;
- **.7** at the steering gear; and
- **.8** at the fire pump, the sprinkler pump and the emergency bilge pump referred to in 21.1.3.6.4 (paragraph 2.4) and at the starting position of their motors. (SOLAS, Reg. II-1/42.2.1)

.2 For a period of 36 hours:

.1 the navigation lights and other lights required by the *International Regulations for Preventing Collisions at Sea* in force; and

.2 (...), the VHF radio installation required by regulation IV/7.1.1 and IV/7.1.2; and, if applicable:

- the MF radio installation required by regulations IV/9.1.1, IV/9.1.2, IV/10.1.2 and IV/10.1.3;
- the ship earth station required by regulation IV/10.1.1; and
- the MF/HF radio installation required by regulations IV/11.1.1 and IV/11.1.2. (SOLAS, Reg. II-1/42.2.2)

.3 For a period of 36 hours:

.1 all internal communication equipment required in an emergency;

.2 the shipborne navigational equipment as required by regulation V/19; where such provision is unreasonable or impracticable the Administration may waive this requirement for ships of less than 5,000 gross tonnage;

.3 the fire detection and fire alarm system, and the fire door holding and release system; and

.4 for intermittent operation of the daylight signalling lamp, the ship's whistle, the manually operated call points and all internal signals that are required in an emergency;

unless such services have an independent supply for the period of 36 hours from an accumulator battery suitably located for use in an emergency. (SOLAS, Reg. II-1/42.2.3)

.4 For a period of 36 hours:

.1 one of the fire pumps required by regulations II-2/10.2.2.2 and II-2/10.2.2.3;

.2 the automatic sprinkler pump, if any; and

.3 the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves. (SOLAS, Reg. II-1/42.2.4)

Note:
For ships of restricted service, the 36 hours period of time required under 21.1.3.6.1 to 21.1.3.6.4 may, subject to the consent of the Administration, be shortened to 18 hours for ships of restricted service **II,** engaged on domestic voyages only and to 12 hours – for ships of restricted service **III,** engaged on domestic and international voyages.

.5 For the period of time required by 5.5.8 (regulation 29.14) the steering gear if required to be so supplied by that Regulation. (SOLAS, Reg. II-1/42.2.5)

.6 For a period of half an hour:

.1 any watertight doors required by regulation 13 to be power operated together with their indicators and warning signals;

.2 the emergency arrangements to bring the lift cars to deck level for the escape of persons. The passenger lift cars may be brought to deck level sequentially in an emergency. (SOLAS, Reg. II-1/42.2.6)

.7 For a period of at least 60 minutes the additional low-location lighting specified in 21.1.5 from the moment of switching on the system in an emergency.

Note:
Regarding requirements for evacuation guidance systems used as an alternative to low-location lighting – see MSC/Circ.1167.

.8 In a ship engaged regularly on voyages of short duration, the Administration if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 36 hour period specified in 21.1.3.6.1 to 21.1.3.6.2 (paragraphs 2.1 to 2.5) but not less than 12 hours. (SOLAS, Reg. II-1/42.2.7)

IACS interpretation

Dispensation to the reduced period of availability of the emergency source of power can be given to:

1 Vessels with a class notation "Coastal Service" i.e. ***Class B, C, D*** *(see 21.1.8)*

2 Vessels engaged in voyages where the route is no greater than 20 nautical miles offshore. (IACS UI SC72)

21.1.3.7 In passenger ships (...), supplementary lighting shall be provided in all cabins to clearly indicate the exit so that occupants will be able to find their way to the door. Such lighting, which may be connected to an emergency source of power or have a self-contained source of electrical power in each cabin, shall automatically illuminate when power to the normal cabin lighting is lost and remain on for a minimum of 30 min. (SOLAS Reg. II-1/41.6)

21.1.3.8 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the following: (SOLAS, Reg. II-1/42.3)

.1 Where the emergency source of electrical power is a generator, it shall be:

.1 driven by a suitable prime-mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43 degrees C;

.2 started automatically upon failure of the electrical supply from the main source of electrical power and shall be automatically connected to the emergency switchboard; those services referred to in 21.1.3.9 (paragraph 4) shall then be transferred automatically to the emergency generating set. The automatic starting system and the characteristic of the prime-mover shall be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 seconds; (...); and

.3 provided with a transitional source of emergency electrical power according to 21.1.3.9 (paragraph 4). (SOLAS, Reg. II-1/42.3.1)

.2 Where the emergency source of electrical power is an accumulator battery, it shall be capable of:

.1 carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12 percent above or below its nominal voltage;

IACS interpretation

Where the emergency and/or transitional emergency loads are supplied from a battery via an electronic converter or inverter the maximum permitted d.c. voltage variations are to be taken as those on the load side of the converter or inverter.

Where the d.c. is converted into a.c. the maximum variations are not exceed those given in 2.2.3 (UR E5). (UI SC186)

.2 automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

.3 immediately supplying at least those services specified in 21.1.3.9 (paragraph 4). (SOLAS, Reg. II-1/42.3.2)

.3 For ships (...) where electrical power is necessary to restore 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. (SOLAS, Reg. II-1/42.3.4)

Note:
Below UI SC124 together with UI SC3 and UI SC152 under 21.1.3.5 contains equivalent provisions to IMO interpretations of SOLAS II-1/42.3.4 in MSC.1/Circ.1572/Rev.2, Sec.7. Consequently the IMO interpretations have not been cited here.

IACS interpretation

"Blackout" as used in 21.1.3.8.3 and 9.3.7 (Regulation II-1/42.3.4 and II-1/43.3.4) is to be understood to mean a "deadship" condition.

"Deadship" condition, for the purpose of 21.1.3.8.3 and 9.3.7 (Regulation II-1/42.3.4 and II-1/43.3.4), is to be understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation and in restoring the propulsion, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxilaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout/dead ship condition as defined above. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

For steam ships, the 30 minute time limit given in SOLAS can be interpreted as time from blackout/dead ship condition defined above to light-off of the first boiler. (IACS UI SC124)

21.1.3.9 The transitional source of emergency electrical power required by 27.1.3.8.1.3 (paragraph 3.1.3) shall consist of an accumulator battery suitably located for use in an emergency which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 percent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation: (SOLAS, Reg. II-1/42.4)

IACS interpretation

Where the emergency and/or transitional emergency loads are supplied from a battery via an electronic converter or inverter the maximum permitted d.c. voltage variations are to be taken as those on the load side of the converter or inverter.

Where the d.c. is converted into a.c. the maximum variations are not exceed those given in 2.2.3 (UR E5). (UI SC186)

.1 For half an hour:

.1 the lighting required by 21.1.3.6.1 and 21.1.3.6.2.1 (paragraphs 2.1 and 2.2.1);
.2 all services required by 21.1.3.6.3.1, 21.1.3.6.3.3 and 21.1.3.6.3.4 (paragraphs 2.3.1, 2.3.3 and 2.3.4) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency. (SOLAS, Reg. II-1/42.4.1)

.2 Power to operate the watertight doors, as required by 21.1.3.21.3 (regulation 13.6.3.3), but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided. Power to the control, indication and alarm circuits as

required by 21.1.3.20 to 21.1.3.21 (regulation 13.6) for half an hour. (SOLAS, Reg. II-1/42.4.2)

21.1.3.10 The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power. (SOLAS, Reg. II-1/42.5.1)

21.1.3.11 Where the emergency source of electrical power is a generator, the emergency switchboard shall be located in the same space unless the operation of the emergency switchboard would thereby be impaired. (SOLAS, Reg. II-1/42.5.2)

21.1.3.12 No accumulator battery fitted in accordance with 21.1.3.9 (this Regulation) shall be installed in the same space as the emergency switchboard. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in paragraph 3.1.3 or 4 are being discharged. (SOLAS, Reg. II-1/42.5.3)

21.1.3.13 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short circuit. (SOLAS, Reg. II-1/42.5.4)

21.1.3.14 In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power shall be available to the emergency circuits. (SOLAS, Reg. II-1/42.5.5)

21.1.3.15 The emergency generator and its prime-mover and any emergency accumulator battery shall be so designed and arranged as to ensure that they will function at full rated power when the ship is upright and when inclined at any angle of list up to 22.5 degrees or when inclined up to 10 degrees either in the fore or aft direction, or is in any combination of angles within those limits. (SOLAS, Reg. II-1/42.6)

21.1.3.16 Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements. (SOLAS, Reg. II-1/42.7)

21.1.4 Electrical equipment of watertight doors in watertight bulkheads below the bulkhead deck

21.1.4.1 Watertight door controls, including hydraulic piping and electric cables, shall be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimize the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls shall be such that if the ship sustains damage within one fifth of the breadth of the ship, as defined in regulation 2 (i.e. the greatest moulded breadth of the ship at or below the deepest subdivision draught), such distance being measured at right angles to the centreline at the level of the deepest subdivision draught, the operation of the watertight doors clear of the damaged portion of the ship is not impaired. (SOLAS, Reg. II-1/13.5.3)

21.1.4.2 The electrical power required for power-operated sliding watertight doors shall be supplied from the emergency switchboard either directly or by a dedicated distribution board

situated above the bulkhead deck. The associated control, indication and alarm circuits shall be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by the transitional source of emergency electrical power required by 21.1.3.8.1.3 (regulation 42.3.1.3) in the event of failure of either the main or emergency source of electrical power. (SOLAS Reg. II-1/13.6.2)

21.1.4.3 Power-operated sliding watertight doors shall have either:

.1 (...)

.2 (...)

.3 an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source shall be capable of being automatically supplied by the transitional source of emergency electrical power as required by 21.1.3.9.2 (regulation 42.4.2) – in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°

For the systems specified in 21.1.4.3.1, 21.1.4.3.2 and 21.1.4.3.3 (paragraphs 6.3.1, 6.3.2 and 6.3.3), provision should be made as follows: Power systems for power-operated watertight sliding doors shall be separate from any other power system. A single failure in the electric or hydraulic power-operated systems excluding the hydraulic actuator shall not prevent the hand operation of any door. (SOLAS Reg. II-1/13.6.3)

21.1.4.4 As far as practicable, electrical equipment and components for watertight doors shall be situated above the bulkhead deck and outside hazardous areas and spaces. (SOLAS Reg. II-1/13.6.5)

21.1.4.5 The enclosures of electrical components necessarily situated below the bulkhead deck shall provide suitable protection against the ingress of water*.

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* Refer to the following publication IEC 60529:2003:

.1 electrical motors, associated circuits and control components; protected to IPX 7 standard;
.2 door position indicators and associated circuit components; protected to IPX 8 standard; and
.3 door movement warning signals; protected to IPX 6 standard.

Other arrangements for the enclosures of electrical components may be fitted provided PRS is satisfied that an equivalent protection is achieved. The water pressure IPX 8 shall be based on the pressure that may occur at the location of the component during flooding for a period of 36 h. (SOLAS Reg. II-1/13.6.6)

21.1.4.6 Electric power, control, indication and alarm circuits shall be protected against fault in such a way that a failure in one door circuit will not cause a failure in any other door circuit. Short circuits or other faults in the alarm or indicator circuits of a door shall not result in a loss of power operation of that door. Arrangements shall be such that leakage of water into the electrical equipment located below the bulkhead deck will not cause the door to open. (SOLAS Reg. II-1/13.6.7)

21.1.4.7 A single electrical failure in the power operating or control system of a power-operated sliding watertight door shall not result in a closed door opening. Availability of the power supply shall be continuously monitored at a point in the electrical circuit as near as practicable to each of the motors required by 21.1.4.3 (paragraph 6.3). Loss of any such power supply shall activate an

audible and visual alarm at the central operating console(s) required 21.1.4.8 (paragraph 7.1). (SOLAS Reg. II-1/13.6.8)

21.1.4.8 A central operating console for all power-operated sliding watertight doors shall be located in the safety centre in accordance with *Part V,* 11.1.17 (regulation II-2/23). If the safety centre is located in a separate space adjacent to the navigation bridge, a central operating console shall also be located on the navigation bridge. The central operating console(s) shall have a "master mode" switch with two modes of control: a "local control" mode, which shall allow any door to be locally opened and locally closed after use without automatic closure, and a "doors closed" mode, which shall automatically close any door that is open in not more than 60 s with the ship in an upright position. The "doors closed" mode shall permit doors to be opened locally and shall automatically re-close the doors upon release of the local control mechanism. The "master mode" switch shall normally be in the "local control" mode. The "doors closed" mode shall only be used in an emergency or for testing purposes. (SOLAS Reg. II-1/13.7.1)

21.1.4.9 (...) the central operating console(s) shall be provided with a diagram showing the location of each power-operated sliding watertight door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door is fully open and a green light shall indicate a door is fully closed. When the door is closed remotely the red light shall indicate the intermediate position by flashing. The indicating circuit shall be independent of the control circuit for each door. Indication shall also be provided to the onboard stability computer, if installed in accordance with *Publication 90/P – Safe return to port and orderly evacuation and abandonment of the ship*, 2.2.2.2 (regulation II-1/8-1.3.1). (SOLAS Reg. II-1/13.7.3)

21.1.4.10 It shall not be possible to remotely open any door from the central operating console. (SOLAS Reg. II-1/13.7.4)

21.1.4.11 Watertight doors which also serve as fire doors shall not be closed automatically in case of fire detection by the fire detection system.

21.1.5 Additional low-location lighting

21.1.5.1 The means of escape including stairways and exits, in addition to the emergency lighting, shall be marked by additional low-location lighting at all points of the escape route including angles and intersections. In addition, all escape route signs and fire equipment location markings shall be made according to paragraph 21.1.5.2.

21.1.5.2 Additional low-location lighting (required in *Part V,* 11.1.5.5.1) shall be made of:
- photoluminescent materials having properties of storing lighting energy when the ambient light source is less effective; or
- light sources supplied by electric power such as incandescent bulbs, light emitting diodes, electroluminescent lamps, electrofluorescent lamps, etc.

Additional low-location lighting products shall not contain radioactive or toxic materials.

21.1.5.3 Additional low-location lighting system shall operate for at least 60 minutes.

The system shall be capable of being activated directly from the continuously manned central control station. It may, additionally, be continuously operating or be switched on automatically, e.g. by the presence of smoke within the spaces served.

21.1.5.4 In all passageways, the additional low-location lighting shall be continuous except as interrupted by corridors and cabin doors, however, the interruption shall not exceed 2 metres.

The additional low-location lighting shall be installed at least on one side of the corridor, either on the bulkhead within 300 mm from the deck, or on the deck within 150 mm from the bulkhead.

In corridors of more than 2 metres wide, additional low-location lighting shall be installed on both sides.

In stairways the additional low-location lighting shall be installed within 300 mm above the steps such that each step may be readily identified from either above or below that step.

The additional low-location lighting shall be installed on both sides if the width of the stairway is two meters or more. The top and bottom of each set of stairs should be identified to show that there are no further steps.

In dead-end corridors, additional low-location lighting shall have arrows placed at intervals not exceeding 1 metre, or equivalent direction indicators, pointing away from the dead-end.

In all passenger cabins a placard explaining the additional low-location lighting system shall be installed on the inside of the cabin door. It should also have a diagram showing the location of, and the way to, the two closest exits with respect to the cabin.

21.1.5.5 Additional low-location lighting shall lead to the exit door handle. No other doors shall be similarly marked. Sliding fire doors and watertight doors shall be marked with an additional low-location lighting sign showing how the door opens.

21.1.5.6 Photoluminescent strips shall not be less than 75 mm wide. Photoluminescent strips having a width less than that stated herein shall be used only if their luminance is properly increased.

Photoluminescent materials shall ensure luminance equal at least 15 mcd/m^2 measured 10 minutes after the removal of all external lighting sources and greater than 2 mcd/m^2 for 60 minutes. Photoluminescent installation materials shall be provided with sufficient external light necessary to charge the photoluminescent materials to meet luminance requirements.

21.1.5.7 Additional low-location lighting supplied by electric power shall be connected to the emergency switchboard so as to be powered by the main source of electric power under normal service conditions and by the emergency power source in emergency conditions (see also 21.1.3.6.7).

For existing ships, additional low-location lighting may be connected to the main lighting system, provided that independent battery charged from the main lighting system, ensuring supply of low-location lighting for at least 60 minutes, is fitted.

Additional low-location lighting supplied from battery shall fulfil the requirements specified in 21.1.5.8 ÷ 21.1.5.10.

21.1.5.8 Additional low-location lighting supplied with electric power shall fulfil the following requirements:

.1 the planar sources of light shall have minimum luminance of 10 cd/m^2 from the active parts in a continuous line of 15 mm minimum width;

.2 the point sources of miniature lamps shall provide not less than 150 mcd mean spherical intensity with a spacing of not more than 100 mm between lamps;

.3 the point of source of light emitting diode systems shall have a minimum peak intensity of 35 mcd. The angle of half intensity cone shall be appropriate to the likely track directions of approach and viewing. Spacing between lamps shall not exceed 300 mm;

.4 electroluminescent lamps shall function for 60 minutes from the moment of removing the main power supply specified in 21.1.5.7.

The typical track directions of approach and viewing shall be considered:

a) for sources which are required to be viewed from a horizontal position, within a 60° cone having its centre located 30° from the horizontal mounting surface of the point source and in line with the track direction,
b) for sources which are required to be viewed vertically, within a 60° cone having its centre located perpendicular to the mounting service of the point source.

21.1.5.9 The power supply arrangements to the additional low-location lighting shall be so arranged that a single fault does not result in the complete loss of the lighting in any fire zone and such that a fire in any fire zone or on any deck does not result in loss of the lighting in any other fire zone or deck. This requirement may be satisfied by the power supply circuit configuration, use of fire resistant cables complying with IEC 60331 or the provision of suitably located power supply units having integral batteries adequately rated to supply the lighting for a minimum period of 60 minutes.

21.1.5.10 Single lights and lighting assemblies of additional low-location lighting shall be so designed or arranged that any single fault or failure in a light or lighting assembly, other than a short-circuit, will not result in a break in visible delineation exceeding 1 meter.

21.1.5.11 Lighting fixtures and assemblies shall be flame retardant, have an ingress protection of at least IP55 and shall fulfil the test requirements specified in *Publication 11/P – Environmental Tests on Marine Equipment*.

21.1.5.12 Additional emergency lighting on passenger ferries, executed according to 21.2.2, may by used partly or totally as low-location lighting, provided that conditions, specified in 21.1.5.1 ÷ 21.1.5.10, are fulfilled.

21.1.6 Public address system

21.1.6.1 In passenger ship, the public address system shall be capable of being connected to three broadcasting lines:

- deck broadcasting line, specified in 7.3.2.6.1;
- service broadcasting line, specified in 7.3.2.6.2;
- passenger broadcasting line, intended for connecting loudspeakers installed in passenger accommodation and public spaces (cabins, messrooms, libraries, verandas, cafeterias, bars, etc., including the adjacent corridors and landings).

21.1.6.2 Provision shall be made for disconnecting passenger broadcasting line from service and deck broadcasting lines when addressing crew accommodation and work spaces.

21.1.6.3 The public address system shall be protected against an unauthorized use. It shall be provided with an override function controlled from the main command microphone post located on the navigation bridge so that all emergency messages will be broadcast even if any loudspeaker has been switched off, its volume has been turned down or the public address system is used for other purposes.

21.1.6.4 The public address system shall fulfil the following requirements:

.1 each of the broadcasting lines, specified in 22.1.6.1, shall have at least two loops of flame retardant cable, which should be sufficiently separated throughout their length and have

two separate and independent amplifiers. Amplifiers cabling shall be run in segregated cable routes;

.2 each loudspeaker shall be individually protected against short-circuit;

.3 each command microphone post shall be provided with emergency function control, which should:

- be clearly indicated as the emergency function;
- be protected against unauthorized use;
- automatically disconnect any other input system or programme;
- automatically override all volume controls and on/off controls in the public address system so that the required emergency mode volume specified in 7.3.2.3 is achieved in all spaces.

21.1.6.5 (...) In ro-ro passenger ships, cabling for emergency alarms and public address systems (...) shall be approved by the Administration having regard to the recommendations developed by the Organization *. (...) (SOLAS, Reg. II-1/45.5.3)

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* Refer to *Recommendation on performance standards for public address systems on passenger ships, including cabling* (MSC/Circ.808).

21.1.6.6 A public address system or other effective means of communication complying with the requirements of 21.1.6.8 to 21.1.6.11 (regulation III/6.5) shall be available throughout the accommodation and service spaces and control stations and open decks. (SOLAS, Reg. II-2/12.3)

21.1.6.7 In addition to the requirements of 21.1.6.7 (regulation II-2/12.3) and of 7.4.2 (paragraph 4.2), all passenger ships shall be fitted with a public address system. (...).(SOLAS, Reg. III/6.5.1)

21.1.6.8 The public address system shall be clearly audible above the ambient noise in all spaces, prescribed by 7.3.2.2 (paragraph 7.2.2.1 of the LSA Code), and shall be provided with an override function controlled from one location on the navigation bridge and such other places on board as the Administration deems necessary, so that all emergency messages will be broadcast if any loudspeaker in the spaces concerned has been switched off, its volume has been turned down or the public address system is used for other purposes. (SOLAS, Reg. III/6.5.2)

21.1.6.9 On passenger ships (...):

.1 the public address system shall have at least two loops which shall be sufficiently separated throughout their length and have two separate and independent amplifiers; and

.2 the public address system and its performance standards shall be approved by the Administration having regard to the recommendations adopted by the Organization. * (SOLAS, Reg. III/6.5.3)

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* Refer to *Recommendation on performance standards for public address systems on passenger ships, including cabling* (MSC/Circ.808).

21.1.6.10 The public address system shall be connected to the emergency source of electrical power required by 21.1.3.6.2 (regulation II-1/42.2.2). (SOLAS, Reg. III/6.5.4)

21.1.6.11 The sound pressure levels specified in paragraph 7.3.2.3 also apply to special category spaces and ro-ro spaces.

21.1.7 Passenger ships carrying 36 passengers or more

21.1.7.1 In passenger ships carrying more than 36 passengers, power ventilation, except machinery space and cargo space ventilation and any alternative system, shall be fitted with controls so grouped that all fans may be stopped from either of two separate positions which shall be situated as far apart as practicable.

21.1.7.2 Passenger ships carrying more than 36 passengers shall have the fire detection alarms for the systems centralized in a continuously manned central control station. In addition, controls for remote closing of the fire doors and shutting down the ventilation fans shall be centralized in the same location. The ventilation fans shall be capable of reactivation by the crew at the continuously manned control station. The control panels in the central control station shall be capable of indicating open or closed positions of fire doors and closed or off status of the detectors, alarms and fans. The control-and-indication circuits (i.e. control panel and wires) shall be powered from the main source of power and shall have an automatic change-over to standby power supply (emergency source of power) in case of loss of normal power supply. Additionally, automatic changeover to batteries shall be provided to ensure power supply to the circuits for the operation for at least 30 minutes (i.e. for the time necessary to start the standby generating set).

21.1.7.3 Cargo hold fans shall be provided with devices for remote shutting down situated outside the space where the fans are located.

21.1.7.4 A flooding detection system for watertight spaces below the bulkhead deck shall be provided based on the guidelines developed by the Organization.* (SOLAS Reg. II-1/22-1)

* Refer to *Guidelines for flooding detection systems on passenger ships* (MSC.1/Circ.1291).

21.1.8 Passenger ships engaged on domestic voyages – marks: Class A, Class B, Class C or Class D supplementing additional marks of passenger ships

Passenger ships engaged on domestic voyages within the EU Community waters, regardless of the flag they fly, shall comply with the safety requirements provided in *Publication 100/P – Safety requirements for sea-going passenger ships and high-speed passenger craft engaged in domestic voyages.*

21.1.9 Passenger ships subject to SOLAS regulations II-1/8-1, II-2/21 and II-2/22 (safe return to port, orderly evacuation and abandonment of the ship) – additional mark: SRP

Passenger ships of 120 m in length or more, or having 3 or more main vertical zones shall comply with additional requirements specified in *Publication 90/P – Safe Return to Port and Orderly Evacuation and Abandonment of the Ship*.

21.1.10 Passenger ships having ro-ro or special category spaces – additional marks: RO-RO/PASSENGER SHIP, RO-RO/PASSENGER SHIP/FERRY

21.1.10.1 Integrity of the hull and superstructure, damage prevention and control

21.1.10.1.1 Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings shall be able to be closed weathertight to prevent ingress of water below and fitted with alarms and open/close indicators on the navigation bridge. (…) (SOLAS, Reg. II-1/17-1.1.2)

21.1.10.1.2 (…) the Administration may permit the fitting of particular accesses to spaces below the bulkhead deck provided they are necessary for the essential working of the ship, e.g.

the movement of machinery and stores, and subject to such accesses being made watertight, fitted with alarms and open/close indicators on the navigation bridge. (SOLAS, Reg. II-1/17-1.1.3)

21.1.10.1.3 Indicators shall be provided on the navigation bridge for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Administration, lead to flooding of a special category space or ro-ro space. The indicator system shall be designed on the fail-safe principle and shall show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked and by audible alarms if such door or closing appliances become open or the securing arrangements become unsecured. The indicator panel on the navigation bridge shall be equipped with a mode selection function "harbour/sea voyage" so arranged that an audible alarm is given on the navigation bridge if the ship leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator system shall be independent of the power supply for operating and securing the doors. (SOLAS, Reg. II-1/17-1.2)

21.1.10.1.4 Television surveillance and a water leakage detection system shall be arranged to provide an indication to the navigation bridge and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to flooding of special category spaces or ro-ro spaces. (SOLAS, Reg. II-1/17-1.3)

21.1.10.1.5 Special category spaces and ro-ro spaces shall be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorized access by passengers thereto can be detected during navigation. (SOLAS, Reg. II-1/23.1)

21.1.10.1.6 Electrical and signalling installations of bow doors and inner doors leading to a complete or long forward enclosed superstructures or to a long non-enclosed superstructure, where fitted to attain minimum bow height equivalence shall fulfil following requirements:

.1 Separate indicator lights and audible alarms shall be provided on the navigation bridge and on the operating panel to show that the bow door and inner door are closed and that their securing and locking devices are properly positioned. The indication panel shall be provided with a lamp test function. It shall not be possible to turn off the indicator light.

.2 The indicator system shall be designed on the fail-safe principle and shall show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system for operating and closing doors shall be independent of the power supply for operating and closing the doors and shall be provided with a back up power supply from the emergency source of power or other power supply e.g. UPS. The sensors of the indicator system shall be protected from water, ice formation and mechanical damage.

Note:
The indicator system is considered designed on the fail-safe principle when:

.1 The indication panel is provided with:

a) a power failure alarm,
b) an earth failure alarm,
c) a lamp test,
d) separate indication for door closed, door locked, door not closed and door not locked.

.2 Limit switches electrically closed when the door is closed (when no more limit switches are provided, they may be connected in series).

.3 Limit switches electrically closed when securing arrangements are in place (when more limit switches are provided, they may be connected in series).

.4 two electrical circuits (also in one multicore cable), one for the indication of door closed/not closed and the other for door locked/not locked.

.5 In case of dislocation of limit switches, indication to show: not closed/not locked/securing arrangement not in place – as appropriate.

.3 The indication panel on the navigation bridge shall be equipped with a mode selection function "harbour/sea voyage" so arranged that audible alarm is given on the navigation bridge if the vessel leaves harbour with the bow door or inner door not closed and with any of the securing devices not in the correct position.

.4 A water leakage detection system with audible alarm and television surveillance shall be arranged to provide an indication to the navigation bridge and to engine control room of leakage through the inner door.

Note:
The indicator system shall be designed on fail-safe principle – see Note to para. 21.1.10.1.6.2.

.5 Between the bow door and the inner door, a television surveillance system shall be fitted with a monitor on the navigation bridge and in engine control room. The system shall monitor the position of doors and a sufficient number of their securing devices. Special consideration shall be given for lighting and contrasting colour of objects under surveillance.

Note:
The indicator system shall be designed on fail- safe principle – see Note to para. 21.1.10.1.6.2.

.6 A drainage system in the area between the bow door and ramp or where no ramp is fitted, between the bow door and inner door shall be equipped with an audible alarm function to the navigation bridge being set off when the water levels in these areas exceed 0.5 m or the high water level alarm, whichever is lesser. See also Note to paragraph 21.1.10.1.6.2.

Note:
The requirements for securing and locking devices of bow doors and inner doors are contained in relevant sections of *Part III*.

21.1.10.1.7 Electrical and signalling installations of side shell doors (abaft the collision bulkhead) and stern doors leading into enclosed spaces shall fulfil following requirements:

.1 Separate indicator lights and audible alarms shall be provided on the navigation bridge and on each operating panel to indicate that the doors are closed and that their securing and locking devices are properly positioned. The indication panel shall be provided with a lamp test function. It shall not be possible to turn off the indicator light.

.2 The indicator system shall be designed on the fail-safe principle and shall indicate by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system shall be independent of the power supply for operating and closing the doors and shall be provided with a backup power supply from the emergency source of power or secure power supply e.g. UPS. The sensors of the indicator system shall be protected from water, ice formation and mechanical damage.

Note:
The indicator system is considered designed on the fail-safe principle, provided it complies with the requirements of Note to paragraph 21.1.10.1.6.2.

.3 The indication panel on the navigation bridge shall be equipped with a mode selection function "harbour/voyage" so arranged that audible alarm is given if the ship leaves

harbour with side shell or stern doors not closed, or with any of securing devices not in the correct position.

.4 A water leakage detection system with audible alarm and television surveillance shall be arranged to provide an indication to the navigation bridge and to the engine control room of any leakage through the doors. In cargo ships, a water leakage detection system with audible alarm shall be arranged to provide an indication to the navigation bridge.

Notes:
Requirements of this paragraph apply to doors in the boundary of special category spaces or ro-ro spaces, through which such spaces may be flooded. The requirements do not apply to cargo ships, where no part of the door is below the uppermost waterline and the area of the door opening is not greater than 6 m^2.
Requirements for securing and locking devices of side and shell doors are contained in relevant sections of *Part III*.

21.1.10.2 Precaution against ignition of flammable vapours in closed ro-ro spaces and special category spaces

21.1.10.2.1 Cables shall be protected against mechanical damage. Cables installed horizontally shall be laid at least 450 mm above the continuous deck or platform preventing the free passage of gas downwards.

Cable passages through decks and bulkheads shall be gastight.

21.1.10.2.2 Lighting shall be divided into at least two groups; each of the groups shall be supplied by a separate circuit.

21.1.10.2.3 Except as provided in 21.1.10.2.4 (paragraph 3.2.2), electrical equipment and wiring shall be of a type suitable for use in an explosive petrol and air mixture.* (SOLAS, Reg. II-2/20.3.2.1)

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* Refer to the recommendations of the International Electrotechnical Commission, in particular publication 60079, *Electrical apparatus for explosive gas atmospheres.*

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* ***IACS interpretation***

This is realized by requiring certified safe equipment suitable for use in Zone 1 areas as defined in IEC 60079-10-1:2015 (Gas Group IIA and Temperature Class T3). Refer to IEC 60079-14:2013 for types of protection suitable for use in Zone 1 areas. (IACS UI SC43)

21.1.10.2.4 In case of other than special category spaces below the bulkhead deck, notwithstanding the provisions in 21.1.10.2.3 (paragraph 3.2.1), above a height of 450 mm from the deck and from each platform for vehicles, if fitted, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment of a type so enclosed and protected as to prevent the escape of sparks* shall be permitted as an alternative on condition that the ventilation system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least ten air changes per hour whenever vehicles are on board. (SOLAS, Reg. II-2/20.3.2.2)

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* ***IACS interpretation***

This is realized by requiring an enclosure of at least IP55, or apparatus suitable for use in Zone 2 areas as defined in IEC 60079-10-1:2015. Refer to IEC 60079-14:2013 for types of protection suitable for use in Zone 2 areas. (IACS UI SC42)

21.1.10.2.5 Electrical equipment and wiring, if installed in an exhaust ventilation duct, shall be of a type approved for use in explosive petrol and air mixtures* and the outlet from any exhaust

duct shall be sited in a safe position, having regard to other possible sources of ignition. (SOLAS, Reg. II-2/20.3.3)

* ***IACS interpretation***

This is realized by requiring certified safe equipment suitable for use in Zone 1 areas as defined in IEC 60079-10-1:2015 (Gas Group IIA and Temperature Class T3). Refer to IEC 60079-14:2013 for types of protection suitable for use in Zone 1 areas. (IACS UI SC43)

21.1.10.3 Supplying road freight units from ship's electrical system

21.1.10.3.1 Where isolated power distribution system is applied, it is recommended to use the residual current circuit breakers in socket outlet supply circuits intended for electrical energy supply of vehicles. Additionally, it is recommended to use a separate transformer with earthed distributing system of secondary circuit, intended for the above electrical system of the ship (for the socket outlet circuits considered).

21.1.10.3.2 It is recommended that the portable cables intended for the connection of ship electrical system with vehicle electrical system should be located onboard and operated by qualified personnel. Additionally it is recommended that the crew should have the possibility of verification of continuity and electrical conductivity of the connection between ship's hull and vehicle chassis/body. The verification is recommended to be carried out using available onboard instruments measuring electrical conductivity (provided e.g. with alarm indication of missing proper connection).

21.1.10.4 Supplementary emergency lighting

21.1.10.4.1 In addition to the emergency lighting required by 21.1.3.6 (regulation 42.2), on every passenger ship with ro-ro cargo spaces or special category spaces as defined in 1.2.48 and 1.2.55 (regulation II-2/3):

.1 all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electric power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen (or to ensure the lighting intensity of 0.5 lux). The source of power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Administration. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service; and

.2 a portable rechargeable battery operated lamp shall be provided in every crew space alleyway, recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required by subparagraph .1, is provided. (SOLAS, Reg. II-1/42-1.1)

21.1.10.5 General alarm system

The minimum sound pressure level of the alarm system specified in paragraph 7.4.5 also applies to special category spaces, ro-ro spaces and vehicle spaces.

21.2 Roll on – roll off ships and ferries – additional marks: RO-RO SHIP, RO-RO SHIP/FERRY

21.2.1 Installation of electrical equipment in ro-ro cargo spaces

21.2.1.1 Ro-ro cargo spaces (see 1.2.48) shall be considered as hazardous areas.

21.2.1.2 The electrical equipment in ro-ro cargo spaces shall fulfil the requirements specified in subchapters 21.1.10.2 and 21.1.10.3

21.3 Container ships and ships intended for the carriage of containers – additional marks: CONTAINER SHIP, ACC (...)

21.3.1 Application

The requirements of subchapter 21.3 are applicable to electrical equipment of container ships and ships intended for carrying isothermal containers.

21.3.2 Supply and distribution of electric power

21.3.2.1 In addition to compliance with the requirements specified in 3.1.2, the output of the main sources of electric power and of power converters shall provide the supply to all isothermal containers to be carried.

In order to ensure the supply to isothermal containers during loading operations on board the ship, all main sources of electric power and all power converters, including the reserve ones, may be used.

As the power value of electrical equipment of isothermal containers, their installed power shall be assumed. The power consumption of electrical equipment of thermal containers under rated operating conditions shall not exceed 15 kW (18.75 kVA).

The application of diversity and load factors is subject to PRS consideration in each particular case.

21.3.2.2 The means of overload protection of electric power sources, specified in 8.2.3, shall provide for the feeder of the thermal container switchboard to be the last to be disconnected from the main switchboard (see also 19.2.1).

21.3.2.3 Electrical network supplying the electrical equipment of isothermal container equipment shall be separated from the ship network by means of separating transformers supplied from the main switchboard.

21.3.2.4 The electrical equipment of isothermal containers shall be supplied from special switchboards supplied by separate feeders.

21.3.2.5 The socket outlets installed in holds or on weather decks in places where isothermal containers are located shall be supplied by separate feeders from special switchboards specified in 21.3.2.4 and 21.3.3.

21.3.2.6 Electrical network of socket outlets intended to supply electrical equipment of isothermal containers shall have the rated voltage of 220 V or 380 V of 3-phase alternating current of a frequency of 50 Hz or 240 V or 440 V of 3-phase alternating current of a frequency of 60 Hz.

21.3.3 Distribution switchboards and transformers

21.3.3.1 The switchboards of isothermal containers, electric converters (if any) and separating transformers shall be located in special electrical spaces.

21.3.3.2 The secondary windings of separating transformers shall have the neutral point insulated.

21.3.3.3 Each switchboard shall be fitted with apparatus providing for:

.1 visual signals to indicate that the switchboard is in live condition;
.2 switching on and off each feeder of socket outlets;
.3 protection of feeders supplying socket outlets against short-circuit;
.4 measuring of insulation resistance.

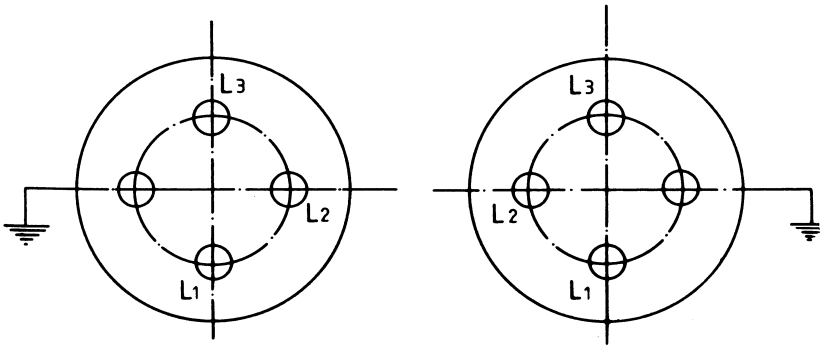
21.3.4 Socket outlets

21.3.4.1 In holds intended for carrying isothermal containers, only the socket outlets to supply containers may be installed. The socket outlets installed in the hold shall have a protection degree of at least IP55 and those installed on the weather deck – at least IP56.

Where electrical system of remote monitoring of temperature, humidity, ventilation and other parameters of isothermal containers in holds and on decks is employed, additional socket outlets may be installed in holds and on decks to connect such a monitoring system.

21.3.4.2 Irrespective of the requirements specified in 14.2.3, socket outlets supplying electrical equipment of isothermal containers shall be fitted with a switch interlocked so that the plug cannot be inserted or withdrawn while the switch is in the ”on” position. They shall also be provided with informative plates indicating their voltage value.

21.3.4.3 The electrical equipment of isothermal containers shall be supplied from the ship network through socket outlets with the direction of phase rotation in the sequence L1, L2, L3 as shown in the diagram presented in Fig. 21.3.4.3.



The front view of plug The front view of socket outlet

Fig. 21.3.4.3 – Sequence of phase connections of plug and socket outlet

21.3.4.4 Socket outlets intended to supply electrical equipment of isothermal containers shall be designed for the following rated currents:

- 60 A for voltages 220 V, 50 Hz or 240 V, 60 Hz,
- 32 A for voltages 380 V, 50 Hz or 440 V, 60 Hz.

21.3.4.5 The design and dimensions of contacting parts of plugs shall be such as to exclude the possibility of connecting the plugs rated for one voltage with the socket outlet rated for another voltage.

21.3.4.6 The design and dimensions of contacting parts of the socket outlets and plugs shall comply with the international standards.

21.3.5 Protective earthing

The socket outlet intended to connect the earthing conductor of the flexible cable of an isothermal container shall be earthed by means of an earthing conductor in the supplying feeder. The earthing conductor in the supply cable shall be earthed in the location of the switchboard supplying socket outlets of isothermal containers.

21.4 Crude oil tankers, product carriers, ships intended for operation in oil spillage area – additional marks: CRUDE OIL TANKER, PRODUCT CARRIER A, OIL RECOVERY VESSEL

21.4.1 Application

21.4.1.1 The requirements of subchapter 21.4 apply to electrical equipment in ships intended for the carriage of liquid cargoes having a flashpoint 60°C and below, as well as to ships intended or adapted for operation in the oil spillage area.

21.4.2 Power distribution systems

21.4.2.1 Earthed distribution systems shall not be used in a tanker. The Administration may exceptionally permit in a tanker the earthing of the neutral for alternating current power networks of 3,000 V (line to line) and over, provided that any possible resulting current does not flow directly through any of the dangerous spaces. (SOLAS, Reg. II-1/45.4.1)

21.4.2.2 Ships (...) shall comply with the following requirements:

.1 except as permitted by 4.3.2 earthed distribution systems shall not be used in a tanker.

.2 the requirement of paragraph 4.3.1 does not preclude the use of earthed intrinsically safe circuits and in addition, under conditions approved by the Administration, the use of the following earthed systems:

.2.1 power supplied, control circuits and instrumentation circuits where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5 amps in both normal and fault conditions, or

.2.2 limited and locally earthed systems, provided that any possible resulting current does not flow directly through any of the dangerous spaces; or

.2.3 alternating current power networks of 1,000 V root mean square (line to line) and over, provided that any possible resulting current does not flow directly through any of the dangerous spaces. (SOLAS, Reg. II-1/45.4.3)

21.4.2.3 Only the following systems may be used for the distribution of electric power:

.1 two-wire insulated system for direct current;

.2 two-wire insulated system for single-phase alternating current;

.3 three-wire insulated system for three-phase alternating current (also for a voltage of 1000 V ÷ 11 000 V alternating current);

.4 three-wire system with the earthed neutral point by a high ohm resistance for a voltage of 1000 V ÷ 11 000 V alternating current (see also 18.2.1).

21.4.2.4 The earthed systems of electric power distribution may be used only for the supply of the following consumers, provided they are used outside the hazardous rooms and spaces:

.1 system of the outer hull cathode current protection against corrosion;
.2 system of monitoring and measuring the insulation resistance (see 4.5.4.8);
.3 electrical system for the starting of diesel engines.

21.4.3 Hazardous rooms and spaces

21.4.3.1 The following rooms and spaces are considered as hazardous:

.1 inner spaces of cargo compartments and cargo tanks, cargo pipelines and the cargo pumping systems;
.2 open spaces up to a height of 1 m above the water surface covered by oil (for ships operating directly in the oil spillage area);
.3 cofferdams and other spaces adjoining cargo compartments and cargo tanks;
.4 enclosed or semi-enclosed spaces containing cargo pumps, enclosed or semi-enclosed spaces, not completely welded, containing cargo pipelines;
.5 enclosed or semi-enclosed spaces situated above the cargo compartments and cargo tanks, as well as spaces having bulkheads above or on the level of the cargo compartment bulkheads and the cargo tank bulkheads;
.6 enclosed or semi-enclosed spaces situated directly above the pump rooms, as well as above the vertical cofferdams adjacent to cargo compartments and cargo tanks, provided they are not divided by the gas-tight decks and do not have power ventilation;
.7 spaces and rooms other than cofferdams, adjoining and situated below the upper part of cargo compartments and cargo tanks;
.8 spaces and semi-enclosed rooms on the open deck within a radius of 3 m from manholes, hatches and other openings not intended for ventilation of cargo compartments and cargo tanks, as well as the ends of cargo pipelines;
.9 spaces on the open deck above cargo compartments and cargo tanks (as well as above the ballast tanks used as cargo tanks) over the full width of the ship and additionally 3 m fore and aft up to a height 2.4 m above the deck. For ships operating directly in the oil spillage area, the space specified above extends over the full length of the ship;
.10 compartments for oil hoses and oil recovery equipment;
.11 enclosed and semi-enclosed spaces having direct exits or other openings leading to one of the above-mentioned rooms or spaces;
.12 rooms and spaces above cofferdams adjacent to the compartments of cargo tanks, not separated by oil-tight and gas-tight bulkheads or decks, lacking proper ventilation and having entrances from the deck above;
.13 rooms situated above the pump rooms, where the electric motors of cargo and stripping pumps are installed.

21.4.3.2 Where the deck of a cargo tank extends to the bulkhead of accommodation spaces, the rooms mentioned in 21.4.3.1.9 shall be defined assuming that the height of the wash barrier is at least equal to the height of the side which restricts the flowing of the liquid cargoes from the ship deck. In that case, the hazardous area extends 3 m beyond the wash barrier.

21.4.3.3 Spaces situated below the level of the main deck and having direct exits or other openings leading to spaces on the main deck, specified in 21.4.3.1.9, are not considered as

hazardous on condition that suitable, double, self-closing gas-tight doors forming an air-lock, as well as the additional power ventilation with an air inlet beyond the hazardous area are provided.

21.4.3.4 For ships adapted for operation in the oil spillage area, entrances, ventilating holes (inlets, outlets) and other openings in non-hazardous spaces, such as accommodation, service and machinery spaces, not provided with gastight closures, shall be situated 6 m above the highest load-line and, in each case, outside the hazardous zone. Entrances to these spaces, situated 6 m below the highest load-line or in the hazardous zone, shall be fitted with air-locks; the remaining openings shall be provided with gastight closures and shall be closed during oil recovery operations.

21.4.3.5 Automatic isolation of non-certified equipment (not intended for application in explosive gas atmosphere) on detection of a flammable gas is not permitted as an alternative to the use of certified equipment (to be selected with respect to the risk of explosion).

21.4.3.6 Electrical generation and distribution systems, and associated control systems shall be so designed that a single fault will not result in the loss of ability to maintain cargo tank pressures and hull structure temperature.

21.4.3.7 Lighting system in hazardous areas shall be divided between at least two branch circuits. All switches and protective devices shall interrupt all poles or phases and shall be located in a non-hazardous area.

21.4.3.8 Electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes shall be housed in gastight enclosures.

21.4.3.9 Submerged cargo pump motors and their supply cables may be fitted in cargo containment systems. Arrangements shall be made to automatically shut down the motors in the event of low-liquid level. This may be accomplished by sensing low pump discharge pressure, low motor current or low liquid level. This shutdown shall be alarmed at the cargo control station. Cargo pump motors shall be capable of being isolated from their electrical supply during gas-freeing operations.

21.4.4 Electrical equipment in hazardous rooms and spaces

21.4.4.1 In tankers, electrical equipment, cables and wiring shall not be installed in hazardous locations unless it conforms with standards not inferior to those acceptable to the Organization.** However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Administration, to ensure that an equivalent level of safety is assured. (SOLAS, Reg. II-1/45.11)

** Refer to the standards published by the International Electrotechnical Commission, and in particular IEC 60092-502:1999 *Electrical installations in ships – Tankers.*

IACS interpretation

Where the prescriptive requirements within SOLAS and related Codes (IBC, IGC) and the standards published by the International Electrotechnical Commission, such as but not limited to IEC 60092-502:1999, are not aligned, the prescriptive requirements in SOLAS and Codes take precedence and are to be applied. The differences revealed between the above-mentioned documents are listed in Annex – see ***Appendix 3*** *(Annex). (IACS UI SC274)*

21.4.4.2 In hazardous rooms and spaces, the installation of electrical equipment is not permitted with the exception of:

.1 lighting fixtures and signal lamps having pressurized enclosures (Exp) flameproof enclosures (Exd) or enclosures of increased safety type (Exe);
.2 switches of increased safety type (Exe) or with flameproof enclosures (Exd);
.3 communication, remote control, monitoring and control equipment of intrinsically safe type (Exi);
.4 electric motors of increased safety type (Exe), with flameproof enclosures (Exd) or with pressurized enclosures (Exp).

21.4.4.3 In inner spaces of cargo compartments and cargo tanks, cargo pipelines and cargo pumping systems, electrical equipment and cables shall not be installed, with the exception of installation of intrinsically safe type (Exi).

21.4.4.4 In open spaces up to a height of 1 m above the water surface covered with oil (for ships operating directly in the oil spillage area), electrical equipment and cables shall not be installed with the exception of installations of intrinsically safe type (Exi).

21.4.4.5 In cofferdams and other spaces adjacent to cargo compartments and cargo tanks, installation of electrical equipment is not permitted except for:

.1 equipment of intrinsically safe type (Exi);
.2 echo depth sounder oscillators and their cables in accordance with the requirements of SOLAS Convention (these requirements are also specified in *Part V – Navigational Equipment* of the *Rules for Statutory Survey of Sea-going Ships*, subchapter 4.2.4);
.3 cables of the outer hull cathode current protection system installed in corrosion-proof steel pipes with gastight joints up to the upper deck.

21.4.4.6 In enclosed and semi-enclosed spaces containing cargo pumps or cargo pipelines, only the following equipment is permitted to be installed:

.1 electrical equipment specified in 21.4.4.5;
.2 lighting supplied by at least two circuits, with fuses and switches on all poles or phases, situated outside the hazardous rooms and spaces, the following constructions are possible:
- illumination by means of lamps installed outside the hazardous rooms and spaces through side scuttles of fixed type placed in gas-tight bulkheads or decks, provided they do not reduce the strength, gastightness and flameproofness of those bulkheads and decks;
- lighting fixtures of explosion-proof construction with pressurized enclosures (Exp) or with flameproof enclosures (Exd), whose cables shall be protected against mechanical damage by means of metallic protective sheaths;

.3 through runs of cables.

Electric motors for driving the devices located in pump-rooms shall be installed in adjacent non-hazardous rooms. Gas-tight stuffing boxes shall be used for the shaft penetrations through bulkheads or decks. Electric motors shall have devices for remote switching off, located outside the rooms in which electric motors are installed and above the tank deck.

21.4.4.7 In enclosed and semi-enclosed spaces above the deck of cargo compartments and cargo tanks, as well as in spaces having bulkheads above or on the level of both the cargo compartment bulkhead and the cargo tank bulkhead, in enclosed and semi-enclosed spaces

situated directly above pump-rooms and above vertical cofferdams adjacent to cargo compartments and cargo tanks which are not separated by gas-tight decks and are not provided with power ventilation, in compartments for cargo hoses and oil recovery equipment, only the following are allowed to be installed:

.1 electrical equipment of intrinsically safe type (Exi);
.2 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd); or of increased safety type (Exe); the switches of these fixtures shall be located outside the hazardous rooms and spaces;
.3 through runs of cables.

21.4.4.8 In rooms and spaces other than cofferdams, adjacent to cargo compartments and cargo tanks or situated below their upper parts, only the following equipment is allowed to be installed:

.1 electrical equipment specified in 21.4.4.5;
.2 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd); this lighting shall be made by means of lamps supplied by at least two circuits, with fuses and switches on all poles or phases, situated outside the hazardous rooms and spaces;
.3 through runs of cables.

21.4.4.9 In semi-enclosed spaces and rooms on the open deck within a radius of 3 m from manholes, hatches and other non-ventilated openings of cargo compartments and cargo tanks, only the following equipment is allowed to be installed:

.1 electrical equipment specified in 21.4.4.2;
.2 through runs of cables in ducts or pipes containing cables, except expansion loops.

21.4.4.10 In spaces on the open deck above cargo compartments and cargo tanks (also above the ballast tanks used as cargo tanks) over the full width of the ship and 3 m fore and aft on the open deck up to a height of 2.4 m above the deck, in enclosed or semi-enclosed spaces having direct exits or other openings leading to one of the above rooms and spaces specified in 2.8.11, only the following equipment is allowed to be installed:

.1 electrical equipment specified in 21.4.4.2;
.2 through runs of cables in ducts or pipes containing cables.

21.4.4.11 In rooms and spaces above cofferdams adjacent to cargo tanks which are not separated by oil-tight and gastight bulkheads or decks and do not have suitable ventilation and have entrances from the deck situated above, only the following equipment is allowed to be installed:

.1 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd) or of increased safety type (Exe);
.2 other electrical devices which do not produce electric arcs during normal operation and whose surfaces are not heated to a dangerous temperature;
.3 other electrical devices of increased safety type (Exe), ventilated and having an enclosure protection of minimum IP55, whose surfaces are not heated to a dangerous temperature.

21.4.4.12 In rooms, where there are electric motors of cargo and stripping pumps, situated above pump-rooms, the following equipment is allowed to be installed:

.1 lighting fixtures of explosion-proof construction having pressurized enclosures (Exp), flameproof enclosures (Exd) or of increased safety type (Exe);

.2 other electrical devices which do not produce electric arcs during normal operation and whose surfaces are not heated to a dangerous temperature;

.3 other electrical devices of increased safety type (Exe), ventilated and having an enclosure protection of minimum IP55 whose surfaces are not heated to dangerous temperature.

Where the room's location and arrangement indicate that the explosive mixtures of gases, vapours or dust with air may accumulate, suitable ventilation shall be ensured. Also interlocking between the starting device for an electric motor of the cargo pump and the electric drive for the ventilation system of this compartment shall be provided. This interlocking shall allow the pump electric motor to be started only after the compartment has been sufficiently ventilated.

21.4.4.13 The possibility of occurrence of explosive mixtures of gas with air during cargo pumping, ballasting and gas-freeing by mechanical means shall be taken into account

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IACS interpretation

This interpretation concerns area classification in relation to vent outlets for cargo loading, discharging and ballasting (SOLAS, Reg. II-2/4.5.3.4)

(...)

Area Classification is to be carried out in accordance with the principles laid down in IEC 60092-502:1999.

*B1 Areas on open deck, or semi-enclosed spaces on open deck, within a vertical cylinder of unlimited height and 6m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet which permit the flow of large volumes of vapour, or gas mixtures during loading/discharging/ballasting are defined as **Zone 1** as specified by IEC 60092-502:1999 para 4.2.2.8.*

*B2 Areas within 4 m beyond the zone specified in B1 above are defined as **Zone 2** as specified by IEC 60092-502:1999 para 4.2.3.2.*

B3 Electrical equipment or cables shall not normally be installed in hazardous areas. Where essential for operational purposes, electrical equipment may be installed in accordance with IEC 60092-502:1999. (IACS UI SC70)

21.4.4.14 The possibility of occurrence of small flow of explosive mixtures of gas with air from cargo tanks due to thermal variations shall be taken into account.

IACS interpretation

This interpretation concerns area classification in relation to openings for small flow by thermal variations (SOLAS, Reg. II-2/11.6.2)

Area Classification is to be carried out in accordance with the principles laid down in IEC 60092-502:1999.

A1 Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of cargo tank ventilation outlets which permit the flow of small volumes of vapour or gas mixtures caused by thermal variation are defined as Zone 1 as specified by IEC 60092-502:1999 para 4.2.2.7.

A2 Areas within 2 m beyond the zone specified in A1 above are to be considered Zone 2 (as opposed to 1.5 m as specified by IEC 60092-502:1999 para 4.2.3.1).

A3 Electrical equipment or cables shall not normally be installed in hazardous areas. Where essential for operational purposes, electrical equipment may be installed in accordance with IEC 60092-502:1999.

(...) (IACS UI SC70)

21.4.5 Portable electrical equipment intended for oil recovery from sea surface

21.4.5.1 Portable electrical equipment shall be of explosion-proof construction.

21.4.5.2 Panels or sockets used for supplying portable electrical equipment shall be fitted with interlocking preventing the connection of live portable electrical equipment, as well as with protective devices against short-circuit and overload in any phase.

Such panels or sockets shall be so installed that a cable used for supplying portable electrical equipment does not run through door openings or any other openings capable of being closed, enclosing hazardous rooms and spaces.

21.4.5.3 Flexible cables used for supplying portable electrical equipment shall have a metal shield covered with a tight non-metallic sheathing resistant to kerosine products.

21.4.6 Installation of cables

21.4.6.1 In crude oil tankers and ships intended or adapted for operation in the oil spillage area, cables installed on gangways shall be laid in appropriate conduits or pipes (see 16.8.8).

Where gangways are provided in the spaces mentioned in 21.4.3.1.9, the cables laid on them shall fulfil the requirements of paragraph 2.9.17.

21.4.6.2 For systems operating at the voltage specified in 21.4.2.1.4, only cables having copper sheaths plus additional isolating coating on those sheaths shall be used. The cross-sectional area of the sheaths shall not be less than the cross-sectional area of the core. The design of such cables is subject to PRS consideration in each particular case.

21.4.7 Additional means for prevention against explosion in cargo pump spaces

21.4.7.1 Cargo, ballast and stripping pumps installed in cargo pump spaces and driven through shafts penetrating through bulkheads of those spaces shall be equipped with temperature measuring systems of bulkhead shaft sealing, bearings and pump casings. The alarm signal shall be given in cargo central station or on pump control stand and it shall be continuous, audible and visual.

21.4.7.2 To discourage personnel from entering the cargo pump-room when the ventilation system is not in operation, one of the following means shall be applied:

.1 interlocking of lighting in the cargo pump-room with the ventilation system shall be provided such that the ventilation shall be in operation to energize the lighting. Failure of the ventilation system should not cause the lighting to go out. Emergency lighting shall not be interlocked;

.2 warning alarms shall be provided at the door to the cargo pump- room:

- visual alarm warning that the cargo pump-room ventilation system is not in operation, that the pump-room atmosphere may therefore be hazardous, and that the pump-room shall not be entered until verified safe;
- visual and audible alarms indicating that pump-room door was opened, although the pump-room ventilation system is not in operation. The alarms shall also operate on the navigation bridge. Reset of the alarm shall be provided from the navigation bridge only.

21.4.7.3 A system for continuous monitoring of the concentration of hydrocarbon gases shall be provided. Sampling points or measuring detector heads shall be located in suitable positions in order that potentially dangerous leakages are easily detected. Sequential sampling is acceptable as long as it is dedicated for the pump-room only, including exhaust ducts, and the sampling time is reasonably short. Suitable positions may be the exhaust ventilation duct, lower parts of the pump-room above floor plates or other areas where air circulation is reduced. The system shall cause activation of alarm signal when gas concentration exceeds 10% of the lower flammable limit.

Alarm signal (visual and audible) shall be given in the pump-room, engine control room, cargo central station and on the navigation bridge. The requirements for gas analysing units are specified in 21.4.8.

21.4.7.4 All cargo pump-rooms shall be equipped with the bilge well monitoring system with properly arranged signalling system.

21.4.8 Location of units for continuous analysis of flammable vapours and gas

21.4.8.1 Gas analysing units with non-explosion proof measuring equipment may be located in areas outside the cargo spaces, e.g. in cargo central station, on the navigation bridge or in the engine room when mounted on the forward bulkhead, provided that the requirements, specified in 21.4.8.2 to 21.4.8.6, are fulfilled.

21.4.8.2 The gas sampling pipes shall not be led through hazardous spaces, except where permitted in 21.4.8.6.

21.4.8.3 The gas sampling pipes shall be equipped with flame arresters. Sample gas shall be led to the atmosphere through outlets arranged in a safe location.

21.4.8.4 Bulkhead penetrations of sample pipes between safe and hazardous areas shall be type-approved and have the same fire integrity as the division penetrated. A manual isolating valve shall be fitted in each of the sampling pipes at the bulkhead on the gas safe side.

21.4.8.5 The gas detection equipment, including sample piping, pumps, solenoids, analysing units, etc. shall be located in a reasonably gastight steel cabinet (e.g. a fully enclosed steel cabinet with a gasketed door) monitored by its own sampling point. At gas concentrations above 30% of the lower flammable limit inside the steel cabinet, the entire gas analysing unit shall be automatically shut down.

21.4.8.6 Where the cabinet cannot be arranged directly on the bulkhead, sample pipes shall be of steel or other equivalent material and without detachable connections, except for the connection points for isolating valves at the bulkhead and analysing units, and they shall be routed on their shortest ways.

21.4.9 Integrated cargo and ballast systems on tankers

21.4.9.1 Integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps.

21.4.9.2 A single failure in the integrated cargo and ballast system – including its control and safety systems – shall not make the integrated cargo and ballast pumps inoperable simultaneously.

21.4.9.3 The emergency stop circuits of the cargo and ballast systems shall be independent of the circuits for the control systems and a single failure in the control system circuits or the emergency stop circuits shall not cause disconnection of power supply and in consequence stopping the ballast pumps.

21.4.9.4 Manual emergency stops of the cargo pumps shall not make the ballast pumps inoperable.

21.4.9.5 The control systems shall be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply shall provide audible and visible alarm activation at each location where the control panel is fitted.

21.4.9.6 In the event of failure of the automatic or remote control systems, secondary means of control shall be made available for the operation of the integrated cargo and ballast system. This shall be achieved by manual overriding and/or redundant arrangements within the control systems.

21.4.10 Earthing and bonding of cargo tanks/process plant/piping systems for the control of static electricity

IACS UR E9

21.4.10.1 The hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of liquids/gases/vapours can be avoided if the resistance between the cargo tanks/process plant/piping systems and the hull of the ship is not greater than 10^6 ohm. (E9.1)

21.4.10.2 This value of resistance will be readily achieved without the use of bonding straps where cargo tanks/process plant/piping systems are directly or via their supports, either welded or bolted to the hull of the ship. (E9.2)

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

a) independent cargo tanks;
b) cargo tanks/piping systems which are electrically separated from the hull of the ship;
c) pipe connections arranged for the removal of spool pieces.
d) wafer-style valves with non-conductive (e.g. PTFE) gaskets or seals. (E9.3)

21.4.10.4 Where bonding straps are required, they should be:

a) clearly visible so that any shortcomings can be clearly detected;
b) 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;
c) easy to install and replace. (E9.4)

21.4.10.5 Checks should be made on the resistance to the hull of the ship during construction of the ship and at subsequent major surveys, supplemented by visual inspection during annual surveys. (E9.5)

END OF IACS UR E9

21.5 Gas tankers – additional mark: LIQUIFIED GAS TANKER

Gas tankers shall fulfil the requirements specified in PRS' *Rules for the Classification and Construction of Sea-going Gas Tankers*.

21.6 Chemical tankers – additional mark: CHEMICAL TANKER

Chemical tankers' electrical systems and equipment shall fulfil the requirements specified in the *International Code for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code)* as amended including standards and guidelines referred therein. Below are listed such requirements from the *IBC Code* concerning electrical installations and control system together with their related interpretations. Original numbering from the *IBC Code* has been retained.

– **Survival requirements**

2.9.3 At final equilibrium after flooding:

.1 (...)
.2 the emergency source of power shall be capable of operating.

IACS interpretation

The following additional requirements are to be taken into account:

1. (...)
2. IMO International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, clause 2.9.3.2. (UI SC290)

– **Cargo temperature control**

7.1.5 Means shall be provided for measuring the cargo temperature.
(...)
.3 A closed temperature-measuring device is subject to the definition for a closed gauging device in 13.1.1.3 (e.g. a remote-reading thermometer of which the sensor is installed in the tank).
.4 When overheating or overcooling could result in a dangerous condition, an alarm system which monitors the cargo temperature shall be provided.

– **Cargo tank venting**

8.2.3 Provision shall be made to ensure that the liquid head in any tank does not exceed the design head of the tank. Suitable high-level alarms, overflow control systems or spill valves, together with gauging and tank filling procedures, may be accepted for this purpose. (...)

8.3.3 Controlled tank venting systems shall consist of a primary and a secondary means of allowing full flow relief of vapour to prevent over-pressure or under-pressure in the event of failure of one means. Alternatively, the secondary means may consist of pressure sensors fitted in each tank with a monitoring system in the ship' s cargo control room or position from which cargo operations are normally carried out. Such monitoring equipment shall also provide an alarm facility which is activated by detection of over pressure or under pressure conditions within a tank.

– **Electrical installations**

10.1 General

10.1.1 The provisions of this chapter are applicable to ships carrying cargoes which are inherently, or due to their reaction with other substances, flammable or corrosive to the electrical equipment, and shall be applied in conjunction with applicable electrical requirements of part D of chapter II-1 of SOLAS.

Note:
All electrical requirements of part D of chapter II-1 of SOLAS i.e. Regulations II-1/40 to II-1/45, have been implemented in this *Part VIII* in chapters: 2, 3, 4, 6, 8, 9, 13, 16 and 21.4.

10.1.2.1 Electrical installations shall be such as to minimize the risk of fire and explosion from flammable products*

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* Reference is made to the recommendations published by the International Electrotechnical Commission, in particular to Publication IEC 60079-1-1:2002 (IEC 60092-502:1999).

10.1.2.2 Where the specific cargo is liable to damage the materials normally used in electrical apparatus, due consideration shall be given to the particular characteristics of the materials

chosen for conductors, insulation, metal parts, etc. As far as necessary, these components shall be protected to prevent contact with gases or vapours liable to be encountered.

10.1.3 The Administration shall take appropriate steps to ensure uniformity in the implementation and the application of the provisions of this chapter in respect of electrical installations.

10.1.4 Electrical equipment, cables and wiring shall not be installed in the hazardous locations unless it conforms with the standards not inferior to those acceptable to the Organization*. However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Administration, to ensure that an equivalent level of safety is assured.

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* Reference is made to the recommendations published by the International Electrotechnical Commission, in particular to Publication IEC 60079-1-1:2002 (IEC 60092-502:1999).

Note:
See IACS interpretation UI SC274 in 21.4.4.1.

10.1.5 Where electrical equipment is installed in hazardous locations, as permitted in this chapter, it shall be to the satisfaction of the Administration and certified by the relevant authorities recognized by the Administration for operation in the flammable atmosphere concerned, as indicated in column *i* in the table of chapter 17.

10.1.6 For guidance, indication is given if the flashpoint of a substance is in excess of 60°C. In the case of a heated cargo, carriage conditions might need to be established and the requirements for cargoes having a flashpoint not exceeding 60°C applied.

10.2 Bonding

Independent cargo tanks shall be electrically bonded to the hull. All gasketed cargo-pipe joints and hose connections shall be electrically bonded.

The requirements of 21.4.10 shall also be complied with.

10.3 Electrical requirements for individual products

Electrical requirements for individual products are shown in column *i* in the table of chapter 17.

– **Mechanical ventilation in the cargo area**

12.1.8 Electric motors driving fans shall be placed outside the ventilation ducts if the carriage of flammable products is intended. (...)

21.7 Special purpose ships – additional marks: SPECIAL PURPOSE SHIP, CREW BOAT, RESEARCH SHIP, TRAINING SHIP

Special purpose ships of gross tonnage 500 and above shall fulfil the requirements specified in the *Code of Safety of Special Purpose Ships, 2008 (SPS Code)*. Ships to be assigned additional mark CREW BOAT , in lieu of compliance with *SPS Code*, shall comply with the applicable requirements of *Publication 12/P – Safety requirements for sea-going ships carrying industrial personnel.*

21.8 Floating cranes – additional mark: FLOATING CRANE

21.8.1 For floating cranes and crane ships in which driving systems similar to those described in Chapter 17 are used for hoisting gears, the requirements of that Chapter may be applied to the electrical drives of hoisting gears within the scope agreed with PRS in each particular case.

21.8.2 For floating cranes having their own propulsion, the output of the main sources of electric power shall be sufficient for ensuring the operation of the crane under one of the conditions: when travelling or during loading operations.

21.8.3 The rooms and lockers intended for the location of accumulator batteries, as well as the rooms of emergency sources of electric power are allowed to be situated below the main deck, provided all other requirements specified in Chapter 13 and subchapter 9.2 are complied with.

21.8.4 Floating cranes shall be provided with an audible signalling system operated from the crane operator cabin to give audible signals during loading operations.

21.8.5 Telephone communication between the navigation bridge and the crane operator cabin shall be provided.

21.9 Bulk carriers and combination carriers – additional marks: BULK CARRIER, SELF-UNLOADING BULK CARRIER, ORE CARRIER, ORE CARRIER/CRUDE OIL TANKER, BULK CARRIER/ORE CARRIER/CRUDE OIL TANKER

Note:
Combination carriers receiving in their symbol of class additional mark **CRUDE OIL TANKER** shall also comply with the relevant requirements of Section 21.4.

21.9.1 Hold, ballast and dry space water ingress alarms* (SOLAS, Reg. XII/12)

* When water level detectors are installed on bulk carriers in compliance with this subchapter (regulation XII/12), they shall be of a type approved by PRS, complying with the requirements specified in *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships* (the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers*, annexed to resolution MSC.188(79) adopted on 3 December 2004, should be applied).

21.9.1.1 Bulk carriers shall be fitted with water level detectors:

.1 in each cargo hold, giving audible and visual alarms, one when the water level above the inner bottom reaches a height of 0.5 m (the pre-alarm) and another at a height not less than 15% of the depth of the cargo hold but not more than 2 m (the main alarm). (...) The water level detectors shall be fitted in the aft end of the cargo holds. For cargo holds which are used for water ballast, an alarm overriding device may be installed. The visual alarms shall clearly discriminate between the two different water levels detected in each hold;

.2 in any ballast tank forward of the collision bulkhead required by regulation II-1/12, giving an audible and visual alarm when the liquid in the tank reaches a level not exceeding 10% of the tank capacity. An alarm overriding device may be installed to be activated when the tank is in use; and

.3 in any dry or void space other than a chain cable locker, any part of which extends forward of the foremost cargo hold, giving an audible and visual alarm at a water level of 0.1 m above the deck. Such alarms need not be provided in enclosed spaces the volume of which does not exceed 0.1% of the ship's maximum displacement volume. (SOLAS, Reg. XII/12.1)

21.9.1.2 The audible and visual alarms specified in 21.9.1.1 (paragraph 1) shall be located on the navigation bridge. (SOLAS, Reg. XII/12.2)

21.10 General cargo ships occasionally carrying bulk cargoes – additional mark: DRY CARGO SHIP

21.10.1 Multiple hold cargo ships other than bulk carriers and tankers (...) shall be fitted with water level detectors* in each cargo hold intended for dry cargoes. Water level detectors are not required for cargo holds located entirely above the freeboard deck. (SOLAS Reg. II-1/25-1.1)

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* Water level detectors are to be of a type approved by PRS, complying with the requirements specified in *Publication 124/P – Performance Standards for Water Level Detection Systems Used on Ships* (Refer to the *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers* (resolution MSC.188(79)), as may be amended).

21.10.2 The water level detectors required by 21.10.1 (paragraph 1) shall:

.1 give audible and visual alarms at the navigation bridge, one when the water level above the bottom of the cargo hold reaches a height of not less than 0.3 m, and another at a height not less than 15% of the depth of the cargo hold but not more than 2 m; and

.2 be fitted at the aft end of the cargo holds. For cargo holds which are occasionally used for water ballast, an alarm overriding device may be installed. The visual alarms shall clearly discriminate between the two different water levels detected in each hold. (SOLAS Reg. II-1/25-1.2)

21.10.3 As an alternative to the water level detector at a height of not less than 0.3 m as per 21.10.2.1 (sub-paragraph 2.1), a bilge level sensor* serving the bilge pumping arrangements required by *Part VI*, 2.3.1 (regulation 35-1) and installed in the cargo hold bilge wells or other suitable location is considered acceptable, subject to:

.1 the fitting of the bilge level sensor at a height of not less than 0.3 m at the aft end of the cargo hold; and

.2 the bilge level sensor giving audible and visual alarm at the navigation bridge which is clearly distinctive from the alarm given by the other water level detector fitted in the cargo hold. (SOLAS Reg. II-1/25-1.3)

21.11 Chemical spill response ships – additional mark: CHEMICAL RECOVERY VESSEL

21.11.1 Chemical spill response ships shall fulfil the requirements specified in subchapter of 21.4 of this *Part* of the *Rules* wherever reference is made to IEC 60092-502.

21.11.2 Chemical spill response ships shall fulfil the requirements specified in *Part V*, subchapters 11.10.13 and 11.10.15.

21.11.3 General

21.11.3.1 Electrical installations shall be such as to minimize the risk of fire and explosion from flammable products.

21.11.3.2 Due consideration shall be given to the particular characteristics of the materials chosen for conductors, insulation, metal parts, etc. As far as necessary, these components shall be protected to prevent contact with gases or vapours liable to be encountered.

21.11.3.3 Electrical equipment, cables and wiring shall not be installed in the hazardous locations unless it is necessary for operational reasons.

21.11.3.4 Where electrical equipment is installed in hazardous locations, as permitted in this subchapter, it shall be certified by competent authorities for operation in the flammable atmosphere concerned.

21.11.3.5 The limitations provided in this subchapter do not preclude the application of intrinsically safe systems and/or circuits in any in explosion hazardous location including cargo piping. It is particularly recommended that intrinsically safe systems and circuits be used for measurement, monitoring, control and communications purposes.

21.11.3.6 For cargoes having a flashpoint not exceeding 60°C (closed-cup test):

.1 For the specific cargo or clearly defined range of cargoes, application of electric motors and associated cables for the drive of immersed cargo pumps taking special care about chemical and physical properties of such cargoes subject to PRS consent in each particular case. Means shall be provided to preclude power supply to the motors and cables located n flammable atmosphere and to enable the power supply to such motors and cables to be cut off where the hazard has been detected. Alarm on such cut-off shall be indicated at the respective operating position.

.2 If electrical equipment is located in the cargo pump room, it shall be certified by competent authorities as intrinsically safe.

.3 If the cargo is heated to a temperature lower, by 15°C or less, than its flashpoint, the cargo pump room and the areas within 3 m from tanks containing such a heated cargo as well as areas within 3 m from access and ventilation openings are considered as explosion hazardous locations. Electrical equipment installed in such areas shall be certified by competent authorities as intrinsically safe.

.4 If the cargo is heated to a temperature above its flashpoint, the requirements specified in 21.11.3.7 apply.

21.11.3.7 Below are defined explosion hazardous areas for cargoes having a flashpoint not exceeding 60°C (closed-cup test) where in addition to the intrinsically safe systems and/or circuits, the following electrical installations are permitted:

.1 Cargo tanks and piping: no additional electrical equipment is permitted;

.2 Void spaces adjacent to or locates above or under integral tanks:

.2.1 Cables passing through to be led in thick-walled steel pipes with gastight connections and without expansion joints.

.2.2 Electrical sounding arrangements or electrical ground logs as well as anodes and electrodes for cathodic protection system to be gastight-sheathed shall be protected in accordance with the requirements specified in 21.11.3.7.2.1.

.3 Cargo spaces containing independent cargo tanks:

.3.1 Cables passing through with no additional protection.

.3.2 Lighting fittings with pressure protection or enclosed in a flameproof enclosure. The lighting system shall be divided into at least two branched off systems. All connections and protecting devices shall isolate all the branched off poles or phases and shall be installed outside explosion hazardous locations.

.3.3 Electrical sounding arrangements or electrical ground logs as well as anodes and electrodes for cathodic protection system to be gastight-sheathed.

.4 Cargo pump rooms and pump rooms in cargo areas:

.4.1 Lighting fittings with pressure protection or enclosed in a flameproof enclosure. The lighting system shall be divided into at least two branched off systems. All connections and protecting devices shall isolate all the branched off poles or phases and shall not be installed in explosion hazardous locations.

.4.2 Electrical motors driving cargo pumps and all the associated auxiliary pumps. Such motors shall be isolated from explosion hazardous locations by means of gastight bulkhead or deck and located in compartments provided with overpressure ventilation. On shafts between the driven machinery and their motors, flexible couplings or other means of alignment shall be installed. Bulkhead or deck penetrations shall be provided with glands in accordance with the recognised standards.

.4.3 Flameproof general alarm sounder system.

.5 Areas on open deck, or semi-enclosed spaces on deck, within 3 m of any cargo tank outlet, gas or vapour outlet, tank associated piping flange, access to or ventilation opening of cargo pump-rooms;

Cargo area on the open deck over all the cargo tanks and cargo holds for cargo tanks including ballast tanks and cofferdams within the block of cargo tanks throughout the ship breadth plus 3 m fore and aft and up to the level of 2.4 m above the deck:

.5.1 Equipment of a certified safe type suitable to be used on open deck.

.5.2 Cables passing through.

.6 Enclosed or semi-enclosed spaces on deck containing cargo piping;

Enclosed or semi-enclosed spaces over cargo tanks (e.g. between decks) or having bulkheads coplanar with cargo tank bulkheads;

Enclosed or semi-enclosed spaces over cargo pump rooms or over vertical cofferdams adjacent to cargo tanks unless they are bounded by gastight deck and properly ventilated;

Cargo hose lockers:

.6.1 Lighting fittings shall be certified by competent authorities as intrinsically safe. The lighting system shall be divided into at least two branched off systems. All connections and protecting devices shall isolate all the branched off poles or phases and shall be installed outside explosion hazardous locations.

.6.2 Cables passing through

.7 Enclosed or semi-enclosed spaces with direct openings to any of the above mentioned hazardous areas shall be provided with electrical installations in accordance with the requirements for the respective area.

21.11.3.8 Control of static electricity

Independent cargo tanks, related pipes having connections containing gaskets and hose connections shall comply with 21.4.10.

21.12 Fishing vessels – additional mark: FISHING VESSEL

21.12.1 Fishing vessels of 24 meters in length and more flying the flag of an EU Member State and registered in the community, or operating in the territorial waters or territorial sea of an EU Member State, or landing their catch in the port of an EU Member State shall comply in full with all the applicable requirements specified in *Publication 10/P – Safety requirements for sea-going fishing vessels.*

21.12.2 Fishing vessels of 24 meters in length and more other than those specified in 21.12.1 shall comply with the applicable requirements of the *Torremolinos International Convention for the Safety of Fishing Vessels 1977* and of the *Torremolinos Protocol* relating to the Convention specified in *Publication 10/P – Safety requirements for sea-going fishing vessels.*

21.12.3 Fishing vessels need not comply with the SOLAS requirements specified in this *Part VIII*.

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

CHAPTER 22

22 ADDITIONAL REQUIREMENTS FOR SPECIFIC STRUCTURES, SYSTEMS OR EQUIPMENT

22.1 Unattended operation of machinery space and one man bridge operation – additional marks: AUT, NAV1

22.1.1 Application

22.1.1.1 The requirements of the present Chapter apply to ships which shall be assigned additional mark **AUT** or **NAV1** in the symbol of class. Automation systems of these ships shall also fulfil the requirements specified in other Chapters of this *Part* of the *Rules*.

22.1.1.2 To be assigned mark **AUT**, which means the ship ability for unattended operation of the machinery space, the requirements specified in subchapter from 21.2 to 21.4 shall be fulfilled. These requirements have been set out under the assumption that the number of engineering staff on board is sufficient to maintain seaworthiness of the ship in case of failure of automatic systems, as well as to perform routine adjustment and inspection of the operation of such systems.

22.1.1.3 To be assigned mark **NAV1**, which means that the ship is adapted for one man bridge operation, the requirements specified in *Publication 35/P – One Man Bridge Operated (OMBO) Ships* shall be fulfilled.

22.1.2 General requirements

22.1.2.1 The extent of machinery automation shall be such that the operation of machinery periodically unattended is possible during a period of 8 hours. This applies to the following machinery and equipment:

.1 the main propulsion, together with auxiliary machinery and controllable pitch propeller;
.2 electric power supply and distribution;
.3 steam boilers and exhaust gas boilers;
.4 air compressors;
.5 fuel and lubricating oil separators;
.6 inert gas generators;
.7 other machinery and equipment covered by the *Rules*.

The automatic control systems maintaining working parameters (temperature, pressure, viscosity, etc.) shall be provided. These systems shall be capable of maintaining the working parameters under all normal service conditions, including manoeuvring, within the limits appropriate for the considered machinery, equipment and installations.

22.1.2.2 Subject to PRS consent in each particular case, the extent of automation of some simple and daily irregular operations may be limited to remote control from the ship navigation bridge.

22.1.2.3 The local manual control may be applied as the only means of control to perform:

.1 operations performed at regular intervals, if, due to the character of these operations or the arrangement of the plant, the intervals are greater than the assumed unmanned period;
.2 operations performed irregularly and not requiring quick response to alternations of the conditions (e.g. blowing-off sea valves or chests with the exception of the case specified in 22.1.2.5, change-over to filling, emptying, cleaning or heating the tanks, etc.);

.3 operations associated with starting the installations.

22.1.2.4 The power units developing the auxiliary energy (pneumatic or hydraulic) used in automatic systems shall start automatically so that the continuity of power supply is maintained in all service conditions.

22.1.2.5 In ships with ice strengthening **L1A** and **L1**, arrangements for clearing sea valves and chests shall be remotely controlled from the navigation bridge.

22.1.2.6 Where on board ship with the mark for unattended machinery space added to the class symbol, refrigerating plant classed with PRS is fitted, the extent of automation of such plant, its monitoring systems and the arrangement of indicators of such systems are subject to PRS consideration in each particular case.

22.1.2.7 A reliable means of vocal communication*, shall be provided between the main machinery control room or the propulsion machinery control position as appropriate, the navigating bridge and the engineer officers' accommodation. (SOLAS, Reg. II-1/50) It is required that the communication system is working also during a blackout.

IMO interpretation
* *such as a dedicated telephone, common battery telephone or voice pipes (MSC/Circ.736)*

22.1.2.8 Means shall be provided for detecting a rise of water in the machinery space bilges or bilge wells. For this purpose, the following requirements shall be fulfilled:

.1 bilge wells shall be large enough to accommodate normal drainage during the unattended period. The arrangement of these wells and level sensors shall be such that accumulation of liquids may be detected at all normal angles of heel and trim as specified in 2.2.2.3;

.2 in the case where bilge pumps start automatically to drain machinery space, means shall be provided to indicate that the influx of liquid is greater than the pump capacity or that the pump is operating more frequently than would normally be expected.

In order to meet the above requirements, the following measures may be taken:
- smaller bilge wells to cover a reasonable period of time for accommodating normal drainage,
- alarms of bilge pump operating for more than 15 minutes,
- alarm of high water level in bilge wells operating prior to automatic starting of the pump.

Where automatically controlled bilge pumps are provided, special attention shall be given to oil pollution prevention requirements.

.3 alarms of high water level in bilges and those resulting from the requirements of sub-paragraph .2 shall be given in the space specified in 22.1.4.5, at the engineers' accommodation area and on the navigation bridge.

22.1.2.9 The requirements for fire detection systems in machinery space are specified in *Part V*, chapter 4,.

22.1.3 Special requirements for machinery, boiler and electrical installations (SOLAS, Reg. II-1/53)

22.1.3.1 The special requirements for the machinery, boiler and electrical installations shall be to the satisfaction of the Administration and shall include at least the requirements of 22.1.3 (this regulation). (SOLAS, Reg. II-1/53.1)

22.1.3.2 The main source of electrical power shall comply with the following:

.1 Where the electrical power can normally be supplied by one generator, suitable load shedding arrangements shall be provided to ensure the integrity of supplies to services required for propulsion and steering as well as the safety of the ship. In the case of loss of the generator in operation, adequate provisions shall be made for automatic starting and connecting to the main switchboard of a stand-by generator of sufficient capacity to permit propulsion and steering and to ensure the safety of the ship with automatic re-starting of the essential auxiliaries including, where necessary, sequential operations. The Administration may dispense with this requirement for a ship of less than 1,600 gross tonnage, if it is considered impracticable.

.2 If the electrical power is normally supplied by more than one generator simultaneously in parallel operation, provision shall be made, for instance by load shedding, to ensure that, in case of loss of one of these generating sets, the remaining ones are kept in operation without overload to permit propulsion and steering, and to ensure the safety of the ship. (SOLAS, Reg. II-1/53.2)

When the arrangement, specified in .1, shall be applied in ships where the main generating set is driven by a steam turbine, the prime mover of stand-by power supply unit shall be an internal combustion engine.

Note:
See also interpretations under 4.3.7.

22.1.3.3 Automatic control of effective reserve output of actually running generating sets shall be provided and the arrangement shall be such that automatic start of large power consuming machinery is only possible when the reserve output of generating sets is sufficient to cover starting and operational power demand of such machinery. In certain circumstances it may be necessary that stand-by generating set be started prior to start of the machinery in question.

22.1.3.4 Where stand-by machines are required for other auxiliary machinery essential to propulsion, automatic change-over devices shall be provided. (SOLAS, Reg. II-1/53.3)

IACS interpretation

This paragraph is applicable to stand-by machines required by the Rules of the individual Societies for:

1. *oil engines for propulsion purposes*
2. *steam turbines for propulsion purposes*
3. *gas turbines for propulsion purposes*
4. *controllable pitch propellers. (IACS UI SC14)*

22.1.3.5 Automatic control and alarm system (SOLAS, Reg. II-1/53.4)

22.1.3.5.1 The control system shall be such that the service needed for the operation of the main propulsion machinery and its auxiliaries are ensured through the necessary automatic arrangements. (SOLAS, Reg. II-1/53.4.1)

22.1.3.5.2 An alarm shall be given on the automatic change-over. (SOLAS, Reg. II-1/53.4.2)

22.1.3.5.3 An alarm system complying with 22.1.6.2 (regulation 51) shall be provided for all important pressures, temperatures and fluid levels and other essential parameters. (SOLAS, Reg. II-1/53.4.3)

22.1.3.5.4 A centralized control position, shall be arranged with the necessary alarm panels and instrumentation indicating any alarm. (SOLAS, Reg. II-1/53.4.4)

22.1.3.6 Means shall be provided to keep the starting air pressure at the required level where internal combustion engines are used for main propulsion. (SOLAS, Reg. II-1/53.5)

IMO interpretation

Starting air receivers are to be automatically charged if the air consumption during normal operation at sea can reduce the pressure by 20 per cent or more in the course of 24 hours. Manoeuvres are not included. (MSC/Circ.736)

22.1.4 Monitoring systems

22.1.4.1 The extent and operation principles of monitoring systems shall comply with:

- Table 22.1.4.1-1 – for ships of 500 gross tonnage and upwards;
- Table 22.1.4.1-2 – for ships of less than 500 gross tonnage.

Configurations where the extent of monitored parameters differs from that specified in the Table or where it is proposed to install the systems based on different operation principles, are subject to PRS consideration in each particular case.

Automatic change-over of stand-by machinery in auxiliary systems of the main internal combustion engine, as required by Tables 22.1.4.1-1 and 22.1.4.1-2, need not be applied if at least two main engines are provided for ship propulsion, each having independent auxiliary systems, as well as independent safety system which will stop one of the engines, when necessary, and will simultaneously disconnect that engine from the propulsion system.

22.1.4.2 The alarm system shall cover all automated machinery, as well as all types of alarms specified in 20.4.1.2.

22.1.4.3 Where the concentration of alarms is necessary in the engine room alarm panel, only such individual alarms may be concentrated which are related to parameters which cannot be exceeded simultaneously, as well as such which are associated with the same machinery, provided that individual alarms are indicated at the location of this machinery.

Group alarms shall fulfil all requirements for alarm system specified in 20.4.1.

Table 22.1.4.1-1 – ships of 500 gross tonnage and upwards

Item	Machinery, system or equipment	Parameters [1)]	Alarm system: alarm condition/monitored value of parameter	Safety system	Remarks
1	**Main propulsion**				
1.1	Main internal combustion engine (cross-head)				See 22.1.8 – Table 1
1.2	Main internal combustion engine (trunk-piston)				See 22.1.8 – Table 2
1.3	Main steam turbine				
1.3.1	Lubricating oil system	– oil pressure before turbine	– minimum	first stage: start of stand-by pump; second stage: shutdown of steam supply to turbine	
		– lubricating oil temperature	– maximum	–	
		– oil level in gravity tank	– minimum	–	
1.3.2	Condensation and cooling water system	– vacuum in condenser	– minimum	stop of turbine	
		– level in condenser	– maximum – minimum	stop of turbine stop of turbine	
		– level in hot-well	– maximum – minimum	– –	
		– level in de-aerator	– maximum – minimum	– –	
		– pressure in de-aerator	– minimum	–	
		– pressure or flow of condenser cooling water (after the condenser)	– minimum	start of stand-by pump	
		– pressure of condensate after pump	– minimum	start of stand-by pump	

Item	Machinery, system or equipment	Parameters [1]	Alarm system: alarm condition/monitored value of parameter	Safety system	Remarks
1.3.3	Steam system	– pressure at inlet to turbine	– maximum – minimum	– –	
		– pressure of gland sealing steam	– maximum – minimum	– –	for each turbine casing separately
1.3.4	Miscellaneous	– turning gear	– engaged	–	
		– temperature of journal and thrust bearings	– maximum	–	
		– axial rotor displacement	– maximum	stop of turbine	
		– transverse rotor displacement	– maximum	stop of turbine	
		– vibration of turbine casing	– dangerous	stop of turbine	
		– excessive speed of turbine	–	stop of turbine	
1.4	Main gear	– pressure of lubricating oil at inlet	– minimum	first stage: start of stand-by pump [2]; second stage: stop of main engine	
		– temperature of lubricating oil at inlet	– maximum	–	
		– pressure difference on lubricating oil filter	– maximum	–	
		– temperature of main bearings	– maximum	–	
1.5	Shaft line	– temperature of thrust, intermediate and stern tube bearings	– maximum	–	
		– oil pressure in hydraulic coupling	– minimum	–	only in the case of separate oil system
		– level in gravity tank of stern tube lubrication	– minimum	–	
		– oil pressure in servo-system of c.p. propeller	– minimum	start of stand-by pump	
		– oil temperature in servo-system of c.p. propeller at outlet	– maximum	–	
1.6	Compressors	– pressure of compressor lubricating oil	– minimum	stop of compressor	

Item	Machinery, system or equipment	Parameters [1)]	Alarm system: alarm condition/monitored value of parameter	Safety system	Remarks
		– flow of compressor cooling water	– no flow	stop of compressor	
		– temperature of compressor cooling water at outlet	– maximum	–	
2	**Electrical installation**				
2.1	Main switchboards	– insulation resistance	– minimum	functional features of safety system will be separately considered depending on the arrangement	
		– voltage	– maximum – minimum		
		– frequency	– maximum – minimum		
2.2	Main generators	– load current	– maximum	functional features of safety system will be separately considered depending on the arrangement	
		– short-circuit current	– minimum		
		– reverse power	– maximum		
2.3	Internal combustion engines driving main generators (trunk-piston)				See 22.1.9 – Table 1
2.4	Internal combustion engines driving emergency generators				See 22.1.10 – Table 1
2.5	Steam turbines driving generators	– pressure of lubricating oil at inlet	– minimum	stop of turbine	
		– temperature of lubricating oil at inlet	– maximum	–	
		– pressure in condenser	– maximum and minimum	stop of turbine	with regard to counter-pressure or vacuum
		– level in condenser	– maximum	stop of turbine	
		– axial rotor displacement	– maximum	stop of turbine	

Item	Machinery, system or equipment	Parameters [1]	Alarm system: alarm condition/monitored value of parameter	Safety system	Remarks
2.6	Steering gear with electric or electrohydraulic propulsion	– supply voltage	– minimum	switching on of second feeder or second power supply unit	
		– load current	– maximum	depending on the arrangement	
		– short-circuit current	– minimum	disconnection of drive	
2.7	Electrical drives of other essential machinery	– load current	– maximum	depending on the arrangement	
		– short-circuit current	– minimum	disconnection of drive	
3	**Piping system**				
3.1	Bilge system	– vacuum on suction side of the pump	– minimum	–	
		– level in bilge wells of machinery space	– maximum	–	separate alarm signal on the bridge (see also 21.2.8) is recommended
3.2	Fuel oil treatment system	– level in fuel settling tank	– minimum	–	only in the case when purifier shall be in operation during unmanned period
		– water seal of fuel purifier	– loss of water	–	
		– fuel temperature at purifier inlet	– maximum	–	
3.3	Sludge systems	– level in purifier wastes tank	– minimum	–	only in the case when purifier shall be in operation during unmanned period
		– level in sludge tanks	– maximum	–	
3.4 [4]	Boiler air supply casings and exhausts (uptakes)	– fire at an early stage (SOLAS, Reg. II-1/47.1.1)	– alarm signal	–	
3.5 [4]	Scavenging air belts of propulsion machinery	– fire at an early stage (SOLAS, Reg. II-1/47.1.2)	– alarm signal	–	
4	**Steam boilers and associated systems**				
4.1	Boiler	– pressure of steam	– maximum	–	

Item	Machinery, system or equipment	Parameters [1)]	Alarm system: alarm condition/monitored value of parameter	Safety system	Remarks
		– water level	– maximum – minimum	shutdown of fuel oil supply at minimum level	
		– temperature of superheated steam	– maximum	–	for main boilers only
		– temperature of saturated steam	– maximum	–	for main boilers only
4.2	Circulating pump	– water flow through pump	– no flow	depending on arrangement of system and type of boiler	
4.3	Feed water system	– pressure on delivery side of feed water pump	– minimum	start of stand-by pump	
		– pressure of lubricating oil at inlet to the turbine driving feed water pump	– minimum	stop of turbine and start of stand-by pump	for main boilers only
4.4	Firing system	– pressure of fuel oil before burner	– minimum	–	
		– flame extinguishing	–	shutdown of fuel oil supply	
		– pressure of combustion air	– minimum	shutdown of fuel oil supply	
		– temperature of fuel oil before burner	– maximum – minimum	shutdown of fuel oil supply at minimum temperature	
		– level in daily service tank	– minimum	–	for auxiliary boilers only in the case when boiler is necessary for the operation of main engine
		– rotary air heater	– stopping	shutdown of fuel oil supply	for main boilers only
		– pressure of atomising steam	– minimum	shutdown of fuel oil supply	for main boilers only
5	**Classified refrigerating plant**				
	Refrigerating plant	–	– malfunction	–	group alarm signal
		–	– failure	–	group alarm signal of operation of safety system

1) Parameters covered by safety and alarm systems, with the exception of levels and flow, shall also be covered by indicating system.
2) The stand-by pump may also be started by the "no flow" signal.
3) Equipment for crankcase oil mist detection and alarm (separate for each engine) or alternatively, the engine bearing temperature monitoring system, or other equivalent devices shall be of the type approved by PRS. The procedure for type testing of equipment for crankcase oil mist detection and alarm is specified in *Publication 79/P – Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment*.

IACS interpretation

An equivalent device could be interpreted as measures applied to high speed engines where specific design features to preclude the risk of crankcase explosions are incorporated. (IACS UI SC133)

4) See also interpretations in *Part V*, item 6.16.5.1
5) For each engine, one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down systems.

Table 22.1.4.1-2 – Ships of less than 500 gross tonnage

Item	Machinery, system or equipment	Parameters [1]	Alarm system: alarm state/monitored value of parameter	Safety system	Remarks
1	**Main propulsion**				
1.1	Main internal combustion engine				
1.1.1	Lubricating oil system	– pressure at inlet to engine (after filter)	– minimum	first stage: start of stand-by pump [3]; second stage: stop of engine	
		– temperature at inlet to engine	– maximum	load reduction [2]	
		– level in circulating oil tank	– minimum	–	
1.1.2.	Cooling system	– temperature of cooling water at outlet from engine	– maximum	–	on outlet manifold after cylinders
		– pressure or cooling water flow at inlet	– minimum	first stage: start of stand-by pump [3]; second stage: load reduction [2]	for fresh and sea water
		– level in compensating tanks	– minimum	–	
1.1.3	Fuel system	– level in service tanks	– minimum	–	
1.1.4	Exhaust system	– temperature of exhaust gases	– maximum	load reduction [2]	on exhaust manifold after cylinders
1.1.5	Engine overspeed	–	– alarm signal	stop of engine	
1.2	Main gear	– pressure of lubricating oil at inlet	– minimum	first stage: start of stand-by pump [3]; second stage: stop of main engine	
		– temperature of lubricating oil at inlet	– maximum	–	
1.3	Shaft line	– temperature of thrust bearing	– maximum	–	
		– oil pressure in hydraulic coupling	– minimum	–	only in the case of separate oil system

Item	Machinery, system or equipment	Parameters [1]	Alarm system: alarm state/monitored value of parameter	Safety system	Remarks
		– level in gravity tank of stern tube lubrication	– minimum	–	
		– oil pressure in servo-system of c.p. propeller	– minimum	start of stand-by pump	
2	**Electrical installation**				
2.1	Main switchboards	– insulation resistance	– minimum	–	recommended
		– voltage	– maximum – minimum	–	recommended
		– frequency	– maximum – minimum	–	recommended
2.2	Internal combustion engines driving electrical generators	– pressure of lubricating oil at inlet	– minimum	stop of engine	
		– temperature of lubricating oil at inlet	– maximum	–	
		– temperature of cooling water or air at outlet	– maximum	–	
		– starting air pressure	– minimum		
		– engine overspeed	– alarm signal	stop of engine	
3	**Piping system**				
3.1	Bilge system	– level in bilge wells of machinery space	– maximum	–	separate alarm signal on the bridge (see also 21.2.7)
3.2 [4]	Boiler air supply casings and exhausts (uptakes)	– fire at an early stage (SOLAS, Reg. II-1/47.1.1)	– alarm signal	–	
3.3 [4]	Air scavenging air belts of propulsion machinery	– fire at an early stage(SOLAS, Reg. II-1/47.1.2)	– alarm signal	–	
4	**Steam boilers and associated systems**				
4.1	Boiler	– steam pressure	– maximum	–	

Item	Machinery, system or equipment	Parameters [1]	Alarm system: alarm state/monitored value of parameter	Safety system	Remarks
		– water level	– maximum – minimum	shutdown of fuel oil supply at minimum level	
4.2	Circulating system	– water flow through circulating installation	– no flow	depending on arrangement of system and type of boiler	
4.3	Feed water system	– delivery pressure of feed water pump	– minimum	start of stand-by pump	
4.4	Firing system	– failure of burner	–	emergency shutdown of fuel oil supply	

1) Parameters covered by safety and alarm systems, with the exception of levels and flow, shall also be covered by indicating system.
2) The function of safety system may be performed by the operator according to the alarm signal, or need not be required if the exceeding of parameter does not cause critical condition for the engine according to the engine manufacturer's statement.
3) The stand-by pump may also be started by the "no flow" signal.
4) See also interpretations in *Part V*, item 6.16.5.1

22.1.4.4 When group alarms are used to indicate alarm conditions on the navigation bridge, the alarm system on the bridge shall cover the following alarm groups, as applicable:

.1 alarm requesting to stop the main engine;
.2 alarm requesting the load reduction of the main engine;
.3 alarm to indicate that safety system stopping the main engine has operated;
.4 alarm to indicate that safety system reducing the main engine load has operated;
.5 alarm to indicate that starting (reversing) of the main engine has failed;
.6 alarm to indicate failure of the steering gear;
.7 alarm to indicate failure of the power supply to automatic systems;
.8 alarm to indicate the excessive bilge water level in machinery space;
.9 group covering all other alarms as specified in 22.1.4.1;
.10 alarm to indicate that alarm system of the internal combustion engine driving emergency generator has operated;
.11 alarm to indicate that safety system of the internal combustion engine driving emergency generator has operated.

Alarms indicating such states of machinery which have direct influence on ship manoeuvrability shall operate on the navigation bridge, no matter which station is actually responsible for the control of machinery.

Switching over of alarm system from the machinery space to the bridge or vice versa shall be accompanied by visual and audible signal given in accordance with 20.4.1.5, 20.4.1.6 and 20.4.1.7.

22.1.4.5 All annunciators of alarm system, and to the necessary extent, the displaying instruments of indicating system, shall be concentrated in the space in which the superior control station is situated.

Where in parallel to the control station on the navigation bridge which is equipped with group alarms, only local control stations in the machinery space are provided, all indicators of indicating system shall be situated on engines, turbines and machinery only, and all annunciators of alarm system giving detailed information shall be concentrated in one place in the machinery space or in an adjacent space having door communication with the machinery space.

22.1.4.6 Where the repeaters of alarm system annunciators are located within the accommodation spaces, the switching off of the alarm signal (alarm acknowledgment) in the accommodation spaces shall also be indicated on the navigation bridge.

Where the repeaters of alarm system annunciators are not provided within accommodation spaces, other reliable and efficient means of communication between the bridge and the accommodation of the personnel responsible for machinery operation shall be fitted. Such means of communication are also recommended in the case where the repeaters of alarm system annunciators are provided.

22.1.5 Control of propulsion machinery

22.1.5.1 Control of propulsion machinery from the navigating bridge (SOLAS, Reg. II-1/49)

22.1.5.1.1 Under all sailing conditions, including manoeuvring, the speed, direction of thrust and, if applicable the pitch of the propeller shall be fully controllable from the navigating bridge. (SOLAS, Reg. II-1/49.1) (Starting of a propulsion plant from the bridge, is required only for fixed propeller systems.)

22.1.5.1.2 Such remote control shall be performed by a single control device for each independent propeller, with automatic performance of all associated services, including where necessary, means of preventing overload of the propulsion machinery. (SOLAS, Reg. II-1/49.1.1)

22.1.5.1.3 The main propulsion machinery shall be provided with an emergency stopping device on the navigating bridge which shall be independent of the navigating bridge control system. (SOLAS, Reg. II-1/49.1.2)

22.1.5.1.4 Propulsion machinery orders from the navigating bridge shall be indicated in the main machinery control room or at the propulsion machinery control position as appropriate. (SOLAS, Reg. II-1/49.2)

22.1.5.1.5 Remote control of the propulsion machinery shall be possible only from one location at a time; at such locations interconnected control positions are permitted. At each location there shall be an indicator showing which location is in control of the propulsion machinery. The transfer of control between the navigating bridge and machinery space shall be possible only in the main machinery space or in the main machinery control room. The system shall include means to prevent the propelling thrust from altering significantly when transferring control from one location to another. (SOLAS, Reg. II-1/49.3)

22.1.5.1.6 It shall be possible for all machinery essential for the safe operation of the ship to be controlled from a local position, even in the case of failure in any part of the automatic or remote control systems. (SOLAS, Reg. II-1/49.4)

22.1.5.1.7 The design of the remote automatic control system shall be such that in case of its failure an alarm will be given. (In this context a failure means broken connection between external circuiting or loss of power supply.) Unless the Administration considers it impracticable, the present speed and direction of thrust of the propeller shall be maintained until local control is in operation. (SOLAS, Reg. II-1/49.5)

22.1.5.1.8 Indicators shall be fitted on the navigating bridge for:

.1 propeller speed and direction of rotation in the case of fixed pitch propellers; or
.2 propeller speed and pitch position in the case of controllable pitch propellers. (SOLAS, Reg. II-1/49.6)

22.1.5.1.9 The number of consecutive automatic attempts which fail to produce a start shall be limited to safeguard sufficient starting air pressure. An alarm shall be provided to indicate low starting air pressure set at a level which still permits starting operations of the propulsion machinery. (SOLAS, Reg. II-1/49.7)

22.1.5.2 Bridge control of propulsion machinery

IACS UR M43

22.1.5.2.1 The remote control for propulsion machinery is to be provided with means of preventing overload and prolonged running in critical speed ranges of the propelling machinery. (M43.1)

22.1.5.2.2 The bridge control system is to be independent from the other transmission system; however, one control lever for both system may be accepted. (M43.2)

22.1.5.2.3 Operations following any setting of the bridge control device including reversing from the maximum ahead service speed in case of emergency are to take place in an automatic sequence and with time intervals acceptable to the machinery. (M43.3)

22.1.5.2.4 Remote starting of the propulsion machinery is to be automatically inhibited if conditions exist which may hazard the machinery, e.g. shaft turning gear engaged, drop of lubricating oil pressure. (M43.4)

22.1.5.2.5 For steam turbines a slow-turning device should be provided which operates automatically if the turbine is stopped longer than admissible. Discontinuation of this automatic turning from the bridge must be possible. (M43.5)

Note:
For attended machinery spaces, the slow turning device may be arranged to be operated manually.

22.1.5.2.6 For SOLAS Convention ships, 22.1.5.1.7 (Regulation II-1/49.5) applies. For ships not covered by the SOLAS Convention, the design of the bridge control system is to be such that in case of its failure an alarm is given. In this case the speed and direction of the propeller thrust is to be maintained until local control is in operation, unless this is considered impracticable. In particular, lack of power (electric, pneumatic, hydraulic) will not lead to major and sudden change in propulsion power or direction of propeller rotation. (M43.6)

END OF IACS UR M43

22.1.6 Alarm systems – unattended machinery spaces

22.1.6.1 Alarm systems for vessels with periodically unattended machinery spaces

IACS UR M29

22.1.6.1.1 Definition (M29.1)

The alarm system is intended to give warning of a condition in which deviation occurs outside the preset limits on selected variables. The arrangement of the alarm display should assist in identifying the particular fault condition and its location within the machinery space. Alarm systems, including those incorporating programmable electronic systems, are to satisfy the environmental requirements of *Publication 11/P – Environmental Tests on Marine Equipment* (IACS UR E10).

22.1.6.1.2 General requirements (M29.2)

Where an alarm system is required by the Rules, the system is to comply with the conditions given in 22.1.6.1.2.1 to 22.1.6.1.2.10 (M29.2.1 - M29.2.10).

22.1.6.1.2.1 The system is to be designed to function independently of control and safety systems so that a failure or malfunction in these systems will not prevent the alarm system from operating. Common sensors for alarms and automatic slowdown functions are acceptable as specified in 22.1.8 (M35) Table 1 and 2 as Gr 1. (M29.2.1)

22.1.6.1.2.2 Machinery faults are to be indicated at the control locations for machinery. (M29.2.2)

22.1.6.1.2.3 The system is to be so designed that the engineering personnel on duty are made aware that a machinery fault has occurred. (M29.2.3)

The requirements may be complied with, inter alia, through:

– arranging group alarms on the navigation bridge and accommodation spaces for the engineering personnel responsible for the operation of the machinery and alarm annunciators giving detailed information in the space where the superior control station is located, or
– arranging all alarm annunciators giving detailed information on the navigation bridge and group alarms in the accommodation spaces of engineering personnel responsible for the operation of the machinery.

In any case, the acknowledgment of alarms in the machinery space and in the accommodation spaces for engineering personnel shall be indicated on the navigation bridge.

22.1.6.1.2.4 If the bridge navigating officer of the watch is the sole watchkeeper then, in the event of a machinery fault being monitored at the control location for machinery, the alarm system is to be such that this watchkeeper is made aware when:

(i) a machinery fault has occurred,
(ii) the machinery fault is being attended to,
(iii) the machinery fault has been rectified. Alternative means of communication between the bridge area, the accommodation for engineering personnel and the machinery spaces may be used for this function. (M29.2.4)

22.1.6.1.2.5 Group alarms may be arranged on the bridge to indicate machinery faults. Alarms associated with faults requiring speed reduction or the automatic shut down of propulsion machinery are to be separately identified. (M29.2.5)

22.1.6.1.2.6 The alarm system should be designed with self monitoring properties. In so far as practicable, any fault in the alarm system should cause it to fail to the alarm condition. (M29.2.6)

22.1.6.1.2.7 The alarm system should be capable of being tested during normal machinery operation. Where practicable means are to be provided at convenient and accessible positions, to permit the sensors to be tested without affecting the operation of the machinery. (M29.2.7)

22.1.6.1.2.8 Upon failure of normal power supply, the alarm system is to be powered by an independent standby power supply, e.g. a battery. Failure of either power supply to the alarm system is to be indicated as a separate alarm fault. Where an alarm system could be adversely affected by an interruption in power supply, change-over to the stand by power supply is to be achieved without a break. (M29.2.8)

22.1.6.1.2.9

(a) Alarms are to be both audible and visual. If arrangements are fitted to silence audible alarms they are not to extinguish visible alarms.
(b) The local silencing of bridge or accommodation alarms is not to stop the audible machinery space alarm.
(c) Machinery alarms should be distinguishable from other audible alarms, i.e. fire, CO_2 flooding.
(d) The alarm system is to be so arranged that acknowledgement of visual alarms is clearly noticeable. (M29.2.9)

22.1.6.1.2.10 If an alarm has been acknowledged and a second fault occurs before the first is rectified, then audible and visual alarms are to operate again.

Alarms due to temporary failures are to remain activated until acknowledged. (M29.2.10)

END OF IACS UR M29

22.1.6.2 Alarm system for periodically unattended machinery spaces (SOLAS, Reg. II-1/51)

22.1.6.2.1 An alarm system shall be provided indicating any fault requiring attention and shall:

.1 be capable of sounding an audible alarm in the main machinery control room or at the propulsion machinery control position, and indicate visually each separate alarm function at a suitable position;
.2 have a connexion to the engineers' public rooms and to each of the engineers' cabins through a selector switch, to ensure connexion to at least one of those cabins. Administrations may permit equivalent arrangements;
.3 activate an audible and visual alarm on the navigating bridge for any situation which requires action by or attention of the officer on watch;
.4 as far as is practicable be designed on the fail-to-safety principle; and
.5 activate the engineers' alarm required by regulation 38 if an alarm function has not received attention locally within a limited time. (SOLAS, Reg. II-1/51.1)

22.1.6.2.2 The alarm system shall be continuously powered and shall have an automatic change-over to a stand-by power supply in case of loss of normal power supply. (SOLAS, Reg. II-1/51.2.1)

22.1.6.2.3 Failure of the normal power supply of the alarm system shall be indicated by an alarm. (SOLAS, Reg. II-1/51.2.2)

22.1.6.2.4 The alarm system shall be able to indicate at the same time more than one fault and the acceptance of any alarm shall not inhibit another alarm. Acceptance at the position referred to in paragraph 1 of any alarm condition shall be indicated at the positions where it was shown. Alarms shall be maintained until they are accepted and the visual indications of individual alarms shall remain until the fault has been corrected, when the alarm system shall automatically reset to the normal operating condition. (SOLAS, Reg. II-1/51.3.1&3.2)

22.1.7 Safety systems – unattended machinery spaces

22.1.7.1 Safety systems for vessels with periodically unattended machinery spaces
IACS UR M30

22.1.7.1.1 Definition

The safety system is intended to operate automatically in case of faults endangering the plant so that:

(i) normal operating conditions are restored (by starting of standby units), or
(ii) the operation of the machinery is temporarily adjusted to the prevailing conditions (by reducing the output of machinery), or
(iii) machinery and boilers are protected from critical conditions by stopping the machinery and shutting off the fuel to the boilers respectively (shutdown). (M30.1)

22.1.7.1.2 General requirements (M30.2)

22.1.7.1.2.1 Where a safety system is required by the Rules, the system is to comply with 22.1.7.1.2.2 to 22.1.7.1.2.8 (M30.2.2 - M30.2.8). (M30.2.1)

22.1.7.1.2.2 Operation of the safety system shall cause an alarm. (M30.2.2)

22.1.7.1.2.3 The safety system intended for the functions listed under 22.1.7.1.1 (iii) (M30.1 (iii)) is to be independent of all other control and alarm systems so that failure or malfunction in these systems will not prevent the safety system from operating. For the safety systems intended for functions listed under 22.1.7.1.1 (i) and (ii) (M30.1(i) and (ii)), complete independence of other control and alarm systems is not required. (M30.2.3)

22.1.7.1.2.4 In order to avoid undesirable interruption in the operation of machinery, the system is to intervene sequentially after the operation of alarm system by:

- starting of standby units,
- load reduction or shutdown, such that the least drastic action is taken first. (M30.2.4)

22.1.7.1.2.5 The system should be designed to 'fail safe'. The characteristics of 'fail safe' of a system is to be evaluated on the basis not only of the safety system itself and its associated machinery, but also on the inclusion of the whole machinery installation as well as the ship. (M30.2.5)

22.1.7.1.2.6 Safety systems of different units of the machinery plant are to be independent. Failure in the safety system of one part of the plant is not to interfere with the operation of the safety system in another part of the plant. (M30.2.6)

22.1.7.1.2.7 When the system has been activated, means are to be provided to trace the cause of the safety action. (M30.2.7)

22.1.7.1.2.8 When the system has stopped a unit, the unit is not to be restarted automatically before a manual reset has been carried out. (M30.2.8)

END OF IACS UR M30

22.1.7.2 Safety systems for periodically unattended machinery spaces (SOLAS, Reg. II-1/52)

22.1.7.2.1 A safety system shall be provided to ensure that serious malfunction in machinery or boiler operations, which present an immediate danger, shall initiate the automatic shut-down of that part of the plant and that an alarm shall be given. Shut-down of the propulsion system shall not be automatically activated except in cases which could lead to serious damage, complete breakdown, or explosion. Where arrangements for overriding the shut-down of the main propelling machinery are fitted, these shall be such as to preclude inadvertent operation. Visual means shall be provided to indicate when the override has been activated. (SOLAS, Reg. II-1/52)

22.1.8 Alarms, remote indications and safeguards for main reciprocating I.C. engines installed in unattended machinery spaces

IACS UR M35

22.1.8.1 General (35.1)

Alarms, remote indications and safeguards listed in Table 1 and 2 are respectively referred to cross-head and trunk-piston reciprocating i.c. engines.

22.1.8.2 Alarms (35.2)

A system of alarm displays and controls is to be provided which readily ensures identification of faults in the machinery and satisfactory supervision of related equipment. This may be provided at a main control station or, alternatively, at subsidiary control stations. In the latter case, a master alarm display is to be provided at the main control station showing which of the subsidiary control stations is indicating a fault condition.

The detailed requirements covering communications of alarms from machinery spaces to the bridge area and accommodation for engineering personnel, are contained in 22.1.6.1. (M29).

22.1.8.3 Remote indications (35.3)

Remote indications are required only for ships which are operated with machinery space unattended but under a continuous supervision from a position where control and monitoring devices are centralized, without the traditional watch service being done by personnel in machinery space.

22.1.8.4 Safeguards (35.4)

22.1.8.4.1 Automatic start of standby pumps – slow down (35.4.1)

A suitable alarm is to be activated at the starting of those pumps for which the automatic starting is required.

22.1.8.4.2 Automatic reduction of power (35.4.2)

If overriding devices of the required automatic reduction of power are provided, they are to be so arranged as to preclude their inadvertent operation, and a suitable alarm is to be activated by their operation.

22.1.8.4.3 Automatic stop – shut down (35.4.3)

If overriding devices of the required automatic stops are provided, they are to be so arranged as to preclude their inadvertent operation, and a suitable alarm is to be operated by their activation. When the engine is stopped automatically, restarting after restoration of normal operating conditions is to be possible only after manual reset, e.g. by-passing the control lever through the 'stop' position.

Automatic restarting is not permissible (see 22.1.7.1.2.8 (M30.2.8)).

Table 1 Cross-head diesel engines

Gr 1 Common sensor for indication, alarm, slow down
Gr 2 Sensor for automatic start of standby pump with alarm
Gr 3 Sensor for shut down

	Gr 1			Gr 2	Gr 3
Monitored parameters for cross-head diesel engines	**Remote indication**	**Alarm activation**	**Slow down with alarm**	**Automatic start of standby pump with alarm**	**Shut down with alarm**
1.0 Fuel oil system					
Fuel oil pressure after filter (engine inlet)	X	low		X	
Fuel oil viscosity before injection pumps or Fuel oil temp before injection pumps		high low			
Leakage from high pressure pipes		X			
Level of fuel oil in daily service tank [1]		low			
Common rail fuel oil pressure		low			
2.0 Lubricating oil system					

Lub oil to main bearing and thrust bearing, pressure	X	low	X	X	X
Lub oil to crosshead bearing pressure[2]	X	low	X	X	X
Lub oil to camshaft pressure[2]		low		X	X
Lub oil to camshaft temp[2]		high			
Lub oil inlet temp		high			
Thrust bearing pads temp or bearing outlet temp		high	X		X
Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main, crank and crosshead bearing oil outlet; or – the engine main, crank and crosshead bearing)[3]		X	X		
Flow rate cylinder lubricator. Each apparatus		low	X		
Level in lubricating oil tanks[4]		low			
Common rail servo oil pressure		low			
3.0 Turbocharger system					
Turbocharger lub oil inlet pressure[9]		low			
Turbocharger lub oil outlet temp each bearing[10]		high			
Speed of turbocharger[11]	X	high			
4.0 Piston cooling system					
Piston coolant inlet pressure[5]		low	X	X	
Piston coolant outlet temp each cylinder		high	X		
Piston coolant outlet flow each cylinder[8]		low	X		
Level of piston coolant in expansion tank		low			
5.0 Sea water cooling system					
Sea water pressure		low		X	
6.0 Cylinder fresh cooling water system					
Cylinder water inlet pressure		low	X	X	
Cylinder water outlet temp (from each cylinder) or Cylinder water outlet temp (general)[6]		high	X		
Oily contamination of engine cooling water system[7]		X			
Level of cylinder cooling water in expansion tank		low			

7.0 Starting and control air systems					
Starting air pressure before main shut-off valve	X	low			
Control air pressure		low			
Safety air pressure		low			
8.0 Scavenge air system					
Scavenge air receiver pressure	X				
Scavenge air box temp (fire)		high	X		
Scavenge air receiver water level		high			
9.0 Exhaust gas system					
Exhaust gas temp after each cylinder	X	high	X		
Exhaust gas temp after each cylinder. Deviation from average.		high			
Exhaust gas temp before each T/C	X	high			
Exhaust gas temp after each T/C	X	high			
10.0 Fuel valve coolant					
Pressure of fuel valve coolant		low		X	
Temperature of fuel valve coolant		high			
Level of fuel valve coolant in expansion tank		low			
11.0 Engine speed/direction of rotation Wrong way	X	X			
12.0 Engine overspeed					X
13.0 Control-Safety-Alarm system power supply failure		X			

1 High-level alarm is also required if no suitable overflow arrangement is provided.
2 If separate lub oil systems are installed.
3 When required by *Part VII*, 2.2.10 (UR M10.8 or by SOLAS Reg. II-1/47.2) i.e. for engines of 2250 kW and above or having cylinders of more than 300 mm bore.
4 Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for the tanks.
5 The slow down is not required if the coolant is oil taken from the main cooling system of the engine.
6 Where one common cooling space without individual stop valves is employed for all cylinder jackets.
7 Where main engine cooling water is used in fuel and lubricating oil heat exchangers.
8 Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted.
9 Unless provided with a self-contained lubricating oil system integrated with the turbocharger.

[10] Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.

[11] Only required for turbochargers of Categories B (Category B: > 1000 kW and ≤ 2500 kW) and C (Category C: > 2500 kW). (see M73.5)

Table 2 Trunk-piston diesel engines

Gr 1 Common sensor for indication, alarm, slow down
Gr 2 Sensor for automatic start of standby pump with alarm
Gr 3 Sensor for shut down

	Gr 1			Gr 2	Gr 3
Monitored parameters for trunk-piston diesel engines	**Remote indication**	**Alarm activation**	**Slow down with alarm**	**Automatic start of standby pump with alarm**	**Shut down with alarm**
1.0 Fuel oil system					
Fuel oil pressure after filter (engine inlet)	X	low		X	
Fuel oil viscosity before injection pumps or Fuel oil temp before injection pumps[1]		high low			
Leakage from high pressure pipes		X			
Level of fuel oil in daily service tank[2]		low			
Common rail fuel oil pressure		low			
2.0 Lubrication oil system					
Lub oil to main bearing and thrust bearing, pressure	X	low		X	X
Lub oil filter differential pressure	X	high			
Lub oil inlet temp	X	high			
Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main and crank bearing oil outlet; or – the engine main and crank bearing)[3]		X			X
Flow rate cylinder lubricator. Each apparatus		low	X		
Common rail servo oil pressure		low			
3.0 Turbocharger system					
Turbocharger lub oil inlet pressure[5]	X	low			
Turbocharger lub oil temperature each bearing[8]		high			
Speed of turbocharger[9]	X	high			

4.0 Sea water cooling system					
Sea water pressure	X	low		X	
5.0 Cylinder fresh cooling water system					
Cylinder water inlet pressure or flow	X	low	X	X	
Cylinder water outlet temp (general)[6]	X	high	X		
Level of cylinder cooling water in expansion tank		low			
6.0 Starting and control air systems					
Starting air pressure before main shut-off valve	X	low			
Control air pressure	X	low			
7.0 Scavenge air system					
Scavenge air receiver temp		high			
8.0 Exhaust gas system					
Exhaust gas temp after each cylinder[7]	X	high	X		
Exhaust gas temp after each cylinder. Deviation from average[7]		high			
9.0 Engine speed	X				
10.0 Engine overspeed					X
11.0 Control-Safety-Alarm system power supply failure		X			

1 For heavy fuel oil burning engines only.
2 High-level alarm is also required if no suitable overflow arrangement is provided.
3 When required by *Part VII*, 2.2.10 (UR M10.8 or by SOLAS Reg. II-1/47.2) i.e. for engines of 2250 kW and above or having cylinders of more than 300 mm bore: for each engine, one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down systems.
4 If necessary for the safe operation of the engine.
5 Unless provided with a self-contained lubricating oil system integrated with the turbocharger.
6 Two separate sensors are required for alarm and slow down.
7 For engine power > 500 kW/cyl.
8 Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.
9 Only required for turbochargers of Categories B (Category B: > 1000 kW and ≤ 2500 kW) and C (Category C: > 2500 kW). (see M73.5)

END OF IACS UR M35

22.1.9 Alarms and safeguards for auxiliary reciprocating internal combustion engines driving generators in unattended machinery spaces

IACS UR M36

22.1.9.1 General (M36.1)

This UR applies to trunk-piston reciprocating i. c. engines running on fuel oil.

22.1.9.2 Alarms (M36.2)

All monitored parameters for which alarms are required to identify machinery faults and associated safeguards are listed in Table 1.

All these alarms are to be indicated at the control location for machinery as individual alarms; where the alarm panel with individual alarms is installed on the engine or in the vicinity, common alarm in the control location for machinery is required.

For communication of alarms from machinery space to bridge area and accommodation for engineering personnel detailed requirements are contained in 22.1.6.1 (M29).

Table 1

Monitored parameters	Alarm	Shut down
Fuel oil leakage from high pressure pipes	X	
Lubricating oil temperature	high	
Lubricating oil pressure	low	X
Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main and crank bearing oil outlet; or – the engine main and crank bearing)[3]	X	X
Pressure or flow of cooling water	low	
Temperature of cooling water or cooling air	high	
Level in cooling water expansion tank, if not connected to main system	low	
Level in fuel oil daily service tank	low	
Starting air pressure	low	
Overspeed activated		X
Fuel oil viscosity before injection pumps or fuel oil temp before injection pumps[1]	low high	
Exhaust gas temperature after each cylinder[2]	high	
Common rail fuel oil pressure	low	
Common rail servo oil pressure	low	
Speed of turbocharger[4]	high	

Notes:

1 For heavy fuel oil burning engines only.
2 For engine power above 500 kW/cyl.

[3] When required *Part VII*, 2.2.10 (UR M10.8 or by SOLAS Reg. II-1/47.2) i.e. engines of 2250 kW and above or having cylinders of more than 300 mm bore: for each engine one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down systems.

[4] Only required for turbochargers of Categories B (Category B: > 1000 kW and ≤ 2500 kW) and C (Category C: > 2500 kW). (see M73.5)

END OF IACS UR M36

22.1.10 Alarms and safeguards for emergency reciprocating I.C. engines

IACS UR M63

22.1.10.1 Field of application (1.)

These requirements apply to reciprocating I.C. engines, which use distillate marine fuels covered by ISO 8217:2017, required to be immediately available in an emergency and capable of being controlled remotely or automatically operated.

22.1.10.2 Information to be submitted (2.)

Information demonstrating compliance with these requirements is to be submitted to the relevant Classification Society. The information is to include instructions to test the alarm and safety systems.

22.1.10.3 Alarms and safeguards (3.)

1. Alarms and safeguards are to be fitted in accordance with Table 1.
2. The safety and alarm systems are to be designed to 'fail safe'. The characteristics of the 'fail safe' operation are to be evaluated on the basis not only of the system and its associated machinery, but also the complete installation, as well as the ship.
3. Regardless of the engine output, if shutdowns additional to those specified in Table 1 are provided except for the overspeed shutdown, they are to be automatically overridden when the engine is in automatic or remote control mode during navigation.
4. The alarm system is to function in accordance with 22.1.6.1 (M29), with additional requirements that grouped alarms are to be arranged on the bridge.
5. In addition to the fuel oil control from outside the space, a local means of engine shutdown is to be provided.
6. Local indications of at least those parameters listed in Table 1 are to be provided within the same space as the reciprocating I.C. engines and are to remain operational in the event of failure of the alarm and safety systems.

Table 1

Parameter	Alarm activation	Shutdown with alarm
Fuel oil leakage from high pressure pipes (fuel injection pipes and common rails)	X	
Lubricating oil temperature[1]	high	
Lubricating oil pressure	low	
Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main and crank bearing oil outlet; or	X	

– the engine main and crank bearing)[2]		
Pressure or flow of cooling water[1]	low	
Temperature of cooling water (or cooling air)	high	
Overspeed activated[1]		X

Note:
1 for engines having a power of or more than 220 kW.
2 for engines having a power of more than 2250 kW or a cylinder bore of more than 300 mm.

END OF IACS UR M63

22.1.11 Personnel alarm

22.1.11.1 The personnel alarm shall automatically set off an alarm on the navigation bridge or in the officers' quarters, as appropriate, if it is not reset from the machinery space, in a period not exceeding 30 minutes.

22.1.11.2 A pre-warning signal shall be provided in the machinery space which operates 3 min before the alarm, referred to in 22.1.11.1, is given.

22.1.11.3 The alarm system shall be put into operation:

.1 automatically when the engineer on duty has to attend the machinery space in case of a machinery alarm;
.2 manually by the engineer on duty when attending the machinery space on routine checks.

22.1.11.4 The alarm system shall be disconnected by the engineer on duty after leaving the machinery space. When the system is brought into operation automatically in accordance with 22.1.11.3.1, its disconnection should not be possible before the engineer acknowledged the alarm in the machinery space.

22.1.11.5 Personnel alarm shall automatically operate the engineers' alarm, required in 22.1.12.

22.1.12 Engineers' alarm

In addition to manual operation from the machinery space, the engineers' alarm on ships with periodically unattended machinery spaces shall operate when the machinery alarm is not acknowledged in the machinery space or ECR in a specified limited period of time, depending on the size of the ship but not exceeding 5 min.

22.2 Energy efficient ships – additional mark ECO EF

22.2.1 Application

The requirements specified in this Chapter apply to new ships or ships who have undergone substantial modification of 400 gross tonnage and upwards engaged on international voyages specified in Regulation 21 of Annex VI to *MARPOL*, in accordance with definitions contained in Regulations 2.23 and 2.24 of Annex VI to *MARPOL*.

22.2.2 Documents to be submitted

The documents to be submitted at each stage of design are specified in the *Guidelines on Survey and Certification of EEDI* and the *Industry Guidelines on Calculation and Verification of EEDI* contained in *Publication 103/P – Guidelines for Energy Efficiency of Ships*.

Prior to commencement and during the ship construction or modification the documentation required at each stage of design, including the documentation prepared after the sea trials conducted shall be submitted to PRS Head Office for consideration and approval.

22.2.3 Assignment of the additional mark

Ships whose attained energy efficiency design index (*EEDI*) does not exceed the required value of *EEDI* (determined for the specific period) may be assigned additional mark **ECO EF** in the symbol of class, according to *Part I* and *Publication 106/P – Eco Class Rules.*

22.3 Ecological ships – additional mark: ECO AIR

Technical requirements for shore power supply systems and automation of ballast water treatment systems are specified in *Publication 106/P – Eco Class Rules*, Chapter 4.7 and 6.8 respectively.

22.4 Ships equipped with Dynamic Positioning Systems – additional mark: DP

In addition to compliance with the applicable requirements of this *Part VIII*, dynamic positioning systems shall fulfil the requirements specified in *Publication 120/P – Requirements for Vessels and Units with Dynamic Positioning (DP) Systems*.

22.5 Ships using low-flashpoint gas fuels – additional marks: IGF DF LNG, IGF DF CNG, IGF DF LPG, IGF DF H_2, LNG READY, CNG READY, LPG READY, H_2 READY, IGF LNG, IGF CNG, IGF LPG, IGF H_2, IGC DF

22.5.1 Ships using low-flashpoint gas fuel, other than gas tankers using their cargo as fuel, receiving in their symbol of class any of the above additional mark except **IGC DF** shall comply with the requirements contained in *Publication 72/P – Safety requirements for ships using low-flashpoint gases as fuel.*

22.5.2 Gas tankers, using their cargo as fuel, receiving in their symbol of class additional mark **IGC DF** shall comply with the requirements of PRS' *Rules for the Classification and Construction of Sea-going Gas Tankers,* Chapter 16

22.5.3 The requirements concerning safe bunkering of LNG on ships are contained in *Publication 116/P – Bunkering Guidelines for LNG as Marine Fuel.*

22.5.4 Ships assigned with additional mark containing the acronyms **LNG** or **CNG** having an I.C. engine(s) supplied with natural gas as fuel, shall be fitted with a control, monitoring and safety system for the engine(s) complying with the below requirements of IACS UR M78, subchapter 2.2.7. The requirements apply to both dual-fuel engines (DF) and gas-only (GF) engines.

Note:

Preceding and remaining part of UR M78 – see *Part VII* and *Publication 28/P – Tests of I.C. Engines*

22.5.4.1 The engine control system is to be independent and separate from the safety system.

22.5.4.2 The gas admission valves are to be controlled by the engine control system or by the engine gas demand.

22.5.4.3 Combustion is to be monitored on an individual cylinder basis.

22.5.4.4 In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in IGF Code 10.3.1.6 (see *Publication 72/P – Safety requirements for ships using low-flashpoint gases as fuel*, 10.3.1.6).

22.5.4.5 If monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted.

22.5.4.6 Unless the risk analysis required by 1.4 of this UR (see *Part* VII, 2.12.2) proves otherwise, the monitoring and safety system functions for DF or GF engines are to be provided in accordance with Table 2 of this UR in addition to the general monitoring and safety system functions given by the Classification Societies.

Table 2: and Safety System Functions for DF and GF Engines

Parameter	Alarm	Automatic activation of the double block-and-bleed valves	Automatic switching over to oil fuel mode[1)]	Engine shutdown
Abnormal pressures in the gas fuel supply line	X	X	X	X [5)]
Gas fuel supply systems – malfunction	X	X	X	X [5)]
Pilot fuel injection or spark ignition systems – malfunction	X	X [2)]	X	X [2) 5)]
Exhaust gas temperature after each cylinder – high	X	X [2)]	X	X [2) 5)]
Exhaust gas temperature after each cylinder, deviation from average – low [3)]	X	X [2)]	X	X [2) 5)]
Cylinder pressure or ignition – failure, including misfiring, knocking and unstable combustion	X	X [2) 4)]	X [4)]	X [2) 4) 5)]
Oil mist cocncentration in crankcase or bearing temperature [6)] – high	X	X		X [9)]
Pressure in the crankcase – high [8)]	X	X	X	
Engine stops – any cause	X	X		
Failure of the control-actuating medium of the block and bleed valves	X	X	X	
Failure of crankcase ventilation system, if applicable	X	X [7)]	X [7)]	

1) DF engine only, when running in gas mode.
2) For GF engines , the double block-and-bleed valves and the engine shutdown may not be activated in case of specific failures affecting only one cylinder, provided that the concerned cylinder can be individually shutoff and the safe operation of the engine in such conditions is demonstrated by the risk analysis.
3) Required only if necessary for the detection of misfiring.
4) In the case where the failure can be corrected by an automatic mitigation action, only the alarm may be activated. If the failure persists after a given time, the safety actions are to be activated.
5) GF engine only.
6) Where required by UR M10 i.e. for engines of 2250 kW and above or having cylinders of more than 300 mm bore.
7) Automatic safety actions to be activated as specified by the engine manufacturer, see *Part VII*, 2.2.11 (UR M10)
8) Only for trunk piston engines. This pressure sensor cannot replace or substitute gas detector.
9) Only for trunk piston engines. For crosshead engines slow down shall apply – see 22.1.8.4.3 (see UR M35 Tab. 1)

CHAPTER 23

23 SPARE PARTS

23.1 General requirements

23.1.1 The number, kind and location of spare parts on board the ship are left to the shipowner's decision. The construction of electrical and automation equipment, the manufacturer's recommendations, intended service conditions, as well as the necessity of compliance with the requirements of the Flag State Administration shall be taken into account.

Furthermore, for remote control systems and automation, the exchange of total elements or units (blocks, cassettes, etc.) and not the exchange of their particular components is a rule.

23.1.2 Spare parts, together with the appropriate tools, materials and instruments shall be located in an easily accessible position protected against corrosion.

23.1.3 Recommended spare parts for auxiliary internal combustion engines and steam turbines driving electric generators for essential services of ships for unrestricted service – see *Part VII* of the *Rules*.

23.2 List of spare parts for ship electrical equipment

The number and kind of spare parts, specified in Table 23.2, are considered as general recommendations.

Table 23.2
Spare parts for ship electrical equipment

Item	Equipment	Spare parts	Number of spare parts	Remarks
1	Generators and rotating exciters	Brushes	1 set	Of each type per 3 identical machines
		Brush-holders	1 pc	
		Bearings	1 set	
2	Static exciters	Thyristors and diodes of the power circuits	1 pc of each type	For 3 static exciters of the same type
		Resistors and condensers of the power circuits inductance	1 pc of each type	
3	Electric motors	Brushes	1 set	Per 6 motors of each type
		Brush-holders	1 pc	
		Bearings	1 set	
4	Steering gear	Brushes	1 set	For each motor
		Brush-holders	1 pc	
		Bearings	1 set	
		Rotors with shaft and the half of coupling	1 unit	Additional spare parts only for D.C. steering gear with one motor
		Exciter coils of each type	1 pc	
		Complete electric motor	1 unit	Only for A.C. steering gear with one motor
5	V-belt drives	V-belts	1 set	For each drive

6	Main, emergency and auxiliary switchboards, control desks, etc. (quantity of spare parts for the whole ship)	Knife switches, rotary switches, etc. Automatic circuit-breakers for current up to 63 A		2 pc	Of each type if there are more than 10 switches, and 1 pc – if there are less than 10
		Automatic circuit breakers for the current over 63 A	Replaceable contacts	1 set	Of each type
			Voltage coils	1 pc	
			Arc chutes	1 pc	
		Fuses	Complete fuses	2 pcs	Of each type
7	Starting and control apparatus and contactors	Replaceable contacts		1 set	Of each type per 6 identical devices
		Voltage coils		1 pc	
8	Emergency lighting	Incandescent lamps		1 set	If lighting supply voltage differs from ship network voltage
9	Navigation lanterns	Incandescent lamps		2 pcs for each lantern	
10	Switchboard of navigation lanterns	Relay		2 pcs	
		Pilot lamps		1 set	
11	Portable measuring instruments	Insulation resistance measuring instrument		1 unit	A multi-purpose multi-range instrument recommended
		Ammeter		1 unit	
		Voltmeter		1 unit	
		Ohmmeter		1 unit	
12	Fans for refrigerated spaces of classed refrigerating installations	Complete rotor		1 unit	Per 6 D.C. motors of the same type where no spare motors are available
		Exciter winding coils		1 set	
		Complete stator		1 unit	Per 6 A.C. motors of the same type where no spare motors are available

Appendix 1

INSULATION RESISTANCE OF CABLE NETWORK

1 The insulation resistance to hull of electrical circuits of the cable network measured during trials on completion of the ship construction or during surveys of ships in service shall not be less than that specified in Table 1.

Table 1

Item	Designation of circuit	Minimum insulation resistance [MΩ]		
		up to 125 V	125 to 500 V	over 500 V
1	Supply to lighting installations	0.3	1.0	–
2	Supply to power consumers	–	1.0	2000 Ω per volt of the rated voltage
3	Communication installation (unless otherwise specified)	0.3	1.0	–

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

Appendix 2

VALUES OF MECHANICAL AND ELECTRICAL PARAMETERS TO BE CHECKED IN COURSE OF TESTING TYPE OF EQUIPMENT AND THE SHIP ELECTRICAL INSTALLATIONS

1 Insulation resistance

1.1 The value of insulation resistance of the new electrical equipment measured at the manufacturer's or research laboratory shall fulfil the requirements of the relevant national standards, however it shall not be less than:

– 10 MΩ in cold condition, 1 MΩ in hot condition – for equipment of rated voltage up to 65 V,
– 100 MΩ in cold condition, 10 MΩ in hot condition – for equipment of rated voltage over 65 V.

For electric machines, at the insulation resistance measurements after the electric strength test, the value of insulation resistance in hot condition equal to 1 MΩ is permitted – see also 10.9

1.2 The value of insulation resistance to hull, as well as between phases (poles) of electrical equipment measured during testing after completion of the ship construction shall not be lesser than the values indicated in Table 1.2.

The insulation resistance of the equipment measured during surveys of ships in service may be less than the values indicated in Table 1.2, however not less than 2000 Ω per volt of the rated consumer voltage.

The insulation resistance values indicated in Table 1.2 are applicable to electrical equipment having a voltage up to 1000 V.

The minimum values of insulation resistance of electrical equipment having a voltage of over 1000 V shall fulfil the requirements of 18.1.2 and for electric machines rated at over 1000 kW (kVA), irrespective of the voltage value, will be specially considered by PRS in each particular case.

Insulation resistance readings shall be taken one minute after the application of the test voltage.

Table 1.2

Item	Type of electrical equipment	Minimum insulation resistance at 20 ± 5°C ambient temperature and normal humidity [MΩ]	
		in cold condition	in hot condition
1	Electric machines	1	1
2	Transformers	5	2
3	Switchboards	1	–
4	Machine control gear	5	–

2 Dielectric strength of insulation

2.1 General requirements

The dielectric strength of insulation in electrical installations, with the exception of that pertaining to individual types described under 2.2 of the present Appendix, shall be tested by applying, for 1 minute, an alternating sinusoidal test voltage having a frequency of 50 Hz and the r.m.s. value as shown in Table 2.1.

Table 2.1

Rated voltage U_n [V]	Test voltage U_p [V]
up to 65	$2\,U_n + 500$
66 to 250	1500
251 to 500	2000
501 to 1000	$2\,U_n + 1000$
over 1000	$3U_n$

Table 2.1 is not applicable to communication appliances and electrical devices incorporating semiconductor elements for which the test voltage value will be specially considered by PRS in each particular case.

2.2 Machines, transformers and apparatus

2.2.1 The insulation of electric machine windings shall withstand for 1 minute, without breakdown and sparking, an alternating practically sinusoidal test voltage having a frequency of 50 Hz and the r.m.s. value as shown in Table 2.2.1.

Table 2.2.1
Test voltage at the test of dielectric strength of insulation

Item	Electric machine or part thereof		Test voltage r.m.s. value U_p [V]
1	Insulated parts of machines rated at	less than 1 kW (kVA)	$2\,U_n + 500$
		from 1 kW (kVA) to 10 000 kW (kVA)	$2\,U_n + 1000$ but not less than 1500
2	Field windings of direct-current machines supplied from external source		$2\,U_w + 1000$ but not less than 1500
3	Field windings of synchronous generators		$10\,U_w$ but not less than 1500 and not more than 3500
4	Field windings of synchronous motors, when:	starting with the field winding short-circuited or connected directly to the rotor, or starting with the a.c. winding idle	$2\,U_w + 1000$ but not less than 1500
		starting either with the field winding closed through, connected in series, resistance, or with the field winding open, regardless of whether it is sectionalized or not	$2\,U_m + 1000$ but not less than 1500
5	Rotor windings of slip-ring induction motors or of synchronous induction motors if not permanently short-circuited (e.g. if intended for resistor starting):	for non-reversing motors or motors reversible from standstill only	$2\,U_r + 1000$ but not less than 1500
		for reversible motors, as well as those braked by counter-current	$4\,U_r + 1000$ but not less than 1500
6	Rotor windings of direct-current reversible crane motors		$3\,U_n + 1000$ but not less than 1500
7	Exciters, except those mentioned in items 2 and 8		As for the field windings they are intended to supply

Item	Electric machine or part thereof	Test voltage r.m.s. value U_p [V]
8	Exciters of synchronous motors or synchronous induction motors if they are disconnected from the motor during starting, or if one of the poles is connected to earth	2 U_n + 1000 but not less than 1500

U_n – rated voltage [V];
U_w – maximum value of rated excitation voltage [V];
U_m – maximum value of voltage which may occur under starting conditions between the terminals of the field winding, or, in the case of a sectionalized field winding, between branch terminals [V];
U_r – voltage between the slip rings or terminals of the rotor at standstill, with rated voltage applied to the stator terminals [V];
f_n – rated frequency of the transformer [Hz];
f_{pr} – frequency of the test voltage [Hz].

2.2.2 In addition to the tests specified in Table 2.2.1, the electric machines shall withstand for 3 minutes, without damage, an elevated interturn test voltage equal to 1.3 times the rated voltage value. Machines operating within a certain voltage range shall withstand an interturn insulation test voltage equal to 1.3 times the highest voltage level.

2.2.3 While tested at the manufacturer's works, the transformers shall withstand, for 1 minute, a test for dielectric strength of insulation by application of test voltage equal to twice the rated voltage between phases plus 1000 V, but not lower than 2500 V. An alternating current test voltage of the above value at any frequency between 25 and 100 Hz shall be applied in turn between each winding and the remaining windings connected to frame and earthed cores.

This test shall be performed after the temperature rise test, if any.

The interturn insulation shall withstand a test voltage equal to twice the voltage which occurs between turns, coils and coil terminals when the rated voltage is applied to the transformer terminals. The duration of the test shall not be less than that obtained from formula 2.2.3, but not less than 15 sec.

$$t = \frac{2 f_n}{f_{pr}} \tag{2.2.3}$$

t – duration of the test, min.

2.2.4 The insulation of electric apparatus shall withstand, for 1 minute, without breakdown or sparking, a practically sinusoidal a.c. test voltage having a frequency of 50 Hz and r.m.s. value as indicated in Table 2.2.4.

Table 2.2.4

Rated voltage [V]	Test voltage [V]
up to 65	1000
66 to 250	2000
251 to 660	2500
661 to 800	3000
801 to 1200	3500
1201 to 7500	$3U_n$

2.2.5 The test voltage for fuses rated at up to 500 V shall be 3000 V.

2.2.6 The insulation of windings of electromagnetic tripping device shall withstand, for 1 minute, without a breakdown or sparking, a practically sinusoidal test voltage having a frequency of 50 Hz and r.m.s. value of 2000 V.

3 Temperature rise limits

3.1 The temperature rise limits for insulation material under continuous duty conditions are listed in Table 3.1.

Where the insulation is composed of different materials, the temperature that each of the materials is permitted to reach shall not be higher than the temperature rise limit for a given material.

Table 3.1

Class of insulation	Temperature rise limit [°C]
A	105
E	120
B	130
F	155
H	180
200, 220, 250	over 180

Where the insulation consists of several layers of different materials and it is not possible to measure the temperature reached by particular materials, the temperature rise limit for the composite shall be assumed to be that applicable to the lowest class of the material used.

A material used solely for mechanical protection or for separating shims may be of a lower class of insulation.

3.2 The temperature rise limits for electric machines are specified in Table 3.2. They are based on the cooling air temperature of 45°C. Where the coolant temperature is lower than the said values, the temperature rise limits may be increased accordingly, but not more than by 10°C.

Where the coolant temperature is higher than the above values, the temperature rise limits shall be reduced respectively.

Table 3.2
Temperature rise limits for electric machines at 45°C cooling-air temperature

Item	Electrical parts	Classes of insulating material														
		A			E			B			F			H		
		Method of measurement [°C]														
		Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors	Thermometer	Resistance	Built-in sensors
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	A.C. windings of synchronous and asynchronous machines rated at 5000 kVA and higher, or having a core length of 1 m and over	–	55	55	–	65	65	–	75	75	–	95	95	–	120	120
2	Windings of A.C. machines rated at under 5000 kVA and having a core length of less than 1 m. Field windings of D.C. and A.C. machines, D.C. excited, except such as are listed under 3, 4 and 5. Windings of rotors connected with commutator	45	55	–	60	70	–	65	75	–	80	95	–	100	120	–
3	Field windings of D.C. excited non-salient-pole machines	–	60	–	–	75	–	–	85	–	–	105	–	–	120	–
4	Single-layer field windings with exposed surface	60	60	–	75	75	–	85	85	–	105	105	–	130	130	–
5	Low resistance field windings with more than one layer, as well as compensating windings	55	55	–	70	70	–	75	75	–	95	95	–	120	120	–
6	Permanently short-circuited windings, insulated	55	–	–	70	–	–	75	–	–	95	–	–	120	–	–
7	Permanently short-circuited windings, uninsulated	The temperature rise of such parts is not to be so high as to constitute risk of damage to insulating and other adjacent materials														
8	Steel cores and other parts out of contact with windings															
9	Steel cores and other parts in contact with windings	55	–	–	70	–	–	75	–	–	95	–	–	120	–	–
10	Commutators and ship rings open and enclosed	55	–	–	65	–	–	75	–	–	85	–	–	95	–	–

3.3 The temperature rise for transformers operating at the rated load and at an ambient temperature of 45°C shall not exceed the values specified in Table 3.3.

Table 3.3

Item	Transformer parts	Method of measurement	Temperature rise limits for insulation classes [°C]				
			A	E	B	F	H
1	Windings	Resistance	55	65	75	95	120
2	Cores and other parts	Thermometer	The temperature rise shall not be higher than that allowed for adjacent materials				

3.4 The temperature rise limits for various parts of equipment (apparatus) at the ambient temperature of +45°C shall not exceed the values specified in Table 3.4.

Table 3.4

Item	Equipment (apparatus) parts			Temperature rise limits [°C]
1	Massive spring contacts	Copper	continuous duty	35
			eight-hour continuous duty, intermittent duty, short-time duty	55
		silver or with silver inserts		*
		other metals or sintered cermets		depending on quality of metal or sintered cermet
2	Brush contacts			25
3	Busbar connections	no protection against oxidation at point of contact		45
		protected against oxidation at point contact by:	tin or cadmium plating, silver plating	55 75
		soldered or welded connections		75
4	Magnets, magnet cores, and similar parts			the same as for insulation in contact with the said parts
5	Manual controls	metallic		10
		insulant		20
6	Enclosures, shields or parts accessible to accidental touch			35
7	Enclosures of rheostats suitably guarded against accidental touch			200
8	Cooling air from rheostats when taking measurements at a distance of 25 mm			175

* The temperature rise is admissible only up to a level at which a hot part does not cause heating of the adjacent parts above their temperature rise limit.

4 Cyclic irregularity of electric generating sets

Cyclic irregularity, per revolution, of electric generating sets using piston engines as prime movers shall not exceed the values specified in Table 4.

Cyclic irregularity, per revolution, for all loads, inclusive of rated load, at rated speed, is determined from the formula:

$$S = \frac{\omega_{\max} - \omega_{\min}}{\omega_{av}} \tag{4}$$

ω_{max} – maximum angular velocity;
ω_{min} – minimum angular velocity;
ω_{av} – average angular velocity.

Table 4

Number of engine impulses per second	Cyclic irregularity	
	one- or two-cylinder engines	engines with more than two cylinders
under 10	1/75	1/150
10 to 20	1/75	number of impulses per second/1500
over 20	1/75	1/75

5 Vibration resistance

The requirements are specified in *Publication 11/P – Environmental Tests on Marine Equipment*.

6 Climatic tests

The requirements are specified in *Publication 11/P – Environmental Tests on Marine Equipment*.

7 Inflammability test of electro-insulating materials

The requirements are specified in *Publication 11/P – Environmental Tests on Marine Equipment*.

Appendix 3

HAZARDOUS AREA CLASSIFICATION IN RESPECT OF SELECTION OF ELECTRICAL EQUIPMENT, CABLES AND WIRING AND POSITIONING OF OPENINGS AND AIR INTAKES (IACS UI SC274)

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
1	Hazardous area and classification on open deck from the cargo tank ventilation outlet for small flow by thermal variations	Within 5 m radius; Regulation 11.6.2.2 of SOLAS Chapter II-2 as amended by IMO resolutions up to MSC.421(98) (hereinafter the same). Reference is made to UI SC70 "Cargo tank vent systems and selection of electrical equipment".			Within 4.5 m radius; IEC 60092-502:1999, 4.2.2.7 and 4.2.3.1. Zone 1: open areas on deck within a 3 m radius. Zone 2: additional 1.5 m beyond Zone 1; IEC 60092-502:1999, 4.2.2.7 and 4.2.3.1.
2	The separation distance of the nearest air intakes for non-hazardous spaces from the tank ventilation outlet for small flow by thermal variations	At least 10 m; the openings shall be arranged in accordance with regulation 4.5.3.4.1 of SOLAS Chapter II-2 referred to in regulation 11.6.2 of SOLAS Chapter II-2.	At least 10 m; paragraph 8.3.4.2 of the IBC Code as amended by IMO resolutions up to MSC.460(101). At least 15 m; paragraph 15.12.1.3 of the IBC Code (although toxicity not flammability).	At least 10 m; paragraph 8.2.11.2 of the IGC Code as amended by IMO resolutions up to MSC.441(99) (hereinafter the same). Cargo tank PRV vent exits: at least equal to B or 25 m, whichever is less. For ships less than 90 m in length, smaller distances may be permitted; paragraph 8.2.11.1 of the IGC Code.	At least 6 m; IEC 60092-502:1999, 4.2.2.7, 4.2.3.1 and 8.2.5.
3	The separation distance of the nearest air intakes for non-hazardous spaces from the tank vent outlets for cargo loading, discharging and ballasting	At least 10 m; Regulation 4.5.3.4.1.3 of SOLAS Chapter II-2. At least 10 m; Regulation 11.6.2.2 of SOLAS Chapter II-2 referring back to 4.5.3.4.1 of SOLAS Chapter II-2.	At least 10 m; paragraph 12.1.5 of the IBC Code. At least 15 m; paragraph 15.12.1.3 of the IBC Code (although toxicity not flammability).	At least 10 m; paragraph 12.1.6 of the IGC Code. Cargo tank PRV vent exits: at least equal to B or 25 m, whichever is less. For ships less than 90 m in length, smaller distances may be	At least 11.5 m; IEC 60092-502:1999, 4.2.2.8, 4.2.3.2 and 8.2.5.

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
				permitted; paragraph 8.2.11.1 of the IGC Code. All other vent outlets connected to the cargo containment system: at least 10 m; paragraph 8.2.11.2 of the IGC Code.	
4	The separation distance of the nearest air intakes for non-hazardous areas from the ventilation exhaust outlet for hazardous areas (i.e. cargo compressor room, cargo pump room, etc.)	MSC.1/Circ.1321 Pt.IV Ch.3 Para.1.2: the position of the cargo pump room vent outlet should be arranged at a distance of at least 3 m measured horizontally from any ignition source and from the nearest opening to accommodation, service or machinery spaces.	At least 10 m; paragraph 12.1.5 of the IBC Code.	At least 10 m; paragraph 12.1.6 of the IGC Code. Ventilation ducts, air intakes and exhaust outlets serving artificial ventilation systems shall be positioned in accordance with recognized standards*; paragraph 12.1.5 of the IGC Code. * IEC60092-502:1999	At least 6 m; IEC 60092-502:1999, 4.2.2.7, 4.2.3.1 and 8.2.5.
5	Hazardous area and classification on open deck from the cargo shore connection or spillage coaming		Within the coaming required by paragraph 3.7.7 of the IBC Code or within a 3 m radius beyond the coaming; paragraph 3.7.8 of the IBC Code. It should be noted that paragraph 3.7.8 of the IBC Code only applies to stern or bow loading arrangements.	Within 3 m beyond the spillage coaming up to a height of 2.4 m above the deck; paragraph 1.2.24.15 of the IGC Code.	Within 4.5 m radius; IEC 60092-502:1999, 4.2.2.10 and 4.2.3.1. Zone 1: open areas on deck within a 3 m radius, up to a height of 2.4 m above the deck. Zone 2: additional 1.5 m beyond Zone 1; IEC 60092-502:1999, 4.2.2.10 and 4.2.3.1.
6	Opening to main cargo control stations and service spaces not giving access to accommodations, control stations and similar spaces containing sources of ignition	Subject to Administration; Regulation 4.5.2.2 of SOLAS Chapter II-2. Note: Regulation 4.5.2.2 of SOLAS Chapter II-2 does not categorize	Paragraph 3.2.3 of the IBC Code		The intent of a minimum distance of 1.5 m from the boundaries of any hazardous area is to be followed; IEC 60092-502:1999, 8.2.5.

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
		the space as hazardous or non-hazardous.			
7	Openings to accommodation spaces, service spaces, control stations and machinery spaces facing the cargo area	Not less than 4% of L, but not less than 3 m from the end of the superstructure or deckhouse. (This distance need not exceed 5 m); SOLAS Regulation 4.5.2 of SOLAS Chapter II-2.	Not less than 4% of L, but not less than 3 m from the end of the superstructure or deckhouse. (This distance need not exceed 5 m); paragraph 3.2.3 of the IBC Code.	Not less than 4% of L, but not less than 3 m from the end of the superstructure or deckhouse. (This distance need not exceed 5 m); paragraph 3.2.4.1 of the IGC Code.	At least 1.5 m from the boundaries of any hazardous area; IEC 60092-502:1999, 8.2.5.
8	Access doors to forecastle spaces containing source of ignition facing the cargo area	Access doors to forecastle spaces containing source of ignition shall not face the cargo area; Regulation 4.5.2.1 of SOLAS Chapter II-2. Access doors to forecastle spaces containing source of ignition shall not face the cargo area and are to be at not less than 3 m from the end of the superstructure or deckhouse. (This distance need not exceed 5 m); Regulation 4.5.2.1 of SOLAS Chapter II-2. Reference is made to UI SC120 "Access to forecastle spaces on tankers; regulations 4.5.2.1 and 4.5.2.2 of SOLAS Chapter II-2, paragraph 3.2.3 of the IBC Code paragraph 3.2.4" of the IGC Code	Access doors to forecastle spaces containing source of ignition shall not face the cargo area; paragraph 3.2.3 of the IBC Code. Reference is made to UI SC120 "Access to forecastle spaces on tankers; regulations 4.5.2.1 and 4.5.2.2 of SOLAS Chapter II-2, paragraph 3.2.3 of the IBC Code and paragraph 3.2.4 of the IGC Code".	Access doors to forecastle spaces containing source of ignition shall not face the cargo area; paragraph 3.2.4.1 of the IGC Code. Accesses to forecastle spaces containing sources of ignition may be permitted through a single door facing the cargo area, provided the doors are located outside hazardous areas as defined in chapter 10; paragraph 3.2.4.4 of the IGC Code. Reference is made to UI SC120 "Access to forecastle spaces on tankers; regulations 4.5.2.1 and 4.5.2.2 of SOLAS Chapter II-2, paragraph 3.2.3 of the IBC Code and paragraph 3.2.4 of the IGC Code".	The forecastle spaces installed the access doors facing the cargo area shall be designated as the hazardous area of Zone 2; IEC 60092-502:1999, 4.2. See also IEC 60092- 502:1999, 4.2.3.6 as commented in item 18 below.
9	Ventilation of cargo pump rooms (cargo handling spaces on chemical and gas carriers)	20 air changes/hour; Regulation 4.5.4.1 of SOLAS Chapter II-2 and MSC.1/Circ.1321, Pt. IV, Ch. 3, Para. 1.1.	30 air changes/hour; paragraph 12.1.3 of the IBC Code.	30 air changes/hour; paragraph 12.1.3 of the IGC Code.	Spaces containing sources of release: 30 air changes/hour; IEC 60092-502:1999, 8.1.3.

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
			45 air changes/hour; paragraph 15.17 of the IBC Code (toxic).		Note: The IEC standard refer to spaces "containing sources of release", while the IBC and IGC Codes refer to spaces for "cargo handling operations".
10	Ventilation of hazardous spaces not containing source of release		20 air changes/hour; spaces normally entered paragraph 12.2 of the IBC Code. 8 air changes/hour; spaces not normally entered paragraph 12.3 of the IBC Code (16 air changes/hour if portable).		Spaces not containing sources of release: 6 air changes/hour; IEC 60092-502:1999, 8.1.3.
11	Concentration of gas implying that space is non-hazardous (alarm limits)	10% LFL (Lower Flammable Limit) for cargo pump rooms in tankers; Regulation 4.5.10.1.3 of SOLAS Chapter II-2. 30% LFL for all ballast tanks and void spaces of double-hull and double-bottom spaces adjacent to the cargo tanks in oil tankers of 20,000 tonnes deadweight and above; Regulation 4.5.7.3 of SOLAS Chapter II-2 and Paragraph 2.2.3.3 of Chapter 16 of the FSS Code as amended by IMO resolutions up to MSC.410(97).	10% LFL for cargo pump room; paragraph 11.1.1.7 of the IBC Code (Res. MSC.219(82)), clarifying that regulation 4.5.10 of SOLAS Chapter II-2 applies, in which case "hydrocarbon gases" are replaced by "flammable vapours".	Alarms shall be activated for flammable products when the vapour concentration reaches 30% of the lower flammable limit, for the spaces of paragraph 13.6.2 of the IGC Code; paragraph 13.6.15 of the IGC Code.	30% LFL; IEC 60092-502:1999, 8.4.2. Note: The requirement of the standard applies to spaces protected by over-pressure.
12	Fan monitoring (air lock)			Where spaces are protected by pressurization, the ventilation shall be designed and installed in accordance with recognized	Motor running or rotating fan monitoring device is not accepted; IEC 60092-502:1999, 8.4.3.

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
				standards*; paragraph 3.6.2 of the IGC Code. * IEC 60092-502:1999. As per the Note to 8.4.3 of the standard, a fan motor or a fan rotation monitoring device will not satisfy this requirement.	
13	Tanks for heated cargo	Tanker requirements apply to tankers carrying cargo with FP below 60°C; Regulation 1.6.1 of SOLAS Chapter II-2. For petroleum cargoes with FP of 60°C and above only deck foam requirements apply; Regulation 1.6.4 of SOLAS Chapter II-2. Hazardous zone classification and electrical installation shall be complied with IEC 60092-502:1999; Regulation 45.11 of SOLAS Chapter II-1 as amended by IMO resolutions up to MSC.436(99) (hereinafter the same).	Follows SOLAS principle related to flashpoint, however the IBC Code considers non-flammable (NF) products and products with a flashpoint of 60°C and above, in a different way (paragraphs 11.1.2 & 11.1.3 of the IBC Code); In the case of a heated cargo, carriage conditions might need to be established and the requirements for cargoes having a flashpoint not exceeding 60°C applied; paragraph 10.1.6 of the IBC Code.		When carrying cargoes heated to temperature within 15°C of their flash point, hazardous zone classification for tankers carrying cargoes with FP not exceeding 60°C applies; IEC 60092-502:1999, 4.3.2 referring back to 4.2.
14	Classification of cargo pump room	Hazardous zone classification and electrical installation shall be complied with IEC 60092-502:1999; Regulation 45.11 of SOLAS Chapter II-1.		Paragraph 1.2.24.6 of the IGC Code.	IEC 60092-502:1999, 4.1.4.1 Table 1 and 4.2.2.4 may indicate that cargo pump rooms are Zone 1. However, as ventilation is only running during cargo handling, the requirements may be interpreted that it is Zone 0 (Flag Administration position may be required).

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
15	Discontinuation of ventilation for long periods		Spare parts shall be carried for each type of ventilation fan required onboard; paragraph 12.1.9 of the IBC Code.	Where fans are required, full required ventilation capacity for each space shall be available after failure of any single fan, or spare parts shall be provided comprising a motor, starter spares and complete rotating element, including bearings of each type; paragraph 12.1.8 of the IGC Code.	IEC 60092-502:1999, 8.3.1 includes an assumption that ventilation shall not be discontinued for long periods
16	Gas carrier ballast tanks			Ballast tanks may be connected to pumps in machinery spaces; paragraph 3.7.5 of the IGC Code.	Ballast tanks on gas carriers, separated from a hold space, where cargo is carried in a cargo tank requiring a secondary barrier, by a single gastight boundary, are hazardous areas Zone 1.
17	Gas carrier hold space				Hold spaces of gas carriers (except those with C-tanks), where a secondary barrier is required, are considered hazardous areas Zone 0; IEC 60092-502:1999, 4.4.1 and Annex D
18	Access to forward spaces below level of main deck	Access openings to service spaces, control stations and machinery spaces are not to face the cargo area; Regulation 4.5.2 of SOLAS Chapter II-2. Reference is made to UI SC120 “Access to forecastle spaces on tankers; regulations 4.5.2.1 and 4.5.2.2 of SOLAS Chapter II-2, paragraph 3.2.3 of	Reference is made to UI SC120 “Access to forecastle spaces on tankers; regulations 4.5.2.1 and 4.5.2.2 of SOLAS Chapter II-2, paragraph 3.2.3 of the IBC Code and paragraph 3.2.4 of the IGC Code”.	Reference is made to UI SC120 “Access to forecastle spaces on tankers; regulations 4.5.2.1 and 4.5.2.2 of SOLAS Chapter II-2, paragraph 3.2.3 of the IBC Code and paragraph 3.2.4 of the IGC Code”.	It is implied that as long as the sill height is above 0.5 m then it is exempted from SOLAS and can face the cargo area; IEC 60092-502:1999, 4.2.3.6.

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
		the IBC Code and paragraph 3.2.4 of the IGC Code".			
19	Hazardous zone classification on main deck of tankers with deck girders				The entire deck area up to 2.4 m is considered as Zone 1 if deck girders are provided as they are considered to restrict natural ventilation; IEC 60092-502:1999, 4.2.2.11.
20	Hazardous zone in way of P/V-breaker	Regulation 4.6.2.2 of SOLAS Chapter II-2: at least 5 m. Regulation 11.6.2.2 of SOLAS Chapter II-2: at least 10 m .			10 m from a cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading; IEC 60092-502:1999, 4.2.2.8 & 4.2.3.2 based on UI SC140, otherwise 4.5 m from a P/V breaker which does not release large volumes of gas or vapour locally; IEC 60092-502:1999, 4.2.2.7 & 4.2.3.1.
21	Location of fan motors for cargo pump room and compressor room		To be located outside ducts; paragraph 12.1.8 of the IBC Code.	To be located outside ducts; paragraph 12.1.7 of the IGC Code.	IEC 60092-502:1999; follows zone classification. I.e. if Zone 0, outside ventilation duct (based on 6.5.2). If Zone 1, inside OK, provided certified for Zone 1
22	Openings to accommodation spaces, service spaces, control stations and machinery spaces facing the cargo	Shall not face the cargo area. Can be located at the transverse bulkhead not facing the cargo area, at a distance of at least 4% of the length of the ship but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area. This distance need not exceed 5 m; Regulation 4.5.2.1 of SOLAS Chapter II-2.	Shall not face the cargo area. They shall be located on the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deck-house at a distance of at least 4% of the length (L) of the ship but not less than 3 m from the end of the superstructure or deck-house facing the cargo area. This distance, however,	Shall not face the cargo area. They Shall be located on the end bulkhead not facing the cargo area or on the outboard side of the superstructure or deck-house or on both at a distance of at least 4% of the length (L) of the ship but not less than 3 m from the end of the superstructure or deck-house facing the cargo area. This distance, however, need not	Access doors or other openings shall not be provided between an area intended to be considered as non-hazardous and a hazardous area, or between a space intended to be considered as Zone 2 and a Zone 1 space except where required for operational reasons. Where access doors or other openings are provided for operational reasons, 4.1.5.2,

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
		Refer to Regulation 4.5.2.2 of SOLAS Chapter II-2 for permitted access doors to main cargo control stations and service spaces and to wheelhouse doors and windows.	need not exceed 5 m. Refer to same paragraph for permitted access doors to spaces not having access to accommodation and service spaces and control stations, and wheelhouse doors and windows; paragraph 3.2.3 of the IBC Code.	exceed 5 m. Refer to same paragraph for wheelhouse doors and windows; paragraph 3.2.4.1 of the IGC Code.	4.1.5.3, 4.1.5.4 or 4.1.5.5 apply; IEC 60092-502:1999, 4.1.5. Where a space has an opening into an adjacent, more hazardous space or area, it may be made into a less hazardous space or non-hazardous space by pressurization designed and operated in accordance with the requirements given in 8.2 and 8.4; IEC 60092-502:1999, 8.1.4. Note: SOLAS and Codes refer to permitted openings of spaces, while the IEC standard defines hazardous areas.
23	Protection by over-pressure			Paragraph 12.1.4 of the IGC Code.	Protection by over-pressure where a non-hazardous space has openings into a hazardous space; IEC 60092-502:1999, 8.4.
24	Air locks			Paragraph 3.6 of the IGC Code.	IEC 60092-502:1999, 4.1.5.3.
25	Earthed distribution systems and hull return systems	Earthed distribution systems shall not be used in a tanker. The Administration may exceptionally permit in a tanker the earthing of the neutral for alternating current power networks of 3,000 V (line to line) and over, provided that any possible resulting current does not flow directly through any of the dangerous spaces; Regulation 45.4.1 of SOLAS Chapter II-1.			Distribution systems: Distribution systems shall comply with the provisions of IEC 60092-201:2019. Both insulated and earthed distribution systems are permitted; systems with a hull or structure return, other than those noted under 5.2.2, are not permitted; IEC 60092-502:1999, 5.2.1.

No.	Title	SOLAS	IBC	IGC	IEC 60092-502:1999
		The hull return system of distribution shall not be used for any purpose in a tanker; Regulation 45.3.1 of SOLAS Chapter II-1. The above regulation does not preclude under conditions approved by the Administration the use of: – impressed current cathodic protective systems; – limited and locally earthed systems; or – insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions. Regulation 45.3.2 of SOLAS Chapter II-1.			The following systems are permitted to be of hull or structure return type: – limited and locally earthed systems outside any hazardous area; – intrinsically-safe systems; – impressed current cathodic protective systems; IEC 60092-502:1999, 5.2.2. The neutral and any conductor required for protection against electric shock shall not be connected together or combined in a single conductor in a hazardous area; IEC 60092-502:1999, 5.2.3.
26	Hazardous zone classification on main deck of tankers	Hazardous zone classification and electrical installation shall be complied with IEC 60092-502:1999; Regulation 45.11 of SOLAS Chapter II-1.	Chapter 10 of the IBC Code: IEC 60092-502:1999.	Paragraph 1.2.24.9 of the IGC Code.	The cargo tanks, including all ballast tanks with cargo tank area; IEC 60092- 502:1999, 4.2.2.11 & 4.2.3.5 (areas on open deck over cargo tanks as per the above IEC paragraphs do not coincide with the definition of the cargo area in SOLAS or the Codes).

SUPPLEMENT

RETROACTIVE REQUIREMENTS

1 GENERAL PROVISIONS

1.1 The requirements specified in this Supplement apply to existing ships.

1.2 The scope of retroactive requirements is specified separately for each of the requirements given below.

1.3 The scope of technical documentation subject to PRS consideration and approval is specified in the sub-chapters relevant to particular issues covered by retroactive requirements. The documentation shall be submitted to PRS well in advance of the retroactive requirements implementation date.

1.4 It is the responsibility of the Owner to execute the applicable retroactive requirements in accordance with the implementation schedule. Retroactive requirements execution is confirmed by PRS Surveyor in the report on the nearest Periodical Survey.

2 REQUIREMENTS

2.1 Central operating console of sliding watertight doors

2.1.1 Application

These requirements apply to existing passenger ships, subject to SOLAS convention, constructed before January 1, 2024, but after January 1, 2020.

2.1.2 Detailed requirements

(...) the central operating console of sliding watertight doors, located at the navigation bridge shall be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door is fully open and a green light shall indicate a door is fully closed. When the door is closed remotely the red light shall indicate the intermediate position by flashing. The indicating circuit shall be independent of the control circuit for each door. (SOLAS, Reg. II-1/13.7.2)

LIST OF EXTERNAL REFERENCE DOCUMENTS

IMO documents:

1. *International Convention for the Safety of Life at Sea, 1974 (SOLAS Convention)*
2. *Torremolinos International Convention for the Safety of Fishing Vessels 1977*
3. *Torremolinos Protocol relating to the Torremolinos International Convention for the Safety of Fishing Vessels 1977*
4. *International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code)*
5. *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)*
6. *International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels (IGF Code)*
7. *Code of Safety for Special Purpose Ships (SPS Code)*
8. *International Life-Saving Appliance Code (LSA Code)*
9. *International Code for Fire Safety Systems (FSS Code)*
10. *International Safety Management Code (ISM Code)*

11. A.813(19).*General requirements for electromagnetic compatibility for all electrical and electronic ship's equipment*
12. A.830(19) *Code on Alarms and Indicators, 1995*
13. A.1021(26) *Code on Alerts and Indicators, 2009*

14. MSC/Circ.736 *Interpretations of vague expressions in SOLAS Chapter II-1*
15. MSC/Circ.808 *Recommendation on Performance Standards for Public Address Systems on Passenger Ships, Including Cabling*
16. MSC/Circ.1120 *Unified interpretations of SOLAS Chapter II-2, the FSS Code, the FTP Code and related fire test procedures*
17. MSC/Circ.1167 *Functional Requirements and Performance Standards for the Assessment of Evacuation Guidance Systems*
18. MSC.1/Circ.1212/Rev.1 *Revised guidelines on alternative design and arrangements for SOLAS Chapters II-1 and III*
19. MSC.1/Circ.1291 *Guidelines for Flooding Detection Systems on Passenger Ships*
20. MSC.1/Circ.1321 *Guidelines for measures to prevent fires in engine-rooms and cargo pump-rooms*
21. MSC.1/Circ.1416/Rev.1 *Unified interpretations concerning the arrangements for steering capability and function on ships fitted with propulsion and steering systems*
22. MSC.1/Circ.1436 *Amendments to the unified interpretations of SOLAS Chapter II-2, the FSS Code, the FTP Code and related fire test procedures (MSC/Circ.1120)*
23. MSC.1/Circ.1455 *Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments*
24. MSC.1/Circ.1464/Rev.1/Corr.2 *Unified interpretations of SOLAS Chapters II-1 and XII, of the technical provisions for means of access for inspections (resolution MSC.158(78)) and of the performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers (resolution MSC.188(79))*
25. MSC.1/Circ.1510 *Amendment to the unified interpretations of SOLAS Chapter II-2, the FSS Code, the FTP Code and related fire test procedures (MSC/Circ.1120)*
26. MSC.1/Circ.1572/Rev.2 *Unified interpretations of SOLAS Chapters II-1 and XII, of the technical provisions for means of access for inspections (resolution MSC.158(78)) and of the performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers (resolution MSC.188(79))*
27. MSC.1/Circ.1615 *Interim Guidelines for Minimizing the Incidence and Consequences of Fires in Ro-Ro Spaces and Special Category Spaces of New and Existing Ro-Ro Passenger Ships*
28. MSC.188(79) *Performance standards for water level detectors on bulk carriers and single hold cargo ships other than bulk carriers*
29. MSC.219(82) *Amendments to the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk*
30. MSC.391(95) *Adoption of the International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code)*
31. MSC.410(97) *Amendments to the International Code for Fire Safety Systems (FSS Code)*
32. MSC.421(98) *Amendments to the International Convention for the Safety of Life at Sea, 1974, as amended*
33. MSC.441(99) *Amendments to the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)*
34. MSC.460(101) *Amendments to the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code)*

IACS Resolutions:

1. PR29 Rev.0 *Definition of date of "contract for construction"*

2. UI SC1 Rev.2 *Main source of electrical power*
3. UI SC3 Rev.1 *Emergency source of electrical power*
4. UI SC7 *Precautions against shock, fire and other hazards of electrical origin (Chapter II-1, Regulation 45.2)*
5. UI SC8 *Precautions against shock, fire and other hazards of electrical origin (Chapter II-1, Regulation 45.3.3)*
6. UI SC9 *Precautions against shock, fire and other hazards of electrical origin (Chapter II-1, Regulation 45.4.2)*
7. UI SC10 Rev.3 *Precautions against shock, fire and other hazards of electrical origin*
8. UI SC11 Rev.1 *Precautions against shock, fire and other hazards of electrical origin*
9. UI SC12 *Precautions against shock, fire and other hazards of electrical origin (Chapter II-1, Regulation 45.5.4)*
10. UI SC13 *Precautions against shock, fire and other hazards of electrical origin (Chapter II-1, Regulation 45.6.1)*
11. UI SC14 *Special requirements for machinery, boilers and electrical installations (Chapter II-1, Regulation 53.3)*
12. UI SC42 Rev.3 *Precaution against ignition of explosive petrol and air mixture in closed vehicle spaces, closed ro-ro spaces and special category spaces*
13. UI SC43 Rev.3 *Precaution against ignition of explosive petrol and air mixture in closed vehicle spaces, closed ro-ro spaces and special category spaces*
14. UI SC70 Rev.4 Corr.1 *Cargo tank vent systems and selection of electrical equipment*
15. UI SC72 Rev.1 *In a ship engaged regularly in voyages of short duration*
16. UI SC83 *Continuity of the Supply when Transformers Constitutes an Essential Part of the Electrical Supply System*
17. UI SC94 Rev.2 Corr.1 *Mechanical, hydraulic and electrical independency of steering gear control systems*
18. UI SC95 *Communication between Navigating Bridge and Machinery Space*
19. UI SC124 Rev.1 Corr.1 *Emergency Source of Power in Passenger and Cargo Ships*
20. UI SC133 *Oil Mist Detector on High Speed Engines – "equivalent device"*
21. UI SC134 *Essential Services and Arrangements of Sources of Power, Supply, Control and Monitoring to the different Categories of Essential Services*
22. UI SC151 *Location of the main generating station with respect to the main switchboard and associated section boards*
23. UI SC152 *Use of emergency generator in port*
24. UI SC157 Rev.1 *Main Source of Electrical Power*
25. UI SC187 *Electric steering gear overload alarm*
26. UI SC194 *Installation of electrical and electronic appliances on the bridge and vicinity of the bridge*
27. UI SC242 Rev.2 *Arrangements for steering capability and function on ships fitted with propulsion and steering systems other than traditional arrangements for a ship's directional control*
28. UI SC274 Rev.1 *Hazardous area classification in respect of selection of electrical equipment, cables and wiring and positioning of openings and air intakes*

29. UR E5 Rev.1 *Voltage and frequency variations*
30. UR E7 Rev.5 *Cables*
31. UR E9 Rev.1 *Earthing and bonding of cargo tanks/process plant/piping systems for the control of static electricity*
32. UR E10 Rev.9 *Test specification for type approval*
33. UR E11 Rev.4 *Unified requirements for systems with voltages above 1 kV up to 15 kV*
34. UR E12 Rev.2 *Electrical equipment allowed in paint stores and in the enclosed spaces leading to the paint stores*
35. UR E13 Rev.3 Corr.1 *Test requirements for rotating machines*
36. UR E15 Rev.4 *Electrical services required to be operable under fire conditions and fire resistant cables*
37. UR E16 *Cable trays/protective casings made of plastic materials*
38. UR E17 Rev.1 *Generators and generator systems, having the ship's propulsion machinery as their prime mover, not forming part of the ship's main source of electrical power*
39. UR E18 Rev.1 *Recording of the type, location and maintenance cycle of batteries*
40. UR E19 Rev.1 *Ambient temperatures for electrical equipment installed in environmentally controlled spaces*
41. UR E20 Rev.1 *Installation of electrical and electronic equipment in engine rooms protected by fixed water-based local application fire-fighting systems (FWBLAFFS)*
42. UR E21 Rev.2 *Requirements for uninterruptible power system (UPS) units as alternative and/or transitional power*
43. UR E24 Rev.1 *Harmonic Distortion for Ship Electrical Distribution System including Harmonic Filters*
44. UR E25 Rev.2 *Failure detection and response of all types of steering control system*
45. UR M29 Rev.3 *Alarm systems for vessels with periodically unattended machinery spaces*
46. UR M30 Rev.1 *Safety systems for vessels with periodically unattended machinery spaces*

47. UR M35 Rev.8 *Alarms, remote indications and safeguards for main reciprocating I.C. engines installed in unattended machinery spaces*
48. UR M36 Rev.6 *Alarms and safeguards for auxiliary reciprocating internal combustion engines driving generators in unattended machinery spaces*
49. UR M40 *Ambient conditions – temperatures*
50. UR M43 Rev.1 *Bridge control of propulsion machinery*
51. UR M46 Rev.3 *Ambient conditions – Inclinations and Ship Accelerations and Motions*
52. UR M61 Rev.2 *Starting Arrangements of Internal Combustion Engines*
53. UR M63 Rev.1 *Alarms and safeguards for emergency reciprocating I.C. engines*
54. UR S2 Rev.2 *Definition of Ship's Length L and of Block Coefficient Cb*

55. REC.49 Rev.1 Corr.1 *Testing of Protection Devices for Generators and Large Consumers on Board*
56. REC.52 Rev. 2 *Power Supply to Radio Equipment required by SOLAS Chapter IV, and Electrical/Electronic Navigation Equipment required by SOLAS regulation V/19*
57. REC.132 *Human Element Recommendations for structural design of lighting, ventilation, vibration, noise, access and egress arrangements*
58. REC.137 *Recommendation for protection of socket outlets for road freight units*
59. REC.166 Corr.2 *Recommendation on Cyber Resilience*
60. REC.178 *Overall Earthing System: Protective Earthing, System Earthing – Guidelines*
61. REC.182 *Onshore Power Supply*

ISO standards:

1. ISO 8217:2017 *Petroleum products – Fuels (class F) – Specifications of marine fuels*
2. ISO 11674:2019 *Ship and marine technology – Heading control systems*

IEC standards:

1. IEC 60034-1:2017 *Rotating electrical machines - Part 1: Rating and performance*
2. IEC 60034-5:2000 *Rotating electrical machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification*
3. IEC 60034-15:2009 *Rotating electrical machines - Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines*
4. IEC 60076 Series *Power transformers*
5. IEC 60076-11:2018 *Power transformers - Part 11: Dry-type transformers*
6. IEC 60079-1-1:2002 *Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"*
7. IEC 60079-10-1:2015 *Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres*
8. IEC 60079-14:2013 *Explosive atmospheres - Part 14: Electrical installation design, selection and installation of equipment, including initial inspection*
9. IEC 60092 Series *Electrical Installations in ships*
10. IEC 60092-201:2019 *Electrical installations in ships - Part 201: System design - General*
11. IEC 60092-301:1980 *Electrical installations in ships - Part 301: Equipment - Generators and motors*
12. IEC 60092-350:2020 *Electrical installations in ships - Part 350: General construction and test methods*
13. IEC 60092-352:2005 *Electrical installations in ships - Part 352: Choice and installation of electrical cables*
14. IEC 60092-353:2016 *Electrical installations in ships - Part 353: Power cables for rated voltages 1 kV and 3 kV*
15. IEC 60092-354:2020 *Electrical installations in ships – Part 354: Single- and three-core power cables with extruded solid insulation for rated voltages 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)*
16. IEC 60092-360:2014 *Electrical installations in ships - Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation and telecommunication cables*
17. IEC 60092-370:2019 *Electrical installations in ships - Part 370: Guidance on the selection of cables for telecommunication and data transfer including radio-frequency cables*
18. IEC 60092-376:2017 *Electrical installations in ships - Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)*
19. IEC 60092-501 *Electrical installations in ships - Part 501: Special features - Electric propulsion plant*
20. IEC 60092-502:1999 *Electrical installations in ships - Part 502: Tankers - Special features*
21. IEC 60092-503:2007 *Electrical installations in ships - Part 503: Special features - AC supply systems with voltages in the range of above 1 kV up to and including 36 kV*
22. IEC 60092-504 *Electrical installations in ships - Part 504: Automation, control and instrumentation*
23. IEC 60092-506 *Electrical installations in ships - Part 506: Special features - Ships carrying specific dangerous goods and materials hazardous only in bulk*

24. IEC 60331 Series *Tests for electric cables under fire conditions*
25. IEC 60331-1:2018 *Tests for electric cables under fire conditions - Circuit integrity - Part 1: Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*
26. IEC 60331-2:2018 *Tests for electric cables under fire conditions - Circuit integrity - Part 2: Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm*
27. IEC 60331-21:1999+AMD1:2009 *Tests for electric cables under fire conditions - Circuit integrity - Part 21: Procedures and requirements - Cables of rated voltage up to and including 0,6/1,0 kV*
28. IEC 60331-23: 1999 *Tests for electric cables under fire conditions - Circuit integrity - Part 23: Procedures and requirements - Electric data cables*
29. IEC 60331-25:1999 *Tests for electric cables under fire conditions - Circuit integrity - Part 25: Procedures and requirements - Optical fibre cables*
30. IEC 60332-1-2:2004+AMD1:2015 *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame*
31. IEC 60332-3-22:2018 *Tests on electric and optical fibre cables under fire conditions - Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A*
32. IEC 60529:2003 *Degrees of protection provided by enclosures (IP Code)*
33. IEC 60533:2015 *Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a metallic hul*l
34. IEC 60945:2002 *Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results*
35. IEC 61162 *Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners*
36. IEC 61363-1 *Electrical installations of ships and mobile and fixed offshore units - Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*
37. IEC 62040-1:2017 *Uninterruptible power systems (UPS) - Part 1: Safety requirements*
38. IEC 62040-2:2016 *Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements*
39. IEC 62040-3:2011 *Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements*
40. IEC 62040-4:2013 *Uninterruptible power systems (UPS) - Part 4: Environmental aspects - Requirements and reporting*
41. IEC 62040-5-3:2016 *Uninterruptible power systems (UPS) - Part 5-3: DC output UPS - Performance and test requirements*
42. IEC 62271-200:2011 *High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*
43. IEC 62271-201:2014 *High-voltage switchgear and controlgear - Part 201: AC solid-insulation enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

EU legal documents:

1. Commission Implementing Regulation (EU) 2024/1975 of 19 July 2024 *laying down rules for the application of Directive 2014/90/EU of the European Parliament and of the Council, as regards design, construction and performance requirements and testing standards for marine equipment and repealing Implementing Regulation (EU) 2023/1667*
2. Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 *on marine equipment and repealing Council Directive 96/98/EC*