PART 6 Electrical Installations

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CHAPTER 1 General Requirements

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SECTION 1 General

1.1 General

1.1.1 Scope

The requirements of this Part apply to the electrical equipment and electric propulsion machinery intended for ships without special limitations for their service and purpose. For electrical equipment and electric propulsion machinery intended for ships with special limitations for their service and purpose, the requirements may be modified.

1.1.2 Whilst the requirements of this part generally satisfy the regulations of Chapter II-1, Part D of the International Convention for the safety of Life at Sea 1974 and the relevant 1988 Amendments, for no classification purposes, reference should be made to the original text of the convention, to special codes (as IGS, IBC) and to any relevant additional statutory requirements of the National Authority of the Country in which the ship is to be registered.

1.1.3 Special electrical equipment

Electrical equipment and electric propulsion machinery not specified in this Part are to be as deemed appropriate by the Society.

1.1.4 Additions and alterations

An addition or alteration, temporary or permanent is not to be made to an existing installation until it has been definitely ascertained that the ratings and the condition of existing accessories, conductors, switchgear, etc. affected, are adequate for the new situation. Special attention is drawn to those factors affecting the existing system design such as current-carrying capacity, short-circuit level, voltage drop and proper discrimination of the protective devices.

1.2 Documents for approval

1.2.1 The drawings and data to be submitted for approval before the commencement of work are generally as follows:

(1) Drawings

(a) Sectional assembly of generators, motors and electro-magnetic slip couplings for electrical propulsion (hereinafter to be called "propulsion") including complete rating, main dimensions, materials used and weight.

(b) Key diagram and explanation of electric propulsion control gear.

(c) Sectional assembly for generators (main, auxiliary, emergency, etc.) and motors of 100 KW (or KVA) and above, including complete rating, main dimensions, materials used and weight.

(d) Arrangement plan and circuit diagram of switchboard (including main materials used).

(e) Arrangement plans of electrical equipment and wiring.

(f) Diagrams of the wiring system including normal working current, rated current, possible short-circuit current in the circuits, line drop of voltages, type of cables, cable sizes, rating and setting of circuit-breakers, rating of fuses and switches and interrupting capacity of circuit-breakers and fuses.

(g) Drawings and data concerning to the construction of explosion-proof equipment.

(2) Data

(a) Description of propulsion system.

(b) Drawings indicating dangerous spaces and the list of electrical equipment installed therein, in case of tanker.

(c) Analysis of electric load for normal and emergency conditions.

(d) Short circuit currents calculations at main, emergency and sub-switchboards.

1.3 Construction and location

1.3.1 Construction

Electrical installations are to be so constructed as to provide easy accessibility to all parts requiring inspection, overhaul and repair.

1.3.2 Protection against Corrosion

Bolts, nuts, pins, screws, terminals, studs, springs and such other small parts are to be made of corrosion resistant materials or those suitably protected against corrosion.

1.3.3 Protection against electrical shock

(1) Where the operators are liable to inadvertently touch the live part of electrical apparatus due to the ship's inclination and/or vibrations, such parts are to be protected with suitable means to prevent electrical shock.

(2) The moving parts, reciprocating parts, high temperature parts or charged parts of electrical equipment are to be provided with suitable protections for persons who monitor, operate or approaches the equipment to avoid injury.

1.3.4 Location of propulsion machine

Means are to be provided to prevent the accumulation of bilge under propulsion machines (generators, motor-generators, motors, electro-magnetic slip couplings).

1.3.5 Location and protective enclosure

Electrical equipment should be so selected, located and protected where necessary that it is unaffected by any water, steam, oil or fumes to which it is likely to be exposed. Where, however, electrical equipment is

unavoidably installed in spaces not fulfilling the above conditions, it is to be in accordance with IEC Publication 529 "Degrees of protection provided by enclosures".

1.3.6 Installation of electrical and electronic equipment in engine rooms protected by fixed water-based local application fire-fighting systems (FWBLAFFS) (IACS UR E20 Rev.1)

(a) Definitions:

- Protected space: Is a machinery space where a FWBLAFFS is installed.
- Protected areas: Areas within a protected space which is required to be protected by FWBLAFFS.
- Adjacent areas:
  - Areas, other than protected areas, exposed to direct spray.
  - Areas, other than those defined above, where water may extend.

See also Figure 6.1.1

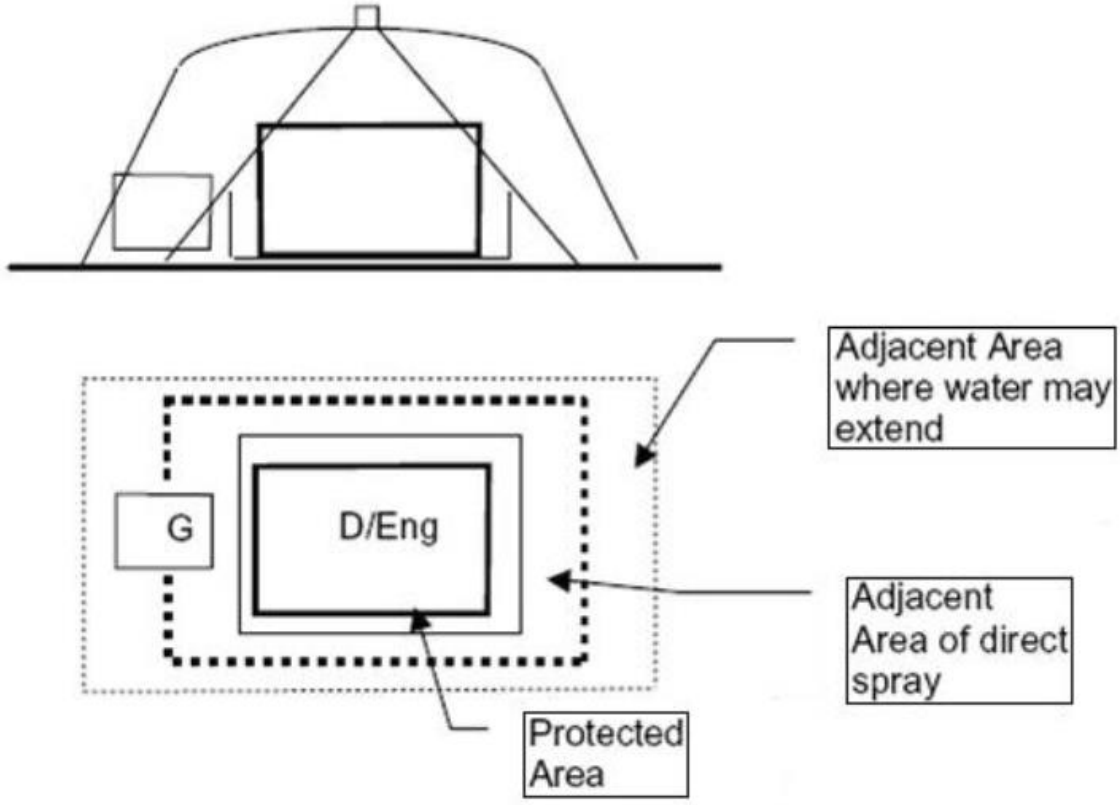
(b) Electrical and electronic equipment enclosures located within areas protected by FWBLAFFS and those within adjacent areas exposed to direct spray are to have a degree of protection not less than IP44, except where evidence of suitability is submitted to and approved by the Society.

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

NOTE:

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

Figure 6.1.1: Definition of areas



1.3.7 Insulating materials and insulated windings

Insulating materials and insulated windings should be resistant to moisture, sea-air and oil vapour unless special precautions are taken to protect insulants against such agencies.

1.3.8 Power source control switches

Electrical equipments are not to remain alive through the control circuits or pilot lamps when switched off by the control switch.

1.3.9 Vibration, shock and inclination of ship

(1) The operation of all electrical equipment and lubricating arrangements are to be efficient under such condition of vibration and shock as with the ship in normal operation, and with the inclinations shown in Part 5, Chapter 1, SECTION 1, Table 1.3.1.

(2) Every horizontal rotating machine should preferably be installed with the shaft in the fore and aft direction. Where a machine is installed athwartship, it shall be ensured that the design of the bearings and the arrangements for lubrication are satisfactory to withstand the rolling specified in of Part 5, Chapter 1, SECTION 1, Table 1.3.1. The manufacturer shall be informed when a machine for installation athwartship is ordered.

1.3.10 Securing of screws and nuts

Screws and nuts securing current-carrying parts are to be effectively locked so that they cannot work loose by vibration. The locking of screws and nuts securing non-current-carrying parts is recommended where necessary.

1.3.11 Consideration of magnetic compass

Conductors and equipment should be placed at such a distance from the compass or should be so screened that the interfering external magnetic field is negligible (deviation less than 0,5°), even when circuits are switched on and off.

1.4 Earthing

1.4.1 Parts for which earthing is required

(1) Unless specifically exempted in (i) - (viii), all accessible metal parts of the electrical installation, other than current-carrying accessible parts, should be earthed.

Exemptions:

(i) Lamp caps.

(ii) Shades, reflectors and guards, supported on lampholders or luminaries constructed of, or shrouded in, non-conducting material.

(iii) Metal parts on, or screws in or through, non-conducting material, which are separated by such material from current-carrying parts , and from earthed non-current-carrying parts.

(iv) Portable appliances having double and/or reinforced insulation (see IEC Publication 60092-101 "Definitions and General Requirements"), provided that the appliances conform with recognized safety requirements.

(v) Bearing housings which are insulated in order to prevent circulation of current in the bearings.

(vi) Clips for fluorescent lighting tubes.

(vii) Apparatus supplied at safety voltage (see IEC Publication 60092-101, Sub-Clause 2.19).

(viii) Cable clips.

(2) To minimize shock from high-frequency voltage induced by the ratio transmitter, handles, hand-rails, etc., of metal on the bridge or upper decks should be in good electrical connection with the hull or superstructure (see IEC Publication 533: "Electromagnetic Compatibility of Electrical and Electronic Installation in Ships").

(3) Secondary windings of instrument transformers shall be earthed.

NOTE:

Consideration shall be given to the earthing of the non-current-carrying parts which are not accessible but which under fault conditions might become live and hence constitute a fire hazard, such as a metal junction-box mounted on a wooden panel.

1.4.2 Methods of earthing

Accessible non-current-carrying metal parts not exempted under 1.4.1 should be earthed as described below:

(i) Metal frames or enclosures of apparatus may be fixed to, and in metallic contact with, the ship's structure, provided that the surfaces in contact are clean and free from rust, scale or paint when installed and are firmly bolted together. Alternatively, they may be connected to the hull by a connection complying with 1.4.3 and 1.4.5. A lead cable sheath shall not be solely relied upon for this purpose.

(ii) All metal coverings of cables shall be electrically connected to the metal hull of the ship at both ends, except in so far as the provisions given in Part 6, Chapter 6, SECTION 1, 1.10.1(1) apply. Single-point earthing is admitted for final sub-circuits (at the supply end) and in those safe circuits, control circuits, etc.) where it is required for technical or security reasons, if any.

(iii) Earthing connections shall be carried out with conductors having cross-sectional areas (see Table 1.1.1) related to the current ratings of the cables, or by equivalent means, such as metal clamps gripping the metal covering of the cable and connected to the metal hull of the ship.

The metal covering of cables may be earthed by means of glands intended for the purpose and so designed as to ensure an effective earth connection.

The glands shall be firmly attached to, and in effective electrical contact with, a metal structure earthed in accordance with these standards.

(iv) The electrical continuity of all metal coverings throughout the length of the cables, particularly at joints and tappings, shall be ensured.

(v) The lead of lead-sheathed cables shall never be used as the sole means of earthing non-current-carrying parts (see 1.4.3(4))

(vi) Metal casings, pipes and conduits or trunking shall be effectively earthed.

(vii) Conduits may be earthed by being screwed into a metal enclosure, or by nuts on both sides of the wall of a metallic enclosure, provided the surfaces in contact are clean and free from rust, scale or paint and that the enclosure is in accordance with these recommendations on earthing.

(viii) Cable sheaths and armor, and conduit, may be earthed by means of clamps or clips of corrosion-resistant metal making effective contact with the sheath or armor and earthed metal. All joints in metal conduits and ducts and in metallic sheath of cables, used for earth continuity shall be soundly made and protected, where necessary, against corrosion.

1.4.3 Earthing connections

(1) Every earthing connection should be of copper or other corrosion-resistant material and should be surely installed and protected where necessary against damage and also, where necessary, against galvanic corrosion.

(2) The nominal cross-sectional area of every copper earthing connection should be not less than is required in Table 1.1.1. Every other earthing connection should have a conductance of not less than that specified for a copper earthing connection.

(3) Metal parts of portable appliances, other than current-carrying parts and parts exempted in 1.4.1 should be earthed by means of an earth-continuity conductor in the flexible cable or cord, which complies with Table 1.1.1 and which is earthed, for example, through the associated plug and socket outlet.

(4) In no circumstances should the lead sheathing of cables be relied upon as the sole means of earthing.

1.4.4 Earthed distribution systems

(1) The system earthing connection in an earthed distribution system, in which the earthing connection does not normally carry current, shall conform with recommendation of 1.4.3, except that the upper limit of 64 mm² does not apply (see Table 1.1.1, Item 3.3).

(2) The system earthing of earthed distribution systems shall be effected by means independent of any earthing arrangements of non-current-carrying parts.

Table 1.1.1: Sizes of earth-continuity and earthing connections

Type of earthing connection	**Cross-sectional area associated current carrying conductor**	**Minimum cross-sectional area of copper earthing connection**
1. Earth-continuity conductor in flexible cable or flexible cord	Any	Same as current-carrying conductor up to and including 16 mm² or one half above 16 mm² but at least 16 mm²
2. Earth continuity conductor incorporated in fixed cable	Any	2.1 For cables having an insulated earth- continuity conductor: (i) a cross section equal to the main conductors up to and including 16 mm², but minimum 1,5 mm² (ii) a cross section not less than 50% of the cross section of the main conductor when the latter is more than 16 mm², but at least 16 mm² 2.2 For cables with a bare earth wire in direct contact with the lead sheath: Cross section of main conductor — Earthing conductor 1,0– 2,5mm² — 1,0mm² 4,0– 6,0mm² — 1,5mm²
1. Separate fixed earthing conductor	3.1 Not exceeding 3 mm² 3.2 Exceeding 3 mm² but not exceeding 125 mm²	Same as current-carrying conductor subject to minimum of 1,5 mm² for stranded earthing connection or 3 mm² for unstranded earthing connection. One-half the cross sectional area of the current-carrying conductor, subject to a minimum of 3 mm²

	3.3 Exceeding 125 mm^2	64 m^2

1.4.5 Connections to the ship's structure

Every connection of an earth-continuity conductor or earthing lead to the ship's structure should be made in an accessible position, and should be secured by a screw of brass or other corrosion-resistant material of diameter not less than 6 mm which should be used for this purpose only. In all circumstances care should be taken to ensure bright metallic surfaces at the contact areas immediately before the screw is tightened.

1.4.6 Aluminium superstructures

Methods of securing aluminium superstructures to the steel hull of a ship often include insulation to prevent galvanic corrosion between these materials. In such case, a separate bonding connection should be provided between superstructure and the hull which should be made in such a manner that galvanic corrosion is avoided and the points of connection may readily be inspected.

1.5 Explosion-protected electrical equipment

1.5.1 General

When an apparatus is required to be suitable for use in explosive gas atmospheres it shall be constructed in accordance with IEC Publication 79: Electrical Apparatus for Explosive Gas Atmospheres, and in accordance with Appendix A of Publication 92-502 : Special Features - Tankers. Such apparatus shall also be type tested, where it is required to be of a certified safe type, the certification for use in the relevant atmosphere(s) is to be carried out by a recognized competent independent testing authority.

1.5.2 Type of explosion-protected construction

The type of explosion-protected construction used for electrical equipment on board ships is generally to be as follows:

Luminaries:

- pressurized type 'p'
- flameproof type 'd'
- increased-safety type 'e'

Portable lamps:

- intrinsically safe-type 'ia' and 'ib'
- flameproof type 'd'
- increased-safety type 'e' each with self-contained battery
- air driven type with or pressurized enclosure type 'p'

Branch connection boxes:

- increased-safety type 'e'
- flameproof type 'd'

Motors:

- increased-safety, type 'e' , with flameproof , type 'd' , enclosure
- pressurized type 'p'
- flameproof type 'd'
- increased-safety type 'e'

Instrumentation, control and communication equipment:

- intrinsically safe-type 'ia' and 'ib' .

1.5.3 Intrinsically-safe systems

Intrinsically-safe systems are to be completely separated and independent of all other electric systems. Intrinsically-safe cables are to have shielded conductors or to be installed a minimum of 50mm from other electric cables and are not to occupy an enclosure (such as a junction box or terminal cabinet) with non-intrinsically-safe circuits. When intrinsically-safe components are located by necessity within enclosures that contain non-intrinsically-safe systems, such as control consoles and motor starters, such components are to be effectively isolated in a sub-compartment by physical barriers having a cover or panel secured by bolts, locks, allen-screws, or other approved methods. The sub-compartment is to have an identifying nameplate indicating that the equipment within is intrinsically safe and that unauthorized modification or repairs are prohibited.

1.5.4 Materials

(1) Materials for explosion-protected construction are to have an adequate electrical, mechanical, thermal and chemical resistance against environmental conditions and flammable gases or vapours (hereinafter referred to as "gases") at the location of the electrical equipment concerned.

(2) Enclosures and outer fittings of portable appliances are to be of material which minimizes the risk of spark by friction, or to have a non-metallic strong cover with a hanging strap.

(3) Insulating compounds and sealing compounds used for integral parts of explosion-protected construction are to be such that no harmful expansion, contraction, softening or crack is found during service. Furthermore, the insulating compounds applied to bare live-parts are to be flame-retardant.

1.6 Lighting conductors

1.6.1 Lighting conductors are to be fitted on each wooden mast or topmast.

1.6.2 Size of lighting conductors

(1) Lighting conductors are to be composed of continuous copper tape or rope having a section not less than 75 mm^2. Lighting conductors are to run as straight as possible and sharp bends are to be avoided.

(2) The resistance of lightning conductor between the mast top and the point on the earth plate or hull is not to exceed 0,02 Ω.

1.7 Electrical Equipment allowed in paint stores and in the enclosed spaces leading to paint stores (IACS UR E12 Rev.2)[1]

1.7.1 General

Electrical equipment is to be installed in paint stores and in ventilation ducts serving such spaces only when it is essential for operational services. Certified safe type equipment of the following type is acceptable:

(a) intrinsically safe Exi

(b) flameproof Exd

(c) pressurized Exp

(d) increased safety Exe

(e) special protection Exs

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

1.7.2 Minimum requirements

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

- explosion group II B
- temperature class T3

NOTE:

The paint stores and inlet and exhaust ventilation ducts under Clause 1 are classified as Zone-1 and areas on open deck under Clause 4 as Zone 2, as defined in IEC 60092-502:1999.

A watertight door may be considered as being gastight.

1.7.3 Special requirements

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

.2 In the areas on open deck within 1m of inlet and exhaust ventilation openings or within 3 m of exhaust mechanical ventilation outlets, the following electrical equipment may be installed:
- electrical equipment with the type of protection as permitted in paint stores;
- equipment of protection class Exn;

[1] NOTE:

1. UR Rev.2 is to be uniformly implemented by the Society on ships contracted for construction on and after 1 January 2022.
2. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder.

- appliances which do not generate arcs in service and whose surface does not reach unacceptably high temperature;
- appliances with simplified pressurised enclosures or vapour-proof enclosures (minimum class of protection IP55) whose surface does not reach unacceptably high temperature; or
- cables as specified in clause 1.

.3 The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that:
- the door to the paint store is a gastight door with self-closing devices without holding back arrangements,
- the paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area,
- warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids.

CHAPTER 2 System Design - Distribution

CONTENTS

SECTION 1 System design

1.1 System of supply

1.1.1 The following systems of supply are considered as standard:

(1) Two-wire for direct current.

(2) Three-wire for direct current (three-wire insulated system or three-wire mid-wire earthed system)

(3) Single phase two-wire insulated for alternating current.

(4) Three phase three-wire for alternating current.

(5) Three phase four-wire with neutral earthed but without hull return for alternating current.

1.2 Voltage and frequency

1.2.1 Supply voltages

(1) Supply voltages are not to exceed:

(a) 500V for generators, power, cooking and heating equipment permanently connected to fixed wiring,

(b) 250V for lighting, heaters in cabins and public rooms and other applications not mentioned above,

(c) 7000V A.C. for electric propulsion equipment

1500V D.C. for electric propulsion equipment.

(2) In case supply voltage more than mentioned above in 1.2.1(1)(a) is to be adopted, construction of electrical equipment and cable, and method of installation, test and inspection are to be submitted for approval by the Society in advance.

1.2.2 Standard frequency

Frequency of 50 and 60Hz is recognized as standard.

1.2.3 Control voltage

For distribution systems above 500V the control voltage shall be limited to 250V, except when all control equipment is enclosed in the relevant control gear and the distribution voltage is not higher than 1000V.

1.2.4 Voltage and frequency variations (IACS E5)

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

(2) Unless otherwise stated in the national or international standards, all equipment should operate satisfactorily with the variations from its rated value shown in Table 2.1.1, Table 2.1.2 and Table 2.1.3 on the following conditions:

(a) For alternative current components, voltage and frequency variations shown in the Table 2.1.1 are to be assumed.

(b) For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table 2.1.2 are to be assumed.

(c) For direct current components supplied by electrical batteries, voltage variations shown in the Table 2.1.3 are to be assumed.

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

Table 2.1.1: Voltage and frequency variations

Quantity in Operation	Variations	
	Permanent	Transient
Frequency	± 5%	± 10% (5s)
Voltage	±6% , -10%	± 20% (1,5s)

Table 2.1.2: Voltage variations for d.c distribution systems

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

Table 2.1.3: Voltage variations for battery systems

Systems	Variations
Components connected to the battery during charging (see NOTE 1)	+30%, -25%

Components not connected to the battery during charging	+20%, -25%

NOTE:

1. Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.

1.3 Main source

1.3.1 Requirement of electrical installation

(1) All electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions will be insured without recourse to the emergency source of electrical power

(2) Electrical services essential for safety will be ensured under various emergency conditions; and

(3) The safety of crew and ship from electrical hazards will be ensured.

1.3.2 Main source of electrical power

(1) A main source of electrical power of sufficient capacity to supply all those services mentioned in 1.3.1(1) shall be provided. This main source of electrical power shall consist of at least two generating sets.

(2) The capacity of the generator set or sets is to be sufficient to carry the necessary sea load essential for the propulsion and safety of the ship, preservation of the cargo, and minimum comfortable conditions of habitability under normal operation with any one generator set in reserve.

(3) If a.c generating sets operate in parallel and are carrying initially the minimum load necessary for the operation of the ship, they shall have sufficient reserve output for starting the largest essential electric motor on board, without the transient voltage and frequency variations exceeding the limits specified in 1.2.4 of this Chapter.

1.3.3 The arrangements of the ship's main source of electrical power shall be such that the services referred to in 1.3.1(1) can be maintained regardless of the speed and direction of the propulsion machinery or shafting. In addition, the generating sets shall be such as to ensure that with any one generator or its primary source of power out of operation, the remaining generating sets shall be capable of providing the electrical services necessary to start the main propulsion plant from a dead ship condition. The emergency source of electrical power may be used for the purpose of starting from a dead ship condition if its capability either alone or combined with that of any other source of electrical power is sufficient to provide at the same time those services required to be supplied by 1.2.2(1) to (4) and 1.5.2(1) to (4) all of Part 6, Chapter 11.

1.3.4 Maintenance or immediate restoration of electric supply in case of loss of any generation in service.

(a) For ships which are required to comply with SOLAS and where the main source of electrical power is necessary for propulsion and steering of the ship, the system shall be so arranged that the electrical supply to equipment necessary for propulsion and steering and to ensure safety of the ship will be maintained or immediately restored in case of loss of any one of the generators in service.

(b) To fulfill the above the following measures are required:

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

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

(iii) Load shedding or other equivalent arrangements should be provided to protect the generators required by this regulation against sustained overload:

~ the load shedding should be automatic.

~ the non-essential services, service for habitable conditions may be shed and where necessary, additionally the secondary essential services, sufficient to ensure the connected generator set(s) is/are not overloaded.

1.3.5 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 (NOTE 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 IEC60092-201 (NOTE 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 1.3.4(b)(ii) 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 (NOTE 3) and the frequency variations in 1.2.4, 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 paragraph 1.3.4(b)(ii).

(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 maneuvering conditions in order to avoid a blackout situation (NOTE 4).

NOTES:

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.

1.4 Ambient Temperatures for Electrical Equipment installed in environmentally controlled spaces

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

~ the equipment is not for use for emergency services.

~ temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit(s) is capable of satisfactorily maintaining the design temperature.

~ the equipment is able to be initially set to work safety within a 45°C ambient temperature until such a time that the lesser ambient temperature may be achieved; the cooling equipment is to be rated for a 45°C ambient temperature.

~ audible and visual alarms are provided, at a continually manned control station, to indicate any malfunction of the cooling units.

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

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

1.5 Clearance and creepage

1.5.1 The distance between live parts of different potential and between live parts and the case or other earthed metal, whether across surfaces or in air, should be adequate for the working voltage having regard to the nature of the insulating material and the conditions of service.

1.6 Test and inspection

1.6.1 General

(1) The following electrical equipment for essential service are to be tested, in principle, in accordance with relevant requirements of this Part at the manufacturer's works:

(a) Propulsion machines and their control gear.

(b) Generators, motors, and their spare armatures, stators and rotors.

(c) Control gear for motors.

(d) Switchboards.

(e) Transformers for power and lighting.

(f) Power semi-conductor rectifiers and their accessories.

(2) The following electrical appliances and cables are to be tested according to the test methods approved by the Society before being taken into use:

(a) Fuses.

(b) Circuit-breakers.

(c) Electro-magnetic contactors.

(d) Cables.

1.6.2 Electrical equipment by mass production system or specially controlled system.

For the electrical equipment listed in 1.6.1(1) and produced by mass production system or specially controlled system, test methods suitable to their production procedures may be adopted subject to the approval of the Society on application from manufacturers.

1.6.3 Trials

Electrical equipment and cables, after installation on board the ship, are to be tested and inspected in accordance with the requirements in Part 6, Chapter 14.

1.6.4 Additional tests and inspections

The Society may require, when it deems necessary, other tests and inspections than those prescribed in this Part.

1.6.5 Exemption from tests and inspections

Electrical equipment having the certificate considered acceptable by the Society may be exempted partially or wholly from the tests and inspections.

1.6.6 Type approval

For the electrical appliances and cables listed in 1.6.1(2), the Society may, on application from manufacturers, survey manufacturing methods, inspection standards, quality control system, etc. and execute type tests. When the test results are satisfactory to the Society, type approval will be given to them with approval numbers and made public by the Society.

1.6.7 Continuation of approval

The manufacturers intending to obtain the continuation of the type approval are to accept periodical inspections at intervals not exceeding 4 years in accordance with the following requirements.

(1) Survey of the materials used, manufacturing methods, inspection standard in the company, quality control, etc.

(2) Tests and inspections designed by the Society.

1.6.8 Cancellation of approval

When approved products do not conform to the required standards and if any of the following is effected, the approval may be cancelled and announced accordingly:

(1) When there is evidence of lower quality in the material used, manufacturing methods, inspection standard in the company, quality control, etc. than the original approved data and they are no longer considered suitable.

(2) When the products failed to pass the specified periodical inspections.

(3) When the products did not undergo the specified periodical inspections.

1.6.9 Tests and inspections of approved products

(1) The electrical appliances and cables having been type approved by the Society may be exempted partially or wholly from tests and inspections.

(2) The manufacturers producing the approved products by the Society shall, by themselves, carry out the tests and inspections on them in accordance to the approved methods. The Society may require the manufacturers to submit the results of the tests and inspections carried out by them, when considered necessary.

SECTION 2 Distribution

2.1 Methods of distribution

2.1.1 General

Every current-consuming appliance is to be supplied by either a switchboard or a section board or a distribution board.

2.1.2 Power and lighting circuits

Lighting circuits and power circuits are to be supplied from a switchboard independently.

2.2 Imbalance of circuits

2.2.1 Three-wire D.C. systems

Imbalance of loads between an outer conductor and the middle wire at the switchboards, section boards and distribution boards is not to exceed 15% of the full load current as far as possible.

2.2.2 Three-wire A.C. systems

Imbalance of loads on each phase at the switchboards, section boards and distribution boards is not to exceed 15% of the full load current as far as possible.

2.3 Shore connection

2.3.1 Installation of connection boxes

Where arrangements are made for the supply of electricity from a source on shore, a connection box is to be installed in a suitable position.

2.3.2 Connection boxes

(1) The connection box is to contain terminals to facilitate a satisfactory connection and a circuit-breaker or an isolating switch with fuses. Means are to be provided for checking the phase sequence (for three-phase alternating current) or the polarity (for direct current).

(2) An earth terminal is to be provided for connecting the hull to an appropriate earth.

(3) At the connection box a notice is to be provided giving full information on the system of supply and the nominal voltage (and frequency if a.c.) of the ship's system and the procedure for carrying out the connection.

2.3.3 Cables between connection box and main switchboard

The cables between the connection box and the main switchboard are to be permanently fixed and a pilot lamp for source and a switch or a circuit-breaker are to be provided on the main switchboard.

2.4 Power feeders

2.4.1 The feeders of the auxiliaries in engine rooms and boiler rooms, cargo gear motors, radio equipment, searchlights, ventilating sets, etc. are to be independently supplied from switchboards or distribution boards.

2.5 Steering gear circuits

2.5.1 General

The electrical systems of the main steering gear and auxiliary steering gear are to be so arranged that any failure in one of the steering gears will not render inoperative the electrical systems of the other steering gear. When an auxiliary steering gear is not required by SOLAS 1974 and the main steering gear comprises two or more power units, the electrical system for each power unit is to be so arranged that the failure of one of them will not render the other units inoperative.

2.5.2 Starters for steering gear motors

Starters for steering gear motors are to be of low-voltage release type and arranged in such a way that the steering gear motors are restarted automatically and safely when electric power is restored after a power failure.

2.5.3 Power circuits supply

Each electric or electrohydraulic steering gear comprising one or more power units is, except as otherwise permitted by SOLAS 1974, to be served by at least two exclusive circuits, fed directly from the main switchboard：one of the circuits are to be supplied through the emergency switchboard.

2.5.4 Supply of control circuits and control systems

Each control for starting and stopping of motors for power units is to be served by its own control circuit supplied from its respective power circuit.

2.5.5 Steering gear control systems

For the main steering gear, control for the steering gear is to be provided both on the navigating bridge and in the steering gear compartment. For the power operated auxiliary steering gear, control for steering gear is to be provided in the steering gear compartment and it is also to be operable from the navigating bridge and shall be independent of the control system for the main steering gear. When, in accordance with SOLAS 1974, an auxiliary steering gear is not installed and the main steering gear comprises two or more identical power units, two independent control systems are to be provided, both operable from the navigating bridge and the steering gear compartment.

2.6 Lighting circuits

2.6.1 The arrangement of the main electric lighting system shall be such that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, the

main switchboard and the main lighting switchboard, will not render the emergency electric lighting system required by 1.2.2(1) to (3) and 1.5.2(1) to (3) both of Part 6, Chapter 11, inoperative.

2.6.2 The arrangement of the emergency electric lighting system shall be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render the main electric lighting system required by this Regulation inoperative.

2.6.3 Fixed lighting fittings of cargo spaces and coal stores

Fixed lighting fittings of cargo spaces and coal stores are to be controlled by multiple linked switches situated outside these areas. Provision is to be made to lock in the switches or switch boxes.

2.6.4 Lighting circuits in machinery spaces, accommodation spaces, etc.

In spaces such as:

- main and large machinery spaces
- corridors
- stairways leading to boat-decks
- public spaces

there are to be more than one final sub-circuit for lighting, one of which may be supplied from the emergency switchboard, in such a way that failure of any one circuit does not reduce the lighting to an insufficient level.

2.7 Final sub-circuits

2.7.1 Motor circuits

(1) In general, a separate final sub-circuit is to be provided for every motor of essential service and every motor of 1 KW or more in rating. The conductors are to have a carrying capacity of not less than 100% of the motor full load current rating.

(2) Means of disconnection

Means are to be provided for the disconnection of the full load from all live poles of supply of every motor rated at 1KW or above and its control gear. The disconnect means is to be a switch with a rating not less than the motor rating or a circuit breaker with an ampere rating at least 115% of motor rating. Disconnect switches and circuit breakers are to be capable of being operated without opening the enclosures in which they are installed.

(3) Undervoltage release

Undervoltage release does not preclude intended automatic restart of motor upon restoration of voltage after a "black-out", but it is to be ensured that the total starting current of motors having automatic restart will not cause excessive voltage drop or overcurrent on the installation.

2.7.2 Lighting circuits

(1) Lighting fittings are not to be supplied from final sub-circuits for heaters and motors. This requirement does not apply to cabin fans and electrical appliances for domestic use.

(2) The number of lighting points supplied from a final sub-circuit of 15A or less in rating is not to exceed the followings, except in the case where the number of lighting points and total load current are invariable, the number of lighting points may be increased, provided the aggregate load current does not exceed 80% of the rating of protective device in the circuit

- For circuits of 50V and below 10 ea.
- For circuits of 51V-130V 14 ea.
- For circuits of 131V-250V 24 ea.

(3) In a final sub-circuit for panel lighting and electric signs, where the lamp holders are closely grouped, the number of points supplied is unrestricted, provided the maximum operating current in the sub-circuit does not exceed 10A.

(4) Final sub-circuits for lighting in accommodation spaces may, as far as practicable, include socket-outlets. In that case, each socket-outlet counts for two lighting points.

(5) Socket-outlets for systems above 250V are to be rated not less than 16A.

(6) Where differing distribution systems supplying socket-outlets are in use, the socket-outlets and plugs are to be of such design that an incorrect connection cannot be made.

2.7.3 Heating circuits

A separate final sub-circuit is to be provided for each heater, except than small heaters up to 10 of aggregate current rating not exceeding 15A may be supplied from a single final sub-circuit.

2.7.4 Heating appliances

Heating appliances are to be controlled by a fixed switch. Where a plug is used for the appliance, the fixed switch is to be placed in the immediate vicinity of the socket-outlet.

2.7.5 Final sub-circuits of rating exceeding 15A

A final sub-circuit of rating exceeding 15A is not to supply more than one point as a rule.

2.7.6 Protection of final sub-circuits

Each insulated pole of final sub-circuits is to be protected by a fuse or a circuit breaker.

2.7.7 Cable's rating of final sub-circuits.

The cables of final sub-circuits are to be rated in accordance with their connected load.

2.8 Circuits other than final sub-circuits

2.8.1 Circuits supplying two or more final sub-circuits are to be rated in accordance with the total connected load subject, where justifiable, to the application of a diversity (demand) factor in accordance with 2.8.3.

2.8.2 Where spare-ways are provided on a section or distribution board, an allowance for future increase in load is to be added to the total connected load, before the application of any diversity factor. The allowance is to be calculated on the assumption that each spare circuit requires not less than the average load on each of the active circuits of corresponding rating.

2.8.3 A diversity (demand) factor may be applied to the calculation of the cross-sectional area of conductors and to the rating of switchgear, taking into account the duty cycle of the connected loads and the frequency and duration of any motor starting loads.

2.9 Internal communication circuits

2.9.1 Supply from power or lighting circuits

Where a communication circuit takes its supply directly from power or lighting circuits and in other cases where the voltage of supply exceed 55V. All equipment is to be in accordance with the requirements for power and lighting circuits.

2.10 Indication of circuits

2.10.1 The current-carrying capacity of each circuit is to be permanently indicated together with the rating or setting of the appropriate overload protective device.

SECTION 3 Earthed distribution system

3.1 General

3.1.1 System earthing is to be effected by means independent of any earthing arrangements of the non-current-carrying parts.

3.1.2 Means of disconnection is to be fitted in the neutral earthing of each generator or transformer so that the generator or transformer may be disconnected for maintenance or insulation resistance measurement.

3.1.3 Transformers' neutrals are not to be earthed on systems where a generator neutral is earthed.

3.2 Earthed system on Tankers

3.2.1 Except as permitted by 3.2.2, earthed distribution systems shall not be used in a tanker.

3.2.2 The requirement of 3.2.1 does not preclude the use of earthed intrinsically safe circuits and in addition, under conditions approved by this society, the use of the following earthed systems:

(i) power-supplied control circuits and instrumentation circuits where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5A in both normal and fault conditions , or

(ii) limited and locally earthed systems, provided that any possible resulting current does not flow directly through any of the dangerous spaces, or

(iii) alternating current power networks of 1,000V root mean square (line to line) and over, provided that any possible resulting current does not flow directly through any of the dangerous spaces.

CHAPTER 3 Protection

CONTENTS

SECTION 1 General

1.1 General requirements

1.1.1 Electrical installations of ships are to be protected against accidental over-currents including short-circuit. The protective devices are to be capable of breaking the fault circuits and continuously serving other circuits as far as possible and at the same time eliminating the danger of damage to the system and fire hazard.

1.1.2 Protection of circuits

(1) Short-circuits protection is to be provided in each pole and phase of all insulated circuits except neutral and equalizer circuits.

(2) Overload protections are to be provided for all circuits liable to be overloaded as follows:

(a) Two -wire D.C. or single-phase A.C. system: at least one line or phase.

(b) Three-wire D.C. system: both outer lines.

(c) Three-phase, three-wire A.C. system: at least two phases.

(d) Three-phase, four-wire A.C. system: at each phase.

(3) Fuse, non-linked circuit breaker or non-linked switch is not to be inserted in an earthed conductor and a neutral line.

1.1.3 Circuit breakers and fuses

(1) Circuit breakers and fuses are to comply with the requirements of I.E.C. Publication 269 and 157.1.

(2) Circuit breakers are to be such that repairs and replacement can be done without disconnecting from the busbar connections and switching off the power source. Where an isolation switch is provided additionally, the requirement may be exempted.

(3) Over current relays of circuit breakers, except moulded-case circuit breakers are to be capable of adjusting their current setting and time-delay characteristics.

1.1.4 Protection against overload

(1) The over current tripping characteristics of circuit breakers and the fusing characteristics of fuses are to be chosen suitably taking into consideration the thermal capacity of electrical equipment and cables to be protected thereby.

(2) Fuses of rated current exceeding 200A are not to be used for overload protection.

1.1.5 Protection against short-circuit

(1) Protection against short-circuits current is to be provided by circuit breakers or fuses.

(2) The rated breaking capacity of every protective device is not to be less than the maximum value of the short-circuit current which can flow at the point of installation at the instant of contact separation.

(3) Where the rated breaking capacity of the short-circuit protection is not in compliance with the requirements in 1.1.1 above, fuses or circuit breakers having a rated breaking capacity not less than the prospective short-circuit current are to be provided at the power source side of the foregoing short-circuit protection. The generator breaker is not to be used for this purpose. The circuit breakers connected to the load side, are to be capable of being continuously in service without excessive damage in the following cases:

(a) When the short-circuit current is broken by the back-up circuit breaker or fuse.

(b) When the circuit breaker at the load side is closed on the short-circuit current, while the back-up circuit breaker or fuse is broken.

(4) The making capacity of every circuit-breaker or switch intended to be capable of being closed, if necessary, on short-circuit, is not to be less than the maximum value of the short-circuit current at the point of installation.

(5) The combination of back up device is permitted only if no essential or emergency service is supplied from there.

(6) Calculation of the prospective short-circuit current is to be carried out in accordance with International or National Standards (e.g IEC 909).

(7) In the absence of precise data of rotating machine, the following short-circuit currents are to be assumed. Where the motor is considered as load, the short-circuit current of motor is to be added to that of generator:

(a) D.C. system

10 times full load current for generators normally connected (including spare) 6 times full load current for motors simultaneously in service.

(b) A.C. system

10 times full load current for generators normally connected (including spare) 3 times full load current for motors simultaneously in service.

(8) Continuity of service of healthy circuits under short-circuit conditions may be achieved by discrimination or by a different system of co-ordinated action of the protective devices.

All systems require:

~ the tripping characteristics of protective devices in series to be properly co-ordinated.

~ all protective devices carrying the fault current shall withstand, without damage, currents up to the maximum level at the point of application in the relevant installation, until complete fault clearance.

1.1.6 Protection of generators

(1) Generators are to be protected against short circuits and over currents by multipole circuit-breaker arranged to open simultaneously all insulated poles. For generators not arranged to run in parallel and less in capacity than 50kW, however, a multipole-linked switch with a fuse or circuit-breaker in each insulated pole may be used for protection.

(2) When multipole-linked switch and fuses are used, fuses rating is to be max. 125% of the generator rated current. When circuit-breakers are used, the setting of the overcurrent trip is to be from 110-125% with a time delay of 20 sec–2 min the maximum. The setting of the short-circuit trip is to be less than the generator's short-circuit current and with a time delay of 0,5-1 sec.

(3) For generators having a capacity of 1500KVA or above and for all high-voltage generators, additional protection should be provided against faults on the generator's side of the circuit-breaker.

(4) For D.C. generators arranged to operate in parallel, in addition to the requirement of (1), an instantaneous reverse-current protection, operating at a fixed value of reverse-current within the limit of 2 to 15% of the rated current of generators, is to be provided. This requirement, however, does not apply to the reverse-current generated from load side, e.g. cargo winch motors, etc.

(5) For A.C. generators arranged to operate in parallel, in addition to the requirement in (1), a reverse-power protection, with time delay, selected and set within the limit of 2 to 15% of full load to a value fixed in accordance with the characteristics of the prime mover, is to be provided.

(6) A fall of 50% in the applied voltage shall not render the reverse power protection inoperative, although it may alter the amount of reverse power required to open the breaker.

1.1.7 Protection of power and lighting transformers

(1) The primary circuits of power and lighting transformers are to be protected against short-circuit and overload by circuit-breakers or fuses.

(2) The overcurrent protective device is to be set at no more than 125% of rated primary current.

(3) When transformers are arranged to operate in parallel, means of isolation are to be provided on the secondary windings. Switches and circuit-breakers are to be capable of withstanding surge currents.

1.1.8 Protection of motors

(1) Motors of rating exceeding 0,5KW and all motors of essential service are to be protected individually against overload and short-circuit, except steering gear motors complying with the requirements of the following 1.1.8(5).

(2) The protective devices are to be set to limit the maximum conditions current between 105% and 120% of the rated current of the protected motor.

(3) The protective device is to have a delay characteristic to enable the motor to start.

(4) For motors of intermittent service, the protective device is to be chosen in relation to the service condition.

(5) Short-circuit protection only is to be provided for each control circuit and each power circuit of electric or electrohydraulic main and auxiliary steering gear. Time-delayed overcurrent relays with release current at least 200% of the full-load current may, however, be accepted.

(6) When fuses are used to protect three-phase A.C. motor circuits, consideration is to be given for protection against single phasing.

1.1.9 Protection of feeder circuits

(1) Feeder circuits to section boards, distribution boards, group starters and the similar are to be protected by multi-pole circuit breakers or fuses. Where fuses are used for this purpose, the switches complying with the requirements of Part 6, Chapter 9, SECTION 2, 2.3.3 are to be provided at the power source side of the fuses as a rule.

(2) Overcurrent protection may be omitted for circuit supplying a distribution board for two or more motors having overcurrent protection in their control gears provided that the sum of the release current of the control gears does not exceed 120% of the supply cable's rating.

(3) In case where condensers for phase advance are used, overvoltage protective devices, if necessary, are to be installed.

1.1.10 Protection of essential services

Where two or more generators are operated in parallel and essential machinery are driven electrically, arrangements are to be made to disconnect automatically the excess non-essential load when the generators are overloaded. If required, this load shedding may be carried out in two or more stages.

1.1.11 Protection of batteries

Storage batteries other than engine starting batteries, are to be protected against overload and short-circuit with devices placed as near as practicable to the batteries. Emergency batteries supplying essential services are to have short-circuit protection only.

1.1.12 Protection of meters, pilot lamps and control circuits

(1) Protection is to be provided for voltmeters, voltage coils of measuring instruments, earth indicating devices and pilot lamps with their connecting leads by means of fuses fitted to each insulating pole. A pilot lamp installed as an integral part of another item of equipment need not be individually protected, provided any damage of pilot lamp circuit does not cause failures on the supply to essential equipment. Consideration is to be given to the omission of fuses in circuits such as those of automatic voltage regulators where loss of voltage might have serious consequences.

(2) Insulated wires for control and instrument circuits directly led from busbars and generator mains are to be protected by fuses at the nearest location to the connecting points. Insulated

wires from the connecting points to the fuses are not to be bunched together with the wires for other circuits.

1.1.13 Switchgear between bus-bar sections

Such switchgear is to have sufficient making and breaking capacity for the service for which it is intended. If wrong operation may cause damage, instructions for correct operation is to be given by signboard on the switchboard. It is to be clearly indicated whether such switch is open or closed. Undervoltage protection is not accepted for such purposes.

1.1.14 Protection of shore power connection

Permanently fixed cables from the shore connection box to the main switchboard are to be protected by fuses or circuit-breakers. In no case is the protection at the shore connection box to be omitted.

1.1.15 Protection of lighting circuits

The lighting circuits are to be protected by overcurrent protective devices. The connected load is not to exceed the rated current carrying capacity of the conductor nor 80% of the overcurrent protective device rating.

1.2 Undervoltage protection

1.2.1 A.C. and D.C. generators

For generators arranged for parallel operation with one another or with shore power feeder, measures are to be taken to prevent the generator breaker from closing if the generator is not generating and to prevent the generator remaining connected to the busbars if voltage collapses. In the case of an undervoltage release provided for this purpose, the operation is to be instantaneous when preventing closure of the breaker, but shall be delayed for discrimination purposes when tripping a breaker.

1.2.2 A.C. and D.C. motors

Motors rated above 0.5KW are to be provided with either:

(i) undervoltage protection, operative on the reduction or failure of voltage, to cause and maintain the interruption of power in the circuit until the motor is deliberately restarted, or

(ii) undervoltage release operative on the reduction or failure of voltage, but so arranged that the motor restarts automatically and without excessive starting current on restoration of voltage, provided that the starter (which may be controlled, e.g. by thermostatic, pneumatic or hydraulic devices) still makes the requisite connections for a restart and that the restarting of all motors does not occur simultaneously if it is necessary to avoid for example, too large a voltage drop or current surge.

(iii) the protective devices shall allow the motor to start when the voltage is above 85% of the rated voltage, and shall without fail intervene when the voltage is lower than approximately 20% of the rated voltage, at rated frequency, and with time delay when necessary.

CHAPTER 4 Rotating Machinery

CONTENTS

SECTION 1 General requirements

1.1 Prime movers

1.1.1 Application

Prime movers are to be constructed in accordance with the following requirements in addition to the requirements of the applicable Chapters of the Rules.

1.1.2 Governors

Governors on prime movers driving main or emergency electric generators are to be capable of automatically maintaining the speed within the following limits:

(1) Momentary variations 10% of the maximum rated speed when the rated load of the generator is suddenly removed.

(2) Momentary variations 10% of the maximum rated speed when 50% of the rated load of the generator is suddenly applied, followed by the remaining 50% load after an interval sufficient to restore the speed to steady state. The speed is to return to within 1% of the final steady states speed in no more than 5 seconds.

When an installation requires different characteristics, this will be taken into consideration.

(3) At all loads between no load and the permanent speed, the difference should not be more than 5% of the maximum rated speed.

1.1.3 Governors on prime movers in parallel operation

For A.C. generating sets in parallel operation, the governors on prime movers are to have such characteristics that load sharing stipulated in 1.4.4 is ensured, and are to be of those easily achieving the load adjustment, at normal frequency, within 5% of the rated load.

1.1.4 Turbine-driven D.C. generators operating in parallel

Turbine-driven D.C. generators arranged to run in parallel operation are to be fitted with switching device to open the generator circuit-breakers when the emergency governor functions.

1.2 Temperature rise

1.2.1 The temperature rise of rotating machines is not to exceed the values given in Table 4.1.1 when continuously operated at the rated load or intermittently operated according to their duties. Where, however, the ambient temperature is less than 45°C, the temperature rise may be increased by the difference from the values in Table 4.1.1.

1.3 Ship's service D.C. generator

1.3.1 D.C. generators

D.C. generators other than those referred to in 1.3.2 are to be either of the following types:

(1) Compound-wound generator.

(2) Shunt-wound generator with an automatic voltage regulator.

Table 4.1.1:

Table 4.1.(1) Temperature rise of rotating machines (deg) (Based on 50 °C ambient temperature)

Item	Part of machine	Class A insulation			Class E insulation			Class B insulation			Class F insulation			Class H insulation		
		T	R	E.T.D.	T	R	E.T.D.	T	R	E.T.D.	T	R	E.T.D.	T	R	E.T.D.
1	Stator windings of A.C. machine	*40	50	50	*55	65	65	*60	70	70	*75	90	90	*95	115	115
2	Insulated rotor windings	40	50	-	*55	65	-	*60	70	-	*75	90	-	*95	115	-
3A	Field windings of multilayer	*40	50	-	*55	65	-	*60	70	-	*75	90	-	*95	115	-
3B	Low-resistance field windings and compensating windings	50	50	-	65	65	-	70	70	-	90	90	-	115	115	-
3C	Field windings of single layer with exposed bare surface	55	55	-	70	70	-	80	80	-	100	100	-	125	125	-
3D	Field windings of synchronous machine having cylindrical type rotor	-	-	-	-	-	-	-	80	-	-	100	-	-	115	-
4	Iron core and other parts in contact with windings	50	-	-	65	-	-	70	-	-	90	-	-	115	-	-
5	Permanently short-circuited windings, uninsulated. Iron core and other parts not in contact with windings, brushes and brush holders	The temperature rise is in no case reach such a value that there is risk of damage to any insulating material on adjacent parts.														
6	Commutators and slip-rings	50	-	-	60	-	-	70	-	-	80	-	-	90	-	-

T : Thermometer method
R : Resistance method
E.T.D. : Embedded temperature detector

NOTES :

1. *Temperature rise of totally enclosed machine may be increased by 5 °C.
2. Where the windings and commutators or slip-rings to which they are connected are insulated with different classes of insulating material, the temperature rise associated with the lower class is to be applied to the commutator or slip-rings.
3. There is no need to simultaneously measure by means of two methods (e.g. thermometer method and resistance method) the temperature of any part.
4. For stator windings of A.C. machines of 5000 kVA and above, or having an axial core length (including the ventilating duct) of one metre and above, the resistance method or embedded temperature detector is to be used. In this case, the temperature rise in class E insulation is not to exceed 60 deg. C.
5. The temperature rise of rotating machines equipped with air cooler may be increased by 20 °C from the values in the Table, provided that the temperature of cooling water at the inlet of air cooler does not exceed 30 °C.

1.3.2 D.C. Generators used for charging batteries

D.C. generators used for charging batteries without series of regulating resistor are to be either of the following types:

(1) Shunt-wound generator.

(2) Compound-wound generator with switches arranged so that the series winding can be made inoperative at the time of charging.

1.3.3 Field regulator for D.C. generators. The field regulator for a D.C. generator is to be capable of adjusting the voltage of the generator to within 0,5% of the rated voltage for machines above 100 kW and 1% of the rated voltage for smaller machines at all loads between no load and full load at the operating temperature.

1.3.4 Overall voltage regulation of D.C. generators

The overall voltage regulation of D.C. generators is to conform to the following requirements. The speed of rotation is to be adjusted with the rated speed at full load.

(1) Shunt-wound generator: After the temperature test, when the voltage is set at full load, the steady voltage at no load is not to exceed 115% of the full load value, and the voltage obtained at any value of load is not to exceed the no load value.

(2) Compound-wound generator: After the temperature test, when the voltage at 20% load is adjusted within 1% of rated voltage, the voltage at full load is to be within ±2.5% of the rated

voltage and the average of the ascending and descending load curves between 20% load and full load is not to vary more than 3% from the rated voltage.

NOTE:

For compound generators operating in parallel, the drop in voltage may be acceptable up to 4% when the load is gradually increased from 20% load to 100% load.

(3) Three-wire generator: In addition to conforming to (1) and (2) above, when the generator is operating at the rated current on either positive or negative lead and a current of 25% of the rated current in the neutral wire, the resulting difference in voltage between the positive and neutral leads and the negative and neutral leads is not to exceed 2% of the rated voltage between the positive and negative leads.

1.3.5 Load sharing of D.C. generators

When D.C. generators are run in parallel, the load on any generator is not to differ by more than ±10% of the rated output of the largest generator from its proportionate share, based on the generator ratings, of the combined load, for any steady-state condition in the combined load between 20% and 100% of the sum of the rated loads of all the generators. The starting point for the test is to be at 75% load with each generator carrying its proportionate share.

1.3.6 Series winding of compound-wound generator

The series winding of each two-wire compound-wound generator is to be connected to the negative terminal.

1.3.7 Equalizer connection

Equalizer connections are to have a cross-sectional area not less than 50% of that of the negative connection from the generator to the switchboard.

1.4 Ship's service A.C. generator

1.4.1 Automatic voltage regulators

Each A.C. generator, unless of the self-excited type, is to be provided with an automatic voltage regulator.

1.4.2 Overall voltage regulation of A.C. generators

The overall regulation of A.C. generators is to be such that for loads from zero to full load at the rated power factor, the rated voltage is to be maintained under steady conditions within ±2,5%, except that for emergency generators the limits may be increased to ±3,5%.

1.4.3 Exciters of A.C. generators

Exciters of A.C. generators are to be capable of maintaining the current of at least three times its rated current for a duration up to 2 seconds, unless protection selectivity requirements which allow different characteristics exist.

1.4.4 Load sharing of A.C. generators

When A.C. generators are run in parallel, each generator is to be stable in running and the load on any generator is not to differ by more than 15% of the rated output of the largest generator from its proportionate share, based on the generator ratings, of the combined load for any steady-state condition in the combined load between 20% and 100% of the sum of the rated loads of all the generators. The starting point for the test is to be at 75% load with each generator carrying its proportionate share.

1.5 Shaft currents

1.5.1 Suitable measures are to be taken to prevent the ill effects of flow of currents circulating between the shaft and bearings.

1.6 Welding

1.6.1 When welding is applied to the shaft and other torque members of rotating machines, this is subject to the approval of the Society.

1.7 Fault current

1.7.1 Ship's service generators are to be capable of withstanding the mechanical and thermal effects of fault current for the duration of any time delay which may be fitted in a tripping device for discrimination purposes.

1.8 Testing requirements for Rotating Machines (IACS UR E13 Cor.1[2])

1.8.1 General

All machines are to be tested by the manufacturer.

Manufacturer's test records are to be provided for machines for essential services, for other machines they are to be available upon request.

All tests are to be carried out according to IEC 60092-301:1980/AMD2:1995.

All machines of 100kW and over, intended for essential services, are to be surveyed by the Society during test and, if appropriate, during manufacturing.

NOTE: An alternative survey scheme may be agreed by the Society with the manufacturer whereby attendance of the Surveyor will not be required as required above.

1.8.2 Shaft material

Shaft material for electric propulsion motors and for main engine driven generators where the shaft is part of the propulsion shafting is to be certified by the Society. Shaft material for other machines is to be in accordance with recognized international or national standard.

1.8.3 Tests

Type tests are to be carried out on a prototype machine or on the first of a batch of machines, and routine tests carried out on subsequent machines in accordance with Table 4.1.2.

Note: Test requirements may differ for shaft generators, special purpose machines and machines of novel construction.

Table 4.1.2: Tests

No.	Tests	A.C. Generators		Motors	
		Type test (1)	**Routine test** (2)	**Type test** (1)	**Routine test** (2)

[2] NOTE:

1. The requirements of UR E13 Rev.3 are to be uniformly implemented by the Society for rotating machines:
   i. when an application for certification of an engine is dated on or after 1 January 2022; or
   ii. which are installed in new ships for which the date of contract for construction is on or after 1 January 2022.

2. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder.

1.	Examination of the technical documentation, as appropriate and visual inspection	x	x	x	x
2.	Insulation resistance measurement	x	x	x	x
3.	Winding resistance measurement	x	x	x	x
4.	Verification of the voltage regulation system	x	x (3)		
5.	Rated load test and temperature rise measurements	x		x	
6.	Overload/overcurrent test	x	x (4)	x	x (4)
7.	Verification of steady short circuit conditions (5)	x			
8.	Overspeed test	x	x	x (6)	x (6)
9.	Dielectric strength test	x	x	x	x
10.	No-load test	x	x	x	x
11.	Verification of degree of protection	x		x	
12.	Verification of bearings	x	x	x	x

NOTES:

1. Type tests on prototype machine or tests on at least the first batch of machines.
2. The report of machines routine tested is to contain the manufacturer's serial number of the machine which has been type tested and the test result.
3. Only functional test of voltage regulator system.
4. Only applicable for machine of essential services rated above 100kW.
5. Verification of steady short circuit condition applies to synchronous generators only.
6. Not applicable for squirrel cage motors.

1.8.4 Description of the test

1.8.4.1 Examination of the technical documentation, as appropriate and visual inspection

a) Examination of technical documentation

Technical documentation of machines rated at 100kW and over is to be available for examination by the Surveyor.

b) Visual inspection

A visual examination is to be made of the machine to ensure, as far as is practicable, that it complies with technical documentation.

1.8.4.2 Insulation resistance measurement

Immediately after the high voltage tests the insulation resistances are to be measured using a

direct current insulation tester between:

a) all current carrying parts connected together and earth,
b) all current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accessible.

The minimum values of test voltages and corresponding insulation resistances are given in Table 4.1.3. The insulation resistance is to be measured close to the operating temperature, or an appropriate method of calculation is to be used.

Table 4.1.3: Test voltages and insulation resistances

Rated Voltage U_n (V)	**Minimum Test Voltage (V)**	**Minimum Insulation Resistance (MΩ)**
$U_n \leq 250$	$2 \times U_n$	1
$250 < U_n \leq 1000$	500	1
$1000 < U_n \leq 7200$	1000	$(U_n/1000) + 1$
$7200 < U_n \leq 15000$	5000	$(U_n/1000) + 1$

1.8.4.3 Winding resistance measurement

The resistances of the machine windings are to be measured and recorded using an appropriate bridge method or voltage and current method.

1.8.4.4 Verification of the voltage regulation system

The alternating current generator, together with its voltage regulation system shall, at all loads from no-load running to full load, be able to keep rated voltage at the rated power factor under steady conditions within ± 2.5%. These limits may be increased to ± 3.5% for emergency sets.

When the generator is driven at rated speed, giving its rated voltage, and is subjected to a sudden change of symmetrical load within the limits of specified current and power factor, the voltage is not to fall below 85% nor exceed 120% of the rated voltage.

The voltage of the generator is then to be restored to within ± 3% of the rated voltage for the main generator sets in not more than 1.5 s. For emergency sets, these values may be increased to ± 4% in not more than 5 s, respectively.

In the absence of precise information concerning the maximum values of the sudden loads, the following conditions may be assumed: 60% of the rated current with a power factor of between 0.4 lagging and zero to be suddenly switched on with the generator running at no load, and then switched off after steady - state conditions have been reached. Subject to the Society's approval, such voltage regulation during transient conditions may be calculated values based on the previous type test records, and need not to be tested during factory testing of a generator.

1.8.4.5 Rated load test and temperature rise measurements

The temperature rises are to be measured at the rated output, voltage, frequency and the duty for which the machine is rated and marked in accordance with the testing methods specified in IEC 60034-1:2017, or by means of a combination of other tests.

The limits of temperature rise are those specified in the relevant table of IEC 60034-1:2017 adjusted as necessary for the ambient reference temperatures specified in Part 5, Chapter 1, SECTION 3, 3.1.2.

1.8.4.6 Overload/overcurrent tests

Overload test is to be carried out as a type test for generators as a proof of overload capability of generators and excitation system, for motors as a proof of momentary excess torque as required in IEC 60034-1:2017. The overload test can be replaced at routine test by the overcurrent test. The over current test shall be the proof of current capability of windings, wires, connections etc. of each machine. The overcurrent test can be done at reduced speed (motors) or at short circuit (generators).

1.8.4.7 Verification of steady short-circuit conditions

It is to be verified that under steady-state short-circuit conditions, the generator with its voltage regulating system is capable of maintaining, without sustaining any damage, a current of at least three times the rated current for a duration of at least 2 s or, where precise data is available, for a duration of any time delay which may be fitted in a tripping device for discrimination purposes.

In order to provide sufficient information to the party responsible for determining the discrimination settings in the distribution system where the generator is going to be used, the generator manufacturer shall provide documentation showing the transient behaviour of the short circuit current upon a sudden short-circuit occurring when excited, and running at nominal speed. The influence of the automatic voltage regulator shall be taken into account, and the setting parameters for the voltage regulator shall be noted together with the decrement curve. Such a decrement curve shall be available when the setting of the distribution system's short-circuit protection is calculated. The decrement curve need not be based on physical testing. The manufacturer's simulation model for the generator and the voltage regulator may be used where this has been validated through the previous type test on the same model

1.8.4.8 Overspeed test

Machines are to withstand the overspeed test as specified in to IEC 60034-1:2017. This test is not applicable for squirrel cage motors.

1.8.4.9 Dielectric strength test

Machines are to withstand a dielectric test as specified in IEC 60034-1:2017. For high voltage machine an impulse test is to be carried out on the coils according to Part 6, Chapter 15.

1.8.4.10 No load test

Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor or if a generator it is to be driven by a suitable means and excited to give rated terminal voltage.

During the running test, the vibration of the machine and operation of the bearing lubrication system, if appropriate, are to be checked.

1.8.4.11 Verification of degree of protection

As specified in IEC 60034-5:2000+AMD1:2006.

1.8.4.12 Verification of bearings

Upon completion of the above tests, machines which have "sleeve" bearings are to be opened upon request for examination by the Surveyor, to establish that the shaft is correctly seated in the bearing shells.

CHAPTER 5 Transformers, Rectifiers

CONTENTS

SECTION 1 Power transformers

1.1 General

1.1.1 Application

Transformers rated at 1KVA or more for single phase and at 5KVA or more for 3-phase are to conform with the requirements of this section.

1.1.2 Number and ratings of transformers

(1) Where essential services are supplied, the number and ratings of transformers are to be sufficient to ensure the operation of essential services even when one transformer is out of service.

(2) When transformers are operated in parallel, then the actual current of each transformer is not to differ from its proportionate share of the total load by more than 10% of its full load current.

1.2 Construction

1.2.1 Type

Dry-type transformers are to be used in ships. The use of other types of transformers is subject to special consideration by this Society in each particular case.

1.2.2 Windings of transformers

Complete insulation is to be made between primary windings and secondary windings of transformers except of those for motor starting.

1.2.3 Precautions against short-circuit current

All transformers are to be capable of withstanding thermal and mechanical effects without damage, when under short-circuit current for 2 seconds while in use.

1.3 Temperature rise

1.3.1 The temperature rise of transformers is not to exceed the values given in Table 5.1.1 during continuous operation at rated output. Where, however, the ambient temperature is not above 40°C, the table values may be increased by the amount of temperature difference.

1.4 Voltage regulation

1.4.1 The voltage regulation of transformers is not to exceed 5% at full load and 100% power factor.

1.5 Testing and inspection

1.5.1 General

Transformers are to meet the requirements of this section in their construction and are to be tested in accordance with the requirements of the articles that follow. However, the test required by 1.5.2 may be omitted subject to the Society's permission for each transformer which is produced in series having identical type with the first unit tested in the presence of the Surveyor.

Table 5.1.1: Limit of temperature rise of transformers (Based on ambient temperature 45°C)

Part		**Limit of temperature rise (deg)**					
		Measuring method	Class A insulation	Class E insulation	Class B insulation	Class F insulation	Class H insulation
Windings	Dry type transformer	Resistance method	55	70	75	95	120
	Oil-immersed transformer	Resistance method	60	-	-	-	-
	Oil	Thermometer method	45				
Core		Thermometer method	Temperature not injurious to insulation				

1.5.2 Temperature test

The temperature rises of transformers under the rated full load are not to exceed the values given in 1.3.

1.5.3 Voltage regulation test

Transformers are to be subjected to the voltage regulation test and comply with the requirements of Art. 1.4, except that it may also be obtained by calculation.

1.5.4 High voltage test

After the temperature test, transformers are to withstand a test which is performed by applying A.C. voltage of 1000 V plus twice the maximum line voltage of commercial frequency between windings and earth for 1 minute. The test voltage in this test is to be at least 2500V.

1.5.5 Induced high voltage test

Transformers are to withstand this for the duration of the test expressed by the following formula, when twice the normal voltage is induced on the winding at any frequency between 100 and 500Hz, but the duration of the test is to be at least 15 seconds and more than 60 seconds:

$$\text{Testing time} = 120 \cdot \frac{\text{rated frequency}}{\text{test frequency}}, \qquad [\text{sec}]$$

1.5.6 Insulation resistance

The insulation resistance of each winding in turn to all the other windings, core, frame and tank or casing connected together and to earth is to be measured and recorded together with the temperature of the transformer at the time of testing.

SECTION 2 Semi-conductor power rectifiers

2.1 General

2.1.1 Semi-conductor power rectifiers and their accessories are to comply with I.E.C. Publication 92-304. "Equipment-Semi-conductor convertors" or an equivalent National Standard.

2.1.2 Semi-conductor static power converter equipment is to be rated for the required duty having regard to peak loads, system transients and overvoltage.

2.1.3 Converter equipment is to be so arranged that the semi-conductor devices, fuses, control and firing circuit boards may be readily removed from the equipment for repair or replacement.

2.1.4 Test and monitoring facilities are to be provided to permit identification of control circuit faults and faulty components.

2.2 Installation and location

2.2.1 Semiconductor convertor stacks or equipment are to be installed in such a manner that the circulation of air to and from the stacks, associated equipment or enclosures (if any) is not impeded and that the temperature of the cooling inlet air to convertor stacks does not exceed the ambient temperature for which the stacks are specified.

2.2.2 Naturally air-cooled cabinets are to be designed with sufficient ventilating openings, or with sufficient radiating surface in the case of totally enclosed convertor equipment to operate within allowable temperature limits.

2.2.3 Convertors stacks and associated equipment are not to be mounted near sources of radiant heat energy, such as resistors, steampipes and engine exhaust pipes.

2.2.4 Semiconductor convertor stacks or semiconductor components are to be mounted in such a manner that they may be removed from equipment without dismantling the complete unit.

2.3 Testing and inspection

2.3.1 General

Rectifiers and their accessories are to be tested in accordance with the following requirements.

2.3.2 Temperature test

Temperature test of rectifiers and their accessories is to be carried out under normal working conditions.

2.3.3 Operation test

Instruments, switching devices and protective devices are to be checked under operating conditions.

2.3.4 High voltage test

(1) Rectifiers are to withstand the test by applying the following A.C. voltage for 1 minute between rectifier cells or live parts of accessories charged with main circuit potential and earth.

$$\text{Testing Voltage} = 1{,}5 \cdot EP_i + 100, (\text{minimum } 2000\text{V}), \qquad [\text{V}]$$

where:

EP_i= Peak reverse voltage.

Where D.C. voltage is less than 100V, minimum testing voltage may be 1500V. Rectifier cell is to be short-circuited before the test.

(2) High voltage test between live parts and earth for accessories charged with auxiliary circuit potential is to be in accordance with the applicable requirements of Part 6, Chapter 7, SECTION 1, 1.2.3.

2.3.5 Insulation resistance test

Insulation resistance between live parts of rectifiers and their accessories and earth is not to be less than 1MΩ when tested with D.C. voltage of at least 500V.

CHAPTER 6 Cables, Distribution

CONTENTS

SECTION 1 Cables

1.1 General (IACS UR E7 Rev. 5[3])

1.1.1 Cables are to be of a type approved by LHR.

1.1.2 Cables manufactured in accordance with the relevant recommendations of IEC 60092-350:2020, 60092-352:2005, 60092-353:2016, 60092-354:2020, 60092-360:2014, 60092-370:2019 and 60092-376:2017 will be accepted by the Society provided that they are tested to its satisfaction.

1.1.3 Cables manufactured and tested to standards other than those specified in 1.1.2 will be accepted provided they are in accordance with an acceptable and relevant international or national standard and are of an equivalent or higher safety level than those listed in 1.1.2. However, cables such as flexible cable, fibre-optic cable, etc. used for special purposes may be accepted provided they are manufactured and tested in accordance with the relevant standards accepted by the Classification Society.

1.2 Choice of cable

1.2.1 Insulating materials

Insulating materials are as shown in Table 6.1.1.

Table 6.1.1: Permissible temperature of insulating materials

Insulating Material	Maximum Rated Conductor Temp. °C	Maximum Ambient Temp. °C
Polyvinyl chloride compound (general purpose)	60	50
Polyvinyl chloride compound (heat resisting)	75	65
Natural rubber (heat resisting)	75	65
Butyl rubber	80	70
Ethylenpropylene (EP) rubber	85	75
Silicon rubber	95 (150)	-

[3] NOTE:

1. UR Rev.4 is to be uniformly implemented by the Society from 1 July 2017.

Mineral	95 (unlimited)	-

NOTES:

1. The values in parenthesis are permitted when installed where they are not liable to be touched by ship's personnel. In case of silicon rubber cable sheathed with lead, the value in parenthesis is to be reduced to 120^{O}C.

2. Polyvinylchloride compounds of general use are applied to PVC sheathed cords and telephone cables, and polyvinylchloride compounds of heat- resistant are applied to other PVC insulated cables.

1.2.2 Sheath and armor

Cables are to be protected by sheath or armour in accordance with the following requirements:

(1) Cables fitted on weather decks in bath rooms, cargo holds, machinery spaces or in any other location where water condensation or oil vapour may be present, are to have a metallic sheath or an impervious sheath.

(2) In permanently wet places, metallic sheaths are to be used for cables with hygroscope insulation.

(3) Except for cables fitted in living quarters or in any other location where they are not exposed to risk of mechanical injury, cables are to be armoured.

1.2.3 Flammability of cables

All the electric cables are to be at least of a flame retardant type that complies with the requirements of IEC Pub. 332-1. Where cables are installed in bunches the requirements of 1.4.3 are to be complied with.

1.3 Current rating of cable

1.3.1 Maximum continuous load

The highest continuous load carried by a cable is not to exceed its current rating specified in 1.3.5. The diversity factor of the individual load may be allowed for in estimating the maximum continuous load.

1.3.2 Voltage drop

The voltage drop from the main or emergency switchboard busboys to any electrical installation, except for navigation lights, is not to exceed 6% of the rated voltage of the installation, when the cables are carrying maximum load current under normal condition of service. For supplies from batteries of voltage not exceeding 24Volts, the voltage drop may be increased to 10%.

1.3.3 Estimation of lighting load

In assessing the current rating of lighting circuits every lamp holder is to be assessed at the maximum load likely to be connected to it, with a minimum of 60Watts, unless the fitting is so constructed as to take only a lamp rated at less than 60 Watts.

1.3.4 Short-time load

Where the motors used for cargo winches, windlasses and capstans are short time duty, the current rating of the cables may be allowed to be increased according to their duty.

1.3.5 Current rating

The current ratings of cables are not to exceed the values in Table 6.1.2.

1.3.6 Correction factor for ambient temperature

Where the ambient temperature is different from that of Table 6.1.2, the correction factors in Table 6.1.3 may be applied to decide the current ratings for cables.

1.3.7 Correction factor for short-time duty

The current ratings for cables of final sub-circuits supplying short-time loads may be decided by applying the correction factors in Table 6.1.4 to the current ratings specified in Table 6.1.2.

1.3.8 Parallel connection of cables

(1) Parallel connection can be used for cables having conductor cross-section 10mm^2 or above. All cables which are parallel connected are to be of the same length and cross-section.

(2) A two, three or four-core cable, in which all cores are of the same cross-section, can be used as single-core cable by parallel connection of all cores in each end, with soldered or pressured terminals. The current-carrying capacity of such single-core cable is the sum of the cores current-carrying capacities.

Table 6.1.2: Current rating of lighting and power cables under continuous service

Current rating in amperes (based on ambient temperature 45°C)												
Nominal cross-section (mm^2)	General purpose rubber and PVC, operating temperature 60°C			Heat resisting PVC operating temperature 75°C			Butyl, operating temperature 80°C			Ethylene propelene rubber, operating temperature 85°C		
	Single core	2 cores	3 cores	Single core	2 cores	3 cores	Single core	2 cores	3 cores	Single core	2 cores	3 cores
1	8	7	6	13	11	9	15	13	11	16	14	11
1,5	12	10	8	17	14	12	19	16	13	20	17	14
2,5	17	14	12	24	20	17	26	22	18	28	24	20
4	22	19	15	32	27	22	35	30	25	38	32	27
6	29	25	20	41	35	29	45	38	32	48	41	34
10	40	34	28	57	48	40	63	54	44	67	57	47
16	54	46	38	76	65	53	84	71	59	90	77	63
25	71	60	50	100	85	70	110	94	77	120	102	84
35	87	74	61	125	106	88	140	119	98	145	123	102
50	105	89	74	150	128	105	165	140	116	180	153	126
70	135	115	95	190	162	133	215	183	151	225	191	158
95	165	140	116	230	196	161	260	221	182	275	234	193
120	190	162	133	270	230	189	300	255	210	320	272	224
150	220	187	154	310	264	215	340	289	238	365	310	256
185	250	213	175	350	298	245	390	332	273	415	353	291
240	290	247	203	415	353	291	460	391	322	490	417	343
300	335	285	235	475	404	333	530	450	371	560	476	392

NOTE:

Where more than six cables belonging to the same circuit are bunched together , a correction factor of 0,85 is to be applied.

Table 6.1.3: Correction factor of current rating of cables for ambient temperature

Insulation	Correction factor for ambient temperature			
	40°C	45°C	50°C	55°C
Polyvinyl chloride (general purpose)	1,15	1	0,82	-
Natural rubber (heat resisting) and polyvinyl chloride (heat resisting)	1,08	1	0,91	0,82
Butyl rubber	1,07	1	0,93	0,85
Ethylenepropylene (EP)	1,06	1	0,94	0,87
Mineral and silicon rubber	1,05	1	0,95	0,89

Table 6.1.4: Correction factor for current rating of cables for short-time duty

Correction Factor	Sectional area (mm^2)			
	Half-hour rating		One-hour rating	
	With metallic sheath	Without metallic sheath	With metallic sheath	Without metallic sheath
1	up to 6	up to 11	up to 14	up to 50
1,05	7 - 14	12 - 50	15 - 50	51 - 150
1,1	15 - 30	51 - 100	51 - 150	151 - 250
1,15	31 - 50	101 - 150	151 - 250	-
1,2	51 - 80	151 - 200	-	-
1,25	81 - 120	201 - 250	-	-
1,3	121 - 160	-	-	-
1,35	161 - 200	-	-	-
1,4	201 - 250	-	-	-

NOTE:

Sectional areas in this table indicate the sum of the nominal sectional areas of all conductors of a cable.

1.3.9 Short-circuit capacity

Cables and their insulated conductors are to be capable of withstanding the mechanical and thermal effects of the maximum short-circuit current which can flow in any part of the circuit in which they are installed, taking into consideration not only the time/current characteristics of the circuit protective device, but also the peak value of the prospective short-circuit current during the first half cycle.

1.4 Installation of cables

1.4.1 General

Cable runs are to be, as far as possible, straight and accessible.

1.4.2 Expansion joints

The installation of cables across expanding parts in the ship's structure is, as far as possible, to be avoided. Where this is not practicable a loop of cable of length proportional to the expansion of the part is to be provided. The internal radius of the loop is to be at least 12 times the external diameter of the cable.

1.4.3 Precaution against fire propagation

(1) Where cables are installed in bunches shall either:

- have been tested in accordance with IEC Pub. 332-3 category A.
- or be provided with protection as specified in the following 1.4.3(2).

(2) When cables are used which pass the test of IEC Publication 332-1 but which do not pass the test in a bunched configuration (IEC Pub. 332-3) the following shall apply:

(a) for vertical cable runs in enclosed or semi-enclosed spaces fire stops are to be arranged:

- at least at alternate deck levels, and with a maximum distance not significantly in excess of 6m, unless installed in totally enclosed cable trunks
- at the main and emergency switchboards
- where cables enter into an engine control room
- at centralized control panels for propulsion machinery and essential auxiliaries
- at the entrance to cable trunks

(b) for horizontal cable runs in enclosed or semi-enclosed spaces fire stops are to be as specified in Item (a) above. The maximum distance may be increased to 14m.

(3) Cables and wiring serving essential or emergency power, lighting, internal communications or signals shall as far as practicable be routed clear of galleys, laundries, machinery spaces of category A and their casings and other high fire risk areas. Cables connecting fire pumps to the emergency switchboard shall be of a fire resistant type where they pass through high fire risk areas. Where practicable all such cables should be run in such a manner as to preclude

their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space.

(4) Where it is required to divide a ship into fire zones (such as is generally the case on passenger ships), cable-runs are to be so arranged that a fire in any main vertical fire zone will not interfere with essential services in any other such zone. This is met if main and emergency cables passing through any zone are separated both vertically and horizontally as widely as is practicable.

1.4.4 Electrical Services Required to be Operable Under Fire Conditions and Fire Resistant Cables (IACS UR E15 Rev.4[4]).

(1) Electrical services required to be operable under fire conditions are as follows:

- Control and power systems to power-operated fire doors and status indication for all fire doors
- Control and power systems to power-operated watertight doors and their status indication
- Emergency fire pump
- Emergency lighting
- Fire and general alarms
- Fire detection systems
- Fire-extinguishing systems and fire-extinguishing media release alarms
- Low location lighting
- Public address systems
- Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion

(2) Where cables for services specified in 1.4.4(1) including their power supplies pass through high fire risk areas, and in addition for passenger ships, main vertical fire zones, other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone. This may be achieved by either of the following measures:

(a) Cables being of a fire-resistant type complying with IEC 60331-1:2018 for cables of greater than 20 mm overall diameter, IEC 60331- 21:1999+AMD1:2009 or IEC 60331-2:2018 for cables with an overall diameter not exceeding 20 mm, are installed and run continuous to keep the fire integrity within the high fire risk area, see Figure 6.1.1.

(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.

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[4] NOTE:

1. The requirements of UR E15 Rev.4 are to be uniformly implemented by the Society on ships contracted for construction on and after 1 January 2022:

2. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder.

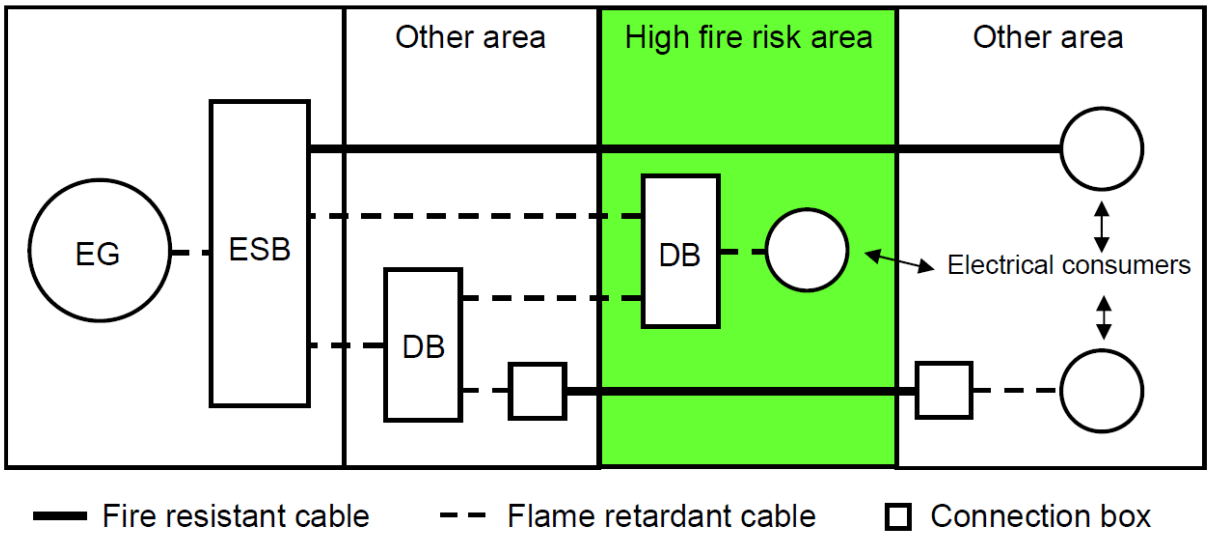
(c) Systems that are self-monitoring, fail safe or duplicated with cable runs as widely separated as is practicable may be exempted.

(3) The electrical cables to the emergency fire pump are not to pass through the machinery spaces containing the main fire pumps and their source(s) of power and prime mover(s). They are to be of a fire-resistant type, in accordance with 1.4.4.2 (a), where they pass through other high fire risk areas.

NOTES:

1. For the purpose of this Section, the definition for "high fire risk areas" is the following:
   (i) Machinery spaces as defined by Regulation 3.30 of SOLAS Chapter II-2, as amended by IMO resolutions up to MSC.421(98) (hereinafter the same), except spaces having little or no fire risk as defined by paragraphs (10) of Regulation 9.2.2.3.2.2 of SOLAS Chapter II-2. (Including the interpretations for tables 9.3, 9.4, 9.5, 9.6, 9.7 and 9.8 given in MSC/Circ.1120 as amended by MSC.1/Circ.1436 and MSC.1/Circ.1510).
   (ii) Spaces containing fuel treatment equipment and other highly flammable substances.
   (iii) Galley and Pantries containing cooking appliances.
   (iv) Laundry containing drying equipment.
   (v) Spaces as defined by paragraphs (8), (12), and (14) of Regulation 9.2.2.3.2.2 of SOLAS Chapter II-2 for ships carrying more than 36 passengers.
2. Fire resistant type cables should be easily distinguishable.
3. For special cables, requirements in the following standards may be used:
   IEC60331-23:1999: Procedures and requirements – Electric data cables
   IEC60331-25:1999: Procedures and requirements – Optical fibre cables

Figure 6.1.1:



1.4.5 Bunching

(1) Cables having insulating materials with different maximum rated conductor temperature are not to be bunched together, or, where this is not practicable, the cables are to be operated so that no cable reaches a temperature higher than that permitted for the lowest temperature-rated cable in the group.

(2) Cables for safety voltages are not to be bunched together with or run through the same pipes as cables for voltages above 500V. Cables for voltages up to 1kV are not to be bunched together with or run through the same pipes as cables for higher voltages.

1.4.6 Protection covering

Cables having a protective covering which may damage the covering of other cables are not to be bunched with those other cables.

1.4.7 Maximum internal radius of bend

When cables are to be installed bent, the minimum internal radius of bend is to be not less than the following values:

(1) 6d, for rubber and PVC insulated cables with metal covering.

(2) 4d, for rubber and PVC insulated cables without metal covering.

(3) 4d, for mineral insulated cables.
(d = overall diameter of cable)

1.4.8 Cables in refrigerated spaces

Cables are not to be installed in refrigerated spaces, as far as possible. Where cables are unavoidably installed in such spaces, however, the following requirements are to be observed:

(1) PVC insulated cables are not to be used.

(2) Cables are to have a lead sheath or cold-resisting impervious sheath.

(3) Cables are not to be, as a rule, embedded in structural heat insulation.

(4) Where cables must pass through structural heat insulation, they are to be installed at a right angle to such insulation and are to be protected by a pipe, preferably fitted with a watertight stuffing tube at each end.

(5) Cables are to be installed with ample space from ceilings, side walls or the face of air duct casings and are to be supported by plating, hangers or cleats.

(6) Supporting strips, plating or hangers used for securing the cable are to be galvanized or otherwise protected against corrosion.

1.4.9 Cable installation methods in relation to electromagnetic interference

In order to avoid as much as possible, the effects of unwanted electromagnetic interference, the indications given in IEC Publication 533 are to be taken into consideration. This might be of particular importance for the installation of cables in the vicinity of radio equipment and for the installation of cables belonging to sensitive electronic control and monitoring systems.

1.4.10 Cables for submersible permanently installed bilge-pumps

Cables and their connections to submersible, permanently installed bilge-pumps are to be capable of operating under a head of water equal to their distance below the bulkhead deck. The cables are to be impervious-sheathed and armored and are to be installed in continuous lengths from above the bulkhead to the motor terminals and shall enter the air bell from the bottom.

1.5 Mechanical protection of cables

1.5.1 General

Cables exposed to risk of mechanical damage are to be protected by metal channels or casing or enclosed in steel conduit.

1.5.2 Cables in cargo holds

Cables in cargo holds and other spaces where there is exceptional risk of mechanical damage are to be suitably protected even if they are armored.

1.5.3 Mechanical protection of cables

Metal casings for mechanical protection of cables are to be efficiently protected against corrosion.

1.5.4 Non-metallic ducts of conduits

Non-metallic ducts or conduit are to be of flame-retardant material. PVC conduits are not to be used in refrigerated spaces or on open decks.

1.6 Earthing

1.6.1 Earthing of metallic coverings of cables

(1) Metal coverings of cables are to be effectively earthed at both ends, provided that in final sub-circuits earthing may be at the supply end only.

(2) Cable sheaths and armor, and conduit, may be earthed by means of clamps or clips of corrosion-resistant metal making effective contact with sheath or armour and earthed metal.

(3) Earthing connections are to be carried out with conductors having cross-sectional areas in accordance with Part 6, Chapter 1, SECTION 1, 1.4.2.

1.6.2 Electrical continuity of metallic coverings of cables

Effective steps are to be taken to ensure that all metallic coverings of cables are made electrically continuous throughout their length.

1.6.3 Lead sheath

The lead sheath of lead sheathed cables is not to be used as the sole means of earthing the non-current carrying metal parts of items of equipment.

1.7 Securing of cables

1.7.1 General

With the exception of cables for portable appliances and of those installed in pipes, conduits, trunkings or special casings, cables are to be fixed by means of clips, saddles or straps of suitable flame-retardant material, and having a surface area so large and shaped that the cables remain tight without their coverings being damaged.

1.7.2 Distance between supports

The distance between supports is to be chosen according to the type of cable, the distance being in accordance with Table 6.1.5.

Table 6.1.5: Distance between metallic supports

Overall diameter of cable (mm)	Distance between metal supports (mm)		
	Non-armored cables	Armored cables	Mineral insulated cables
Note exceeding 7,6	200	250	300
Exceeding 7,6 and not exceeding 12,7	250	300	370
Exceeding 12,7 and not exceeding 20	300	350	450
Exceeding 20 and not exceeding 30	350	400	450
Exceeding 30	400	450	450
NOTES: In case of vertical runs, the distance may be increased by 25%.			

1.7.3 Clips, supports and accessories

(1) Clips are to be robust and are to be those by which cables are effectively secured without any damage on coverings of the cables.

(2) Clips, supports and accessories are to be of corrosion-resistant material or to be suitably treated to prevent corrosion.

(3) Clips and supports of non-metallic materials are to be flame-retardant.

(4) When cables secured by clips of non-metallic materials are not laid on top of horizontal cable trays or supports, suitable metal clips are to be added at regular distances, each not exceeding 2m in order to prevent the release of cables during a fire.

1.7.4 Cable trays/protective casings made of plastics materials

(a) General requirement

Cable trays/protective casings made of plastics materials are to be type tested (NOTE 1).

NOTE:

1. "Plastics" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fiber reinforced plastics - FRP. "Protective casing" means a closed cover in the form of a pipe or other closed ducts of non-circular shape.

(b) Installation Requirements

(i) Cable trays/protective casings made of plastics materials are to be supplemented by metallic fixing and straps such that in the event of a fire they, and the cables affixed, are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route. When plastics cable trays/protective casings are used on open deck, they are additionally to be protected against UV light.

(ii) The load on the cable trays/protective casings is to be within the Safe Working Load (SWL). The support spacing is not to be greater than the Manufacturer's recommendation nor in excess of spacing at the SWL test. In general the spacing is not to exceed 2 meters. The selection and spacing of cable tray/protective casing supports are to take into account:

- cable trays/protective casings' dimensions;
- mechanical and physical properties of their material;
- mass of cable trays/protective casings;
- loads due weight of cables, external forces, thrust forces and vibrations;
- maximum accelerations to which the system may be subjected;
- combination of loads.

(iii) The sum of the cables' total cross-sectional area, based on the cables' external diameter is not to exceed 40% of the protective casing's internal cross-sectional area. This does not apply to a single cable in a protective casing.

Cable trays/protective casings made of plastic materials are to be type tested in accordance with the Type Approval Procedure applied by the Society. For guidance on testing, refer to IACS Recommendation No 73.

1.8 Penetration of bulkheads and decks

1.8.1 Penetration through bulkheads and decks

Where cables pass through bulkheads and decks which are required to have some degree of tightness, they are to be so constructed as to ensure that the strength and tightness are not impaired.

1.8.2 Penetration through fireproof bulkheads and decks

Where cables pass through bulkheads and decks which are required to have some degree of fire integrity, they are to be so constructed as to ensure that the fire integrity is not impaired.

1.8.3 Bushing

Where cables pass through non-watertight bulkheads or structural steel, the holes are to be bushed with lead or other suitable material in order to avoid damage to cables. If the thickness of the steel is sufficient, adequately round edges may be accepted as the equivalent of bushing.

1.9 Metallic pipes and conduits

1.9.1 General

Metallic pipe or conduit systems are to be effectively earthed and are to be mechanically and electrically continuous across joints.

1.9.2 Internal radius of bend

The internal radius of bend of pipes and conduits is to be in accordance with the requirement in 1.4.6 provided that for pipes exceeding 64mm in outside diameter, the internal radius of bend is not less than twice the outside diameter of the pipe.

1.9.3 Internal cross-sectional area of pipes

The internal cross-sectional area of the pipe is not to be less than 250% of the sum of the cross-sectional areas of the cables to be installed in the pipe.

1.9.4 Drainage

Horizontal pipes or conduits are to have suitable drainage.

1.9.5 Expansion joints

Where the pipe arrangement is long, expansion joints are to be provided where necessary.

1.9.6 Cables in non-metallic pipes, conduits, trunking, ducts or cappings and casings

Cables may be installed in non-metallic pipes, conduits, ducts or cappings and casings either on surface or concealed behind ceilings or panelling, provided the following requirements are complied with.

(1) All cables or insulated wiring are to be flame-retardant.

(2) If the fixing of capping is by means of screws they are to be of non-rusting material arranged so as not to damage the cables. The capping shall be readily accessible.

(3) Non-metallic pipes, conduits, trunkings, ducts or cappings and casings are to be flame-retardant in accordance with IEC Publication 92-101.

(4) Cables are to be fixed if necessary with clips as described in 1.7.3 of this Chapter.

(5) The precautions recommended in 1.4.4(1) and 1.4.5 of this Chapter should be observed also for installation in non-metallic casings.

1.10 Cables for alternating current

1.10.1 Single-core cables

Where it is necessary to use single-core cables for alternating current circuits rated in excess of 20 A, the following requirements are to be complied with:

(1) Cables are to be either non-armored or armored with non-magnetic material in order to avoid current loops, the metallic screen shall be earthed at one point only.

(2) If installed in pipe or conduit, cables belonging to the same circuit are to be installed in the same pipe or conduit.

(3) Cable clips are to include cables of all phases of a circuit unless the clips are of non-magnetic material.

(4) When installing two or three single-core cables forming respectively single-phase circuits or three-phase circuits, the cables are to be in contact with one another as far as possible. In any event, the distance between adjacent cables is not to be greater than one diameter.

(5) If single-core cables of current rating greater than 250A are to run along a steel bulkhead, wherever practicable, the cables should be spaced as far away from the steel bulkhead as possible.

(6) Where single-core cables of large cross section and exceeding 30m in length are used in order to balance the impedances of circuits, the phases are to be transposed at regular intervals of approximately 15m.

(7) In case of circuits involving two or more single-core cables in parallel per phase, all cables are to have the same length and the same cross-section. Further, the cables pertaining to the same phase shall be as far as practicable alternated with those of the other phases so that unequal division of the current is avoided.

(8) Magnetic material is not to be placed between single-core cables of a group. Where cables pass through steel plates, all cables of the same circuit are to pass through a plate or gland of non-magnetic material and the space between the cables and the magnetic material is not to be less than 75mm wherever practicable.

1.11 Joints and branch circuits

1.11.1 General

Cables are to be joined by terminals. Soldering fluxes containing corrosive substances are not to be used.

1.11.2 Terminals for cables

(1) Terminals are to have sufficient contacting surface and pressure.

(2) The length of soldered parts of copper tube terminals and other terminals is to be more than 1,5 times the diameter of conductors.

1.11.3 Joints and branch circuit

Joint of branch circuit of cables is to be carried out in a suitable box, except where the method of connection causes no possible risk of deteriorating water-proof characteristics, flame retardation, mechanical strength or electrical characteristics of cables.

1.12 Testing and inspection

1.12.1 Cables are to be in compliance with the requirements of Part 6, Chapter 2, SECTION 1, 1.6.1 and 1.6.9.

CHAPTER 7 Control Gear

CONTENTS

SECTION 1 Control gear

1.1 General

1.1.1 Control gear is to comply with I.E.C. Publication 92-302 "Equipment-Switchgear and control gear assemblies" or an equivalent national standard.

1.2 Motor Control Center

1.2.1 Control gear for duplicated essential motors are to be mutually independent and are to be divided between two motor control centers having separate supplies from the main switchboard.

1.2.2 Control gear for essential motors are to be separated from each other, and from other current carrying parts, by screens. The arrangement is to be such that maintenance work can be carried out on each unit without danger when isolated.

1.2.3 Control gear for non-essential motors may be installed in a common cubicle provided this cubicle can be effectively isolated.

1.2.4 When installed in main switchboards motor control gear is to be placed in separate cubicles separated from all other parts of the switchboard by partitions of flame-retardant material. The arrangement is to be such that arcs occurring by short-circuit in one cubicle cannot spread to the bus-bars.

1.3 Testing and inspection

1.3.1 General

Control gear is to be tested in accordance with the requirements of the following articles.

1.3.2 Operation test

Operation of instruments, switching gear, protective devices, etc. for control gear are to be confirmed.

1.3.3 High voltage test

Control gears with its components is to withstand the test when subject to the following voltage at commercial frequency for 1 minute between all current-carrying parts of switching gear including control devices and earth and between poles or phases. Instruments and auxiliary apparatus may be disconnected during the high voltage test.

~	Rated voltage of 60V or less	:	500V
~	Rated voltage exceeding 60V	:	1000V + twice rated voltage (minimum 1500V)

1.3.4 Insulation resistance test

Immediately after the high voltage test, the insulation resistance between all current-carrying parts and earth and between the current-carrying parts of poles or phases are to be not less than 1MΩ when tested with a direct current voltage of at least 500V.

CHAPTER 8 Switchboards

CONTENTS

SECTION 1 Switchboards

1.1 General

1.1.1 Location

(1) Switchboards are to be installed in dry places away from the vicinity of steam, water and oil pipes. If such placing is unavoidable, suitable protection is to be provided in this position.

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

1.1.2 Space for operation and maintenance

An unobstructed space not less than 1m wide for operation is to be provided in front of switchboards. Where necessary space at the rear of switchboards is to be ample to permit operation and maintenance of disconnecting switches, fuses and other parts. The space is not to be less than 0,5m in width.

1.1.3 Safety precautions for operators

Where the live parts of switchboards face a passage-way, the following means are to be provided:

(1) Insulated handrails are to be provided.

(2) Insulated mats are to be provided on the floor of passage-way.

1.2 Construction

1.2.1 Construction

(1) Busbars, circuit-breakers and other electrical appliances of the main switchboards are to be so arranged that the electrical equipment of essential use installed in duplicate will not come out of action simultaneously by a single fault.

(2) A generator switchboard is to be provided for each generator, and switchboards adjoining each other are to be partitioned by walls of steel or frame-retardant materials.

(3) Cable entrances are generally to be from below or from the side. Cable entries from the top may be accepted provided watertight cable glands are used.

(4) Earth connection of all metallic non-current carrying parts is to be provided.

(5) Instruments and handles or push-buttons of switchgear are to be placed on the front of the switchboard.

(6) All parts of the main switchboard are to be placed accessible for maintenance work. 1.2.2

Dead-front type switchboards

For voltage between poles, or to earth, exceeding 55V D.C. or 55V A.C., switchboards are to be of dead front type.

1.2.3 Materials for insulation and wiring for switchboard

(1) Insulating materials used in the construction of switchboards are to be mechanically strong, flame-retardant and moisture-resistant.

(2) Insulated wires for switchboard are to be those of flame-retardant and moisture-resistant type, having maximum permissible conductor temperature not less than 75°C.

(3) Ducts and straps for wiring are to be of flame-retardant materials.

(4) Insulated wires for control and instrument circuits are not to be bunched together with wires for main circuits, unless the rated voltage and maximum permissible conductor temperature of both wires are the same.

1.3 Busbars and equalizer connections

1.3.1 Busbars

(1) Busbars are to be of copper having a conductivity of 97% or more.

(2) Busbar connections are to be so made as to inhibit corrosion and oxidization.

(3) Busbars and their connections are to be so supported as to withstand the electromagnetic force resulting from short-circuiting. A test report or calculation to verify the short-current withstand strength of the switchboard is to be submitted for consideration, when required.

(4) Temperature rises of busbars, connecting conductors and their connections are not to exceed 45°C at the limit ambient temperature of 45°C when carrying full load current.

(5) Insulating clearances between live parts or between live parts and earthed metals are not to be less than the values in Table 8.1.1.

(6) Generator bus-bars are to be designed on a basis of maximum generator rating. All other bus-bars and bus-bar connections are to be designed for at least 85% of the combined full-load rated currents of all apparatus they supply except that when they supply one unit or any group of units in continuous operation, they are to be designed for full load.

(7) Where the total installed electrical power of the main generating sets is in excess of 3MW, the main busbars shall be subdivided into at least two parts which shall normally be connected by removable links or other approved means: so far as is practicable, the connection of generating sets and any other duplicated equipment shall be equally divided between the parts.

Table 8.1.1: Minimum insulating clearance

Rated voltage between poles or phases (V)	Minimum insulating clearance (mm)	
	Between phase or poles or live parts	Between live parts and earthed metals
125 or less	13	13
Over 125 up to 250	16	13
Over 250 up to 500	23	23

1.3.2 Equalizer for D.C. generator

(1) The current rating of equalizer connections and equalizer switches is not to be less than 50% the rated full-load current of the generator.

(2) The current rating of equalizer busbars is not to be less than 50% the rated full-load current of the largest generator in the group of parallel operation.

1.4 Measuring instruments for switchboards

1.4.1 D.C. ship's service generator panels are at least to be provided with the instruments given in Table 8.1.2.

Table 8.1.2: Instruments for D.C. generator panel

Operation	**Type of instrument**	**Quantity**	
		2-wire system	**3-wire system**
Not parallel	Ammeter	1 for each generator (positive pole)	2 for each generator (positive and negative poles) (see NOTE 1)
	Voltmeter	1 for each generator	1 for each generator (voltage measurement of positive and negative poles or between positive or negative pole and neutral pole)

Parallel	Ammeter	1 for each generator (positive pole)	2 for each generator (in case of compound winding, between equalizer and armature, and in case of shunt winding, for positive and negative poles) (see NOTE 1)
	Voltmeter	2 (busbar and each generator)	2 (voltage measurement between busbar and positive and negative poles of each generator, or between positive or negative pole and neutral pole)

NOTES:

1. In the above table, a zero center ammeter is to be added to earth line when employed neutral line earthed system is employed.
2. One voltmeter is to be capable of measuring shore supply voltage.
3. Where a control panel is provided for automatic control of generators, the instruments in the above Table may be installed on the control panel, except that, if the control panel is installed outside engine rooms, minimum number of instruments required to carry out single or parallel operation of generators are to be mounted on switchboards.

Table 8.1.3: Instruments for A.C. generator panel

Operation	Type of instrument	Quantity
Not parallel	Ammeter	1 for each generator (current measurement of each phase)
	Voltmeter	1 for each generator (voltage measurement between each phase)
	Wattmeter	1 for each generator

	Frequency meter	(it may be omitted for 50KVA or less) 1 (frequency measurement of each generator)
	Ammeter (see NOTE 1)	1 for exciting circuit of each generator
Parallel	Ammeter	1 for each generator (current measurement of each phase)
	Voltmeter	2 (voltage measurement between each phase of generators and busbar)
	Wattmeter	1 for each generator
	Frequency meter	2 (frequency measurement of each generator and busbar)
	Synchroscope	1
	Ammeter (see NOTE 1)	1 for exciting circuit of each generator

NOTES :

1. In above Table, the ammeters are to be provided only if necessary.
2. One voltmeter is to be capable of measuring shore supply voltage.
3. Where a control panel is provided for automatic control of generators, the instruments in the above Table may be installed on the control panel, except that, if the control panel is installed outside engine rooms, minimum number of instruments required to carry out single or parallel operation of generators are to be mounted on switchboards.

1.4.2 A.C. ship's service generator panels

A.C. ship's service generator panels are to be provided at least with the instruments given in Table 8.1.3.

1.4.3 Instrument scales

(1) The upper limit of the scale of every ammeter is to be approximately 130% of the normal rating of the circuit.

(2) The upper limit of the scale of every voltmeter is to be approximately 120% of the normal voltage of the circuit.

(3) Ammeters for D.C. generators and wattmeters for A.C. generators which may operate in parallel are to be capable of indicating reverse current or reverse power up to 15% respectively.

1.4.4 Earth indication

Each insulated primary or secondary distribution system is to be provided with devices to continuously monitor the values of electrical insulation to earth and to give an audible or visual indication in case of abnormally low insulation values.

1.4.5 Fuses, circuit breakers

Fuses, circuit-breakers and electromagnetic contactors are to comply with I.E.C. Publication 269, "Low Voltage Fuse with High Breaking Capacity", and I.E.C. Publication 157-1, "Low Voltage Distribution Switchgear" and/or equivalent the national standard.

1.4.6 Protection

See Part 6, Chapter 3.

1.5 Testing and inspection

1.5.1 General

Switchboards are to be meet the requirements of this Chapter in their construction and are to be tested in accordance with the requirements of the following articles.

1.5.2 Operation test

Operation of instruments, circuit-breakers, switching gear, etc. on switchboards is to be confirmed.

1.5.3 High voltage test

Switchboards complete or in section with all components are to withstand a test when following voltages are applied at commercial frequency for 1 minute between all current-carrying parts connected together and earth and between current-carrying parts of opposite polarity of phase. Instruments and auxiliary apparatus may be disconnected during the high voltage test:

~ Rated voltage up to 60V : 500V

~ Rated voltage exceeding 60V : 1000V + twice rated voltage (minimum 2000V)

1.5.4 Insulation resistance test

Immediately after the high voltage test, the insulation resistance between all current-carrying parts of opposite polarity of phase is not to be less than 1 MΩ when tested with a direct current voltage of at least 500Volts.

CHAPTER 9 Batteries, Luminaries, Accessories

CONTENTS

SECTION 1 Storage batteries

1.1 Applicable standards

1.1.1 Lead-acid storage batteries are to comply with I.E.C. Publication 92-305 "Accumulator (storage) batteries" or an equivalent national standard.

1.2 Construction

1.2.1 The cells of all batteries are to be so constructed and secured as to present spilling of the electrolyte due to the vibration, inclination, etc., of the ship and to prevent emission of acid or alkaline spray.

1.3 Location

1.3.1 Batteries are to be located where they are not exposed to excessive heat, extreme cold, spray, steam or other conditions which would impair performance or accelerate deterioration.

1.3.2 Alkaline batteries and lead-acid batteries are not to be installed in the same compartment.

1.3.3 Batteries are not to be placed in living quarters.

1.3.4 Large batteries are to be installed in a space assigned to the batteries only or alternatively in a deck box if such a space is not available.

1.3.5 Engine starter batteries are to be located as close as practicable to the engine served. If such batteries cannot be accommodated in the battery room, they are to be installed so that adequate ventilation is ensured.

1.4 Electrical installations in battery compartment

1.4.1 Lighting fittings in battery rooms are to be of explosion-proof type.

1.4.2 Switches, fuses and other electrical equipment liable to cause an arc are not to be fitted in battery compartments.

1.4.3 Cables, with the exception of those appertaining to the battery or the local lighting are not to be installed in battery compartments as a rule. In the case where cables enter battery rooms, for the above exceptions, the holes are to be bushed as required for watertight bulkheads, all the connections within the battery room are to be resistant to the electrolyte.

1.5 Protection against corrosion

1.5.1 The interior of all battery compartments are to be protected with lead-sheet lining of 1,6 mm thick or more or corrosion-resistant paint in accordance with the following paragraphs:

1.5.2 The entire floor and all walls up to 150 mm high of battery rooms are to be lined with lead-sheet and the linings are to be watertight. Where approved by the Society, lead-sheet lining may be substituted by electrolyte-resisting coating.

1.5.3 Ceilings, walls other than those of 1.5.2, battery shelves and wooden crates are to be painted with electrolyte-resisting coating.

1.5.4 Battery tray and sulfuric acid bottle bases are to be lined with lead-sheet.

1.5.5 Ventilating ducts and fans are to be made of corrosion-resisting material or their internal, surfaces are to be painted with corrosion-resisting paint.

1.6 Ventilation

1.6.1 All rooms, lockers and boxes for storage batteries are to be arranged to avoid accumulation of inflammable gas. Where batteries are arranged in two or more tiers, all shelves are to have not less than 50 mm space, front and back, for circulation of air.

1.6.2 The ventilation of battery room may be conducted with either natural ventilation or ventilating fan.

1.6.3 In every case the quantity of the air expelled is to be at least equal to:

$$Q = 110 \cdot I \cdot n$$

where:

Q = quantity of expelled air in litres per hour

I = maximum charging current during gas formation, however at least one-quarter of the maximum obtainable charging current of the charging facility in amperes.

n = number of cells

1.6.4 The battery room is to be provided with an effective air inlet near the floor surface.

1.6.5 Ventilating fans are to be so constructed and be of a material such as not to result in sparking in the event of the impeller touching the fan casing.

1.6.6 Fan motors associated with a duct used to exhaust the air from a battery space is to be placed outside of the duct.

1.6.7 Ventilating ducts terminating at least 1,25 m above in a gooseneck shape or equivalent are to be provided above the top of battery boxes. Holes for air inlets are to be provided on at least two opposite sides of the box.

1.7 Charging facilities

1.7.1 For floating service or for any other conditions where the load is connected to the battery while it is on charge, the maximum battery voltage is not to exceed the safe value of any connected apparatus. A voltage regulator may be provided for this purpose.

1.7.2 Battery charging facilities by means of D.C. generator and series resistor are to be provided with protection against reversal of current when the charging voltage is 20% of the line voltage or higher.

1.8 Recording of the Type, Location and Maintenance Cycle of Batteries

1.8.1 Where batteries are fitted for use for essential (UI SC134) and emergency services a schedule of such batteries is to be compiled and maintained. The schedule, which is to be reviewed by the Society, is to include at least the following information regarding the battery(ies):

- Type and manufacturer's type designation.
- Voltage and ampere-hour rating.
- Location.
- Equipment and/or system(s) served.
- Maintenance/replacement cycle dates.
- Date(s) of last maintenance and/or replacement.
- For replacement batteries in storage, the date of manufacture and shelf life. (1)

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

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

1.8.4 Details of the schedule and of the procedures are to be included in the ship's safety management system and be integrated into the ship's operational maintenance routine as appropriate (5) to be verified by the Society's surveyor.

NOTES:

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:

$$Q = 110 \cdot I \cdot n$$

where

Q = quantity of air expelled in litres/hr.

I = maximum current delivered by the charging equipment during gas formation, but not

less than 25% of the maximum obtainable charging current in amperes

n = number of cells in series

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

5. See section 10 of the IMO ISM Code.

SECTION 2 Lighting fittings, accessories

2.1 General

2.1.1 Lighting fittings, heating appliances and wiring accessories are to comply with an acceptable National Standard or equivalent thereto, and in addition they are also to comply with the requirement of this section.

2.2 Lighting fittings

2.2.1 Construction and location

(1) Enclosures are to be composed of metal, glass or synthetic resin having a sufficient mechanical, thermal and chemical resistivity and to have a suitable degree of protection depending on their location. Synthetic resin enclosures which support current-carrying parts are to be flame retardant.

(2) The terminal box and the leading-in part of cables are to be of construction suitable for ship cables. Consideration is to be given so that the insulation of cables may not deteriorate at an early stage due to the temperature rise on terminals and other parts.

(3) Lighting fittings installed in engine room of similar spaces which are exposed to the risk of mechanical damage are to be provided with suitable grilled metallic guards to protect their lamps and glass globes against such damage.

2.2.2 Fluorescent lighting fittings

(1) Reactors, capacitors and other auxiliaries are not to be mounted on surfaces which are liable to be subjected to high temperatures.

(2) Every capacitor of 0,5 microfarad or more is to be provided with a protective leak or other protective means which reduces the voltage of the capacitor to not more than 50V within 1 minute after disconnection from the supply source.

(3) Inductors and high reactance transformers are to be installed as close as practicable to the associated discharge lamp.

2.2.3 Emergency lights are to be marked for easy identification.

2.3 Wiring accessories

2.3.1 Material

(1) Enclosures are to be of metal or of flame-retardant material.

(2) The insulating material of live parts is to be of flame-retardant and non-hygroscopic material.

2.3.2 Temperature rise

The temperature rise on live parts is not to exceed 30°C.

2.3.3 Switches

Switches are to be capable of breaking and making safely a load current equal to 150% of their rated current at the rated voltage.

2.3.4 Plugs and socket-outlets

(1) Socket-outlets of rated current exceeding 15A are to be provided with a switch so interlocked that the plug cannot be inserted or withdrawn when the switch is in the "off" position.

(2) Where distribution systems of different voltages are in use, the socket-outlets and plugs are to be of such design that an incorrect connection cannot be made.

(3) Each socket-outlet and plug having the rated voltages of 55V and over for D.C. and A.C. are to be provided with an additional contactor for earthing the casing or frame of appliance, except those for double insulated appliances having no non-current carrying metal parts for which earthing is required. The earthing contactors are to make contact in advance of the live contact pins when inserting the plug.

CHAPTER 10 Internal Communications

CONTENTS

SECTION 1 General requirements

1.1 Applicable standards

1.1.1 Each internal communication apparatus is to comply with an acceptable National Standard or equivalent thereto.

1.2 Essential internal communication systems

1.2.1 Electrical internal communication and signal systems forming part of the essential operating systems of the ship are to be as independent and self-sustaining as possible.

1.3 Induced interference suppression

1.3.1 All communication cables are to be so arranged that unwanted interference and cross-talk is avoided.

1.4 Protective devices

1.4.1 Where numerous internal communication circuits are branched from common feeder, each circuit, each circuit and feeder is to be protected by the fuses and other means, and the rating of feeder is to be based on the connected load.

1.5 General emergency alarm system

1.5.1 The emergency alarm system is to be capable of operation from at least the navigating bridge and at a position adjacent to the alarm distribution panel.

1.5.2 The alarm system is to be led by exclusive circuits, one from the main source of electrical power and one from an emergency source with automatic change-over facilities located in or adjacent to the alarm signal panel.

1.5.3 No switch is to be provided for feeder circuits of general alarm devices, except for the operation switch. Where a circuit breaker is used for over current protection, suitable means are to be taken to prevent the circuit breaker from being at “off” position.

1.5.4 The emergency alarm system is to be audible throughout all the accommodation, normal crew working spaces, and open deck and is to have sound pressure level in accordance with the requirement of Chapter III, Regulation 50 of SOLAS 74 as amended. The alarm shall continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system.

1.6 Communication between navigating bridge and machinery space

1.6.1 At least two independent means shall be provided for communicating orders from the navigating bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled: one of these shall be an engine-room telegraph which provides visual indication of the orders and responses both in the machinery spaces

and on the navigating bridge. Appropriate means of communication shall be provided from the navigating bridge and the engine-room to any other position from which the speed or direction of thrust of the propellers may be controlled.

1.7 Public address system for passenger ship

1.7.1 Public address systems for emergency purposes on passenger ships should comply with the following:

(1) The public address system is to be connected to the emergency source of power.

(2) The public address system should be one complete system consisting of a loudspeaker installation which enables simultaneous broadcast of messages from the navigation bridge, and at least one other location on board for use when the navigation bridge has been rendered unavailable due to the emergency, to all spaces where crew members or passengers or both are normally present, and to assembly stations (i.e. muster stations). The controls of the system on the navigation bridge should be capable of interrupting any broadcast on the system from any other location on board. It should not require any action by the address. It should also be possible to address crew accommodation and work spaces separately from passenger spaces.

(3) In addition to any function provided for routine use aboard the ship, the system should have

an emergency function control at each control station which:

~ is clearly indicated as the emergency function

~ is protected against unauthorized use

~ automatically overrides any other input system or programme, and

~ automatically overrides all volume controls and on/off controls so that the required volume for the emergency mode is achieved in all spaces

(4) The system should be installed with regard to acoustically marginal conditions, so that emergency announcements are clearly audible above ambient noise in all spaces. With the ship underway in normal conditions, the minimum sound pressure levels for broadcasting

emergency announcements should be:

~ in interior spaces 75 dB (A) and at least 20 dB (A) above the speech interference level, and

~ in exterior spaces 80 dB (A) and at least 15 dB (A) above the speech interference level.

(5) The public address system should have at least two loops which are to be sufficient separated throughout their length and have two separate and independent amplifiers.

CHAPTER 11 Emergency Source of Power

CONTENTS

SECTION 1 Emergency source of electrical power in cargo ships (SOLAS II-1/Reg. 43)

1.1 General (SOLAS II-1/Reg. 43/1.1)

1.1.1 A self-contained emergency source of electrical power shall be provided.

1.1.2 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck. They shall not be located forward of the collision bulkhead, except where permitted by the Administration in exceptional circumstances.

1.1.3 The location of the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Administration that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard, or in any machinery space of category A will not interfere with the supply, control and distribution of emergency electrical power. As far as practicable the space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard shall not be contiguous to the boundaries of machinery spaces of category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard.

1.1.4 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits.

1.2 Capacity of emergency source of electrical power in cargo ships (SOLAS II-1/Reg. 43/2)

1.2.1 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation:

1.2.1.1 For a period of 3 h, emergency lighting at every muster and embarkation station and over the sides as required by SOLAS Regulation III/11.4 and SOLAS Regulation III/16.7.

1.2.1.2 For a period of 18 h, emergency lighting:

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

2. in the machinery spaces and main generating stations including their control positions;
3. in all control stations, machinery control rooms, and at each main and emergency switchboard;
4. at all stowage positions for firemen's outfits;
5. at the steering gear;
6. at the fire pump referred to in 1.2.1.5, at the sprinkler pump, if any, and at the emergency bilge pump, if any, and at the starting positions of their motors; and
7. in all cargo pump-rooms of tankers constructed on or after 1 July 2002

1.2.1.3 For a period of 18 h:

1. the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force;
2. on ships constructed on or after 1 February 1995 the VHF radio installation required by SOLAS

   Regulation IV/7.1.1 and SOLAS Regulation IV/7.1.2; and, if applicable:

   the MF radio installation required by SOLAS Regulation IV/9.1.1, SOLAS Regulation IV/9.1.2, SOLAS Regulation IV/10.1.2 and SOLAS Regulation IV/10.1.3;

   the ship earth station required by SOLAS Regulation IV/10.1.1; and

   the MF/HF radio installation required by SOLAS Regulations IV/10.2.1, SOLAS Regulation IV/10.2.2 and SOLAS Regulation IV/11.1.

1.2.1.4 For a period of 18 h:

1. all internal communication equipment as required in an emergency;
2. the shipborne navigational equipment as required by SOLAS Regulation V/12 (1); where such provision is unreasonable or impracticable the Administration may waive this requirement for ships of less than 5,000 gross tonnage;
3. the fire detection and fire alarm system; and
4. intermittent operation of the daylight signalling lamp, the ship's whistle, the manually operated call points and all internal signals that are required in an emergency;

unless such services have an independent supply for the period of 18 h from an accumulator battery suitably located for use in an emergency.

1.2.1.5 For a period of 18 h one of the fire pumps required by SOLAS Regulation II-2/4.3.1 and SOLAS Regulation 4.3.3 (2) if dependent upon the emergency generator for its source of power.

1. For the period of time required by SOLAS Regulation 29.14 the steering gear where it is required to be so supplied by that regulation.
2. In a ship engaged regularly in voyages of short duration, the Administration if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 18 h period specified in 1.2.1.2, 1.2.1.3, 1.2.1.4 and 1.2.1.5 but not less than 12 h.

NOTES:

1. This relates to the SOLAS Chapter V in force before 1 July 2002. The equivalent in the amended Chapter V is SOLAS Regulation 19.
2. These relate to the SOLAS Chapter II-2 in force before 1 July 2002. The equivalents in the amended SOLAS Chapter II-2 are 10.2.2.2 and 10.2.2.3

1.3 Kind and performance of emergency source of electrical power in cargo ships (SOLAS II-1/Reg. 43/3)

1.3.1 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the following:

1.3.1.1 Where the emergency source of electrical power is a generator, it shall be:

1. driven by a suitable prime mover with an independent supply of fuel, having a flashpoint (closed cup test) of not less than 43°C;
2. started automatically upon failure of the main source of electrical power supply unless a transitional source of emergency electrical power in accordance with paragraph 3.1.3 is provided; where the emergency generator is automatically started, it shall be automatically connected to the emergency switchboard; those services referred to in paragraph 4 shall then be connected automatically to the emergency generator; and unless a second independent means of starting the emergency generator is provided the single source of stored energy shall be protected to preclude its complete depletion by the automatic starting system; and
3. provided with a transitional source of emergency electrical power as specified in paragraph 4 unless an emergency generator is provided capable both of supplying the services mentioned in that paragraph and of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 s.

1.3.1.2 Where the emergency source of electrical power is an accumulator battery it shall be capable of:

1. carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;

2. automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

3. immediately supplying at least those services specified in 1.4.1.

1.3.1.3 The following provision in 1.3.1.1.2 shall not apply to ships constructed on or after 1 October 1994:

Unless a second independent means of starting the emergency generating set is provided, the single source of stored energy shall be protected to preclude its complete depletion by the automatic starting system.

1.3.1.4 For ships constructed on or after 1 July 1998, where electrical power is necessary to restore propulsion, the capacity shall be sufficient to restore propulsion to the ship in conjunction with other machinery, as appropriate, from a dead ship condition within 30 min after blackout.

1.4 Transitional source of emergency electrical power in cargo ships (SOLAS II-1/Reg. 43/4)

1.4.1 The transitional source of emergency electrical power where required by 1.3.1.1.3 shall consist of an accumulator battery suitably located for use in an emergency which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and shall be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the following services if they depend upon an electrical source for their operation:

1.4.1.1 the lighting required by 1.2.1.1, 1.2.1.2 and 1.2.1.3.1. For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

1.4.1.2 all services required by 1.2.1.4.1, 1.2.1.4.3 and 1.2.1.4.4 unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

1.5 Emergency Switchboard (SOLAS II-1/Reg. 43/5)

1.5.1 The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power.

1.5.2 Where the emergency source of electrical power is a generator, the emergency switchboard shall be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

1.5.3 No accumulator battery fitted in accordance with this regulation shall be installed in the same space as the emergency switchboard. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of electrical power referred to in 1.3.1.2 or 1.4.1 are being discharged.

1.5.4 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short circuit.

1.5.5 In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that electrical power shall be available automatically to the emergency circuits.

1.6 Functional requirements (SOALAS II-1/Reg. 43/6)

1.6.1 The emergency generator and its prime mover and any emergency accumulator battery shall be so designed and arranged as to ensure that they will function at full rated power when the ship is upright and when inclined at any angle of list up to 22.5° or when inclined up to 10° either in the fore or aft direction, or is in any combination of angles within those limits.

1.7 Periodic Testing (SOLAS II-1/Reg. 43/7)

1.7.1 Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements.

SECTION 2 Kind and performance of emergency source of electrical power in passenger ships

2.1 General (SOLAS II-1/Reg. 42/1)

2.1.1 A self-contained emergency source of electrical power shall be provided.

2.1.2 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck. They shall not be located forward of the collision bulkhead.

2.1.3 The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency electric lighting switchboards in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Administration that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of category A will not interfere with the supply, control and distribution of emergency electrical power. As far as practicable, the space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard shall not be contiguous to the boundaries of machinery spaces of category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard.

2.1.4 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used exceptionally, and for short periods, to supply non-emergency circuits.

2.2 Capacity of emergency source of electrical power in passenger ships (SOLAS II-1/Reg. 42/2)

2.2.1 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation:

2.2.1.1 For a period of 36 h, emergency lighting:

1. at every muster and embarkation station and over the sides as required by regulations III/11.4 and III/16.7;
2. in alleyways, stairways and exits giving access to the muster and embarkation stations, as required by regulation III/11.5;
3. in all service and accommodation alleyways, stairways and exits, personnel lift cars;
4. in the machinery spaces and main generating stations including their control positions;
5. in all control stations, machinery control rooms, and at each main and emergency switchboard;
6. at all stowage positions for firemen's outfits;
7. at the steering gear; and

8. at the fire pump, the sprinkler pump and the emergency bilge pump referred to in 2.2.1.4 and at the starting position of their motors.

2.2.1.2 For a period of 36 h:

1. the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force; and
2. on ships constructed on or after 1 February 1995, the VHF radio installation required by regulation IV/7.1.1 and IV/7.1.2; and, if applicable:

   the MF radio installation required by regulations IV/9.1.1, IV/9.1.2,IV/10.1.2 and IV/10.1.3; the ship earth station required by regulation IV/10.1.1; and

   the MF/HF radio installation required by regulations IV/10.2.1, IV/10.2.2 and IV/11.1.

2.2.1.3 For a period of 36 h:

1. all internal communication equipment required in an emergency;
2. the shipborne navigational equipment as required by regulation V/12 (1); where such provision is unreasonable or impracticable the Administration may waive this requirement for ships of less than 5,000 gross tonnage;
3. the fire detection and fire alarm system, and the fire door holding and release system; and
4. for intermittent operation of the daylight signalling lamp, the ship's whistle, the manually operated call points, and all internal signals that are required in an emergency;

unless such services have an independent supply for the period of 36 h from an accumulator battery suitably located for use in an emergency.

NOTE:

1. This relates to the chapter V in force before 1 July 2002. The equivalent in the amended chapter V is regulation 19

2.2.1.4 For a period of 36 h:

1. one of the fire pumps required by regulation II-2/4.3.1 and 4.3.3; (1)
2. the automatic sprinkler pump, if any; and
3. the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves.

NOTE:

1. These relate to the chapter II-2 in force before 1 July 2002. The equivalents in the amended chapter II-2 are 10.2.2.2 and 10.2.2.3.

2.2.1.5 For the period of time required by regulation 29.14 the steering gear if required to be so supplied by that regulation.

2.2.1.6 For a period of half an hour:

1. any watertight doors required by regulation 15 to be power-operated together with their indicators and warning signals;
2. the emergency arrangements to bring the lift cars to deck level for the escape of persons. The passenger lift cars may be brought to deck level sequentially in an emergency.

2.2.1.7 In a ship engaged regularly on voyages of short duration, the Administration if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 36 h period specified in 2.2.1.1, 2.2.1.2, 2.2.1.3, 2.2.1.4 and 2.2.1.5 but not less than 12 h.

2.3 Kind and performance of emergency source of electric power in passenger ships (SOLAS II-1/Reg. 42/3)

2.3.1 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the following:

2.3.1.1 Where the emergency source of electrical power is a generator, it shall be:

1. driven by a suitable prime mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43°C;
2. started automatically upon failure of the electrical supply from the main source of electrical power and shall be automatically connected to the emergency switchboard; those services referred to in 2.4.1 shall then be transferred automatically to the emergency generating set. The automatic starting system and the characteristic of the prime mover shall be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 s; unless a second independent means of starting the emergency generating set is provided, the single source of stored energy shall be protected to preclude its complete depletion by the automatic starting system; and
3. provided with a transitional source of emergency electrical power according to 2.4.1.

2.3.1.2 Where the emergency source of electrical power is an accumulator battery, it shall be capable of:

1. carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;
2. automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and
3. immediately supplying at least those services specified in 2.4.1.

2.3.1.3 The following provisions in 2.3.1.1.2 shall not apply to ships constructed on or after 1 October 1994:

Unless a second independent means of starting the emergency generating set is provided, the single source of stored energy shall be protected to preclude its complete depletion by the automatic starting system.

2.3.1.4 For ships constructed on or after 1 July 1998, where electrical power is necessary to restore propulsion, the capacity shall be sufficient to restore propulsion to the ship in conjunction with other machinery, as appropriate, from a dead ship condition within 30 min after blackout.

2.4 Transitional source of emergency electrical power in passenger ships (SOLAS II-1/Reg. 42/4)

2.4.1 The transitional source of emergency electrical power required by 2.3.1.1.3 shall consist of an accumulator battery suitably located for use in an emergency which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation:

2.4.1.1 For half an hour:

1. the lighting required by 2.2.1.1 and 2.2.1.2;
2. all services required by 2.2.1.3.1, 2.2.1.3.3 and 2.2.1.3.4 unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

2.4.1.2 Power to operate the watertight doors, as required by regulation 15.7.3.3, but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided. Power to the control, indication and alarm circuits as required by regulation 15.7.2 for half an hour.

2.5 Emergency switchboard (SOLAS II-1/Reg. 42/5)

2.5.1 The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power.

2.5.2 Where the emergency source of electrical power is a generator, the emergency switchboard shall be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

2.5.3 No accumulator battery fitted in accordance with this regulation shall be installed in the same space as the emergency switchboard. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in 2.3.1.1.3 or 2.4.1 are being discharged.

2.5.4 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short circuit and which is to be disconnected automatically at the emergency

switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short circuit.

2.5.5 In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power shall be available to the emergency circuits.

2.6 Functional requirements (SOLAS II-1/Reg. 42/6)

2.6.1 The emergency generator and its prime mover and any emergency accumulator battery shall be so designed and arranged as to ensure that they will function at full rated power when the ship is upright and when inclined at any angle of list up to 22.5° or when inclined up to 10° either in the fore or aft direction, or is in any combination of angles within those limits.

2.7 Testing (SOLAS II-1/Reg.42/7)

2.7.1 Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements.

SECTION 3 Supplementary emergency lighting for Ro-Ro passenger ships (SOLAS II-1/Reg. 42-1)[5]

3.1 Additional emergency lighting requirements for Ro-Ro passenger ships

3.1.1 In addition to the emergency lighting required by regulation 42.2, on every passenger ship with ro-ro cargo spaces or special category spaces as defined in regulation II-2/3:

1. all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least 3 h when all other sources of electrical power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen. The source of power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Administration. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service; and

[5] This Section applies to all passenger ships with ro-ro cargo spaces or special category spaces as defined in regulation II-2/3, except that for ships constructed before 22 October 1989, Regulation 42-1 shall apply not later than 22 October 1990)

2. a portable rechargeable battery-operated lamp shall be provided in every crew space alleyway, recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required by 1, is provided.

SECTION 4 Requirements for uninterruptible power system (UPS) units as alternative and/or transitional power (IACS UR E21)

4.1 Scope

These requirements to UPS units, as defined in IEC 62040-3:2011, apply when providing an alternative power supply or transitional power supply to services as defined in Regulations 42 and 43 of SOLAS Chapter II-1 as amended by IMO resolutions up to MSC.436(99).

A UPS unit complying with these requirements may provide an alternative power supply as an accumulator battery in terms of being an independent power supply for services defined in Regulation 42.2.3 or 43.2.4 of SOLAS Chapter II-1 as amended by IMO resolutions up to MSC.436(99).

4.2 Definitions

Uninterruptible Power System (UPS) - combination of converters, switches and energy storage means, for example batteries, constituting a power system for maintaining continuity of load power in case of input power failure *[IEC 62040:2011]*

Off-line UPS unit - a UPS unit where under normal operation the output load is powered from the bypass line (raw mains) and only transferred to the inverter if the bypass supply fails or goes outside preset limits. This transition will invariably result in a brief (typically 2 to 10 ms) break in the load supply.

Line interactive UPS unit - an off-line UPS unit where the bypass line switch to stored energy power when the input power goes outside the preset voltage and frequency limits.

On-line UPS unit - a UPS unit where under normal operation the output load is powered from the inverter, and will therefore continue to operate without break in the event of the supply input failing or going outside preset limits.

4.2.1 Design and construction

(a) UPS units are to be constructed in accordance with IEC 62040-1:2017, IEC 62040-2:2016, IEC 62040-3:2011. IEC 62040-4:2013 and/or IEC 62040-5-3:2016, as applicable, or an acceptable and relevant national or international standard.

(b) The operation of the UPS is not to depend upon external services.

(c) The type of UPS unit employed, whether off-line, line interactive or on-line, is to be appropriate to the power supply requirements of the connected load equipment.

(d) An external bypass is to be provided.

(e) The UPS unit is to be monitored and audible and visual alarm is to be given in a normally attended location for

- power supply failure (voltage and frequency) to the connected load,
- earth fault,
- operation of battery protective device,
- when the battery is being discharged, and
- when the bypass is in operation for on-line UPS units.

4.2.2 Location

(a) The UPS unit is to be suitably located for use in an emergency.

(b) UPS units utilising valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC 62040-1:2017, IEC 62040-2:2016, IEC 62040-3:2011, IEC 62040-4:2013 and/or IEC 62040-5-3:2016, as applicable, or an acceptable and relevant national or international standard.

4.2.3 Performance

(a) The output power is to be maintained for the duration required for the connected equipment as stated in Regulation 42 or 43 of SOLAS Chapter II-1 as amended by IMO resolutions up to MSC.436(99).

(b) No additional circuits are to be connected to the UPS unit without verification that the UPS unit has adequate capacity. The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in the regulations.

(c) On restoration of the input power, the rating of the charge unit shall be sufficient to recharge the batteries while maintaining the output supply to the load equipment.

4.2.4 Testing and survey

(a) UPS units of 50 kVA and over are to be surveyed by the Society during manufacturing and testing.

(b) Appropriate testing is to be carried out to demonstrate that the UPS unit is suitable for its intended environment. This is expected to include as a minimum the following tests:

- Functionality, including operation of alarms;
- Temperature rise;
- Ventilation rate;
- Battery capacity.

(c) Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical test.

SECTION 5 Starting arrangement for emergency generating sets (SOLAS II-1/Reg. 44)

5.1 General

5.1.1 Emergency generators shall be capable of being readily started in their cold condition at a temperature of 0°C. If this is impracticable, or if lower temperatures are likely to be encountered, provision acceptable to the Administration shall be made for the maintenance of heating arrangements, to ensure ready starting of the generating sets.

5.1.2 Each emergency generating set arranged to be automatically started, shall be equipped with starting devices approved by the Administration with a stored energy capability of at least three consecutive starts. A second source of energy shall be provided for an additional three starts within 30 minutes unless hand (manual) starting can be demonstrated to be effective.

5.1.2.1 Ships constructed on or after 1 October 1994, in lieu of the provision of the second sentence of 5.1.2, shall comply with the following requirements:

The source of stored energy shall be protected to preclude critical depletion by the automatic starting system, unless a second independent means of starting is provided. In addition, a second source of energy shall be provided for an additional three starts within 30 min unless manual starting can be demonstrated to be effective.

5.1.3 The stored energy shall be maintained at all times, as follows:

1. electrical and hydraulic starting systems shall be maintained from the emergency switchboard;
2. compressed air starting systems may be maintained by the main or auxiliary compressed air receivers through a suitable non-return valve or by an emergency air compressor which, if electrically driven, is supplied from the emergency switchboard;
3. all of these starting, charging and energy storing devices shall be located in the emergency generator space; these devices are not to be used for any purpose other than the operation of the emergency generating set. This does not preclude the supply to the air receiver of the emergency generating set from the main or auxiliary compressed air system through the non-return valve fitted in the emergency generator space.

5.1.4 Where automatic starting is not required, manual starting is permissible, such as manual cranking, inertia starters, manually charged hydraulic accumulators, or powder charge cartridges, where they can be demonstrated as being effective.

5.1.5 When manual starting is not practicable, the requirements of 5.1.2 and 5.1.3 shall be complied with except that starting may be manually initiated.

CHAPTER 12 Electric Propulsion

CONTENTS

SECTION 1 Electric propulsion

1.1 General

1.1.1 Application

The rotating machines, control gear, excitation apparatus and cables for the electric propulsion are to meet the requirements in this Chapter and also those in other applicable Chapters of this Part.

1.1.2 Motor torque

(1) Torque available for manoeuvering a ship is to be capable of stopping or reversing of the ship in a reasonable time when the ship is running at the maximum service speed.

(2) Adequate torque margin is to be provided in A.C. propulsion systems to guard against the motor to being pulled out of synchronism during rough weather and at the time of turning in a multiple-screw ship.

1.1.3 Protection against torsional vibration, etc.

Prime movers, generators, motors, shafting and propellers are to be such that harmful torsional vibrations or excessive electrical oscillations in alternating-current systems are not observed at any normal operating speed.

1.1.4 Protection overload

Where arrangements permit a propulsion motor to be connected to the generating plant having a continuous rating greater than the motor rating, means are to be provided to prevent continuous operation at the overload or over torque conditions not permitted to the motor and shafting.

1.1.5 Lubrication

(1) Lubrication of the bearings of propulsion motors and shafting is to be effective at all operational speeds including creep speeds.

(2) When a forced lubrication system is used for the bearings of rotating machines and prime movers, low oil pressure alarm is to be provided.

1.2 Prime movers

1.2.1 General

Prime movers are to comply with the requirements of Part 5, Chapter 2 and 3, and their rated power in conjunction with their overloading facilities and load built-up facilities is to be adequate to supply the needed power during transitional changes in operating conditions of electrical equipment.

1.2.2 Speed governor

(1) Prime movers of any type are to be provided with a governor capable of maintaining the preset steady speed within a range not exceeding 5% of the rated full-load speed for load changes from full-load to no load.

(2) The governors are to be such that they will automatically maintain the momentary speed within 10% of the rated speed when the full load is suddenly thrown off.

(3) In the case of parallel operation of generators, the governing system used is to permit stable operation to be maintained over the entire operational speed range of the prime movers.

(4) Where the speed control of the propeller requires speed variation of the prime mover, the governor is to permit a very gradual variation of speed within the necessary speed range and means are to be provided to enable local manual control as well as remote control of the governor.

(5) The overspeed governor is to be set to a speed in excess of the highest possible speed during periods of regenerated power, and the generator set including prime mover is to be so designed that no damage will be caused by an overspeed equal to that at which the governor is set.

1.3 Rotating machines

1.3.1 General

(1) When variable speed rotating machines are fitted with an integral fan and have to be operated at speeds below the rated speed with full-load torque, full-load current, full load excitation or the like, temperature limits according to Part 6, Chapter 4, SECTION 1, Table 4.1.1 are not to be exceeded.

(2) The rotors are to be so constructed that they will withstand for 2 minutes an overspeed in accordance with the requirements of Part 6, Chapter 4, SECTION 1, 1.9.5. However, the overspeed of turbo-generators and electromagnetic slip couplings is to be 120% of the rated speed.

(3) The collector rings and commutators are to be suitably arranged to be maintained easily. For purposes of inspection and repair, provision is to be made for easy access to each kind of coils and bearings, and for withdrawal and replacement of the field coils as well.

(4) Effective means are to be provided in rotating machines to prevent accumulation of moisture and condensation even when they are idle for appreciable periods.

1.3.2 Generators and motors

(1) For A.C. generators and motors of 500KW and above, embedded temperature detectors are to be provided in the stator windings, and the temperature indicator is to be mounted in a convenient position to read a temperature on the control board.

(2) For D.C. motors liable to overspeed excessively, overspeed protection devices are to be provided, and the rotors are to be suitably constructed to prevent damage due to temporary overspeed.

1.3.3 Means of excitation

(1) Separately excited rotating machines are to be provided with at least 2 independent sources of excitation. In this case, current may be derived from the auxiliary power or lighting sets as one means of excitation.

(2) The strength of shafts and couplings of exciters is to be suitable for the increased output necessary during manoeuvring and sudden short-circuit conditions.

1.3.4 Electromagnetic slip couplings

(1) Means are to be provided to facilitate periodical checking of the air gaps of the magnetic circuit, and appropriate calibrated gauges are to be supplied for this purpose.

(2) Electromagnetic slip couplings are to be at least of drip-proof type. Where they are of non-enclosed type, suitable means are to be taken to prevent accidental touch with rotating parts and ingress of foreign material.

1.3.5 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.

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

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

(2) arrangements are fitted to automatically start one or more of the generators, constituting the main source of electrical power required by SOLAS, in compliance with paragraph 2.2 of SC 157 and also upon the frequency variations exceeding ± 10% of the limits specified below.

(3) within the declared operating range of the generators and/or generator systems the specified limits for the voltage variations in IEC 60092-301 (3) and the frequency variations in Part 6, Chapter 2, SECTION 1, 1.2.4 can be met.

(4) the short circuit current of the generator and/or generator system is sufficient to trip the generator/generator system circuit-breaker taking into account the selectivity of the protective devices for the distribution system.

(5) where considered appropriate, load shedding arrangements are fitted to meet the requirements of paragraph 2.3 of SC 157.

(6) on ships having remote control of the ship's propulsion machinery from the navigating bridge means are provided, or procedures be in place, so as to ensure that supplies to essential services are maintained during maneuvering conditions in order to avoid a blackout situation (4).

NOTES:

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.

1.4 Control gear

1.4.1 General

(1) Control gears for propulsion equipment is to be designed for the appropriate voltages and is to include the apparatus necessary for starting, stopping, reversing and controlling the speed of motors together with essential instruments and safety devices.

(2) Where on stopping or reversing the propeller the regenerated energy transmitted by the propulsion motor in such as to cause a dangerous increase of speed in the prime mover, means are to be provided for suitably absorbing or limiting such energy.

(3) All levers, handles and their accessories for switches and contactors are to be of such proportions as to permit a satisfactory manual operation.

(4) All levers for operating contactors, line switches, field switches and the like are to be interlocked to prevent their wrong operation. These interlocks are to be of mechanical type as far as practicable.

(5) Where steam and oil gauges are mounted on the main control assembly, provisions are to be made so that in case of leakage, steam and oil may not come into contact with the energized parts.

(6) When power-aided control is used, other suitable means are to be provided to restore control in a short time in the event of power failure.

(7) The control gear is to be so arranged that in case of damage to the equipment outside the engine room, control can always be executed from the engine room manoeuvring control stations.

1.4.2 Locating of maneuvering control

(1) Control of the propulsion machines may be carried out from the bridge or deck. Alternative control in the engine room is to be provided. Transfer of control to the engine room in an emergency is to be possible without excessive loss of time.

(2) When two or more control stations are provided, indicating lights are to be located at each control station to indicate which station is in control. Means are to be provided to make impossible the operation simultaneously from different stations.

1.4.3 Main circuit and control circuit

(1) A propulsion system having two or more generator or motors respectively on one propeller shaft, is to be so arranged that any unit of them can be taken out of service and isolated electrically.

(2) Field circuits are to be provided with means of suppressing voltage rise when a field switch is opened.

1.4.4 Protection

(1) Over-current protective devices, if any, in the main circuits are to be set sufficiently high so that there is no possibility of their operating due to over-currents caused by manoeuvring or normal operation in heavy seas.

(2) Where separately driven D.C. generators are connected electrically in series, means are to be provided to prevent reversal of the rotation of a generator at the failure of the driving power of its prime mover.

(3) In excitation circuits, there is to be no overload protection causing the opening of the circuit.

(4) Means are to be provided to detect sudden short-circuit currents and to protect against phase imbalance. When damage likely to be caused to the electrical equipment is more serious than the possible consequences of losing propulsion power, consideration is to be given to providing means for rapid reduction of the magnetic fluxes of the generators or motors.

(5) Means for earth leakage detection are to be provided for the main propulsion circuit, and these are to be arranged to operate an alarm upon the occurrence of an earth fault.

(6) Insulated excitation circuits are to be provided with earth leakage detection which may consist of voltmeters or lamps.

1.4.5 Control gear for electromagnetic slip couplings

Control gear for electromagnetic slip couplings is to include a two-pole disconnecting switch, short-circuit protection and an ammeter for the coupling excitation circuit. Interlocking gear is to be provided to prevent the coupling from being energized when the driving machine control levers are in an inappropriate position. Such control gear may be combined with the prime mover speed control and reversing gear.

1.4.6 Instruments

(1) The following instruments, where required, are to be mounted on the main control assembly or any other location:

(a) For A.C. systems:

~ Ammeter, voltmeter, indicating wattmeter and field ammeter for each propulsion generator.

~ Field ammeter for each synchronous motor.

~ Speed indicator for each propeller shaft.

~ Temperature indicator for reading directly the temperature of each propulsion generator stator and motor stator.

(b) For D.C. systems:

~ Ammeter for each generator and motor field circuit.

~ Voltmeter for reading voltage in each generator, motor and exciter.

~ Speed indicator for each propeller shaft.

(2) Where control outside the engine room is used, instruments necessary for operation and monitoring of the main propulsion system are to be installed at a convenient location near such a station.

1.5 Cables

1.5.1 The conductors of cables and wiring are to consist of not less than 7 strands and conductors of a cross-sectional area smaller than 1,5mm^2 are not to be installed except cables or wiring for automatic equipment not directly connected to main circuits.

1.6 Testing and inspection

1.6.1 Following installation of the electric propulsion plant on board the ship, sea trials are to be carried out.

CHAPTER 13 Spares

CONTENTS

SECTION 1 General requirements

1.1 Application

1.1.1 It is recommended that adequate spares, together with the tools necessary for maintenance or repair, be carried.

1.1.2 The spare parts to be supplied and their location is to be the responsibility of the Owner but must take into account the design and arrangements of the electrical equipment and the intended service and operation of the ship. Account should also be taken of the recommendations of the manufacturers and any applicable statutory requirement of the country of registration of the ship.

1.1.3 The maintenance of the spares is the responsibility of the Owners.

CHAPTER 14 Testing

CONTENTS

SECTION 1 Testing of Ship's Electrical Installation

1.1 Insulation resistance test

1.1.1 Insulation-testing instruments

It is recommended that insulation resistance be measured by self-contained instruments such as direct-reading ohmmeter of the generator type, applying a voltage of at least 500V. When an insulation test is made on a circuit incorporating capacitors of a total capacitance exceeding 2μF, an insulation tester of the constant-voltage type shall be used in order to ensure that accurate test readings are obtained.

1.1.2 Switchboards, section boards and distribution boards

Before switchboards, section boards and distribution boards are put into service, their insulation resistance is to be not less than 1MΩ when measured between each busbar and earth and between each insulated busbar and the busbar connected to the other pole or poles. This test shall be made with all circuit-breakers and switches open and all fuselinks for pilot lamps, earth-fault indicating lamps, voltmeters, etc. removed and voltage coils temporarily disconnected.

1.1.3 Lighting and power circuits

A test for insulation resistance between all insulated poles and earth and, where practicable, between poles, shall be applied to all permanent wiring. It is not considered practicable to specify minimum values for insulation resistance as these will depend on climatic conditions at the time of the test, but a minimum value of 1MΩ shall be obtainable under average conditions. The installation may be subdivided to any desired extent and appliances may be disconnected if initial tests give results lower than that indicated above.

1.1.4 Insulation resistance of generators and motors

The insulation resistance of generators and motors is to be measured in warm condition immediately after running with normal load. The results obtained depend not only on the characteristics of the insulation materials and on the way in which they are applied, but also on the test conditions. It is therefore necessary that the obtained values be completed by recording these conditions, particularly those concerning the ambient temperature and the degree of humidity at the moment of the test. The insulation resistance in MΩ while at their operating temperatures is to be normally at least equal to:

$$\frac{3 \times Rated\ Voltage\ of\ the\ Machine}{Rating\ (in\ kVA) + 1000}$$

1.1.5 Internal communication circuits

Each circuit operating at a voltage of 55V and above is to have an insulation resistance between conductors and between each conductor and earth of not less than 1MΩ. For circuits operating at

voltages below 55V, the insulation is to be not less than one-third MΩ. If necessary, any or all appliances connected to the circuit may be disconnected while the test is being made.

1.2 Performance test

1.2.1 Generators

Generators are to be tested as follows:

(1) The operation of overspeed trip and other safety devices are to be demonstrated.

(2) If generators are intended to operate in parallel, they are to be tested over a range of loading sufficient to demonstrate that load sharing and parallel operation are satisfactory. Voltage regulation is to be satisfactory.

(3) All generators are to run at full rated load for a duration sufficient to demonstrate that temperature rises, commutation and absence of vibration are satisfactory.

1.2.2 Switchboards

All switches, circuit-breakers, and associated equipment on the switchboard are to be operated on load to demonstrate suitability, and also section and distribution boxes are to be tested as above.

1.2.3 Motors

Motors are to be tested as follows:

(1) Each motor with all its associated control equipment is to run under operating conditions to demonstrate wiring, capacity, speed and satisfactory operation.

(2) Motors driving various auxiliary machinery, pumps, etc., are to be operated to demonstrate that the operating characteristics are satisfactory.

(3) Motors driving cargo winches and windlasses are to hoist and lower their specified loads.

1.2.4 Lighting circuits

Lighting circuits are to be tested as follows:

(1) Circuits are to be tested to demonstrate that all lighting fittings, switches, receptacles and other connected fittings, are in suitable operating condition.

(2) Emergency lighting systems is to be tested in the same manner as specified in (1) above.

1.2.5 Electric heaters and electric cooking ranges

Electric heaters, electric cooking ranges and the like are to be tested to demonstrate that the heating elements function satisfactorily.

1.2.6 Internal communication systems

Each internal communication system is to be thoroughly tested to demonstrate its specified functioning. Particular attention is to be paid to test the operation of the ships essential electric communication systems which include engine order telegraphs, helm indicators, fire alarms, emergency signal, morse signal lamp, navigation light indicator panel and telephones.

1.2.7 Voltage drop

During above tests, it is to be ascertained that the voltage drop of feeder circuits does not exceed the values specified in Part 6, Chapter 6, SECTION 1, 1.3.2.

1.2.8 Requirements of international conventions on safety of life at sea

Equipment installed to implement the international conventions in force is to be specially tested to ensure that all requirements have been met. Where operation is required to be maintained from emergency sources, correct functioning from and by such emergency supply shall be tested and the duration of emergency supply, where specified, shall also be tested.

CHAPTER 15 Special requirements for systems with voltages above 1kV up to 15kV

CONTENTS

SECTION 1 General

1.1 Field of application

1.1.1 The following requirements apply to a c. three-phase systems with nominal voltage exceeding 1kV, the nominal voltage is the voltage between phases. If not otherwise stated herein, construction and installation applicable to low voltage equipment generally apply to high voltage equipment.

1.2 Nominal system voltage

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

NOTE:

Where necessary for special application, higher voltages may be accepted by the Society.

1.3 High-voltage, low-voltage segregation

1.3.1 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.

SECTION 2 System Design

2.1 Distribution

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

2.1.2 Earthed neutral systems

In case of earth fault, the current is not to be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any device against earth fault. It is to be assured that at least one source neutral to ground connection is available whenever the system is in the energized 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.

2.1.3 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.

2.1.4 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.

2.1.5 Divided systems

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

2.2 Degrees of protection

2.2.1 General

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.

2.2.2 Rotating machines

The degree of protection of enclosures of rotating electrical machines is to be at least IP23. The degree of protection of terminals is to be at least IP44. For motors installed in spaces accessible to unqualified personnel, a degree of protection against approaching or contact with live or moving parts of at least IP4X is required.

2.2.3 Transformers

The degree of protection of enclosures of transformers is to be at least IP23. For transformers installed in spaces accessible to unqualified personnel a degree of protection of at least IP4X is required. For transformers not contained in enclosures, see 7.1.

2.2.4 Switchgear, control gear assemblies and converters

The degree of protection of metal enclosed switchgear, control gear assemblies and static converters is to be at least IP32. For switchgear, control gear assemblies and static converters installed in spaces accessible to unqualified personnel, a degree of protection of at least IP4X is required.

2.3 Insulation

2.3.1 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 15.2.1.

Table 15.2.1: Minimum clearances

Nominal Voltage (KV)	Minimum clearance (mm)
3 (3,3)	55
6 (6,6)	90
10 (11)	120
15	160

Intermediate values may be accepted for nominal voltages provided that the next higher air clearance is observed. In the case of smaller distances, appropriate voltage impulse test must be applied.

2.3.2 Creepage distances

Creep age 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 insultation material and the transient overvoltage developed by switch and fault conditions. For non-standardized 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.

2.4 Protection

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

2.4.2 Faults to earth

Any earth fault in the system is to be indicated by means of a visual and audible alarm. In low impedance or direct earthed systems provision is to be made to automatic disconnect the faulty circuits. In high impedance earthed systems, where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase-to-phase voltage.

NOTE:

Earthing factor is defined as the ratio between the phase to earth voltage of the health phase and the phase-to-phase voltage. This factor may vary between $\left(\frac{1}{\sqrt{3}}\right)$ and 1.

A system is defined effectively earthed (low impedance) when this factor is lower than 0,8. A system is defined non-effectively earthed (high impedance) when this factor is higher than 0,8.

2.4.3 Power transformers

Power transformers are to be provided with overload and short circuit protection. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

2.4.4 Voltage transformers for control and instrumentation

Voltage transformers are to be provided with overload and short circuit protection on the secondary side.

2.4.5 Fuses

Fuses are not to be used for overload protection.

2.4.6 Low voltage systems

Lower voltage systems supplied through transformers from high voltage systems are to be protected against over-voltages. This may be achieved by:

i. direct earthing of the lower voltage system
ii. appropriate neutral voltage limiters
iii. earthed screen between the primary and secondary windings of transformers.

SECTION 3 Rotating machinery

3.1 Stator windings of generators

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

3.2 Temperature detectors

3.2.1 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.

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

3.3 Tests

3.3.1 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.

SECTION 4 Power Transformers

4.1 General

4.1.1 Dry type transformers have to comply with IEC Publication 60726. Liquid cooled transformers have to comply with IEC Publication 60076. Oil immersed transformers are to be provided with the following alarms and protections:

~ liquid level (Low)-alarm

~ liquid temperature (High)-alarm

~ liquid level (Low)-trip or load reduction

~ liquid temperature (High)-trip or load reduction

~ gas pressure relay (High)-trip

SECTION 5 Cables

5.1 General

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

SECTION 6 Switchgear and control gear assemblies

6.1 General

6.1.1 Switchgear and control gear assemblies are to be constructed according to the IEC Publication 60298 and the following additional requirements.

6.2 Construction

6.2.1 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.

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

6.2.3 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.

6.2.4 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.

6.3 Auxiliary systems

6.3.1 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. 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.

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

6.4 High voltage test

6.4.1 A power-frequency voltage test is to be carried out on any switchgear and control gear assemblies. The test procedure and voltages are to be according to the IEC Publication 60298.

SECTION 7 Installation

7.1 Electrical equipment

7.1.1 Where equipment is not contained in an enclosure but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down. At the entrance of the spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed which indicates danger of high-voltage. As regard the high-voltage electrical equipment installed out-side a.m. spaces, the similar marking is to be provided.

7.2 Cables

7.2.1 Runs of cables

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

7.2.2 Segregation

High voltage cables are to be segregated from cables operating at different voltage ratings each other; in particular, they are not to be run in the same cable bunch, nor in the same ducts or pipes, or, in the same box. Where high voltage cables of different voltage ratings are installed on the same cable tray, the air clearance between cables is not to be less than the minimum air clearance for the higher voltage side in 2.3.1. However, high voltage cables are not to be installed on the same cable tray for the cables operating at the nominal system voltage of 1 kV and less.

7.2.3 Installation arrangements

High voltage cables, in general, are to be installed on carrier plating when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth; otherwise they are to be installed for their entire length in metallic castings effectively bonded to earth.

7.2.4 Terminations

Terminations in all conductors of high voltage cables are to be, as far as practicable, effectively covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases are to be separated from earth and from each other by substantial barriers of suitable insulating materials. High voltage cables of the radial field type, i.e. having a conductive layer to control the electric field within the insulation, are to have terminations which provide electric stress control. Terminations are to be of a type compatible with the insulation and jacket material of the cable and are to be provided with means to ground all metallic shielding components (i.e. tapes, wires etc).

7.2.5 Marking

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

7.2.6 Test after installation

Before a new high voltage cable installation, or an addition to an existing installation, is put into service a voltage withstand test is to be satisfactorily carried out on each completed cable and its accessories. The test is to be carried out after an insulation resistance test. When a d.c. voltage withstand test is carried out, the voltage is to be not less than:

~ 1.6 (2.5 U_o +2kV), for cables of rated voltage (U_o) up to and including 3.6 kV, or

~ 4.2 U_o, for higher rated voltages

where:

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

The test voltage is to be maintained for a minimum of 15 minutes. After completion of the test the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge. An insultation resistance test is then repeated. 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.

NOTE:

Tests according to those specific in IEC Publication 60502 will be considered adequate too.

CHAPTER 16 Safety Arrangements

CONTENTS

SECTION 1 General requirements

1.1 Fire pumps

1.1.1 Where an electrically driven fire pump is supplied from the emergency generator the supply to such pump is not to pass through the main machinery spaces. The cables are to be of a fire-resistant type where they pass through high fire risk areas.

1.2 Automatic sprinkler system

1.2.1 Electrically driven sea-water pumps for automatic sprinkler systems are to be served by not less than two circuits reserved solely for this purpose, one fed from the main switchboard and one from the emergency switchboard. Such feeders are to be connected to an automatic change-over switch situated near the sprinkler pump and the switch is to be normally closed to the feeder from the main switchboard. The Switches on the main and emergency switchboards are to be clearly labeled and normally kept closed. No other switch is permitted in the feeders.

1.2.2 Automatic alarm and detection system is to be served by two circuits, reserved solely for this purpose, one fed from the main power source and one from an emergency power source. Such feeders are to be connected to an automatic change-over switch situated near to the main alarm and detection panel.

1.3 Fire detection and alarm system

1.3.1 Electrical circuits and controls for the fire detection system are to be in accordance with the requirements of Chapter II-2, Regulation 13 of SOLAS 74 and the amendments in force.

1.4 Fire safety stops

1.4.1 Means are to be provided for stopping the motors of ventilators, boiler blowers, fuel oil transfer pumps, fuel oil burning pumps, cargo oil pumps and other fuel oil pressure pumps from an accessible position outside the space where the motors are installed in case of fire in the space or in the vicinity thereof. But, each separate emergency stop control circuits of ventilators are to be provided for machinery space and accommodation spaces.

1.4.2 New passenger ships carrying more than 36 passengers shall have the detection alarms for the systems required by 1.2 and 1.3 of this Section centralized in a continuously manned central control station. In addition, controls for remote closing of the fire doors and shutting down the ventilation fans are to be centralized in the same location. The ventilation fans are to be capable of reactivation by the crew at the continuously manned control station. The control panels in the central control station are to be capable of indicating open or closed positions of fire doors and closed or off status of the detectors, alarms and fans. The control panel is to be continuously powered and should have an automatic change-over stand by power supply in case of loss of normal power supply. The control panel is to be powered from the main source of electric power and the emergency source of electric power as defined in the Part 6, Chapter 11. The control panel is to be designed on the fail-scale principle.

1.4.3 Means of cutting off power to the galley, in the event of a fire are to be provided outside the galley exits, at positions which will not readily be rendered inaccessible by such a fire.

1.5 Arrangement of the safety system

1.5.1 Distribution systems are to be so arranged that a fire in any main vertical fire zone will not interfere with services essential for safety in any other such zone. These requirements will be met if main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable.

1.6 Navigation light circuits

1.6.1 Navigation lights are to be fitted with duplicate lamps or other dual light sources, and are to be controlled by an indicator panel placed in an accessible position on the navigating bridge.

1.6.2 Control and protection

Each navigation light is to be controlled and protected in each insulated pole by a switch with fuses and a circuit-breaker fitted on the navigation light indicator panel.

1.6.3 Feeder circuits of navigation lights

The navigation light indicator is to be served by two circuits fed from the main switch-board. The circuits are to be separated throughout their length as widely as practicable. One of the circuits is to pass through the emergency switchboard, if provided. One of the circuits may be supplied from a lighting distribution board installed in the wheel house, if the emergency switchboard is not provided.

1.6.4 Each navigation light is to be provided with an automatic indicator which gives audible and/or visual warning in the event of extinction of the light. If an audible device is used, it is to be connected to a separate source of supply, for example a primary or accumulator (storage) battery. If a visual signal is used which is connected in series with the navigation light, means are to be provided to prevent the extinction of the navigation light due to failure of the visual signal.

1.7 Emergency Lighting

1.7.1 Emergency lightings are to be installed in accordance with the requirements of Part 6, Chapter 11.

1.7.2 The level of illumination provided by the emergency lighting is to be adequate to permit safe evacuation in an emergency, having regard to the possible presence of smoke.

1.7.3 Switches are not to be installed in the final subcircuits to emergency lighting fittings.

1.7.4 Emergency lightings shall be marked for easy identification.

1.8 Watertight doors

1.8.1 The electrical sources, circuits and controls for the watertight doors are to be in accordance with the requirements of Chapter II-1, Regulation 15 of SOLAS 74 and amendments in force.

1.9 Radio installations

1.9.1 A special circuit from the main switchboard or the emergency switchboard shall be provided for supplying radio installations.

CHAPTER 17 Special Requirements for Tankers

CONTENTS

SECTION 1 Electrical Equipment in Tankers

1.1 General

1.1.1 The electrical equipment in tankers are to comply with I.E.C Publication (92-502), or an equivalent national standard.

1.2 Oil Tankers

1.2.1 Application

In addition to the above, the following requirements are applicable to the vessels carrying oil having a flash point not exceeding 60°C.

1.2.2 Installation of Equipment

Electrical equipment are not to be installed in any hazardous areas unless essential for operation purposes. In such cases, the installation of equipment is to comply with 1.2.6 of this Section.

1.2.3 Cables

(1) Unless otherwise mentioned in this Chapter, or when associated with intrinsically safe circuits, cables shall not be installed in hazardous areas.

(2) In addition to the requirements of Part 6, Chapter 6, cables for circuits that are not intrinsically safe, which are located in dangerous zones or spaces, or which may be exposed to cargo oil, oil vapour or gas, are to be either:

(a) mineral insulated with copper sheath, or

(b) armored or braided for earth detection.

(3) Metal coverings of cables installed in dangerous zones or spaces are to be effectively earthed at least at both ends.

(4) Cables associated with intrinsically-safe circuits are to be used only for such circuits. They are to be physically separated from cables associated with non-intrinsically-safe circuits, e.g. neither installed in the same protective casing nor secured by the same fixing clip.

1.2.4 Hazardous areas

The hazardous areas include:

- Cargo tanks and cargo piping
- Cofferdams, and permanent (for example, segregated) ballast tanks adjacent to cargo tanks
- Cargo pump rooms
- Compartments for cargo hoses

- Enclosed or semi-enclosed spaces, immediately above cargo tanks or having bulkheads above and in line with cargo bulkheads, where permitted by Reg. II-2/56 of SOLAS 1974 as amended.
- Enclosed or semi-enclosed spaces, immediately above cargo tanks, or above vertical cofferdams adjacent to cargo tanks, unless separated by a gas-tight deck and suitably mechanically ventilated, where permitted by Reg. II-2/56 of SOLAS 1974 as amended.
- Spaces. other than cofferdams, adjacent to and below the top of a cargo tank (for example, trunks, passage-ways and holds)
- Areas on open decks, or semi-enclosed spaces on open decks , within 3m of any cargo tank outlets, gas or vapor outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump room entrances or cargo pump room ventilation openings.
- Areas on open deck over all cargo tanks (including all ballast tanks within cargo tank area) and to the full breadth of the ship plus 3m fore and aft on open deck, up to a height of 2.4m above the deck which do not belong to the hazardous areas.
- Enclosed or semi-enclosed spaces, having an opening into any hazardous area unless 1.2.8 is applicable.

1.2.5 Earthed Distribution System

An earthed distribution system is not to be used except as specified in Part 6, Chapter 2, SECTION 3, 3.2.

1.2.6 Electrical equipment in hazardous areas

(1) Cofferdams adjoining cargo tanks

(a) Intrinsically – safe (ia) apparatus.

(b) Electric depth-sounding devices hermetically enclosed, with cables installed in heavy gauge steel pipes with gas-tight joints up to the main deck.

(c) Where impressed current cathodic protection systems are fitted (external hull protection only) and if it is necessary for the cables to pass through cofferdams, these cables are to be installed in heavy gauge steel pipes with gas-tight joints up to the main deck.

Corrosion-resistant pipes, giving adequate mechanical protection, are to be used in compartments which might be filled with sea water, e.g. permanent ballast tanks.

(2) Cargo pumps rooms

(a) Electrical devices in cargo pump-rooms are to be installed as in (1) above.

(b) Certified safe-type luminaries of the pressurized type or flameproof type arranged on at least two independent final sub-circuits (see NOTE). All switches and protective devices are to interrupt all poles or phases and are to be located in a non-hazardous area. The luminaries, switches and protective devices shall be suitably labelled for identification purposes.

NOTE:

This arrangement permits light from one circuit to be retained while maintenance is carried out on the other.

(c) Where it is necessary for cables other than those supplying the luminaries, as provided in

(2)(b) above, to pass through cargo pump-room entrances, they are to be installed in heavy gauge steel pipes with gas-tight joints.

(3) Enclosed or semi-enclosed spaces immediately above cargo tanks (e.g between-decks) or having bulkheads above and in line with cargo tank bulkheads.

Enclosed or semi-enclosed spaces immediately above cargo pump-rooms or above vertical cofferdams adjoining cargo tanks unless separated by a gas-tight deck and suitably ventilated.

(4) Compartments for cargo hoses

(a) Intrinsically-safe apparatus

(b) Certified safe-type luminaries as under (2)(b). All switches and protective devices are to interrupt all poles or phases and are to be located in a non-hazardous area. The luminaries, switches and protective devices are to be suitably labelled for identification purposes.

(c) Through-runs of cables.

(5) Spaces, other than cofferdams, adjoining and below the top of a cargo tank (e.g., trunks, passage-ways and holds)

(a) Electrical devices installed as indicated in (1) above.

(b) Certified safe-type luminaries of the pressurized type or flameproof type, arranged on at least two independent final sub-circuits. All switches and protective devices shall interrupt all poles or phases and are to be located in a non-hazardous area. The luminaries, switches and protective devices shall be suitably labelled for identification purposes.

(c) Through-runs of cables require special consideration.

(6) Areas on open deck or semi-enclosed spaces on open deck, within 3m of any cargo oil tank outlet or gas or vapour outlet.

For example, areas within 3m of cargo tank hatches, sight ports, tank cleaning openings, ullage openings, sounding pipes, cargo pump-room entrances, cargo vapour outlets or ventilation outlets for cargo pump-rooms, cargo pump-room entrance, cofferdams and cargo tanks.

(a) Certified safe-type equipment as mentioned in of Part 6, Chapter 2, SECTION 1, 1.5.2 and suitable for use on open deck.

(b) Through-runs of cables: cable expansion bends shall not be fitted in these areas.

(7) Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank block) and to the full width of the vessel plus 3m fore and aft on open deck, up to a height of 2,4m above the deck.

Enclosed or semi-enclosed spaces having a direct opening in one of the previously mentioned areas.

(a) Certified safe-type equipment as mentioned in Part 6, Chapter 2, SECTION 1, 1.5.2 and suitable for use on open deck, where necessary.

(b) Through-runs of cables.

(8) Enclosed or semi-enclosed spaces, having an opening into any hazardous area.

(a) Certified safe-type equipment as mentioned in Part 6, Chapter 2, SECTION 1, 1.5.2.

1.2.7 Cargo pump-rooms

Electric motors driving equipment located in cargo pump-room spaces is to be separated from these spaces by a gas-tight bulkhead or deck. Flexible couplings or other means of maintaining alignment are to be fitted in the shafts between the pumps and the motors and, in addition, suitable stuffing boxes are to be fitted where shafts pass through gas-tight bulkheads or decks. The luminaries for such spaces are to be permanently fitted and wired outside the spaces. Pump-rooms immediately adjoining machinery spaces or similar non-hazardous areas may be lit through permanently fixed glass lenses or ports fitted in the bulkhead or deck to maintain the oil-tight, gas-tight and strength integrity of the structure. Where the location of the pump-room does not permit the use of bulkhead lighting arrangements, or where deck lighting installations do not furnish sufficient light in lower pump-rooms, pump-rooms may be lit as provided in par.1.2.7 (2)b.

1.2.8 Enclosed or semi-enclosed spaces which have openings into hazardous area may be regarded as non-dangerous and non-safe type equipment is permitted within these spaces, if fulfilling all the following conditions:

~ Access is by means of an air-lock, having two gas-tight steel doors, of self-closing type without any hold-back arrangement.

~ It is maintained at an overpressure relative to the external hazardous area by ventilation from a non-hazardous area.

~ The relative air pressure within the space is continuously monitored and, so arranged, that in the event of loss of overpressure an alarm is given and the electrical supply to all equipment not of a safe type is automatically disconnected. Where the shut-down of equipment could

introduce a hazard, an alarm may be given, in lieu of shutdown, upon loss of overpressure, and a means of disconnection of non-safe type electrical equipment, capable of being controlled from a manned station, provided in conjunction with an agreed operational procedure： where the means of disconnection are located within the space then it is to be effected by equipment of a safe type.

~ Any electrical equipment required to operate upon loss of overpressure, lighting fittings and equipment within the air-lock, is to be of a safe type.

~ Means are to be provided to prevent electrical equipment, other than of a safe type, being energized until the atmosphere within the space is made safe, by air renewal of at least 10 times the capacity of the space.

1.2.9 Earthing and bonding of cargo tanks/ process plant/ piping systems for the control of static electricity (IACS UR E9 Rev.1[6])

(1) The hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of liquids/gases/vapours can be avoided if the resistance between the cargo tanks/process plant/piping systems and the hull of the ship is not greater than 10^6 Ω.

(2) This value of resistance will be readily achieved without the use of bonding straps where cargo tanks/process plant/piping systems are directly or via their supports, either welded or bolted to the hull of the ship.

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

(a) independent cargo tanks,

(b) cargo tanks/piping systems which are electrically separated from the hull of the ship,

(c) pipe connections arranged for the removal of spool pieces.

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

(4) Where bonding straps are required, they should be:

(a) clearly visible so that any shortcomings can be clearly detected,

[6] NOTE:

1. The requirements of UR E9 Rev.1 are to be uniformly implemented by the Society on ships contracted for construction on and after 1 January 2014:

2. The "contracted for construction" date means the date on which the contract to build the vessel is signed between the prospective owner the shipbuilder

(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.

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