PART II RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF VESSELS IDENTIFIED BY THEIR MISSIONS

TITLE 11 SHIPS IN GENERAL

SECTION 7 ELECTRICITY

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CHAPTER A
APPROACH

CHAPTER CONTENTS

A1. APPLICATION

A2. DEFINITIONS

A1. APPLICATION

100. Scope

101. These Rules apply to electrical installations in newbuildings of ships designed and built without restrictions or limitations of service for open sea navigation.

102. RBNA reserves the right to allow deviations from these Rules on ships classified for limited service, with restrictions on navigation or AB <500, depending on each specific case, however this may not be taken as a precedent for future amendments of the Rules. Moreover, additional requirements may be required for vessels having special construction features.

103. Designs and facilities whose characteristics differ from the rules set forth herein may be approved, provided that they are recognized by RBNA and their equivalence with other regulations and standards is no less effective than the Rules. Additional documents may be required, as well as special tests and trials.

200. Installation types

201. The electric installations are to be such that:

a. all electrical auxiliary services necessary to maintain the ship in normal operational and habitable condition are assured without the use of the emergency source of electrical power;

b. electrical services essential for safety are ensured under various emergency conditions; and

c. the safety of the crew and staff aboard the ship is guaranteed in relation to hazards caused by electricity.

A2. DEFINITIONS

100. Terms

101. The terms employed in the present Section have the following definitions:

Category A machinery spaces: Machinery spaces of category A are those spaces and trunks to such spaces which contain:

a. internal combustion machinery used for main propulsion;

b. 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

c. any oil-fired boiler or oil fuel unit.

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 firefighting recording or fire control equipment is centralized.

Dead ship condition: The condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power.

Guidance

Dead ship condition is a condition in which the entire machinery installation, including the power supply, is out of operation and the auxiliary services such as compressed air, starting current from batteries etc., for bringing the main propulsion into operation and for the restoration of the main power supply are not available.

End of guidance

Loading area: is the part of the vessel containing cargo tanks, waste tanks and cargo pumps spaces, including cofferdams square, ballast tanks and void spaces adjacent to cargo tanks, as well as the areas of the deck along the entire length and breadth of the part of the vessel located above of these spaces mentioned.

Earthing connecting device to the hull or other structure permanently attached, used as an arbitrary zero potential in such a manner as will ensure at all times an immediate discharge of electrical energy without danger, in order to protect the individual against hazardous contacts with accidentally energized metal parts, which can cause injuries during a phase-earth fault.

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.

Emergency consumers are mandatory consumers which, after breakdown of the main energy supply, shall be fed by the emergency energy supply.

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.

Essential services: those who are constantly required to: navigation, propulsion, manoeuvring the ship's machine (rudder, windlass, mooring winch, impeller side), services of specialized ships (cargo refrigeration system, air conditioning systems in ships passengers, cargo pump system in oil tankers) and required for safety of life at sea.

Hazardous areas are areas in which an explosive atmosphere in dangerous quantity (a dangerous explosive atmosphere) is liable to occur owing to local and operating conditions. Hazardous areas are divided into zones depending on the probability that a dangerous explosive atmosphere may occur:

Zone 0 comprises areas in which a dangerous explosive atmosphere is present either permanently or for long periods.

Zone 1 comprises areas in which a dangerous explosive atmosphere is liable to occur occasionally.

Zone 2 comprises areas in which a dangerous explosive atmosphere is liable to occur only rarely, and then only for a brief period (extended hazardous areas).

High voltage: high voltage circuits are those with more than 1000 V r.m.s. for alternating current and at least 1500 V for direct current.

Low-voltage systems: Are systems operating with rated voltages of more than 50 V r.m.s. up to 1000 V r.m.s. inclusive and with rated frequencies of 50 Hz or 60 Hz, or direct-current systems where the maximum instantaneous value of the voltage under rated operating conditions is greater than 50 V and not exceeding 1500 V.

Machinery spaces: 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.

Main generating station is the space in which the main source of electrical power is situated.

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 conditions.

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.

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.

Emergency source of electrical power is a source of electrical power, intended to supply the emergency switchboard in the event of a failure of the supply from the main source of electrical power.

Dangerous goods: are those listed in the Chapter VII of the SOLAS 1974, as amended.

Hull return: a system in which insulated conductors are effectively connected to the mass of the ship for earthing.

Special category spaces: those enclosed spaces above or below the bulkhead deck intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, to which such vehicles can be taken and removed them by their own means and to which the passengers have access.

Transient source of emergency power: accumulator batteries with sufficient capacity to supply automatically power for the emergency switchboard in the event of failure of main power source.

CHAPTER B
DOCUMENTS, REGULATIONS AND STANDARDS

CHAPTER CONTENTS

B1. DOCUMENTATION TO THE RBNA

B2. REGULATION

B3. STANDARDS AND UNITS

B1. DOCUMENTATION TO THE RBNA

100. Submission of documents

101. Drawings and documents are to be submitted to the approval of the RBNA in triplicate.

102. The plans, diagrams and specifications indicated as following, equipment and components for electrical systems, where applicable, are to be submitted to the approval of the RBNA, before starting the installation on board the ship, indicating at least, the location of essential service equipment, distribution of the circuits, rated current for each extension and circuit protection devices. Three hard copies or virtual files are to be submitted. Where hard copies

are submitted, RBNA will retain two copies and return one with the approval.

200. Documents of installation on all types of ships

201. The documents are to include, at least, the following topics:

a. short description of the installations, stating type of generation, distribution, alternative sources, emergency supplies, criteria of installations. etc.;

b. direct current and alternating current electrical load analysis to the ship's operating conditions and dimensioning of generators, batteries and battery chargers, in order to confirm that the installation of the main and emergency power supplies are appropriately dimensioned;

c. AC single line diagram, showing distribution basic connections and providing data of generators, transformers, converters and major consumers;

d. DC single line diagram showing distribution basic connections and providing data of generators, batteries, battery chargers and major consumers;

e. in the above diagrams, indication of main and emergency distribution, with battery groups, converters, main switchboards, circuit breakers, fuses, connecting and automatic switching devices, stop circuits, consumers and conductors and list of each f power supply and electric power distribution circuit, indicating the rated current, prediction of short-circuit current (if applicable), type, gauge, insulation, temperature rise, earthing system, rated current and voltage drop for the largest cable length, adjustment and rated values of the circuit breakers, breaking capacity of circuit breakers and fuses;

f. single line diagram, schematic and functional of the main switchboard, distribution of each electrical power, distribution and light distribution board, with indication of the voltage, generator or transformer connected to each circuit and providing conductor's gauge, size of enclosures and setting value of circuit-breakers, bus rated current, fuse rated current, disconnect switches, protective devices and instrumentation etc. and respective capabilities of making and breaking circuits under over-currents and short-circuits.

g. arrangement of the emergency switchboard, navigation lights panels and main switchboards, indicating the technical specifications and showing the details of the various construction sections, arrangement of the equipment installation, protective devices and instrumentation;

h. calculations of short-circuit current:

h.1. Where the sum of the rate power from the electrical sources which can be simultaneously connected to the main bus exceeds 500 kVA (or 500 kW) or when the rated current at the main bus exceeds 1000 A.

h.2. in order to establish that the protective devices on the main and emergency switchboards have sufficient short-circuit breaking and making capacities, data are to be submitted giving the maximum calculated short-circuit current in symmetrical r.m.s. and asymmetrical peak values available at the main bus bars together with the maximum allowable breaking and making capacities of the protective device. Similar calculations are to be made at other points in the distribution system, where necessary, to determine the adequacy of the interrupting capacities of the protective devices.

h.3. when it is estimated that the maximum short circuit current in the main bus is greater than 50 kA for the main and emergency switchboards, justification is to be provided of the main bus strength and supports related to electromagnetic forces induced (except buses to connect to switches and devices of protection.)

i. drawings of electrical plant installations on board showing location of the electrical equipment, conduits, cable routes, earthing system, details of cable penetrations through bulkheads and decks, main and emergency systems;

j. drawings of power distribution for lighting, showing normal and emergency fixtures and lighting circuits , indicating arrangement, type, gauge and insulation of cables, cable pathways, conduits, capacity of circuit breakers and fuses, luminance, degree of protection, insulation class, with double circuits for maintaining the ship in normal operating and habitability conditions without having recourse to the emergency source of power;

k. arrangement and details of generators and motors for essential service with power $\geq$ 100 kW, with technical specification, type, voltage, number of phases, power factor, degree of protection, insulation class, main dimensions, mass, material and heat treatment for the shaft, data for calculation of critical speed and details of rotor and stator (the plans and details of motor drives for generators must be submitted for approval as per requirements of part II-Title 11-Section 5-Chapter B-Item B2. and Chapter F2 Item F2.100);

l. arrangement and details of generators and motors for essential service with power $\geq$ 50 kW and < 100 kW with technical specification, type, voltage, degree of

protection, insulation class, main dimensions and Declaration of the manufacturer that the shaft material complies with recognised standards;

m. arrangement and details of generators and motors for essential service with power < 50 kW with technical specification, type, degree of protection and insulation class.

300. Control and monitoring Documents

301. The documents are to include the power and control diagrams of each consumer equipment, with, at least, the following topics:

a. **relating to hull equipment**:

a.1. Diagram of the systems of distribution, control, monitoring and steering gear alarms, showing the duplicity of power circuits and cables;

b. **for fire fighting**:

b.1. Diagram of the systems of distribution, control and monitoring showing the supply by main and emergency sources of the fireproof doors;

c. **relating to machinery**:

c.1. diagram of control systems, monitoring and alarms of the main propulsion plant, auxiliary and engine room;

c.2. diagram of the systems of distribution, control, monitoring and alarms of controllable pitch propeller;

c.3. diagram of systems of distribution, control, monitoring and alarms of azimuthal thruster and side propeller;

d. relating to pipings:

d1. diagram of the system of distribution, control, monitoring and shutdown of ventilation to machinery spaces;

d2. diagram of fixed fire fighting system, showing the main and emergency feeding sources, duplicity of circuits, insulation of cables, automatic switching, control, monitoring, visual and audible alarms;

d3. diagram of fixed water sprinkler system under pressure for fire extinguishing in machinery compartment, showing generator, pump, power supply by main and emergency sources, automatic switching, control, monitoring, audible alarms;

d4. diagram of the systems of automatic sprinkler, fire detection and fire alarm, showing the generator, pump, control panel with indicator units of fire location, main and emergency sources, automatic switching, control, monitoring, visual and audible alarms;

d5. diagram of the systems of distribution, control, monitoring and visual and audible alarm of high level of bilge systems in machinery spaces.

e. **relating to electricity**:

e.1. schematic diagram of control of the navigation lights system;

e.2. diagram of the general alarm system in emergency, showing the duplicity of cables, automatic switching, power supply from main and emergency sources;

e.3. diagram of the emergency disconnect system, showing the power supply and distribution circuits, insulation, locking and connection devices;

f. **relating to nautical**:

f.1. diagram of the systems of distribution, control, monitoring, visual and audible alarms of navigation lights, showing the duplicity of the circuits of power supply or the cables;

f.2. diagram of interior communication system or other system of communication;

400. Documents for vessels with electric propulsion

401. For ships with electric propulsion plant, in addition to the requirements for generators, are to be submitted details with full indication of motors, rectifiers, transformers, type, gauge, insulation, rated current, rise temperature of cables and specification of protective devices and instrumentation.

500. Documents of spaces for internal combustion motors

501. Passenger ships and cargo ships with cargo spaces intended for the carriage of motor vehicles with fuel in their tanks and/or dangerous goods, are to submit:

a. general arrangement of the ship showing the gauge, type, insulation and cable penetrations in bulkheads and decks, location and type of safety of electrical equipment in special category spaces;

b. distribution diagram of the systems of indication of the doors at ship's side access, cargo doors and closing devices, TV surveillance or detection of flooding and visual alarm showing segregation of

circuits of indication, operation and locking in ro-ro cargo spaces and special category spaces;

c. diagram of distribution and monitoring systems of the electric power for additional lighting in emergency showing the lanterns and connection device for continuous charging of batteries;

d. diagram of distribution systems, control, and monitoring showing the safety type of electrical equipment, type, gauge and insulation of cables, automatic closing of "flaps" and shutdowns of the forced ventilation in main vertical zones and special category spaces;

e. diagram of the systems of distribution, control, monitoring and high water level alarms in cargo spaces and special category spaces.

600. Documents related to changes

601. In the case of temporary or permanent increasing of the load capacity of existing vessels or change in the characteristics of electrical equipment and components of ships under construction, the relevant documentation is to be submitted to the examination and approval of the RBNA.

B2. REGULATION

100. Statutory requirements

101. The requirements of NORMAM 01 (Standard of the Brazilian Maritime Authority for ships employed in navigation in open seas) are to be satisfied and of the International Convention for the Safety of Life at Sea SOLAS 74 – where applicable. Foreign flag ships are to comply with National Regulations or, in the absence of those, with the SOLAS Convention regulations as far as practicable.

102. According to Part I, Title 01, Section 1, item D5.101, of these Rules, the texts referred to statutory regulations are marked with a border line in the left margin, as exemplified in this very paragraph. In particular, in this section are marked the texts that relate to the regulations of the Chapter II-1 of the SOLAS 1974 International Convention, with amendments. The term Administration, when mentioned and appropriate, it is understood the performance of the RBNA under Brazilian Government delegation.

B3. STANDARDS AND UNITS

100. Standards

101. The electrical installations and all the equipment and materials to be employed on vessels covered by these Rules are to be designed, constructed and tested according to the latest revisions of the applicable Standards of the following organizations, in addition to the requirements laid down in these Rules:

a. INMETRO: National Institute of Metrology, Standardization and Industrial Quality;

b. ABNT: Brazilian Association of Technical Standards;

c. IEC: International Electrotechnical Commission;

d. ANSI: American National Standards Institute;

e. NEMA: National Electrical Manufactures Association;

f. IEEE: Institute of Electrical and Electronics Engineers;

200. Units

201. Drawings and documents to be submitted to the RBNA are to have all the dimensions given in the international system. Consecrated dimensions in other systems of units should have indications of the corresponding values in the international system.

CHAPTER C
MATERIALS AND MANUFACTURE

CHAPTER CONTENTS

C1. SELECTION

C2. CLASSIFICATION OF INPUTS

C3. MATERIALS TO CONSUMERS PLANT

C1. SELECTION

100. General Conditions

101. The materials and equipment for the electrical systems of essential services of classified ships are constructed, installed and tested under the supervision of the RBNA, in accordance with the procedures for specific classification or type approval homologation.

102. Materials with characteristics other than those listed here may be used, provided that its specification is subject to approval of the RBNA along with the design of the facility to which the material is intended.

103. Bolts, nuts, washers, pins, terminals, springs and all other small parts are to be manufactured from anti-corrosion or corrosion-protected material.

104. Electrical installation components that have a certificate of origin, considered satisfactory by RBNA and at its discretion, may be exempted, in whole or in part of the tests and inspections at the manufacturer.

200. Electrical components

201 In principle and unless they are especially protected and are approved by the RBNA, the electrical equipment and components should consist of non-hygroscopic materials, resistant to saline contamination, corrosion, moisture and of the flame-retardant type.

300. Wires and Cables
[IACS UR E 7]

301. The conductors of cables and wires for use in vessels covered by these Rules are to be consisted of bare or tinned electrolytic copper, depending on the type of insulation.

302. Cables are to be of a type approved by the RBNA. All the electrical cables and wiring external to equipment are to be at least flame-retardant type and installed so that their original flame retardant properties are not harmed. Where necessary for certain applications, the RBNA may permit the use of special types, such as radio frequency cables.

303. Cables manufactured in accordance with the relevant recommendations of IEC Publication 60092-350, 60092-351, 60092-352, 60092-353, 60092-354, 60092-359, 60092-373, 60092-374, 60092-375 and 60092-376 will be accepted by the RBNA provided that they are tested to its satisfaction.

304. Cables manufactured and tested to standards other than those specified in C1.303 will be accepted provided they are in accordance with an acceptable and relevant international or national standard.

400. Insulation and covering

401. In principle will be accepted cables with insulation of polyvinylchloride (PVC) for control circuits, ethylene propylene rubber (EPR) or, optionally, cross-linked polyethylene (XLPE) for general use and silicone rubber (S 95) for circuit in which continuity of operation is needed even under extreme heat or fire.

500. Shielding

501. The cable shielding is to be consisted of a galvanized steel wire braid.

502. Shielded cables are to receive a final coat of anti-corrosive paint or a layer of PVC.

503. All the electrical cables and wiring external to equipment are to be, at least, flame-retardant type and installed so that their original properties of flame-retardant are not harmed. Where necessary for certain applications, the RBNA may allow the use of special types, such as radio frequency cables.

600. Lighting fixtures

601. The lighting fixtures should be of galvanized steel, cast aluminium or alloys, flame-retardant, not hygroscopic and properly protected from the effects of heat produced with inner conductors and bases of live parts of anti-flame material.

602. The lighting fixtures installed in spaces where there is a risk of mechanical damage are to be of reinforced construction and properly protected by grilles.

603. Portable fixtures to light up the decks, cargo holds, machinery spaces or similar spaces are to be endowed with closed glass globe and grille of metal protection threaded with holder of insulating material so as to prevent contact with live parts.

C2. CLASSIFICATION OF INPUTS

100. Definition

101. The term "input", when mentioned in the Rules, refers to materials, machinery, equipment and manufactured components of the electrical installation for essential service of classified ships. They are subject to special supervision of RBNA in accordance with the following procedures .

200. Type approval

201. Type approval tests on electrical components covered by the rules are to be carried out in the presence of the surveyors of the RBNA at the manufacturers' premises. Product certificates issued by manufacturers will be accepted from companies homologated by RBNA.

202. The procedures for specific classification or manufacturers' type approval are considered as minimum requirements applicable to ships classified under special supervision of the RBNA. Alternative procedures for specific classification of products may be accepted at the discretion of the RBNA, if requested in advance by the manufacturer, depending on the particularities of the products and regional peculiarities.

203. These procedures for specific classification or homologation of type approval apply to products manufactured by continuous or semi-continuous processes under controlled conditions and capable of producing homogeneous products in accordance with the requirements laid down in the quality system.

204. The classification framed as type approval comprises the supervision of manufacturing and of all the tests, which are witnessed by the Surveyor per unit of product, in

accordance with the requirements of the Rules of the RBNA. The parts considered in accordance with the Rules will be marked individually on visible place with the signet of the RBNA.

205. The following electrical components are to be classified by the type approval procedure:

a. electrical cables;

b. accessories for cable splicing;

c. protection, connection and disconnection devices;

d. electronic protection devices, panel alarms, sensors, equipment of remote and automatic controls and actuators;

e. safety devices for essential service installations of propulsion machinery, steering system, controllable pitch propellers, electronic speed regulators and shutdown of the main and auxiliary machinery;

f. alarm systems for opening and closing devices, monitoring and supervision systems and flooding detection systems.

300. Homologation

301. The homologation of a manufacturer includes a satisfactory demonstration of the manufacturer's experience with the technology employed, complexity to the type of product and establishment of procedures appropriate to the manufacture of each product in type test of prototype.

C3. MATERIALS TO THE CONSUMERS PLANT

100. Design and assembly

101. The material for the electrical installation is to be sufficiently protected against mechanical damage and manufactured in corrosion resistant materials.

102. Portable appliances are to be equipped with means for protection of cables of connections against mechanical stress.

103. Terminals, bolts, nuts, etc. are to be of bronze.

CHAPTER D
PRINCIPLES OF CONSTRUCTION

CHAPTER CONTENTS

D1. INSTALLATIONS ON BOARD

D2. FACILITIES

D1. INSTALLATIONS ON BOARD

100. Application

101. All the electrical components are to be manufactured for operation in harsh environments and installed so as not to cause injury when handled or touched in normal operating conditions.

102. All the electrical materials intended for use in vessels covered by these Rules are to be resistant to saline and/or industrial contamination and adequate to installation in highly favourable corrosion environment.

103. All the electrical equipment shall be designed and manufactured so that live parts cannot be accidentally touched, unless if supplied with a low safety voltage, and isolated by means of gangways, protections or other adequate device in such a way as to avoid the risk of staff injured in service.

104. Electrical equipment exposed to the weather or installed in areas subject to salt contamination, spills or other moisture are to be watertight or effectively protected by watertight enclosure, without this procedure implying the submission of the equipment to temperatures higher than those for which they were designed.

105. In principle, the rotating machinery is to be installed horizontally with its rotation shaft along the longitudinal direction of the ship. When impractical, if installed across or vertically the design is to ensure that the bearings are adequate to operate satisfactorily in the specified rotation and the lubrication system able to absorb shocks or vibration under any operating condition.

106. The design and assembly of electrical equipment on board should take into account the accessibility of the parts that need maintenance, repair and inspection.

107. Live parts are to be effectively protected to prevent injury from contact in the case of nominal voltage $\geq$ 250 V DC or $\geq$ 150 V AC.

108. Insulation materials and insulation of windings are to be resistant to moisture, salt contamination and oily fumes unless effective precautions are taken for protection against these agents.

109. All the bolts and nuts applied in energized connections or working parts are to be effectively locked or wire locked to avoid loosing or giving off when subjected to vibrations.

110. Soldered terminals are to have length equal to, at least 1.5 times the diameter of the conductor.

200. Spacing tolerances

201. The spacing between live parts and between live parts and earthed metallic parts are to be adequate to the working voltage, taking into consideration the nature of the insulation material and transient over-voltage developed by switches and abnormal failure conditions.

202 The minimum clearance and creepage distances between exposed metal parts and internal leakage current to the terminals' box of rotating machines are to be measured.

203. The minimum clearance and creepage distances between main distribution bars and main and emergency electrical and non-isolated metal parts, as well as exposed conductive parts are to be measured.

300. Hazardous areas

301. The electrical equipment intended for operation in areas with risk of explosion or in cargo areas of fuel oils should be of "safe type" and approved for use in ships classified by RBNA.

302. Certificates of "safe type" should consider the characteristics of protection of the enclosures defined in topic E2.200. of Title 32, Section 7 of this Rule.

303. Certificates of specific classification or type approval of equipment as being explosion-proof or intrinsically safety equipment and instruments will be accepted, provided that the design and manufacture are approved by RBNA and that are conducted tests of "safe type" in recognized laboratory in accordance with IEC Publication 60079 or other equivalent standard.

D2. INSTALLATIONS

100. Location of switchboards

101. The main switchboard is to be installed in ventilated, dry place and out of areas with risk of explosion or near steam, water and oil pipes. There must be at least 900 mm of free and unobstructed area in front. When needed access and maintenance by the rear, this should have a minimum clearance of 600 mm from adjacent areas or 450 mm from structure stiffeners (stanchions and frames). In the case of the vicinity of oil or heated tanks, these distances will be reviewed particularly by the RBNA.

102. It should be provided separation of the parts that conduct earthing currents. Ship structures with contact withdrawal of circuit breakers exposed to the air less than 300 mm are to have insulating barriers.

103. In front and behind of the electrical panel is to be placed carpet or isolated platform, extending along the length and width depending of the workspace.

104. Trays are to be installed on switchboards or where better located, when there is the possibility of damage due to leaks or falling objects.

200. Cable installation

201. The cables are to be individually attached to beds or cable holders through straps of galvanized steel, copper, brass or anti-flame plastic. The maximum spacing between straps is to be as shown in table T.D2.201.1.

202. The cables are to be installed and fixed in such a way that the mechanical stresses that may occur are kept within allowed limits. This concern is to be taken particularly for cables of conductor of small cross section, installed in long vertical stretches.

203. Conductors for electrical power circuits for essential or emergency service, lighting, internal communications or signals shall so far as possible, pass the farthest possible from galleys, laundries, machinery spaces of category A and of their ceilings or other high risk fire areas.

204. The installation of cables in conduits should be avoided as much as possible. However, if conduits are required for cable protection against mechanical damage, the following must be observed:

a. conduits and ducts are to be installed with enough trim and hole for drainage;

b. the cables can occupy a maximum of 40% internal section of conduit, and cable area, for this verification, calculated from the outer diameters of the cables;

c. long stretches in conduits are to be avoided and if necessary cable-passing boxes are to be installed.

205. Cables passing through the deck or entering into compartments are not to harm the mechanical strength, water tightness and fire resistance of these areas, and should be used cable glands that, preferably, will have the body welded to the deck or bulkhead.

206. In the installation of cables, the radii of curvature limits presented in table T.D2.206.1. are to be followed.

300. Installation of accumulator batteries [IACS UR E18, IACS UR M 61]]

301. Accumulator batteries are to be installed in uninhabited spaces, airy and sheltered, where are not exposed to excessive heat, low temperatures, humidity, vapours or other conditions that may affect the performance or accelerate deterioration. They are to be installed, when

fixed in decks, with a minimum height of 400 mm from the floor and arranged in such a way as to allow easy access for maintenance, cleaning and recharging.

302. Accumulator batteries are not to be installed in accommodation spaces, except if hermetically sealed and especially approved by the RBNA.

303. The accumulator batteries for the emergency service are to be installed outside the space of the electrical emergency switchboard and in location where they are protected from the risk of damages, fire or other casualty.

304. The accumulator batteries for starting internal combustion engines should be installed as close as possible to the engines they serve, in order to minimize the voltage drop in the cables

[IACS UR M 61]

305. 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 as required in case of air starting, according to Part II, Title 11, Section 5 of these Rules, 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. The number of starts refers to engine in cold and ready to start conditions. Additional number of starts may be required when the engine is in the warm running condition. Regardless of the above, for multi-engine installations the number of starts required for each engine may be reduced upon the agreement with the RBNA depending upon the arrangement of the engines and the transmission of their output to the propellers.

306. 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.

307. 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.

[IACS UR E18]

308. Where batteries are fitted for use for essential and emergency services a schedule of such batteries is to be compiled and maintained. The schedule, which is to be reviewed by the RBNA, is to include at least the following information regarding the battery(ies):

a. Type and manufacturer's type designation.

b. Voltage and ampere-hour rating.

c. Location.

d. Equipment and/or system(s) served.

e. Maintenance/replacement cycle dates.

f. Date(s) of last maintenance and/or replacement.

g. For replacement batteries in storage, the date of manufacture and shelf life (*see Guidance – 1*).

307. Procedures are to be put in place to ensure that where batteries are replaced that they are of an equivalent performance type.

308. Where **vented type batteries** (*see Guidance – 2)* replace **valve-regulated sealed types** (*see Guidance – 3)*, it is to be ensured that there is adequate ventilation (*see Guidance – 4*) and that the RBNA's requirements relevant to the location and installation of vented types batteries are complied with.

309. 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 *(see Guidance – 5)* to be verified by the RBNA's surveyor.

Guidance

***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** which have charging power higher than 2kW are to be such that the quantity of air expelled is at least equal to:*

$Q = 110In$ where

n = number of cells in series

I = maximum current delivered by the charging equipment during gas formation, but not less than 25 per cent of the maximum obtainable charging current in amperes

Q = quantity of air expelled in litres/hr.

*The **ventilation rate for compartments containing valve-regulated batteries** may be reduced to 25 per cent of that given above.*

***5.** See section 10 of the IMO ISM Code.*

End of guidance

400. Installation of electrical machinery

401. Generators and rotating machines should be installed in dry and ventilated spaces out from nearby steam, water and oil pipes. To allow enough space for maintenance and accessibility in the removal of the rotor and, induced, must be mounted with 450 mm minimum clearance between sets and objects of adjacent areas.

402. The spaces where electrical equipment is installed must have lighting according to the topic that follows.

500. Lighting installations

501. For dimensioning and uniform distribution of lighting of the spaces must be adopted the luminance values shown in standard ABNT NBR ISO/CIE 8995-1.

502. The spaces where electrical equipment is installed must have minimum luminance of 50 lux. and sufficiently ventilated for at least 2 air changes per hour. This is considered as standard and sufficient for the application, unless more appropriate luminance environment or a forced ventilation system is required.

503. The maximum spacing between luminaire centres must not be greater than 1.5 times the available height of the space and the clearance to the bulkhead of at least 0.75 times this height.

504. The fixtures must be installed so that it is maintained a minimum spacing of 5 mm between the base and the surface that will be fixed in order to allow for air circulation for cooling.

600. Installations of equipment in areas with risk of explosion

601. Areas with risk of explosion are those defined in. A2.101 and intended for the carriage of flammable cargo in tanks, dangerous goods, spaces designed exclusively for accumulator batteries, paint rooms, welding storerooms with gas bottles and other similar spaces.

602. No electrical equipment should be installed in spaces where flammable mixtures may accumulate, including those in tankers or compartments intended mainly for, accumulator batteries, paint storerooms, acetylene bulbs deposits or similar spaces, unless there is approval of the RBNA and the equipment is:

a. essential for operational purposes;

b. of a type that does not cause ignition of the mixture;

c. suitable for the space; and.

d. duly certified as safe for use in environments with dust, gases or fumes likely to be encountered.

603. Electrical equipment and conductors which may constitute an ignition source or flammable vapours shall not be installed in areas with risk of explosion, unless considered essential for operation and are certified safety type explosion-proof or intrinsically safe and in accordance with the following:

a. areas with risk of explosion due to the concentration of combustible dusts; the equipment shall be considered satisfactory if made with degree of protection IP6X and maximum temperature of the surface and type of protection determined in accordance with the requirements of the standards IEC 60079-14 and IEC 61241;

b. areas with risk of explosion due to concentration of gaseous atmospheres; the equipment shall be considered satisfactory if manufactured as specified in the previous items and in accordance with IEC Publication 60079 " Explosive Atmospheres" or another equivalent standard;

700. Electrical Equipment allowed in paint stores and in the enclosed spaces leading to paint stores [IACS UR E 12]

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

702. 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

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

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

a. explosion group II B

b. temperature class T3

705. 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.

706. 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:

a. electrical equipment with the type of protection as permitted in paint stores

or

b. equipment of protection class Exn or

c. appliances which do not generate arcs in service and whose surface does not reach unacceptably high temperature

or

d. appliances with simplified pressurised enclosures or vapour-proof enclosures (minimum class of protection IP55) whose surface does not reach unacceptably high temperature

e. cables as specified in D2.703.

706. The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that:

a. the door to the paint store is a gastight door with self-closing devices without holding back arrangements,

b. the paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area,

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

707. Note: The paint stores and inlet and exhaust ventilation ducts under D2.701 are classified as Zone-1 and areas on open deck under D2.706 as Zone 2, as defined in IEC standard 60092-502, Electrical Installation in ships-part 502: Tankers-special features:

708. A watertight door may be considered as being gastight.

CHAPTER E
BASIC PRINCIPLES FOR DIMENSIONING

CHAPTER CONTENTS

E1. OPERATIONAL AND ENVIRONMENTAL CONDITIONS

E2. DEGREES OF PROTECTION

E3. CLASSES OF INSULATIONS

E4. DISTRIBUTION SYSTEMS, VOLTAGES AND FREQUENCIES

E5. ESSENTIAL SERVICES

E1. OPERATIONAL AND ENVIRONMENTAL CONDITIONS

100. Electric current conditions

101. Electric equipment, cables and accessories must be designed and constructed so to operate correctly under following Conditions of electric current:

a. maximum variation of a.c. voltage and frequency for distribution systems: see Table T.E4.203.1;

b. maximum variation of d.c. voltage for distribution systems: see Table T.E4.203.2;

c. maximum variation of voltage for battery systems: see Table T.E4.203.3.

200. Conditions of ambient temperatures

201. On ships without navigation restriction, the standard ambient temperature to be considered is 40^0. For machinery spaces and boilers the temperature is 45^0 with relative humidity average of 70% and seawater temperature of 32^0 C.

202. For rotating electrical machinery installed in machinery spaces, it will be considered the standard ambient temperature of 50^0 C.

203. Ships employed in service out of tropical waters, the standard ambient temperature considered will be of 40^0 C and seawater temperature of 25^0 C.

204. In the case of ambient temperatures higher than the specified values, the temperature increase of the engine or equipment installed in the space will be reduced by the equivalent average excess temperature.

300. Ambient temperature for electrical equipment installed in environmentally controlled spaces [IACS UR E19]

301. 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:

a. the equipment is not for use for emergency services.

b. 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.

302. 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.

303. The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with IACS UI SC 134 and to be subject to survey in accordance with the requirements of RBNA.

400. Position conditions

401. All machinery, equipment and essential service devices are to be designed and installed in such a way as to operate satisfactorily in permanent maximum inclination of 5°.

402. Inclining angles of roll or trim are to be considered which could occur simultaneously in most unfavourable combination of operation of the installation.

403. The allowable rolling dynamic period is to be assumed as 10 s.

500. Vibration Conditions

501. The natural frequencies of equipment and their foundations are to be kept within the permissible values. Where it is not possible to fix the vibrations by means of adequate construction techniques, the equipment is to be transferred to avoid unnecessary amplitudes.

E2. DEGREES OF PROTECTIONS

100. General conditions

101 Electrical equipment, cables, and accessories are to be designed and built for services in the respective locations of installation, with adequate degree of protection of the enclosure against accidental contact, ingress of solid objects and harmful ingress of water, in accordance with the standard ABNT NBR IEC 60529. The minimum requirements are shown in table T.E2.101.1. – Minimum degrees of protection for electrical equipment enclosures.

102. Metallic enclosures, housings and all and any metal parts that can be touched and whose method of installation does not ensure a perfect grounding are to be earthed through specially installed conductors aimed to grounding and adequately protected against mechanical accidents that might interrupt this connection.

103. Depending on the application the RBNA may require that electrical equipment is to be protected against bad weather, being added the letter W to letters IP.

E3. CLASSES OF INSULATION

100. Characteristics

101. The definition of insulation classes and their respective temperature limits follows the Standard ABNT NBR 17094. They are the following.

a. **Insulation Class A:** Materials or combinations of materials such as cotton, silk and paper, when properly impregnated or covered or immersed in dielectric liquids such as oil. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 105^0 C.

b. **Insulation Class E:** materials or combination of materials that are able to demonstrate to operate continuously, through tests, at the temperature of 120^0 C.

c. I**nsulation Class B**: materials or combinations of materials such as mica, fiberglass, asbestos or other appropriate substances. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 130^0 C.

d. **Insulation class F**: materials or combinations of materials such as mica, fiberglass, asbestos or other appropriate substances. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 155^0 C

e. **Insulation class H:** materials or combinations of materials such as elastomeric compounds, mica, fiberglass, asbestos with binding substances as appropriate silicone resins. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 180^0 C.

200. Performance

201. The difference between the warmest and the average temperature of the electrical equipment in relation to the insulation class, considering the ambient temperature of 40°C, is not exceed the following values:

a. insulation Class A: 5^0 C

b. insulation Class E: 5^0 C

c. insulation Class B: 10^0 C

d. insulation Class F: 15^0 C**,**

E4. DISTRIBUTION SYSTEMS, VOLTAGES AND FREQUENCIES

100. Wiring and earthings

101. Distribution systems listed below are accepted:

a. of two-wire with one earthed without hull return;

b. of one-wire with hull return;

c. of two-wire insulated from the hull;

d. of four-wire with earthed neutral without hull return;

e. of three-wire with hull return;

f. of three-wire insulated from the hull.

102. Systems using hull return should be avoided in liquid fuel transport vessels when these liquids have flash point less than or equal to 55°C or in aluminium-hulled craft.

103. The hull return system shall not be used for power supply, heating or lighting in any ship with gross tonnage equal or more than 1600.

104. The voltages are to be selected, as much as possible, within the standard voltage systems, being the preferred frequency of 60 Hz. Maximum variations in the rated values are not to exceed the limits specified Tables T.E4.203.1, T.E4.203.2 and T.E4.203.3.

200. Voltage and frequency variations
[IACS UR E5]

201. The voltage and frequency variations for a.c. / d.c. shall be measured.

202. 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.

203. 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 T.E4.203.1, T.E4.203.2 and T.E4.203.3 on the following conditions.

a. For alternative current components, voltage and frequency variations shown in the Table T.E4.203.1 are to be assumed.

b. For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table T.E4.203.2 are to be assumed.

c. For direct current components supplied by electrical batteries, voltage variations shown in the Table T.E4.203.3 are to be assumed.

204. 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.

TABLE T.E4.203.1: 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 T.E4.203.2: VOLTAGE VARIATIONS FOR D.C DISTRIBUTION SYSTEMS

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

TABLE T.E4.203.3: 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.	

300. Primary and secondary systems

301. Primary systems are those powered directly by generators and secondary systems and generators are powered by transformers or converters.

400. Harmonic distortion

401. The tolerance on the voltage waveform is not to exceed the following percentage values of harmonic distortion:

a. simple harmonic distortion: 3%;

b. total harmonic distortion: 5%.

E5. ESSENTIAL SERVICES

Guidance

IMO MSC/Circ.1176 represents a revised version of IACS UI SC134 ***Essential Services and Arrangements of Sources of Power, Supply, Control and Monitoring to the different Categories of Essential Services*** *(SOLAS Regulations II-1/40 & 41) which is shown in the present Part II, Title 11, Section 7, Chapter E, sub chapter E5.*

End of guidance

100. Classification of electrical services

101. 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 E5.200 and E5.300 below.

102. Services to ensure minimum comfortable conditions of habitability are those services such as defined in E5.400 below.

200. Primary Essential Services

201. 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:

a. Steering gears

b. Pumps for controllable pitch propellers

c. 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

d. 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

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

f. Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps

g. Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps

h. Electric generators and associated power sources supplying the above equipment

i. Hydraulic pumps supplying the above equipment

300. Secondary Essential Services

301. 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:

a. Windlass

b. Fuel oil transfer pumps and fuel oil treatment equipment

c. Lubrication oil transfer pumps and lubrication oil treatment equipment

d. Pre-heaters for heavy fuel oil

e. Starting air and control air compressors

f. Bilge, ballast and heeling pumps

g. Fire pumps and other fire extinguishing medium pumps

h. Ventilating fans for engine and boiler rooms

i. Services considered necessary to maintain dangerous spaces in a safe condition

j. Navigation lights, aids and signals

k. Internal safety communication equipment

l. Fire detection and alarm system

m. Lighting system

n. Electrical Equipment for watertight closing appliances

o. Electric generators and associated power sources supplying the above equipment

p. Hydraulic pumps supplying the above equipment

q. Control, monitoring and safety systems for cargo containment systems

r. Control, monitoring and safety devices/systems for equipment to secondary essential services.

400. Services for habitability

401. 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:

i. Cooking

ii. Heating

iii. Domestic refrigeration

iv. Mechanical ventilation

v. Sanitary and fresh water

vi. Electric generators and associated power sources supplying the above equipment

500. SOLAS Regulations

501. Regulation II-1/40.1.1 and Regulation II-1/41.1.1 – For the purposes of these regulations, the services as included in items E5.200 to E5.400 are to be considered.

502. Regulation II-1/40.1.2 - For the purposes of this regulation, the services as included in items E5.200 and E5.300 and the services in the Regulation II-1/42 or II-1/43, as applicable, are to be considered.

503. Regulation II-1/41.1.2 - For the purposes of this regulation, the services as included in items E5.200 to E5.400 are to be considered.

504. Regulation II-1/41.1.5 - For the purposes of this regulation, the services as included in items E5.200, E5.300 and E5.400 are to be considered. See also IACS UI SC83.

505. Regulation II-1/41.5.1.2 - For the purposes of this regulation, the following interpretations are applicable.

a. Services in item E5.200 are not to be included in any load shedding or other equivalent arrangements.

b. Services in item E5.300 may be included in the automatic load shedding or other equivalent arrangement provided disconnection will not:

b.1. Cause immediate disruption of systems required for safety, e.g.:

i. Lighting systems,

ii. Navigation lights, aids and signals,

iii. Internal safety communication equipment.

b.2. Prevent services required for safety being immediately available when the power supply is restored to normal operating conditions, e.g.:

i. Fire pumps, and other extinguishing medium pumps,

ii. Bilge pumps,

iii. Ventilating fans for engine and boiler rooms.

Examples of equipment in the item E5.300, for which the automatic load shedding or other equivalent arrangement is normally allowed, includes:

iv. Fuel oil transfer pumps and fuel oil treatment equipment

v. Lubrication oil transfer pumps and lubrication oil treatment equipment

vi. Pre-heaters for heavy fuel oil

vii. Starting air and control air compressors (except for control air compressors for propulsion control and its safety systems)

c. Services for habitability in the item E5.400 may be included in the automatic load shedding or other equivalent arrangement.

600. Electrical Services Required to be Operable Under Fire Conditions and Fire Resistant Cables [IACS UR E15]

601. Electrical services required to be operable under fire conditions are as follows:

a. Control and power systems to power-operated fire doors and status indication for all fire doors

b. Control and power systems to power-operated watertight doors and their status indication

c. Emergency fire pump

d. Emergency lighting

e. Fire and general alarms

f. Fire detection systems

g. Fire-extinguishing systems and fire-extinguishing media release alarms

h. Low location lighting

i. Public address systems

j. Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion

602. Where cables for services specified in item E5.601 above 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.

603. This may be achieved by either of the following measures:

a. Cables being of a fire resistant type complying with IEC 60331-31 for cables of greater than 20 mm overall diameter, otherwise 60331-21, are installed and run continuous to keep the fire integrity within the high fire risk area, see Figure F.E5.603.1.

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.

604. Systems that are self monitoring, fail safe or duplicated with cable runs as widely separated as is practicable may be exempted.

605. Notes**:**

a. For the purpose of this Subchapter E5 – Item 600 application, the definition for “high fire risk areas” is the following:

a.1. Machinery spaces as defined by Chap. II-2 / Reg. 3.30 of SOLAS.

a.2. Spaces containing fuel treatment equipment and other highly flammable substances

a.3. Galley and Pantries containing cooking appliances

a.4. Laundry containing drying equipment

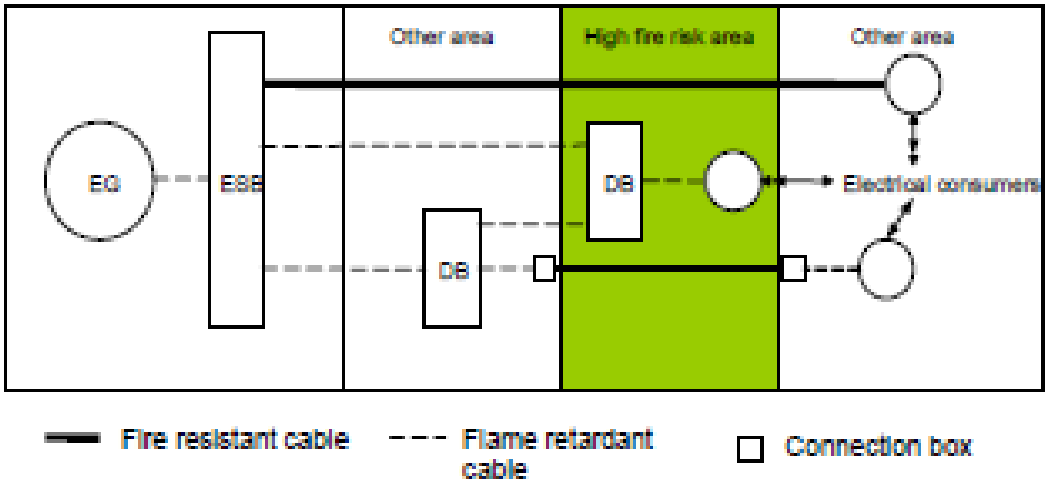
a.5. Spaces as defined by paragraphs (8), (12), and (14) of Chap. II-2 / Reg. 9.2.2.3.2.2 of SOLAS for ships carrying more than 36 passengers

b. Fire resistant type cables should be easily distinguishable.

c. For special cables, requirements in the following standards may be used:

IEC60331-23: Procedures and requirements – Electric data cables
IEC60331-25: Procedures and requirements – Optical fibre cables

FIGURE F.E5.603.1 – CABLES OF FIRE RESISTANT TYPE INSTALLED AND RUN CONTINUOUS TO KEEP THE FIRE INTEGRITY WITHIN THE HIGH FIRE RISK AREA



CHAPTER F
DESIGN AND CONSTRUCTION OF ELECTRIC POWER GENERATION SYSTEM

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F6. SHORE POWER SOURCE

F1. ELECTRICAL LOAD ANALYSIS

100. Criteria

101. In the preparation of the electrical consumption analysis that serves as input to the dimensioning of the generators, batteries and associated chargers, the following criteria are to be adopted:

a. demands should be calculated for the conditions below:

a.1. Vessel in the port;

a.2. Vessel in cargo handling operation;

a.3. Vessel in manoeuvring; and

a.4. Vessel in navigation.

b. each consumer equipment is to be listed individually with an indication of the rated load and demand factor;

c. concurrency factors to be considered for temporary loads groups are to be clearly indicated;

d. equipment in stand which only operate when their respective main equipment are shutdown are to be listed even though they are not computed in the calculation of demand;

e. to the maximum estimated demand obtained from the above criteria, is to be applied, where appropriate, a safety factor to cover peak loads of short duration and thus obtain the minimum capability of the generating system or batteries.

102. In the dimensioning of the ability of generating sets, should be taken into account the starting up of high-rated engines or of two or more motors simultaneously, so that as a result of a voltage drop higher than permissible limits for operation in steady state may cause operational disturbances in control and protection equipment, or even cause the shutdown of other engine in operation, in addition to affecting the performance of the lighting system.

F2. DIRECT CURRENT GENERATORS

100. Voltage characteristics

101. “Compound” type generators are to have the following voltage characteristics, when in regime operation:

a. at 20% of the rated power, the voltage is adjusted to the rated voltage previously set;

b. in the mid-range band, the characteristics curves of the voltage are not to show variations more than 4% of the rated voltage from the average value of voltages for both loading and unloading;

102. "Shunt" type generators, equipped with automatic voltage regulator, should have the following voltage characteristics, when operating in steady state, at constant speed:

a. with automatic voltage regulator: performance as defined for "compound" generator type;

b. with automatic voltage regulator off: with field current set to value of rated excitation in empty, so that the voltage shall be not less than 80% of the rated voltage, when at full load;

103. Voltage regulators should allow voltage adjustment with the following accuracies under any load until the rated capacity, within the temperature conditions of the generator:

a. 1.5 % of the rated voltage, for generators of up to 100 kW;

b. 3 % of the rated voltage, for generators greater than 100 kW.

F3. ALTERNATE CURRENT GENERATORS

100. Specific conditions

101. The alternators are to be appropriately designed so that the apparent power delivered to the system should be sufficient to avoid undesired voltage falls due to the starting up of motors. In no event the starting of motors of high starting current may cause voltage drop in the system that result in shutdown or flickering of consumers in operation.

102. The shape of the curve of voltage in empty load is to be as sinusoidal as possible, being so that the deviations should not be larger than 5 % of the peak value of the fundamental sine curve. The effective values of the phase-neutral voltage of three-phase generators should not differ more than 0.5 % between each other under conditions of balanced load- between phases.

103. The alternators and excitation systems must be dimensioned in such a way as to be able to operate without damage for two minutes, with 150 % of their rated currents with delayed power factor (inductive) equal to 0.5 and with rated voltage maintained.

F4. MAIN SOURCE OF ELECTRICAL POWER AND LIGHTING SYSTEMS

100. Main source of electrical power

101. There is to be installed a main source of electrical power with sufficient capability to supply all the services mentioned in paragraph. E5.101 and E5.102 above. This source consists of at least two generator sets.

102. The capability of these generators is to be such that, in the event of shutdown of any of the sets, it is possible to supply those services necessary to provide conditions for normal operation of propulsion and safety and ensure comfortable conditions of habitability, that includes, at a minimum, adequate services for: kitchen, heating, domestic refrigeration, mechanical ventilation, sewage and fresh water.

103. The services necessary to provide conditions for normal operation of propulsion and safety include the essential primary and secondary services.

104. In the duplication of services, being one driven electrically and another non-electrically (for example, the main lubricating oil pump driven by the main motor and the stand by lube oil pump powered by electric motor), its electric capacity will not be included in the calculations for dimensioning.

105. The arrangements of the main source of electrical energy of the ship shall be such that the services referred to in paragraph E5.101 and E5.102 can be kept regardless of the speed and direction of rotation of the propulsion motor or shaft.

106. Additionally, the generator sets are to be so arranged that, with any one of the generators or their primary sources of energy out of operation, the remaining generator set is capable of supplying the electric utilities needed to start up the main propulsion plant from the condition of the ship off.

107. Where transformers consist of essential part of he electric power system by this paragraph, the system is to be designed to ensure the same continuity of power supply that is required in this paragraph.

108. The main electric lighting system which is to provide illumination of those parts of the ship normally accessible to and of use of the passengers or crew is to be supplied from the main source of electrical energy.

109. The arrangement of the main electric lighting system is to be such that a fire or other casualty in spaces containing the main source of electrical power, associated transformer equipment, if any, the main switchboard and the main lighting panel, should not turn inoperative the emergency system of electric lighting, required by the regulations of SOLAS Convention Chapter II-1, Part D, Rules 42.2.1 and 42.2.2 or 43.2.1, 43.2.2 and 43.2.3.

110. The arrangement of the emergency system of electric lighting should be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transformer equipment, if any, the emergency panel and the panel of emergency lighting should not turn inoperative the main electric lighting system, required by this regulation.

111. The main switchboard is to be located, in relation to a single main station of generation, so that as far as practicable, the integrity of normal supply can only be affected by a fire or other accident in a space. An enclosure with separate ambient for the main switchboard, as it can be predicted by a machinery control room situated within the main limits of space, is not to be considered as a separator between the electric panels and the generators.

112. Where the total installed electrical power of the generator sets is greater than 3 MW, the main bus should be subdivided into at least two parts, which should normally be connected by removable links or other approved means; as far as practicable, the connection of the generator set and of any other duplicate equipment should be equally divided between the parts. Equivalent arrangements are permitted, to the satisfaction of the Administration.

113. For ships built from July 1, 1998:

a. in addition to items F4.101 to F4.111 are to meet the following:

a.1. where the main source of electrical power is required for ship propulsion and steering, the system is to be so arranged that the power supply of for the equipment necessary for propulsion and steering and to ensure the safety of the ship is maintained or restored immediately in case of loss of any one of the generators in service;

a.2. the load limitation or other equivalent arrangement shall be provided to protect the generators required by this regulation against maintained overload;

F5. EMERGENCY SOURCE OF ELECTRICAL POWER IN CARGO SHIPS

100. General

101. There are to be installed an autonomous emergency source of electrical power.

102. The location of the emergency source of electrical power, associated transformer equipment, if any, the transitional source of emergency power, the emergency panel and emergency lighting panel should be located above the highest continuous deck and are to be readily accessible to from the open deck. They should not be located forward of the collision bulkhead, except where permitted by the Administration in exceptional circumstances.

103. The location of the emergency source of electrical power, associated transformer equipment, if any, the transitional source of electrical power, the emergency panel and emergency lighting panels, in relation to the main source of electrical power, associated transformer equipment, if any, and the main switchboard are to 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 transformer equipment, if any, and the main switchboard, or any machinery space of category A will not interfere with the supply, control and distribution of emergency power. As far as practicable, the space containing the emergency source of electrical power, associated transformer equipment, if any, the transitional source of emergency power and emergency panel should not be contiguous to the boundaries of machinery spaces of category A or those spaces containing the main source of electrical power, associated transformer equipment, if any, and the main switchboard.

104. The emergency source of electric power can be used for the purpose of starting on up from the condition of ship off if the capabilities, either alone or combined with any other source of electricity provided are sufficient to supply, at the same time, those services required to be powered by the International Convention SOLAS Chapter II-1, Part D, regulations 42.2.1 to 42.2.3 or 43.2.1 to 43.2.4.

105. Being provided adequate measures to safeguard the independent emergency operation in any circumstances, the emergency generator can be used exceptionally and for short periods, to supply circuits not considered of emergency.

106. The emergency electrical power source is to be able, taking into account the starting currents and the transient nature of certain loads, to supply at the same time, at least, the services indicated below in the periods specified as follows, if they depend on an electrical supply for their operations.

a. For a period of 3 hours:

a.1. emergency lighting at every muster and embarkation station for survival crafts and over the sides, as required by International Convention SOLAS regulations III/11.4 and III/16.7.

b. For a period of 18 hours, emergency lighting:

b.1. in all service and accommodation alleyways, stairways and exits, personnel lifts and personnel lift trunks;

b.2. in the machinery spaces and main generating stations including their control positions;

b.3. in all control stations, machinery control rooms, and at each main and emergency switchboards;

b.4. at all stowage positions for firemen's outfits;

b.5. at the steering gear;

b.6. at the fire pump referred to in paragraph F5.106.e.1), at the sprinkler pump, if any, at the emergency bilge pump, if any, and at the starting position of their motors.

c. for a period of 18 hours:

c.1. the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea (COLREGs), in force;

c.2. ships built from February 1, 1995:

c.3. the VHF radio installation required by International Convention SOLAS regulations IV/7.1.1 and IV/7.1.2; and, if applicable:

c.4. the MF radio installation required by International Convention SOLAS regulations IV/9.1.1, IV/9.1.2, IV/10.1.2 and IV/10.1.3;

c.5. the ship earth station required by International Convention SOLAS regulation IV/10.1.1; and

c.6. the MF/HF radio installation required by International Convention SOLAS regulations IV/10.2.1, IV/10.2.2 and IV/11.1.

d. for a period of 18 hours, unless such services have an independent power supply for a period of 18 hours from an accumulator battery suitably allocated for use in emergency:

a.1. all internal communication equipment required in an emergency, including:

i. the means of communication between the bridge and machinery spaces of category A or the machinery control and central control station;

ii. the means of communication between the bridge and the steering gear compartment;

a.2. the navigation equipment supported by the vessel as required by International Convention SOLAS regulation V/12 – where such provision is unreasonable or impracticable, the Administration may waive this requirement for ships of less than 5.000 gross tonnage;

a.3. the fire detection and fire alarm system;

a.4. intermittent operation daylight signalling lamp, the ship's whistle, the manually operated call points and all internal signals that are required in an emergency.

a.5. For a period of 18 hours:

i. one of the fire pumps required by International Convention SOLAS regulations II-2/4.3.1 and 4.3.3 if dependent on emergency generator for its power source;

e. For the period of time required by the International Convention SOLAS regulation II-1/29.14: 30 minutes for ships with GT $\geq$ 10000 and at least 10 minutes for any other vessel of continuous operation by the emergency electrical power source or by the independent source of power located in the steering gear compartment used exclusively for this purpose.

f. the steering gear, which is required to be so supplied by that regulation.

g. for a period less than 18 hours specified in paragraphs b) to e) of the item F5.106., but not less than 12 hours, that can be accepted on a ship regularly engaged on voyages of short duration and, to the satisfaction of the Administration, that an adequate safety standard is met.

107. The emergency source of electric power may be either a generator or an accumulator battery.

200. Emergency source of electrical power in vessels less than 500 GT

201. The emergency source of electrical power is to be able to supply at the same time, at least, the services indicated below.

a. Emergency lighting for a period of 6 hours:

a.6. at muster and embarkation stations for survival crafts and over the sides;

a.7. at survival crafts, their launching equipment and the water area where they are launched.

a.8. in all service and accommodation alleyways, stairways and exits, personnel lifts and shafts;

a.9. in the machinery spaces and main generating stations including their control positions;

a.10. in all control stations, navigation bridge, machinery control rooms, and at each main and emergency switchboards;

a.11. at all stowage positions for firemen's outfits;

a.12. at the steering gear;

b. The required services for a period of 6 hours:

a.13. the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea (COLREGs), in force;

a.14. radio installations for calling distress signals and rescue;

a.15. navigational equipment;

a.16. internal communication system, as required in an emergency;

a.17. fire detection and fire alarm system, if existent;

202. Attention is drawn to the specific requirements from national authorities for the services to be supplied by the emergency source of electrical power.

300. Emergency source of electric power by generator

301. Where the emergency source of electrical power is a generator, it should:

a. be driven by suitable driving machine, with independent supply of fuel with flash point (closed cup test) not less than 43^{o} C;

b. have automatic starting in case of failure of the main electric power supply, unless a transitional source of emergency electrical power, in accordance with item c) below, be installed; where the emergency generator has automatic starting, it should be automatically connected to the emergency switchboard; those services referred to in paragraphs a) and b) of the item F5.501. are then to be automatically connected to the emergency generator; and, except for vessels built from October 1, 1994: unless it is installed a second independent means of starting of the emergency generator set, the only source of stored energy, that is to be protected so as to prevent its complete unloading by the automatic starting system; and

c. have a transitional source of emergency electrical power as specified in item F5.501, unless it is installed an emergency generator capable to simultaneously supply the services mentioned in paragraphs a) and b) of item F5.501, with automatic starting, and feed the required load as fast as is safe and practicable, within not more than 45 s.

400. Emergency source of electric power from accumulator battery

401. Where the emergency source of electric power is an accumulator battery, it should be able to:

a. support the emergency electrical load without reloading while sustaining the battery voltage during the discharging period, within 12% above or below its rated voltage;

b. connect automatically with the emergency switchboard in the event of failure of the main source of electrical power; and

c. feed immediately, at least, those services specified in paragraphs a) and b) of the item F5.501.

500. Starting arrangements for emergency generator sets

501. The emergency generator set is to be capable of immediate starting in cold condition at a temperature of 0° C. If this is impractical or if lower temperatures may occur, provision should be made for installation of heating devices acceptable by the Administration, which ensures the quick starting of the emergency generator set.

502. Each set of emergency generator with automatic starting is to be equipped with a starting device approved by the RBNA with capability of stored energy for at least three consecutive startings.

503. Provision should be made for periodic tests complete the emergency system, including the installation of automatic starting test.

600. The transitional source of emergency electrical power

601. The transitional source of emergency power consists of a battery of accumulators suitably allocated for use in an emergency which should operate without recharging, sustaining the battery voltage, during the discharging period within 12% above or below its rated voltage and be of sufficient capacity and, in this way, expected to feed automatically, in case of failure or main supply or electric power emergency for half an hour, at least, the following services, if they depend on an electrical supply for its operations:

a. emergency lighting for a period of half an hour:

a.1. At every muster and embarkation deck and over the sides as required by International Convention SOLAS regulation SOLAS III / 11.4 and III / 16.7;

a.2. In all service and accommodations alleyways, stairways and exits, personnel lifts and elevator trunks;

a.3. In the machinery spaces and main generating stations, including their control positions;

a.4. In all control stations, machinery control rooms and in each main and emergency switchboard;

a.5. At all stowage positions for firemen's outfits;

a.6. At the steering gear;

a.7. At the fire pump referred to in item F5.106.e), the sprinkler pump, if present, in the emergency bilge pump, if any, and the starting position of their motors; and

a.8. The navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea (COLREGs), in force.

b. The required services for a period of half an hour:

b.1. All internal communication equipment required in an emergency;

b.2. The fire detection and fire alarm system; and

b.3. Intermittent operation of daylight signalling lamp, ship's whistle, the manually operated call point and all internal signals that are required in an emergency.

602. For this transitional phase, the emergency electric lighting required, in relation to the machinery space and the accommodation and service spaces, may be by the accumulator lamps operated by relay, permanently fixed y, individual and automatically loaded; and

603. All the services required by item F5.106.b), unless such services have an appropriately allocated power supply for use in an emergency.

604. The emergency switchboard should be installed as close as practicable to the emergency source of electrical power.

605. Where the emergency source of electrical power is a generator, the emergency switchboard should be located in the same space, unless the operation of the emergency switchboard might be hampered by this.

606. No accumulator battery installed in accordance with this regulation is to be in the same space of the emergency switchboard. An indicator is to be fitted in the appropriate location in the main switchboard or in the machinery control room to indicate when the batteries being either the source of emergency electrical power or the transitional source of emergency electrical power referred to in paragraphs F5.400 and F5.600 are being discharged.

607. The emergency switchboard is to be supplied during normal operation from the main switchboard through an interconnector feeder which is to be suitably protected in the main switchboard against overload and short circuit and should be disconnected automatically from the emergency switchboard, on the failure of the main electrical power source. Where the system is designed to retroaction operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short circuit.

608. To ensure ready availability of the emergency source of electric power, arrangements should be provided, where needed, to automatically disconnect the circuits that are not in emergency from the emergency switchboard to ensure that the energy will be available for emergency circuits.

609. The emergency generator and its driving motor and any emergency accumulator battery are to be designed and arranged to ensure that will work at full rated power when the ship is upright and when tilted at any list angle up to 22.5° or when tilted up to 10° or with trim forward or aft, or in any combination of angles within these limits.

.610. The transitional source of emergency power where required, should be of sufficient capacity to feed at least the services indicated in items F5.106.c) for the period of half an hour in cargo ships.

F6. SHORE POWER SOURCE

100. General

101. Where there are devices to receive power supply from an external source ashore one or more connection boxes should be installed permanently to receive flexible cable from ashore in appropriate place on the ship.

102. The connection box is to be corrosion resistant and watertight construction with opening at the bottom for the flexible cable accessing with closure device so as to prevent entrance of moisture or water when closed.

103. For the connection of the shore energy box with the main switchboard suitable gauge cables are to be installed and permanently attached.

104. Where the external power source is of the earthed system type, an appropriate terminal is to be installed to hull connection to shore.

105. In the case of systems with grounded neutral, the energy connection box is to be provided with a ground terminal for connection between the ship and shore neutrals or for connection to a protected cable.

106. The shore connection box is to be equipped with circuit breaker or with switch of fuses or fuses.

107. The connection between the shore energy cable and the main switchboard is to be fitted, at least, with switch of fuses.

108. In the main switchboard, before the connecting gears, devices should be installed intended to indicate that the branch circuit of the external source of shore energy is energized.

109. There is to be installed voltmeter to allow the reading of the voltage between the positive and negative poles to direct current or a phase meter that allows the reading of the terminal phases of AC shore power input energy in relation to the vessel's system.

110. A warning nameplate is to be installed in the energy shore box showing the full details of the nature of power supply, rated voltage, frequency, and all the instructions for the connection.

F7. 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 E 17]

100. General

101. 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 (see guidance 1) may be used whilst the ship is at sea to supply electrical services required for normal operational and habitable conditions provided that:

a. there are sufficient and adequately rated additional generators fitted, which constitute the main source of electrical power required by SOLAS, meeting the requirements of IEC 60092-201 (see guidance 2) paragraph 6.2.3.

b. 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 IACS UI SC 157 and also upon the frequency variations exceeding ± 10% of the limits specified below.

c. within the declared operating range of the generators and/or generator systems the specified limits for the voltage variations in IEC 60092--301 (see guidance 3) and the frequency variations in 5 E4.200 can be met.

d. 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.

e. where considered appropriate, load shedding arrangements are fitted to meet the requirements of IACS UI SC 157.

f. 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 (see guidance 4).

Guidance

1. Such generator systems are those whose operation does not meet the requirements of IEC 60092-201, paragraph 6.2.3.

2. IEC 60092-201 Electrical installations in ships - part 201: System design - General

3. IEC 60092-301 Electrical installations in ships - part 301: Equipment — Generators and motors.

4. 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 guidance

CHAPTER G
DESIGN AND CONSTRUCTION OF ELECTRIC POWER DISTRIBUTION SYSTEM

CHAPTER CONTENTS

G1. LIGHTING CIRCUITS AND SOCKET OUTLETS

G2. NAVIGATION LIGHT CIRCUITS

G3. MOTOR FEEDER CIRCUITS

G4. EQUIPMENT AND CIRCUITS PROTECTION SYSTEM

G5. EARTHING SYSTEM

G6. DETERMINATION OF NOMINAL SECTION OF CONDUCTORS

G7. PRECAUTIONS AGAINST SHOCK, FIRE AND OTHER HAZARDS OF ELECTRICAL ORIGIN

G1. LIGHTING CIRCUITS AND SOCKET OUTLETS

100. Arrangement

101. Lighting circuits and light socket outlets are to be protected by fuses or circuit breakers of up to 16 A. The number of light points connected in a same circuit should not be greater than:

a. For 24 V voltage: 10 lamps, total 300 W;

b. For 110 V voltage: 12 lamps, total 200 W;

c. For 220 V voltage: 18 lamps, total 1800 W.

102. The socket outlets are to be fed by independent circuits whenever possible.

103. Important areas, such as engine room etc. should be fitted with two independent circuits with lighting fixtures arranged so as to ensure a partial illumination evenly distributed, when one of the circuits fails.

104. For the density of lighting, meet the table T.G1.104.1. Guide to minimum Power of illumination.

G2. NAVIGATION LIGHT CIRCUITS

100. Specific conditions

101. Navigation light circuits are to be individually protected by fuses or circuit breakers installed in navigation light control panel. Each circuit is to be equipped with pilot lamp to indicate light is on (circuit with voltage).

102. Navigation light circuits should be designed for operation in one of the following standard voltages: 24V, 110V or 220V.

103. The voltage variation at the lamp should not exceed permanently ± 10 % of voltage values cited above.

G3. MOTOR FEEDER CIRCUITS

100 Specific conditions

101. Independent circuits are to be provided for each motor with rated current equal to or greater than 6 A. The conductors should be dimensioned to at least 125 % of rated current at full load;

102. Conductors of motor feeder circuits are to be of rated section not less than 2 mm^2.

G4. EQUIPMENT AND CIRCUITS PROTECTION SYSTEM

100. Application

101. Generators, motors and circuits are to be protected against damages caused by overload or short-circuit. The protective devices are to be selected in order to provide a coordinated and selective system.

200. Protective equipment for generators of direct and alternating current.

201. Circuit-breakers are to be equipped with elements of instantaneous trip adjusted to value lower than the short-circuit current and trigger element of inverse-time characteristic set to value not exceeding 115% of the maximum continuous current at full load of the generator. The settings of trips should be such that coordinate with the circuit breakers of protection of feeders provided from the generator.

300. Protective equipment for transformers

301. Circuit breakers are to be provided on the primary of the transformers, with:

a. instantaneous trip element properly set to value lower than the capacity of the transformer to withstand short-circuit current;

b. element of trip of characteristic of inverse time, properly set to value lower than capacity of the transformer to withstand continuous overload.

302. The settings of trips are to be such as to permit the circulation of magnetizing current during the energizing of the transformer.

400. Protective equipment for batteries

401. Except in the case of batteries for the starting of Diesel engines, the protection against short-circuit is to be provided in cubicle next to each set of batteries. Such protection may be by means of circuit breaker or fuses.

500. Protective equipment for circuits

501. All the distribution circuits and feeders are to be individually protected by circuit breakers or fuses properly selected and fitted to protect the conductors against overload and short-circuit.

G5. EARTHING SYSTEMS

100. General

101. Exposed metal parts of electrical machines or equipment which are not intended to be energized, but that are likely to become energized because of a defect shall be earthed unless such machines or equipment are:

a. Fed by voltage not exceeding 50 V direct current or 50 V as root mean square of voltages between the conductors (auto-transformers should not be used for the purpose of obtaining this tension); or

b. Fed by voltage not exceeding 250 V by safe insulating transformer feeding only one consumer device; or

c. Constructed in accordance with the principle of double insulation.

102. Where applied, connections for earthing shall be of copper or other corrosion-resistant material, equivalent conductivity, and installed firmly fixed in structure and, if necessary, protected against damage and electrolytic corrosion.

103. Each connection of a continuous earthing conductor or grounding terminal is to be assembled in a position accessible and securely attached to the ship's structure by bronze screw or other corrosion-resistant material of equivalent conductivity with a diameter of at least 4 mm, used solely for this purpose.

104. The contact surfaces for attaching the earthing conductor on the ship's structure should be clean and free from corrosion, crusts or painting.

105. To avoid shocks due to the high frequency voltage induced by radio transmitters in doorknobs, stair handrails and other metal parts in the bridge and other decks the grounding connection is to be firmly fixed to the hull or superstructure.

106. Exposed metal parts of portable equipment, energized from an electric distribution system, should be grounded by means of continuous conductor that can be a flexible wire or cable.

200. Distribution system with hull return

201. Where the hull return system is used, all the final sub circuitry, i.e. all circuits installed after the last protection device, are to be of double insulation and taken special precautions at the RBNA satisfaction.

202. In the hull grounding system each current conductor of the hull circuits is to have, at least, the same nominal cross section area of the conductor to be isolated.

300. Hull insulated distribution system

301. When a distribution system either primary or secondary, intended to power, heating or lighting, is used without grounding, should be installed device for continuous monitoring of the grounding isolation level with visual and sound indication for abnormal values of low isolation.

400. Earthing and bonding of cargo tanks/process plant/piping systems for the control of static electricity
[IACS UR E9]

401. 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 1 mega ohm.

402. 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.

403. 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.

404. 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.

405. Checks should be made on the resistance to earth during construction of the ship and at subsequent major surveys, supplemented by visual inspection during annual surveys.

G6. DETERMINAITON OF THE CROSS SECTIONAL AREA OF THE CONDUCTORS

100. Currrent capacity

101. Current values shown in Table T.G6.101.1. should be considered as the maximum allowable in steady state regime, for direct current systems and ambient temperature of 45° C, applicable to cables in groups of 3 or 4 cables with ambient air circulating freely around the cables. For ambient temperature other than 45° C the cable conductive capacity is to be corrected using the correction factors from the Table T.G6.101.2.

102. The correction factors for current capacity of the conductors for ambient temperature different from 45° C mentioned in Table T.G6.101.2 do not consider the temperature increase, if happens, due to solar radiation or other infrared radiation. When the insulated cables or conductors are submitted to this kind of radiation, the current conduction capacity should be calculated in accordance with the methods in the standard IEC 60287. **IEC 60092:352, item 3.3.4**

200. Correction factors for cable grouping

201. Cables grouped or installed side by side, around which the air cannot circulate freely, should be considered with their current conducting capacity reduced to 85 % of the values given in Table T.G6.101.1. or in such a way that the conductor maximum allowable temperature should not be exceeded.

300. Voltage drop

301. The following maximum voltage drop limits should be considered:

a. cables conducting the maximum circuit current, under normal service conditions:

a.1. 5 % rated voltage to lighting circuit and

a.2. 7 % to power circuits

b. for special conditions of short duration voltage limits turn to be 8 % and 11 % respectively.

G7. PRECAUTIONS AGAINST SHOCK, FIRE AND OTHER HAZARDS OF ELECTRICAL ORIGIN

100. Enhancing concerning the International Convention SOLAS Regulation-Chapter II-1-Part D- Regulation 45

101. When portable equipment are used in confined or restricted spaces where there may be hazards due to conductivity, relevant additional prescriptions are to be submitted to the RBNA. (Note: see "Guia para entrada em espaços confinados" – "A guide to entry into confined spaces" of the RBNA)

200. Lightning rod

201. Each wooden mast is to incorporate a lightning rod.

CHAPTER H
DESIGN AND CONSTRUCTION OF ELECTRICAL CONSUMERS - LIGHTS AND MOTORS

CHAPTER CONTENTS

H1. LIGHTS, SOCKETS AND SWITCHES

H2. ELECTRIC MOTORS

H1. LIGHTS, SOCKETS AND SWITCHES

100. Lights

101. All the areas of service, circulation and equipment are to be endowed with lighting fixtures of a type appropriate to the use and specific conditions of the facility location, according to the degree of protection of the Table T.E2.101.1.

102. The use of lamps and lighting commonly used in commercial and residential facilities will not be permitted. In the engine room and pump room or in locations where there may be the risk of electric shock or fire or explosion due to the presence of flammable gases or combustible oils, the fixtures are to be provided of guardrails and adequate dripping proof covers.

103. Light fixtures are to be assembled in locations that are not exposed to damages due to heat generated and such that do not cause the combustion of structural elements like wood, fiberglass etc.

200. Sockets and switches

201. Conductive parts of sockets and plugs should be protected so as to prevent from being touched, even during the turning on and off.

202. Each socket outlet of rated current above 16 A should be interlocked with a turning off switch in order to prevent the connection with the socket energized.

203. Socket outlets connected in different distribution system voltages and frequencies are to be non-interchangeable in order to ensure that the appliance cannot be mistakenly switched on.

H2. ELECTRIC MOTORS

100. General

101. In AC motors, the use of windings in opened triangle on multi-speed induction motors should be avoided as far as practicable, because of the difficulties associated with the large number of conductors of cables with such windings.

102. All the openings in motors are to be protected with removable screens resistant to corrosion, of sturdy construction, such as wire screens, expanded metal or perforated covers.

200. Installation and location

201. The motors located on open decks are to be of the watertight type or enclosed in metallic cubicles with the same protection of the waterproof motor housing.

202. The motors cooled by fans are not to be installed in locations subject to the formation of ice.

203. As far as practicable, the motors are to be installed with the rotor or shafts in the direction forward/aft of the ship. In the case of motors, for service at sea, being mounted athwartship, the manufacturer should be notified.

300. Accessibility

301. All the motors are to be designed to allow quick removal of the rotor or armature and field coils, and bearings and to facilitate cleaning and re-lubrication of the bearings.

302. Provision should be made for eyebolts for hoisting motors weighing from 68 kg or more.

CHAPTER I
[IACS UR E11]
REQUIREMENTS FOR SYSTEMS WITH VOLTAGES ABOVE 1 KV UP TO 15 KV

CHAPTER CONTENTS

I1. APPLICATION

I2. DESIGN PRINCIPLES

I3. ROTATING MACHINERY

I4. POWER TRANSFORMERS

I5. CABLES

I6. SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

I7. INSTALLATION

I1. APPLICATION

100. Field of application

101. 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.

200. Nominal system voltage

201. The nominal system voltage is not to exceed 15 kV.

Note: Where necessary for special application, higher voltages may be accepted by the RBNA.

300. High-voltage, low-voltage segregation

301. 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.

I2 SYSTEM DESIGN

100. Distribution

101. Network configuration for continuity of ship services: 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.

102. Services which are duplicated are to be divided between the sections.

200. Earthed neutral systems

201. 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.

202. 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.

203. Neutral disconnection: 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.

204. Hull connection of earthing impedance: 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.

205. Divided systems: In the systems with neutral earthed, connection of the neutral to the hull is to be provided for each section.

300. Degrees of protection

301. 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 Publication 60092-201.

302. **Rotating machines**:

a. The degree of protection of enclosures of rotating electrical machines is to be at least IP23.

b. The degree of protection of terminals is to be at least IP44.

303. 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.

304. **Transformers**:

a. The degree of protection of enclosures of transformers is to be at least IP23.

b. For transformers installed in spaces accessible to unqualified personnel a degree of protection of at least IP4X is required.

c. For transformers not contained in enclosures, see I7.101 below.

305. **Switchgear, control gear assemblies and static converters**

a. The degree of protection of metal enclosed switchgear, controlgear assemblies and static **converters** is to be at least IP32.

b. 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.

400. Insulation

401. **Air clearance**: 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 T.I2.401.1

TABLE T.I2.401.1

Nominal Voltage (kV)	Minimum air clearance (mm)
3 (3.3)	55
6 (6.6)	90
10 (11)	120
15	160

402. Intermediate values may be accepted for nominal voltages provided that the next higher air clearance is observed.

403. In the case of smaller distances, appropriate voltage impulse test must be applied.

404. **Creepage distances**: Creepage distances between live parts and between live parts and earthed metal parts for standard components are to be in accordance with relevant IEC Publications for the nominal voltage of the system, the nature of the insulation material and the transient overvoltage developed by switch and fault conditions.

405. For non-standardised parts within the busbar section of a switchgear assembly, the minimum creepage distance is to be at least 25 mm/kV and behind current limiting devices, 16mm/kV.

500. Protection

501. **Faults on the generator side of circuit breaker**: 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.

502. In distribution systems with a neutral earthed, phase to earth faults are also to be treated as above.

503. **Faults to earth:** any earth fault in the system is to be indicated by means of a visual and audible alarm.

504. 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.

505. **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.

506. 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.

507. **Power transformers: power** transformers are to be provided with overload and short circuit protection.

508. 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.

509. **Voltage transformers for control and instrumentation**: voltage transformers are to be provided with overload and short circuit protection on the secondary side.

510. **Fuses**
Fuses are not to be used for overload protection.

511. **Low voltage systems**: lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

a. direct earthing of the lower voltage system

b. appropriate neutral voltage limiters

c. earthed screen between the primary and secondary windings of transformers.

I3. ROTATING MACHINES

100. Stator winding of generators

101. Generator stator windings are to have all phase ends brought out for the installation of the differential protection.

200. Temperature detectors

201. 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.

302. If embedded temperature detectors are used, means are to be provided to protect the circuit against overvoltage.

300. Tests

301. In addition to the tests normally required for rotating machinery, a high frequency high voltage test in accordance with IEC Publication 60034-15 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.

I4. POWER TRANSFORMERS

100. General

101. Dry type transformers have to comply with IEC Publication 60726.

102. Liquid cooled transformers have to comply with IEC Publication 60076.

103. Oil immersed transformers are to be provided with the following alarms and protections:

a. liquid level (Low) alarm

b. liquid temperature (High) alarm

c. liquid level (Low) - trip - or load reduction

I5. CABLES

100. General

101. Cables are to be constructed in accordance with the IEC Publication 60092-353 and 60092-354 or other equivalent Standard.

I6. SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

100. General

101. Switchgear and controlgear assemblies are to be constructed according to the IEC Publication 60298, IEC 60092-302 or equivalent (IEEE St45 Chapter 8) and the following additional requirements.

200. Construction

201. Mechanical construction: switchgear is to be of metal – enclosed type in accordance with IEC Publication 60298 or of the insulation – enclosed type in accordance with the IEC Publication 60466.

202. **Locking facilities:** 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.

203. Withdrawable circuit breakers are to be located in the service position so that there is no relative motion between fixed and moving portions.

204. **Shutters**: 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.

205. **Earthing and short-circuiting**: 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.

300. Auxiliary systems

301. Source and capacity of supply: 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.

302. 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.

303. Number of external supply sources: 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.

304. Where necessary one source of supply is to be from the emergency source of electrical power for the start up from dead ship condition.

400. High voltage test

401. 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 Publication 60298.

I7. INSTALLATION

100. Electrical equipment

101. 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.

102. 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.

200. Cables

201. Runs of cables: In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

300. Segregation

301. 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.

302. 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 item I2.401. 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.

400. Terminations:

401. 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.

402. 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.

403. 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).

500. Marking:

501. High voltage cables are to be readily identifiable by suitable marking.

CHAPTER T
TESTS ON ELECTRICAL INSTALLATIONS ON BOARD

CHAPTER CONTENTS

T1. TESTS DURING THE VESSEL CONSTRUCTION

T2. TESTS DURING THE COMMISSIONING OF THE VESSEL

T3. TEST METHODS AND VALUES

T4. TESTS AFTER INSTALATION OF SYSTEMS WITH VOLTAGES ABOVE 1 KV UP TO 15 KV

T1. TESTS DURING THE VESSEL CONSTRUCTION

100. Compliance

101.During the period of the vessel construction, the electrical systems should be checked to ensure that they are in accordance with these Rules and with approved drawings and documents.

200. Tests of electrical equipment in manufacturers

201. Main generators and electric motors with power greater than 50 kVA will have inspections in the manufacturers and certification, as well as generators and electric propulsion motors, emergency generators, transformers, electrical switchboards for electric propulsion, electric main and emergency switchboards and safety devices.

202. Generators and electric motors with power less than 50 kVA will have certificates of manufacturers, indicating the characteristics of the materials and test results.

203. Circuit-breakers, contactors, fuses and sockets, and cables are to be of an approved type.

T2. TESTS DURING THE COMMISSIONING OF THE VESSEL [IACS UR E 10]

100. List of tests in the commissioning phase

101. The following tests and inspections are to be carried out in the vessel's commissioning phase:

a. insulation resistance measurement;

b. generators tests, comprising;

b.1. Overload capacity;

b.2. Speed regulation;

b.3. Voltage regulation;

b.4. Device of control, protection and measurement;

b.5. Automatic and quick starting equipment;

c. switchboards and cubicles, comprising:

c.1. Checking of protection against short-circuit;

c.2. Checking of protection against overload;

c.3. Checking of protection against overvoltage;

c.4. Checking of the panels and cubicles related to the access to live parts, ventilation and heating.

d. Connections to hull and cables, including:

d.1. visual inspection of the cables related to its correct routing and connections to the hull to for return and/or grounding;

e. condition of as-built drawings and documents including:

e.1. checking that all documents and drawings of the design of the vessel, are corrected "as built" and are available on board; part of this documentation consists of drawings and documents submitted for approval as listed in Chapter B.

200. Engine starts

201. For starts of propulsion engines, the batteries will have capacity for at least 6 (six) starts in 30 (thirty) minutes without recharging.

202. For auxiliary engines the capacity will be for at least 3 (three) starts within 30 (thirty) minutes without recharging.

T3. TEST METHODS AND PARAMETERS

100. Parameters

101. The methods and extent of tests to be carried out, as well as the values to be achieved, are to be submitted to the RBNA for approval.

T4. TESTS AFTER INSTALATION OF SYSTEMS WITH VOLTAGES ABOVE 1 KV UP TO 15 KV [IACS UR E 11]

100. Test after installation:

101. 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.

102. The test is to be carried out after an insulation resistance test.

103. When a d.c. voltage withstand test is carried out, the voltage is to be not less than:

a. 1.6 (2.5 Uo + 2kV) for cables of rated voltage (Uo) up to and including 3.6 kV, or

b. 4.2 Uo for higher rated voltages

where

Uo is the rated power frequency voltage between conductor and earth or metallic screen, for which the cable is designed.

104. The test voltage is to be maintained for a minimum of 15 minutes.

105. 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.

106. An insulation resistance test is then repeated.

107. Alternatively, an a.c. voltage withstand test may be carried out upon advice from high voltage cable manufacturer at a voltage not less than normal operating voltage of the cable and it is to be maintained for a minimum of 24 hours.

TABLE T.D2.201.1. - SPACING BETWEEN CABLE FIXATION STRAPS IN TRAYS OR SUPPORTS FOR CABLES

Cable outer diameter (mm)	Distance between straps (mm)	
	Horizontal	Vertical
less than 8	200	250
from 8 to 13	250	350
from 13 to 20	300	400
from 20 to 30	350	450
greater than 30	400	500

TABLE T.D2.206.1. - MINIMUM RADIUS OF CURVATURE FOR MULTIPLE CABLE INSTALLATION OF THE CABLE EXTERNAL DIAMETERS

Cable type Cable external diameter (mm)	Unarmored	Armored
Less than 25	4	10
from 25 to 50	5	10
greater than 50	6	10

TABLE T.E2.101.1 - MINIMUM DEGREES OF PROTECTION FOR ELECTRICAL EQUIPMENT ENCLOSURES

Equipment / Place of Installation	Conditions at the place of installation	Generators	Motors	Transformers	Main Switch boards	Controllers	Distribution Boards	Motor Control Centers	Junction Boxes	Socket outlets	Switches	Luminaires	Instrumentation Equipment	Heating Appliances	Cooking Equipment	Communications equipment	Control devices
Locked dry electrical room		IP00	IP00	IP00	IP00		IP00		IP20	IP20	IP20	IP20		IP20	IP20	IP20	IP20
Dry accomodation places	Danger of touching live parts	N	IP20	IP20	IP20	IP20	IP20	IP20	IP20	IP20	IP20	IP20		IP20	IP20	IP20	IP20
Dry control rooms		N	IP22	IP21	IP22		IP22	IP22	IP20	IP22	IP20	IP22	IP20	IP22	IP20	IP20	IP20
Dry Service rooms		IP20	IP20	IP20	IP20		IP20		IP20	IP20	IP20	IP20		IP20	IP20	IP20	IP20
Deckhouses		N	IP22 (9)	IP22 (9)	IP22 (9)		IP22 (9)		IP44	IP44	IP44	IP22	IP44	IP22			
Forecastle spaces		N	IP22 (9)	IP22 (9)	IP22 (9)		IP22 (9)		IP44	IP44	IP44	IP22	IP44	IP22			
Control stations	Danger of dripping liquid and/or moderate mechanical damage	N	IP22	IP22	IP22	IP22	IP22	IP22	IP22	IP22	IP22	IP22		IP22	IP22	IP22	IP22
Radio room		N	IP22	IP22	IP22		IP22	IP22	IP22	IP22	IP22	IP22		IP22	IP22	IP22	IP22
Wheelhouse		N	IP22	IP22	IP22	IP20	IP22	IP22	IP22	IP22	IP22	IP22		IP22	IP22	IP22	IP22
Engine rooms above floor		IP22 (4)	IP22 (4)	IP22 (4)	IP22 (4)	IP22	IP22 (4)	IP22	IP44 (3)	IP44 (3)	IP44 (3)	IP22 (4)	IP44	IP22 (4)	IP22 (4)	IP44 (3)	IP44 (3)
Boiler rooms above floor		IP22	IP22	IP22	IP22		IP22	IP22	IP44	IP44	IP44	IP22	IP44	IP22	IP22		
Steering gear rooms		N	IP22 (9)	IP22 (9)	IP22 (9)	IP22	IP22	IP22	IP44	IP44	IP44	IP22	IP44	IP22	N		
Bow thruster rooms		IP22	IP22 (4)	IP22 (4)	IP22 (4)		IP22 (4)		IP44 (3)	IP44 (3)	IP44 (3)	IP22 (4)		IP22 (4)	IP22 (4)	IP44 (3)	IP44 (3)
Emergency machinery rooms		IP22	IP22	IP22	IP22	IP22	IP22	IP22	IP44	IP44	IP44	IP22		IP22	N		
Refrigerating machinery rooms		N	IP22	IP22	IP22	IP22	IP22	IP22	IP22		IP22	IP22		IP22			
Passage ways		IP22 (4)	IP22 (4)	IP22 (4)	IP22 (4)		IP22 (4)		IP44 (3)	IP44 (3)	IP44 (3)	IP22 (4)		IP22 (4)	IP22 (4)	IP44 (3)	IP44 (3)

Equipment / Place of Installation	Conditions at the place of installation	Generators	Motors	Transformers	Main Switch boards	Controllers	Distribution Boards	Motor Control Centers	Junction Boxes	Socket outlets	Switches	Luminaires	Instrumentation Equipment	Heating Appliances	Cooking Equipment	Communications equipment	Control devices
Store rooms		N	IP22 (4)	IP22 (4)	IP22 (4)	IP22	IP22 (4)	IP22	IP44 (3)	IP44 (3)	IP44 (3)	IP22 (4)		IP22 (4)	IP22 (4)	IP44 (3)	IP44 (3)
Pantries		N	IP22 (4)	IP22 (4)	IP22 (4)	IP22	IP22 (4)	IP22	IP44 (3)	IP44 (3)	IP44 (3)	IP22 (4)		IP22 (4)	IP22 (4)	IP44 (3)	IP44 (3)
Provision rooms		N	IP22 (4)	IP22 (4)	IP22 (4)	IP22	IP22 (4)	IP22	IP44 (3)	IP44 (3)	IP44 (3)	IP22 (4)		IP22 (4)	N	IP44 (3)	IP44 (3)
Internal ventilation ducts		N	IP44	N	N		N	N	N	N	N	N (8)	N (8)	N	N	IP44 (3)	IP44 (3)
Bathrooms	Increased danger of liquid and/or mechanical damage	N	N	N	N	N	N	N	IP55	IP55	IP55	IP34		IP44	N		
Showers		N	N	N	N	N	N	N	IP55	IP55	IP55	IP34		IP44	N		
Engine rooms below floor		N	IP44	N	N	N	N	N	IP55 (3)	N	IP55 (3)	IP44	IP56	IP44	N	IP55 (3)	IP55 (3)
Boiler rooms below floor		N	IP44	IP44	IP44		IP44		IP44	N		IP44	IP56	IP44			
Closed fuel oil separator rooms		N	IP44	N	IP44	IP44	IP44	IP44	IP55 (3)	N	IP55 (3)	IP44	IP44	IP44	N	IP55 (3)	IP55 (3)
Closed lubricating oil separator rooms		N	IP44	N	IP44	IP44	IP44	IP44	IP55 (3)	N	IP55 (3)	IP44	IP44	IP44	N	IP55 (3)	IP55 (3)
Galleys	Increased danger of liquid and mechanical damage	N	IP44	IP44	IP44	IP44	IP44	IP44	IP44	IP44	IP44	IP34		IP44	IP44	IP44	IP44
Laundries		N	IP44	IP44	IP44	IP44	IP44	IP44	IP44	IP44	IP44	IP34		IP44	IP44	IP44	IP44
Public bathrooms and showers		N	IP44	IP44	IP44		N	N	IP55 (3)	IP55 (3)	IP55 (3)	IP34 (5)		IP44 (5)	N	IP55 (3)	IP55 (3)
Ballast pump rooms		N	IP44 (6)	IP44 (6)	IP44	IP44	IP44	IP44	IP56	IP56	IP56	IP44	IP56	IP44	N		
Columns below main deck		N	IP44	IP44	IP44		IP44		IP56	IP56	IP56	IP44	IP56	IP44			
Pontoons and similiar rooms below load line		N	IP44	IP44	IP44		IP44		IP56	IP56	IP56	IP44	IP56	IP44			

Equipment / Place of Installation	Conditions at the place of installation	Generators	Motors	Transformers	Main Switchboards	Controllers	Distribution Boards	Motor Control Centers	Junction Boxes	Socket outlets	Switches	Luminaires	Instrumentation Equipment	Heating Appliances	Cooking Equipment	Communications equipment	Control devices
Refrigerated rooms		N	IP44	N	N	N	N	N	IP55 (3)	IP55 (3)	IP55 (3)	IP34 (5)		IP44 (5)	N	IP55 (3)	IP55 (3)
Shafts or pipe tunnels in double bottom	Danger of liquid spraying, presence of cargo dust, serious mechanical damage and/or agreessive fumes	N	IP55	IP55	IP55	IP55	IP55	IP55	IP56 (3)	IP56 (3)	IP56 (3)	IP55		IP55	N	IP55 (3)	IP55 (3)
Holds for general cargo		N	N	N	N	N	N	N	IP56 (3)	IP56 (3)	IP56 (3)	IP55	IP56	N	IP55	IP55 (3)	IP55 (3)
Ventilation trunks to open deck		N	IP55	N	N		B	N	IP55 (3)	IP55 (3)	IP55 (3)	N		N	N	IP55 (3)	IP55 (3)
Open decks	Subject to heavy sea	N	IP56	N	N	IP56	IP56	IP56	IP56	IP56	IP56	IP56		IP56	N	IP56	IP56
Ballast water tanks		N	IP68	N	N		N		N	N	N	N	IP68	IP68		IP56	
Bilge wells	Subject to submersion	N	IP68	N	N		N		N	N	N	N	IP68	IP68			
Fuel oil tanks		N	N	N	N		N		N	N	N	N	IP68	N			
Batteries and static chargers rooms		N	EX	EX / IP44	EX		EX / IP44		EX	EX / IP23	EX / IP23	EX / IP23	EX	EX			
CO_2 rooms		N		IP44	IP44		IP44			IP23	IP23	IP23					
Ventilator fan rooms		N	IP44							IP23	IP23	IP23					
Painting stores		N	EX	EX	EX		EX		EX	EX	EX	EX	EX	EX			
Welding gas bottle stores		N	EX	EX	EX		EX		EX	EX	EX	EX	EX	EX			

Remarks for Table T.E2.101.1:

(1) Symbol "N" means the equipment shall not be installed at such place.

(2) Equipment for watertight doors installed below the bulkhead deck:

- devices to indicate the closure of doors: IPX6
- devices to indicate the position of the doors: IPX8
- electric motors and related control devices: IPX7

(3) Measuring chamber of smoke detectors: IP42
(4) Electrical and electronic equipment within areas protected by FWBLAFFS (fixed water-based local application fire-fighting systems) or adjacent areas: IP44
(5) For shower rooms and bathrooms installed in the hazardous areas:
- Zone 0 - IPX7
- Zone 1 - IP55
- Zone 2 - IP34

(6) Transformers and electric motors used to supply propellers for side thrusters installed in spaces like ballast pump rooms: IP22.
(7) Socket outlets shall not be installed in engine rooms below floor, including lubricating and fuel oil separator rooms or rooms for which certified safe apparatus are required.
(8) Luminaries and instrumentation components can be accepted in ventilation ducts after special analysis from RBNA, as these spaces can be inside a hazardous area depending on the classification of the areas at the ends of the duct.
(9) This equipment should be kept dry when not in use by the use of heating elements, normally activated when the equipment is switched off. The continuous use of the heating can be accepted, provided the temperature is kept under the permitted limit during the operation.

TABLE T.G1.104.1. – GUIDE FOR MINIMUM LIGHTING POWER

Site to be illuminated	**Ilumination in Minimum Watts per m^3 of the compartment**		
	Direct	**Semi direct**	**Indirect**
Cargo spaces - permanent lighting	2.12		
Rudder machine compartment and similar spaces	2.93		
Entries for passengers Cabins, mess rooms etc.	3.89	5.82	7.77
. Lavatories and toilets	3.89	7.27	13.24
..Crew cabins Machinery and its access square Cargo space - portable lighting	3.89		
External walkways Boiler compartment	3.18		

TABLE T.G6.101.1 – MAXIMUM PERMISSIBLE CURRENT FOR CONTINUOUS SERVICE AT AMBIENT TEMPERATURE OF 45° C AND MAXIMUM RATED TEMPERATURE IN THE CONDUCTORS OF 90° C

Quantity of conductors Nominal cross sectional area in mm^2	1 (A)		2 (A)		3 or 4 (A)	
1	17		14		12	
1,5	23		20		16	
2,5	30		26		21	
4	40		34		28	
6	52		44		36	
10	72		61		50	
16	96		82		67	
25	127		108		89	
35	157		133		110	
50	196		167		137	
70	242		206		169	
95	293		249		205	
120	339		288		237	
150	389		331		272	
185	444		377		311	
240	522		444		365	
300	601		511		421	
	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.
400	690	670	587	570	483	469
500	780	720	663	612	546	504
630	890	780	757	663	623	546

TABLE T.G6.101.2. - MAXIMUM CURRENT CORRECTION IN ETHYLENE PROPILENNIC RUBBER-INSULATED CABLES (90° C)

Ambient temperature in °C / Maximum temperature in the conductor in °C	35	40	45	50	55
75	1,15	1,08	1,00	0,91	0,82
90	1,10	1,05	1,00	0,94	0,88

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