INTLREG
INTERNATIONAL REGISTER OF SHIPPING

RULES FOR CLASSIFICATION OF FRP VESSELS

PART 6
Electrical Systems

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CHANGES HISTORY

Refer Part 1 for Changes

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CHAPTER 1 GENERAL

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SECTION 1 REQUIREMENTS

Contents

1.1 Application

1.1.1. This Part applicable to the electrical equipment and wirings for FRP ships without special service limitations or restrictions. INTLREG shall, however, amend the requirements in certain cases for their application to ships with service limitations or restrictions.

1.1.2. The INTLREG shall provide special consideration to the novel features of design in respect of the electrical installation based on the best information available at the time.

1.1.3. The electrical equipment's and the wiring system of a classed ship shall be constructed, installed and tested under the supervision and to the satisfaction of the Surveyor in accordance with the following requirements.

At any case it shall consider ,to the arrangements or details of the equipment and machinery which comply with other recognized standards provided they are not less effective than the requirements of this Part.

1.1.4. Applying the requirements of the following Chapters, the so-called essential auxiliaries shall be as specified in Chapter 1 of Part 5,Machinery and Piping of the INTLREG Rules for Classification of FRP Ships.

1.1.5. Passenger ships intended for classification shall be constructed in accordance with the requirements of INTLREG,as well as those of Governmental and International Convention Regulations.

1.2 Documents

1.2.1. The shipbuilder or manufacturer shall submit the following drawings and data for approval before the work commences:

a) For propulsion machineries, generators and essential motors of 100kW and over:
Complete rating, seating arrangements, assembly, shaft, stator and rotor details, electric propulsion coupling details, mass, main dimensions, main materials used, and data for calculation of critical speed.

b) For generators and essential motors below 100kW:
Compete rating, seating arrangements, type of enclosure and dimensional outline.

c) For switchboards:
Arrangements and details, front view, installation arrangements and wiring diagram.

d) For wiring:
All wiring plans and circuit diagrams including load distribution, wire size, type of cable, maximum temperature rise of conductor and voltage drop, type of insulation, rating or setting of circuit breaker, rating of fuse and switch, and interrupting capacity of circuit breaker and fuse.

e) For arrangement:
General arrangement of electric equipment including details of the main cable runs.

1.2.2. The shipbuilder shall submit the following specification and data for approval before the work commences:

a) Specifications and detailed list of electrical equipments.
b) Load analysis and safety protection description.
c) Calculations of short circuit currents at main, emergency and sub-switchboards including those fed from transformers.
d) Explanation of electric propulsion system.

1.3 Ambient Conditions

1.3.1. 45°C shall be considered the standard ambient temperature for the inside of the boiler or machinery space and 32°C shall be considered the standard temperature for the inlet of sea water. For other spaces, a temperature of 40°C shall be considered as the standard ambient temperature.

1.3.2. The values as specified in the tables of limits of temperature rise in this Part are based on 45°C standard ambient temperature. For the ambient temperature of 40°C, these values shall be increased by 5°C.

1.3.3. If the ambient temperature of a space is in excess of the values specified in [1.3.1] above, the permissible temperature rise of the machine or equipment installed in that space shall be reduced by an amount equivalent to the excess temperature.

1.4 Inclination of Ship

1.4.1. Machines and apparatus should operate satisfactorily under all conditions with the ship inclined up to the following angles from the normal:

a) athwartships, static 15° ,dynamic 22.5°
b) fore-and-aft, static 5° dynamic 7.5°

1.4.2. Emergency machines and apparatus fitted in accordance with statutory requirements should operate satisfactorily when the ship is inclined up to 22.5o and/or when the trim of the ship is 10°.

1.5 Voltage and Frequency Variations

1.5.1. All electrical equipment supplied from the main and emergency source of electrical power shall be so designed and manufactured that it is capable of operating satisfactorily under normally occurring variations of voltage and frequency. Unless specified otherwise electrical equipment, other than that supplied by battery systems, shall operate satisfactorily with the following simultaneous variations, from their nominal value, when measured at the consumer input terminals.

a) voltage:

permanent variations +6%, -10%
transient variations ±20%
recovery time 1.5 seconds

b) frequency:

permanent variations ± 5%
transient variations ± 10%
recovery time 5 seconds

1.6 Equipment Location

1.6.1. Electrical equipment shall be accessible , placed in well-ventilated and adequately lighted spaces such that no risk of mechanical injury or damage arising from water, steam or oil. If it is unavoidable to be exposed to such risks, the equipment shall be so constructed as to meet the conditions of the locations.

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

1.6.3. Live parts shall be effectively shielded from any accidental contact when the voltage is above 250V D.C. or 150V, A.C.

1.6.4. All electrical apparatus shall be so constructed and installed such that it does not cause injury when handled or touched in the normal manner.

1.6.5. Insulating materials and insulated windings shall be resistant to moisture, sea air and oil vapour unless special precautions are taken to protect them.

1.6.6. Equipment shall not to remain alive through the control circuits and/or pilot lamps when switched off by the control switch. This does not apply to synchronizing switches and/or plugs.

1.6.7. The operation of all electrical equipment and the lubrication arrangements shall be efficient under such conditions of vibration and shock as arise in normal practice.

1.6.8. All nuts and screws used in connection with current-carrying parts and working parts shall be well locked to prevent loosen due to vibration.

1.6.9. No electrical equipment shall be installed in any space where flammable mixtures are liable to collect including those on board oil tanks or in compartments assigned principally to accumulator batteries, in paint lockers, acetylene stores or similar spaces, unless INTLREG is satisfied that such equipment is:

a) essential for operational purposes;
b) of a type which shall not ignite the mixture concerned;
c) appropriate to the space concerned; and
d) appropriately certified for safe usage in the dusts, vapours or gases likely to be encountered.

1.6.10. Generators and motors are preferably be placed with their axis of rotation in the fore and aft direction of the ship. 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 ship’s inclination specified in [1.3] above.

1.6.11. The electrical equipment exposed to the weather or located in spaces exposed to sea splashing or other severe moisture condition shall be of the waterproof type or protected by means of waterproof enclosure.

1.6.12. Conductors and equipment shall be placed at such a distance from the magnetic compass or all to be so screened that the interfering external magnetic field is negligible, even when circuits are switches on and off.

1.7 Earthing and Lightning Protection

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

a) supplied at a voltage not exceeding 50V direct current or 50V, root mean square between conductors; auto-transformers are not to be used for the purpose of achieving this voltage; or

b) supplied at a voltage not exceeding 250V by safety isolating transformers supplying only one consuming device; or
c) constructed in accordance with the principle of double insulation.

1.7.2. Metal frames of all portable electric lamps, tools and similar apparatus supplied as unit's equipment and rated in excess of 50V shall be earthed through a suitable conductor unless equivalent safety provisions are made such as by double insulation or by an isolating transformer.

1.7.3. Where earthing connections are necessary, they shall be of copper or other approved material and shall be protected against damage and, where necessary, against electrolytic corrosion.

1.7.4. In general, the nominal cross-section area of copper earthing conductor shall be not less than that required in Table 1.1.1

1.7.5. The connection of the earthing conductor shall be made in an accessible position, and shall be secured by a screw or stud of diameter not less than 6 mm which shall be used for this purpose only. Bright metallic surfaces at the contact areas shall be ensured immediately before the nut or screw is tightened and, where necessary, the joint shall be protected against electrolytic corrosion. The connection shall remain unpainted.

1.7.6. The metal parts of all electrical equipment of the ships shall be earthed to the sea water, in so far as possible in consideration of galvanic corrosion between dissimilar metals. The earthing of isolated components inside the structure is not generally necessary, except in fuel tanks. Each pressure refueling point shall be provided with a means of earthing the fueling equipment to the ships.

1.7.7. The reliable lightning protection system shall be provided as follows:

a) the lightning spikes shall be made of copper rod not less than 8 mm in diameter or of aluminum with equivalent surge current carrying capacity.

b) the lightning spikes shall be projected at least 150 mm above the top of the mast.

c) the lightning spikes shall be connected effectively to and in good electrical contact with the metal earthing plate of not less than 450 cm2 in area by means of a copper bar not less than 50 mm^2 in cross section, the earthing plate shall be so arranged to ensure it immersed in sea water under any navigating condition.

1.8 Bonding for the Control of Static Electricity

1.8.1. Metallic pipes capable of generating electrostatic discharges, due to the flow of liquids and gases shall be bonded so as shall be electrically continuous throughout their length and shall be adequately earthed.

1.8.2. Where bonding straps required for the control of static electricity, they shall be robust, having a cross-sectional area of about 5 mm^2, and shall to comply with Sections [1.7.3] and [1.7.5] above.

1.9 Clearances and Creepage Distances

1.9.1. Clearances and creepage distances between live parts and earthed metal, whether across surfaces or in air, shall be adequate for the working voltage having regard to the nature of the insulating material and the transient over-voltages developed by switch and fault conditions.

1.9.2. Bare main bus bars in main and emergency switchboards, but not including the conductors between the main bus bars and the supply side of out- going units, shall have minimum clearances (in air) and creepage distances (across surfaces) as given in Table 1.1.2

1.10 Electrical Equipment for Use in Explosive Gas Atmospheres

1.10.1. In case of electrical equipment is installed in areas where explosive gas atmospheres shall be present, it shall be of a "safe type", certified for the gases/ vapours involved. The construction and type testing shall be in accordance with IEC Publication 79, Electrical Apparatus for Explosive Gas Atmospheres, or an equivalent national standard.

1.10.2. Certified safe type equipment includes the following types of protection:

a) Intrinsically safe - Ex "i"
b) Increased safety - Ex "e"
c) Flameproof - Ex "d"
d) Pressurized enclosure - Ex "p"

1.10.3. In addition, lighting fittings of the air driven type with pressurized enclosure are considered to be a "safe type" of lighting fitting.

1.10.4. When "safe type" equipment is permitted in hazardous zones or spaces all switches and protective devices shall interrupt all lines or phases and, where practicable, shall be located in a non-hazardous zone or space unless specifically permitted otherwise. Such equipment, switches and protective devices shall be suitably labeled for identification purposes.

1.11 Tests and Inspection

1.11.1. All generators, including emergency generators, motors, and other rotating machines for essential auxiliary services shall be tested in the presence of the Surveyor, preferably at the plant of the manufacturer. For electrical machines of less than 750 kW an application shall be considered to the acceptance of standardized, batch and line produced machinery without tests and inspections of individual units subject to approval of the proposed designs and the manufacturer‘s quality control program.

1.11.2. Shop tests of generators and motors shall be carried out as follows:

a) For generators:

i) Temperature rise test
ii) Load characteristics
iii) Overload test
iv) Overspeed test

v) High voltage test
vi) Insulation resistance measurement
vii) Mechanical check of end play setting, running balance, vibration and bearing temperature

b) For motors:
i) Temperature rise test
ii) Speed range if variable speed
iii) Excess torque test
iv) Overspeed test
v) High voltage test
vi) Insulation resistance measurement
vii) Mechanical check of end play setting, running balance, vibration and bearing temperature.

1.11.3. The switchboard and controller shall be inspected and dielectric tested in the presence of the Surveyor. Satisfactory operation of tripping safety devices shall also to be demonstrated.

1.11.4. The shaft material of generators and motors of 375 kW and over shall be tested in accordance with the requirements in INTLREG Part 2 Rules and Regulations for Classification of Steel Vessel ,Materials and welding For the shaft material of machines below 375 kW the manufacturer's certificate of material test shall be acceptable in each case provided the test record submitted by the manufacturer is satisfactory.

1.11.5. Transformers shall be inspected in the presence of the Surveyor at the plant of the manufacturer and subject to the tests of momentary short circuit, voltage regulation, voltage ratio, temperature rise, high voltage and induced overvoltage.

1.11.6. Cables shall be tested and inspected in the presence of the Surveyor at the plant of the manufacturer for conductor resistance, high voltage, insulation resistance, and flammability tests. The dimensions and construction of the cables shall also to be inspected.

1.11.7. The electrical equipment for use in explosive gas atmospheres shall be approved and tested in the presence of the Surveyor.

Table 1.1.1
Size of Earth-continuity Conductors and Earthing Connections

Type of earthing connection	Cross-sectional area of associated current carrying	Minimum cross-sectional area of copper
Earth-continuity conductor in flexible cable or flexible cord	A ≤16 mm^2	A
	16 mm^2 <A ≤32 mm^2	16 mm^2
	A >32 mm^2	A / 2
Earth-continuity conductor incorporated in fixed cable	For cables having an insulated earth-continuity conductor	
	A ≤1.5 mm^2	1.5 mm^2
	1.5 mm^2 <A ≤16 mm^2	A
	16 mm^2 <A ≤32 mm^2	16 mm^2
	A >32 mm^2	A / 2
	For cables with a bare earth wire in direct contact with the lead sheath	
	A ≤2.5 mm^2	1 mm^2
	2.5 mm^2 <A ≤6 mm^2	1.5 mm^2
Separated fixed earthing conductor	A ≤2.5 mm^2	Stranded earthing 1.5 mm^2 for A ≤1.5 mm^2 A for A >1.5 mm^2

		Unstranded earthing connection : 2.5 mm^2
	2.5 mm^2 <A ≤8 mm^2	4 mm^2
	8 mm^2 <A ≤120 mm^2	A / 2
	A >120 mm^2	70 mm^2

Table 1.1.2
Minimum Clearance and Creepage Distances

Rated insulation voltage(V)	Minimum clearances	Minimum creepage distances(mm)
Up to 250	15	20
Over 250 to 660	20	30
Over 660 to 1000	25	35

Notes: The values in this table apply to clearances and creepage distances between live parts as well as between live parts and exposed conductive parts, including grounding

CHAPTER 2 DISTRIUTION AND CIRCUIT PROTECTION DESIGN

CONTENTS

SECTION 1 DESIGN

Contents

1.1 General

1.1.1. Distribution systems.

a) standard distribution systems are as follows,

i) Two-wire direct current.

ii) Three-wire direct current (three-wire insulated system or three-wire mid-wire earthed system).

iii) Two-wire, single-phase alternating current.

iv) Three-wire, three-phase alternating current.

v) Four-wire, three-phase alternating current.

b) The voltage of electric supply is not to exceed:

i) 500 V A.C. and D.C. for generators, power equipment, and heating and cooking equipment connected to fixed wiring.

ii) 250 V A.C. and D.C. for lighting, heaters in cabins and public rooms, equipment other than those specified in (i).

1.1.2. Earth indicating lamps.

Consider a distribution system, primary or secondary, for power, heating or lighting, with no connection to earth is used, an earth indicating lamps shall be provided.

1.1.3. Unbalance of load.

a) Unbalance 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.

b) Unbalance 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.

1.1.4. Diversity factor.

a) Circuits supplying two or more final sub-circuits shall be rated in accordance with the total connected load subject, where justifiable, to the application of a diversity factor. Where spare ways are provided on a section or distribution board, an allowance for future increase of load shall be added to the total connected load before application of any diversity factor.

b) The diversity factor specified in (a) above shall be applied to the calculation of the cross sectional area of conductors and ratings of switchgears (including circuit breakers and switches) and fuses.

1.2 Feeder circuits.

a) Electric motors for essential services requiring dual arrangement shall be supplied by individual circuits without the use of common feeders, protective devices and control gears.

b) Auxiliaries and ventilating fans in the machinery space shall be independently supplied from switchboards or distribution boards.

c) Ventilating fans for the cargo hold and those for the accommodation spaces are not to be supplied from the common feeder circuits.

d) Lighting circuits and motor circuits shall be arranged to be supplied independently from the switchboards.

e) A final sub-circuit of rating exceeding 15 A shall not to supply more than one appliance.

1.3 Motor circuits.

A separate final sub-circuit shall be provided for every motor for essential service and for every motor of rating at 1 kW or more.

1.4 Lighting circuits.

1.4.1.

a) Lighting circuits shall be supplied by final sub-circuits separate from those for heating and power except cabin fans and electrical appliances for domestic use.

b) The number of lighting points supplied by a final sub-circuit of rating 15 A or less is not to exceed:

i) 10 for the circuits up to 55 V
ii) 14 for the circuits over 55 V up to 127 V
iii) 24 for the circuits over 127 V up to 250 V

In case where the number of lighting points and total load current are invariable, more than the number of points specified above shall be connected to final sub-circuit, provided that the aggregate load current does not exceed 80% of the rating of protective device in the circuit.

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

d) In spaces such as compartments where the main engine is provided, large machinery rooms, lighting shall be supplied from at least two circuits and shall be so arranged that failure of any one circuit shall not leave these spaces in darkness. One of the circuits shall be emergency lighting circuit.

e) Emergency lighting circuits shall be in accordance with the requirements in Chapter 8 of this Part.

f) Lighting for enclosed hazardous spaces shall be supplied from at least two final sub-circuits to permit light from one circuit to be retained while maintenance is carried out on the other.

1.4.2. Circuits for internal communication systems and navigational aids.

a) Essential internal communication and signal systems and navigational aids shall have completely self-sustaining independent circuits for ensuring the perfect maintenance of their functions.

b) Cables for communication systems shall be so arranged that no induced interference would be caused.

c) No switch shall be provided for feeder circuits of general alarm devices, except for operating switch. If circuit breaker is used, suitable means shall be taken to prevent the breaker from being kept "off" position.

1.4.3. Circuits for radio installation.

Feeder circuits for radio installation shall be arranged in accordance with the requirements of relevant international and national regulations.

1.5 Circuits for shore connection.

1.5.1.

a) In case of power supply from a source on shore, a connection box shall be installed in a suitable position. If shore connection cables shall be drawn into a switchboard easily and put into service safely, the connection box shall be omitted, provided that the protective devices and checking devices stipulated in (b) are equipped on the switchboard.

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

c) If power is supplied form the three-wire neutral earthed system, an earth terminal shall be provided for connecting the hull to an appropriate earth in addition to those specified in (b) above.

d) A notice shall be displayed at the connection box regarding information on the system of power supply and nominal voltage (and frequency if A.C.) of system and the procedure for carrying out the connection

e) An indication pilot lamp and a circuit –breaker shall be fitted on Main switch board with a safety interlock .

1.5.2. Disconnecting switch of circuits.

a) Power circuits and lighting circuits terminating in the cargo holds or coal bunkers shall be provided with the multiple linked switches situated outside these spaces. Provision shall be arranged for the complete isolation of these circuits and locking in the "off" position of the switches or switch boxes.

b) Feeder circuits for the electrical equipment installed in dangerous spaces shall be provided with multiple linked isolation switches in a safe space. In addition, the isolation switches shall be clearly labeled to identify the electrical equipment to be connected with.

1.6 Remote stopping of ventilating fans and pumps.

1.6.1.

a) Power ventilation of accommodation spaces, service spaces, cargo spaces, control stations and machinery spaces shall be capable of being stopped from an easily accessible position outside the space being served. This position shall not be readily cut off in the event of a fire in the spaces served. The means provided for stopping the power ventilation of the machinery spaces shall be entirely separated from the means provided for stopping ventilation of other spaces.

b) The motors for the fuel oil burning pumps, fuel oil transfer pumps, fuel valve cooling oil pumps or other similar pumps, fuel oil purifiers and forced and

induced draught fans shall be capable of being stopped from an easily accessible position outside the space being served. This position shall not to be readily cut off in the event of a fire in the space served.

SECTION 2 SYSTEM DESIGN PROTECTION

Contents

2.1 General

2.1.1. Installations shall be protected against accidental overcurrents including short-circuit. The protective devices shall provide complete and coordinated protection to ensure:

a) Continuity of service under fault conditions through discriminative action of the protective devices to maintain supply to healthy circuits.

b) Elimination of the fault to reduce damage to the system and hazard of fire.

2.1.2. Protection against overload.

a) Circuit-breakers and automatic switches provided for overload protection shall have tripping characteristics appropriate to the system. Fuses above 320 A shall not to be used for overload protection, but shall be used for short-circuit protection.

b) The rating or appropriate setting of the overload protection device for each circuit shall be permanently indicated at the location of the protection device.

c) The overload relays of circuit-breakers for generators and the setting of preferential trip relays shall be adjustable or, if of the non-adjustable type, shall be readily replaceable by others of different values.

2.1.3. Protection against short-circuit.

a) Protection against short-circuit currents shall be provided by circuit-breakers or fuses.

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

c) The making capacity of every circuit-breaker or switch intended to be capable of being closed, if necessary, on short-circuit, shall be not less than the maximum value of the short-circuit current at the point of installation. On alternating current this maximum value corresponds to the peak value allowing for maximum asymmetry.

d) Every protective device or contactor not intended for short-circuit interruption shall be adequate for the maximum short-circuit current which can occur at the point of installation having regard to the time required for the short-circuit to be removed.

e) The use of a circuit-breaker of breaking capacity less than the prospective short-circuit current at the point of installation is permitted, provided that it is preceded on the generator side by fuses, or by a circuit-breaker having at least the necessary breaking capacity. The generator breakers are not to be used for this purpose.

f) Circuit-breakers with fuses connected to the load side shall be used where operation of the circuit-breaker and fuses is coordinated.

g) The characteristics of the arrangement shall be such that:

i) When the short-circuit current is broken, the circuit-breaker on the load side shall not be damaged and shall be capable of further service.

ii) When the circuit-breaker is closed on the short circuit current, the remainder of the installation shall not to be damaged. However, it is admissible that the circuit-breaker on the load side shall require servicing after the fault has been cleared.

h) In the absence of precise data, the following short circuit currents at the machine terminals shall be assumed:

i) Direct current systems.

1) Ten times full load current for generators that shall be connected simultaneously.

2) Six times full load current for motors simultaneously in service.

ii) Alternating current systems.

1) Ten times full load current for generators that shall be connected simultaneously.

2) Three times full load current for motors simultaneously in service.

The value derived from the above is an approximation to the r.m.s. symmetrical fault current; the peak asymmetrical fault current shall be estimated to be 2.5 times this figure (corresponding to a fault power factor of approximately 0.1).

2.1.4. Protection of circuits.

a) Each pole and phase of all insulated circuits except neutral and equalizer circuits shall be provided with short-circuit protection.

b) All circuits liable to be overloaded shall be provided with overload protection as indicated below:

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

ii) Three-wire D.C. system - both outer lines.

iii) Three-phase, three-wire system - each phase.

iv) Three-phase, four-wire system - each phase.

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

2.1.5. Protection of generators.

a) Generators shall be protected against short-circuit and overcurrent by a multiple circuit-breaker arranged to open simultaneously all insulated poles, or in the case of generators less than 50 kW not arranged to run in parallel, shall be protected by a multiple-linked switch with fuse or a circuit-breaker in each insulated pole. The overload protection shall be suitable to the thermal capacity of generators.

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

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

d) Where generators are operated in parallel and essential machinery is electrically driven, arrangements shall be made to disconnect automatically the excess non-essential load when the generators are overloaded. If necessary, this preference tripping shall be carried out in one or more stages. Refer Chapter 2 , Sect 1[1.2.2] of this Part.

2.1.6. Protection of feeder circuits.

a) All feeder circuits shall be protected in accordance with the current carrying capacities. Feeder and branch circuits for lighting, heating or ship's service power shall have each ungrounded conductor protected by circuit breaker or fuses of suitable interrupting capacity.

b) Supply circuits to section boards, distribution boards, grouped starters and the similar shall be protected against overload and short-circuit by multi-pole circuit-breakers or fuses. In case where the fuses are used, the switches which are capable of breaking and making safely a load current equal to 150% of their rated current at the rated voltage shall be provided at the power source side of the fuses.

c) Each insulated pole of the final sub-circuits shall be protected against short-circuit or overload by a circuit breaker or fuse. For the protection of supply circuits of the steering gears, the requirements in Section 3 of this Part shall apply.

d) Circuits which supply motors fitted with overload protection shall be provided with short-circuit protection only.

e) Where fuses are used to protect polyphase A.C. motor circuits, consideration shall be given to protection against single phasing.

f) Where condensers for phase advance are used, over-voltage protective devices shall be installed as required.

2.1.7. Protection of Electric Motors.

a) Motors of rating exceeding 0.5 kW and all motors for essential services, except the motors for steering gears, shall be protected individually against overload. The overload protection of motors for the steering gears shall comply with the requirements in Sect 3 [3.1.2] of this Part.

b) The protective device shall have a delay characteristics to enable the motor to start.

c) For motors for intermittent services, the current setting and the delay shall be chosen in relation to the load factor of the motor.

d) Over current trips of circuit breakers or fuses shall have a rating not greater than the allowable carrying capacity of the conductors protected except that for motor branch circuits the ratings shall be increased.

e) The maximum setting of the circuit breaker trip element for motor branch circuit shall be the standard value equal to or, if not in exact agreement, next above the value stated below in percent motor full load current.

i) D.C. motor 150%
ii) A.C. motor:

1) Full voltage, reactor or resister starting 250%
2) Autotransformer starting 200%
3) Wound rotor 150%

2.1.8. Protection of power and lighting transformers.

The primary circuits of power and lighting transformers shall be protected against short-circuit and overcurrent by multiple circuit-breakers or fuses. When transformers are arranged to operate in parallel, a means of isolation shall be provided on the secondary circuits.

2.1.9. Protection of lighting.

Lighting circuits shall be protected against short-circuit and overload.

2.1.10. Protections of meters, pilot lamps and control circuits.

a) Protection shall be provided for voltmeters, voltage coils of measuring instruments, earth indicating devices and pilot lamps together with their connecting leads by means of fuses fitted to each insulating pole.

b) A pilot lamp installed as an integral part of another item of equipment need not be individually protected, provided that any damage of pilot lamp circuit does not cause failures on the supply to essential equipment.

c) Insulated wires for control and instrument circuits directly led from busbars and generator mains shall be protected by uses at the nearest location to the connecting points. Insulated wires between the fuses and the connecting points shall not to be bunched together with the wires for other circuits.

d) Fuses in circuits such as those of automatic voltage regulators where loss of voltage might have serious consequences shall be omitted. If omitted, proper means shall be provided to prevent risk of fire in the unprotected part of the installation.

2.1.11. Protection of batteries.

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

SECTION 3 CONTROL CIRCUITS AND POWER FOR STEERING GEAR

Contents

3.1 Control circuits

3.1.1. Short circuit protection, an overload alarm and, in the case of polyphase circuits, an alarm to indicate single phasing shall be provided for each main and auxiliary motor circuit.

3.1.2. Only short circuit protection shall be provided for the steering circuit on the switchboard or emergency switchboard. The use of fuses instead of circuit breakers for steering gear motor feeder short circuit protection is not permitted. The setting values shall be as follows:

a) For D.C. circuit.

i) On the main switchboard: 300 to 375% of the motor rating.

ii) On the emergency switchboard: Not less than 200% of the motor rating.

b) For A.C. circuit breaker on all switchboard. 200% of the steady state locked rotor current of one steering gear motor plus all other loads that shall be on this feeder.

3.1.3. Indicators for running indication of each main and auxiliary motor shall be installed on the navigating bridge and at a suitable machinery control station (if any).

3.1.4. Two exclusive circuits shall be provided for each electric or electrohydraulic steering gear arrangement consisting of one or more electric motors.

3.1.5. Each of these circuits shall be fed from the main switchboard. One of these circuits shall pass through the emergency switchboard.

3.1.6. One of these circuits shall be connected to the motor of an associated auxiliary electric or electro hydraulic power unit.

3.1.7. Each of these circuits shall have adequate capacity to supply all the motors which shall be connected to it and which can operate simultaneously.

3.1.8. These circuits shall be separated throughout their length as widely as is practicable.

3.1.9. If an auxiliary steering gear shall not electrically powered or shall powered by an electric motor primarily intended for other services, the main steering gear shall be fed by one circuit from the main switchboard. Consideration shall be given to other protective arrangements than described in [3.1.1] above for such a motor primarily intended for other services.

3.1.10. Electric control systems shall be independent and separated as far as is practicable throughout their length.

3.1.11. Each main and auxiliary electric control system which shall be operated from the navigating bridge shall comply with the following:

a) It shall be served with electric power by a separate circuit supplied from the associated steering gear power circuit, from a point within the steering gear compartment, or directly from the same section of switchboard busbars, main or emergency, to which the associated steering gear power circuit is connected.

b) Each separate circuit shall be provided with short circuit protection only.

3.1.12. Monitoring and alarms.

Alarms and monitoring requirements are indicated in Table 2.3.1.

3.2 Navigation Lights

3.2.1. Navigation lights shall be connected separately to a special distribution board which is not to supply any other group. This distribution board shall be placed in an accessible position to the officers of the watch.

3.2.2. The navigation distribution board shall be provided with a change over switch making it possible to obtain supply for this board from an alternative feeding circuit following a route as different as possible from the first circuit and each navigation light shall be protected by a fuse switch on each insulated pole fitted on the distribution board.

3.2.3. Each navigation light shall be provided with an automatic indicator giving audio and visual warning in the event of extinction of the light. This requirement shall be modified for tugs, trawlers of fishing and small ships.

3.3 Internal Communication

3.3.1. Internal communication circuits such as the engine room telegraph, revolution counter, rudder angle indicator, alarm system (automatic or manual), siren, bell, telephone and loud speaker installation, signal lighting system, electric log, remote temperature control, indication system, etc. shall comply with the following requirements.

3.3.2. The supply source of the internal communication system shall be tapped from the general lighting and power sources or from the motor-generator, transformer, storage battery and dry cell for the low voltage system.

3.3.3. Electric interior communication and signal systems forming part of the essential operating systems of the ship shall be as independent and self-sustaining as possible.

3.3.4. The voltage of supply for internal communication circuits shall be between 20V and 120V of D.C. or A.C. For simple circuits, voltages of not less than 6V shall be used.

3.3.5. Communication circuits other than those supplied from the primary battery shall be protected on such insulated pole by the fuse of a current rating of the cables to be protected.

3.3.6. Cables used for the internal communication shall be suitable for the rated voltage and the current of the connected load. The voltage drop shall be so limited that the normal operation of the connected equipment is ensured. Cables shall be kept separate from the power and lighting unless they are of similar type.

3.3.7. Power for the general emergency alarm shall be fed from the main source of electrical power and emergency source of electrical power. The system shall be capable of operation from the navigating bridge and other strategic positions. After being brought into operation the alarm shall continue to function until it is manually turned off or is temporarily interrupted by a message on the public address system.

3.3.8. An engine order telegraph system shall be provided for communicating orders from the navigating bridge to the main propulsion control station in the engine room, and for transmitting acknowledgment of orders from the main propulsion control station to the navigating bridge.

3.3.9. A common talking means of voice communication and calling shall be provided between the navigating bridge and main propulsion control station

Table 2.3.1.
Monitoring and Alarms for Steering Gear

Item	Alarm	Note
Rudder position	--	Indication
Steering gear power units, power	Failure	--
Steering gear motors	Overload, single phase	Also running indication on bridge and machinery control station, Refer [3.1.3] of this chapter
Control system power	Failure	----
Steering gear hydraulic oil tank level	Low	Each tank to be monitored
Auto pilot	Failure	Running indication

CHAPTER 3 GENERATORS AND MOTORS

CONTENTS

SECTION 1 GENERATORS

Contents

1.1 General

1.1.1. Generators shall comply with the relevant part of IEC Publication 92, or an acceptable and relevant National Standard, and the requirements of this Chapter.

1.1.2. The rotating parts of machines shall be so balanced that when running at any speed in the normal working range the vibration does not exceed the levels of IEC 34

1.2 Prime Movers

1.2.1. Governors on prime movers driving generating sets shall be capable of maintaining the speed within the following limits:

a) Momentary variations shall be 10% of the maximum rated speed when the rated load of the generator is suddenly thrown off.

b) Momentary variations shall be 10% of the maximum rated speed when 50% of the rated load of the generator is suddenly thrown on followed by the remaining 50% load thrown on after an interval to restore the steady state. The speed shall return to within 1% of the final steady speed in no more than 5 seconds. When difficulty arises to meet the above requirements or when an installation requires different characteristics, this shall be considered.

c) At all loads between no load and rated load the permanent speed variation shall not to be more than 5% of the maximum rated speed.

1.2.2. Generators driven by diesel engines of 37 kW and over with forced lubrication shall be provided with a means to shut down the engine automatically in case of failure of the lubricating system.

1.2.3. For A.C. generating sets operating in parallel, the governors on prime movers shall be such that the load sharing specified in [1.5.5] of this Section below ,is ensured and facilities shall be provided to adjust the governor sufficient to permit a load adjustment, at normal frequency, within 5% of full load.

1.3 Generator Construction

1.3.1. Every generator shall be fitted with a name plate of corrosion resistant material clearly marked with the following items of information:

a) Maker’s name and serial number.
b) Nature of current (D.C. or A.C.) and kind of rating (if the generator is designed for continuous rating it need not be mentioned).
c) Rated output, voltage, current and speed
d) For D.C. Generators --- type of winding.
e) For A.C. Generators --- number of phases, rated frequency, power factor, exciting current and voltage.
f) Temperature rise at rated load and design ambient temperature.

1.3.2. Insulating materials used in the construction of generators shall be at least of Class A insulation. When the weight of the generators excluding shaft is over 500 kg, it shall be provided with means to prevent moisture condensation in the machine when it is not running.

1.3.3. The lubrication arrangement for bearings shall be effective under all operating conditions including the maximum ship inclinations defined by Chapter 1 sect 2 [2.2] and there shall be effective means provided to ensure that lubricant does not reach the machine windings or other conductors and insulators.

1.3.4. Means shall be taken to prevent the ill effects of the flow of currents circulating between the shaft and machine bearings or bearings of connected machinery.

1.3.5. Every generator terminal shall be protected against accidental contact, mechanical damage and if necessary against dripping and moisture by the drip proof enclosure.

1.3.6. External frames, spiders and brackets shall be of rigid construction. If welding is applied to shafts of machines for securing arms or spiders, stress relieving shall be carried out after welding.

1.3.7. Brushes for commutator or slip rings shall be provided with flexible copper connections and are staggered longitudinally along commutators in such a manner that the whole surface of the commutators is swept by the brushes so that the formation of ridge shall be prevented.

1.3.8. A provision shall be made for supplying the necessary amount of cool air and removing hot air, and to avoid as far as possible the admission of moisture or oil vapour.

1.4 D. C. Service Generators

1.4.1. Automatic voltage regulators shall be provided for shunt wound direct current generators.

1.4.2. Direct current generators used for charging batteries without series-regulating resistors shall be either:

a) Shunt wound, or

b) Compound wound with switches arranged so that the series winding shall be switched out of service.

1.4.3. Where manual adjustment of terminal voltage is necessary for the satisfactory operation of generators the facilities shall be provided at the switchboard or at an appropriate control position.

1.4.4. For each direct current generator, coupled to its prime mover, at any temperature within the working range the means provided shall be capable of adjusting the voltage at any load between no load and full load to within:

a) 0.5% of rated voltage for generators of rating exceeding 100 kW, and

b) 1.0% of rated voltage for generators of rating not exceeding 100 kW.

1.4.5. The inherent regulation of the service generators shall be such that the following conditions are satisfied:

a) For shunt or stabilized shunt wound generators when the voltage has been 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 intermediate value of load shall not to exceed the no load value.

b) For compound wound generators with the generator at full load operating temperature, and starting at 20% load with voltage within 1% of rated voltage, then at full load the voltage shall be within 1.5% of rated voltage. The average of the ascending and descending load/voltage curves between 20% load and full load not to vary more than 3% from rated voltage.

Note: For compound-wound generators operated in parallel, the drop in voltage shall be acceptable up to 4% of the rated voltage when the load is gradually increased from 20% load to full load.

c) Three-wire generator.

In addition to compliance with the requirements in (a) and (b), when operating at the rated current on the heavier loaded side, i.e., either positive or negative lead, with the rated voltage between the positive and negative leads and a current of 25% of the generator current rating in the neutral wire, the resulting difference in voltage between the positive and neutral leads or the negative and neutral leads is not to exceed 2% of the rated voltage between the positive and negative leads.

1.4.6. When D.C. generators are operated in parallel, the load on any generator is not to differ more than ±10% of its rated output of the largest machine 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 outputs of all the machines. The starting point for the determination of the foregoing load distribution requirement shall be at 75% load with each generator carrying its proportionate share.

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

1.4.8. Equalizer connections shall be have a cross-sectional area appropriate to the system but in no case less than 50% of that of the negative connection from the generator to the switchboard.

1.5 A. C. Service Generators

1.5.1. Each alternating current service generator, unless of the self-regulating type, shall be provided with automatic means of voltage regulation.

1.5.2. The voltage regulation of any alternating current generator with its regulating equipment shall be such that at all loads from zero to full load the rated voltage at rated power factor is maintained under steady conditions within ± 2.5%, except that for emergency generators the limits shall be within ±3.5%.

1.5.3. Generators, and their excitation systems, when operating at rated speed and voltage on no-load shall be capable of absorbing the suddenly switched, balanced, current demand of the largest motor or load at a power factor not greater than 0.4 with a transient voltage dip which does not exceed 15% of rated voltage. The voltage shall recover to rated voltage within a time not exceeding 1.5 seconds.

1.5.4. The transient voltage rise at the terminals of a generator shall not to exceed 20% of rated voltage when rated kVA at a power factor not greater than 0.8 is thrown off.

1.5.5. Generators required to run in parallel shall be stable from no load (kW) up to the total combined full load (kW) of the group, and load sharing shall be such that the load on any generator does not normally differ from its proportionate share of the total load by more than 15% of the rated output (kW) of the largest machine or 25% of the rated output (kW) of the individual machine whichever is less.

1.6 Exciters

1.6.1. Excitation current for ship's service and emergency generators shall be provided by attached rotating exciters or by static exciters deriving their source of power from the machine being excited.

1.6.2. Propulsion generators shall be provided with at least two different means of excitation. The current derived from the ship’s service power or lighting set shall be taken as one means of excitation.

1.6.3. AC and DC rotating exciters shall conform to all applicable requirements for generators.

1.6.4. Arrangements for electric propulsion generators shall be such that propulsion shall be maintained in case of failure of an excitation system or failure of a power supply for an excitation system. Propulsion shall be at reduced power under such conditions where two or more propulsion generators are installed provided such reduced power is sufficient to provide for a speed of not less than 7 knots or of design speed whichever is the lesser.

1.7 Short Circuit Conditions

1.7.1. Service generators shall be capable of withstanding the mechanical and thermal effects of fault current for the duration of any time delay which shall be fitted in a tripping device of discrimination purposes. They shall be capable of maintaining under steady state short-circuit conditions a current of at least three times the full load rated current for a duration of 2 seconds or, where precise data is available, for the duration of any time delay which shall be fitted in a tripping device for discrimination purposes.

1.8 Test and Inspection

1.8.1. Temperature rise test.

a) The temperature rise of a generator of continuous rating shall be determined by a run at full load for a duration until a final steady temperature has been reached. The maximum permissible temperature rise of a generator shall not to exceed the limit given in Table 3.1.1

b) Where the ambient temperature has been assured to be in excess of the standard ambient temperature the temperature rise shall be reduced according to Chapter 1 ,Sect 1[1.3.1] of this Part.

1.8.2. Insulation resistance test.

The insulation resistance of a generator shall be measured with a D.C. voltage of about 500 V preferably at the conclusion of the temperature rise test of the machine. The insulation resistance of the circuit shall not to be less than:

$$\frac{3\times\text{Rated voltage of the machine (V)}}{\text{Rated output (kW or kVA)} + 1000} \quad (\text{M}\Omega)$$

1.8.3. High voltage test.

a) The dielectric strength of the insulation of a generator shall be tested by an A.C. voltage of practically sine wave form applied between the terminal and the frame of the machine which has been completely assembled in a state of normal working condition for a period of 1 minute. The winding which is not under test shall be connected to the ground.

b) The standard testing voltage shall be as mentioned in Table 3.1.2. The frequency of the testing voltage shall be 25 to 100 Hz.

c) In case of a repaired generator the above dielectric test shall be carried out using a test voltage equal to 75% of the value specified in Table 3.1.2

1.8.4. Generators shall comply with the requirements in [1.4.4] or 1.5.2] above by conducting the voltage regulation test.

1.8.5. Generators operated in parallel shall comply with the requirements in Sect 1[1.4.6] or [1.5.5] by conducting the parallel operation test.

1.8.6. Other tests.

a) A.C. generators shall be capable of carrying a momentary overload of 50% in current for 2 minutes, D.C. generator shall be capable of carrying a momentary overload of 50% in current for 15 seconds without injury.

The test shall be carried out immediately after the temperature rise test as mentioned in Sect 1[1.8.1] of this Chapter, and the voltage, revolutions and frequency of the generators shall be maintained as near the rated values as possible.

b) Generators shall be capable of withstanding overspeed for two minutes according to the following requirements:

i) Turbine driven 115% of rated speed
ii) Diesel driven 120% of rated speed
iii) All others 125% of rated speed

c) The commutation of the generator shall be clear of any objectionable sparking when running from no load to full load. This examination is preferably to be carried out at the conclusion of the temperature rise test.

d) Performance test of the generator shall be carried out after the machine has been installed on ship in accordance with Part 6, Chapter 9,Sect 1 [1.3.2]

Table 3.1.1
Limit of Temperature Rise for Generator and Motor

(Based on ambient temperature 45°C)

Item	Generator or motor parts	Type of enclosure	Limit of temperature rise (°C)									
			Class A Insulatio		Class B Insulatio		Class E Insulatio		Class F Insulatio		Class H Insulatio	
			T	R or D	T	R or D	T	R or D	T	R or D	T	R or D
1	Insulated winding: A. C. stator winding. D. C. multi-layer field winding. Armature winding connectedto commutator.	Open and Semi-enclosed	45	55	65	75	60	70	80	95	100	120
		Totally enclosed	50	55	70	75	65	70	85	95	105	120
2	Low resistance field winding andcompensating winding.	Ally types	55	55	75	75	70	70	95	95	120	120
3	Single-layer field winding withexposed bare surface.	All types	60	60	85	85	75	75	105	105	130	130
4	Rotating field winding of highspeed turbine driven synchronous generators.	All types	-	-	-	85	-	-	-	105	-	120
5	Iron core and mechanical part incontact with or adjacent to insulated winding.	All types	55	-	75	-	70	-	95	-	120	-
6	Permanently short circuit uninsulated winding, iron core and other parts in contact with oradjacent to insulated windings, brushes and brush	All types	The temperature rise is in no case to reach such a valuethat there is risk of injury to any insulating material onadjacent parts.									
7	Permanently short circuitinsulated winding	All types	55	-	75	-	70	-	95	-	120	-
8	Commutator and slip ring	All types	55	-	75	-	65	-	85	-	95	-
9	Bearing	Open and Semi-enclosed	40	-	45	-	45	-	55	-	55	-
		Totally enclose	45	-	50	-	50	-	60	-	60	-

Notes:

1. The methods of temperature measurement in the above table are as follows: T = The temperature measured by thermometer.
   R = The temperature measured by resistance method.
   D = The temperature measured by embedded temperature detector.
2. The class of insulation for the bearing refers to the insulation of the winding.
3. The temperature rise of the bearing as specified in the value measured by the thermometer embedded in the bearing.

Table 3.1.2
High Voltage Test for Generator and Motor

Item	Machine or part	Test voltage (A.C.r.m.s)
1	Insulated windings of rotating machines having rated output less than 1 kVA (or kW), and of rated voltage lessthan 100 V with the exception of those in items 4	500 V + twice the rated voltage.
2	Insulated windings of rotating machines having rated output less than 10,000 kVA (or kW) with the exceptionof those in items 1 and 4 to 8 (see Note	1,000 V + twice the rated voltage with minimum of1,500 V (see Note 1).
3	Insulated windings of rotating machines having rated output 10,000 kVA (or kW) or more with the exceptionof those in items 4 to 8 (see Note 2). Rated voltage (see Note 1):Up to 2000 V Above 2000 V to 6000 V Above 6000 V to 17000 V Above 17000 V	1,000 V + twice the rated voltage 2.5 times the rated voltage 3,000 V + twice the rated voltageSubject to special agreement
4	Separately-excited field windings of D.C. machines.	1,000 V + twice the maximum rated circuit voltage withminimum of 1,500 V (see Note
5	Field windings of synchronous generators andsyn-chronous motors.	
a)	Field windings of synchronous generators.	Ten times the rated excitation voltage with a minimumof 1,500 V and a maximum of
b)	When the machine is intended shall be started with the fieldwinding short-circuited or connected across a resistance of value less than ten times the	Ten times the rated excitation voltage with a minimumof 1,500 V and a maximum of 3,500 V.
c)	When the machine shall be started either with: -the field winding connected across a resistance of valueequal to, or more than, ten times of the field winding resistance, or -the field windings on open circuit or without a field dividing switch.	1,000 V + twice the maximum value of the r.m.s voltagewith a minimum of 1,500 V -between the terminals of the field winding, or -between the terminals of any section for asection-alized field winding, which shall be occurred under the
6	Secondary (usually rotor) windings of induction motorsor synchronous induction motors if not permanently short-circuited (e.g., if intended for	
a)	For non-reversing motors or motors reversible fromstandstill only.	1,000 V + twice the open-circuit standstill voltage asmeasured between slip-rings or secondary terminals with rated voltage
b)	For motors to be reversed or braked by reversing theprimary supply while the motor is	1,000 V + four times the open-circuit standstillsecondary voltage as
7	Exciters (except as listed below) *Exception 1* - Exciters of synchronous motors (includingsynchronous induction motors) if connected to earth or disconnected from the field winding during starting. *Exception 2* - Separately excited field	As for windings to which they are connected. 1,000 V + twice the rated exciter voltage with aminimum of 1,500 V.
8	Assembled group of machines and apparatus.	A repetition of the tests in items 1 to 7 above shall be avoided if possible. But, if a test on an assembledgroup of several pieces of new apparatus, each one of which has previously passed its high-voltage test, is made, the test voltage to be applied to such assembled group shall be 80% of the lowest test voltage

Notes:

4. For two-phase windings having one terminal in common, the rated voltage for the purpose of calculating the test voltage shall be taken as 1.4 times the voltage of each separate phase.

5. High-voltage tests on machines having graded insulation shall be subject to special consideration.
6. The voltage, which is occurred between the terminals of field windings or sections thereof under the specified starting conditions, shall be measured at any convenient reduced supply voltage. The voltage so measured shall be increased in the ratio of the specified starting supply voltage to the test supply voltage.

SECTION 2 MOTORS

Contents

2.1 General

2.1.1. The requirements for the construction, materials, insulation, lubrication and testing of motors are the same as those for generators as specified in Chapter 3,Sect [1.3], [1.8.1], [1.8.2] and [1.8.3] of this Part except the means shall be provided for propulsion motors to prevent moisture condensation when motors are idle for appreciable periods. Refer Ch 3 Sect 1 [1.3.2] of this Part.

2.1.2. Motors for essential service when installed with their rotor shafts not in fore and aft direction, the lubrication shall require special consideration.

2.1.3. All propulsion and essential service motors shall be of continuous rating except those for deck machinery which shall be of non-continuous rating.

2.1.4. The standard application for types of enclosures of motors shall be as follows:

a) In the engine room or spaces where motors are subject to mechanical injury, or dripping of oil or water shall have an enclosure of at least IP22 protection. Motors below the level of the floor plates shall have an enclosure of at least IP44 protection.

b) In galleys, toilets, washing rooms and similar spaces, use an enclosure of at least IP44 protection.

c) In the wheelhouse, the chart room, the radio room, the public saloon, offices, stores, living places passages and the pantry, use an enclosure of at least IP20 protection.

d) On the weather deck, use a protection enclosure of IP56 or enclose motors in metal housing, giving the same protection.

2.2 Test and Inspection

2.2.1. Temperature rise test.

The temperature rise of a motor of continuous rating shall be in accordance with the requirements for generator in Ch 3, Sect [1.8.1] of this Part and the maximum permissible temperature rise is not to exceed those given in Table 3.1.1.

2.2.2. Insulation resistance test.

The insulation resistance for motors shall be in accordance with the requirements set forth in [3.8.2] of this Part.

2.2.3. High voltage test.

The dielectric strength of the insulation of motors shall be in accordance with the requirements set forth in Ch 3 Sect 1[1.8.3] of this Part.

2.2.4. Other tests.

a) After the temperature rise test, motors of continuous ratings, except those of non-continuous ratings or special types, shall withstand the following excess torque test by maintaining the voltage, revolving speed and frequency as near their rated values as possible:

i) D.C. motors 50% 15 seconds
ii) Synchronous motors 50% 15 seconds
iii) Induction motors 60% 15 seconds

b) Motors of non-continuous ratings or special types, the excess torque test shall be specially considered.

c) The excess torque test for propulsion motors shall be specially considered for each installation.

d) The commutation of motors shall be clear of any objectionable sparking when running under all conditions of load and field adjustment.

e) Overspeed tests.

Motors shall be capable of withstanding overspeed for two minutes according to the following requirements:

i) Shunt-wound motors 125% of rated speed
ii) Series-wound motors 200% of rated speed
iii) Compound-wound motors 125% of no load speed
iv) Synchronous motors 125% of synchronous speed
v) Induction motors 125% of synchronous speed.

CHAPTER 4 SWITCHBOARDS AND BATTERIES

CONTENTS

SECTION 1 SWITCHBOARDS

Contents

1.1 General

1.1.1. The switchboard shall be installed in an accessible and well-ventilated place, free from inflammable gas, acid fume, and not exposed to mechanical injury or damage from water, steam or oil. Unobstructed clearance for operation and ample space to permit maintenance shall be maintained.

1.1.2. The space at the rear of switchboards shall be ample to permit maintenance and in general not less than 0.6 m except that this shall be reduced to 0.5 m in way of stiffeners or frames.

1.1.3. The arrangement of the main system of supply shall be such that a fire or other casualty in spaces containing the main source of power, associated transforming equipment, if any, the main switchboard and the main lighting switchboard shall not render the emergency services inoperative.

1.1.4. The arrangement of the emergency system of supply shall be such that a fire or other casualty in spaces containing the emergency source of power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard, shall not render the essential services inoperative.

1.1.5. The main switchboard shall be so placed relative to the main source of power that, as far as is practicable, the integrity of the main system of supply shall be affected only by a fire or other casualty in one space.

1.1.6. The sides and the rear and, if necessary, the front of switchboard shall be suitably guarded.

1.1.7. Insulated handrails shall be provided on the front and rear faces of switchboard, and if necessary, non-conducting mats or gratings shall be provided at front and rear of the switchboard.

1.1.8. The dead front type switchboard shall be used where the voltage to ground or between poles is in excess of 50V, D.C. or 50V, AC. root mean square.

1.1.9. Earth indicating lamps are required for every insulated distribution system, whether primary or secondary, for power, heating or lighting circuits.

1.2 Fabrication

1.2.1. Switchboard panels shall be made of permanent high dielectric strength insulating materials of adequate strength such as impregnated ebony asbestos, laminated phenolic material or the equivalent. They shall be made of metal if all conducting parts shall be insulated from the panels with bushes and washers of mica or other non-absorbent insulating material.

1.2.2. No wood shall be used in the fabrication or installation of switchboards except the non-conducting handrails installed in front of the panels as required by [1.1.7] above of this section.

1.2.3. Cable entries of a switchboard shall be so constructed that no ingress of water into the switchboard is permitted along the cables.

1.2.4. Every live part shall be suitably spaced or shielded with non-ignitable insulating material that any arc cannot be maintained between the working parts or between such parts and earth.

1.2.5. The apparatus, measuring instruments, circuit breakers, switches and operating handles shall each to be provided with a name plate bearing a clear indelible indication for identification. The rating of the fuse, current rating of the circuit breaker and the cross sectional area of the cables which these devices protected are also to be marked on labels placed in suitable positions.

1.2.6. Section and distribution boards shall be suitably enclosed unless they are installed in a cupboard or compartment to which only authorized persons have access, in which case the cupboard shall serve as an enclosure.

1.2.7. All enclosures shall be constructed of, or lined with, non-flammable and non-hygroscopic material, and shall be of robust construction.

1.3 Bus Bars

1.3.1. Bus bars and their connections shall be made of copper and provided with anti-corrosion and oxidization surfaced contact. All joints shall be provided with locking devices to prevent loosening due to vibration.

1.3.2. The cross section of bus bars shall be such that the maximum permissible temperature rise of 45ºC as measured by the thermometer shall not to be exceeded when carrying full load current.

1.3.3. A clearance shall be maintained between the bare metal part and the bus bar according to Table 4.1.2

1.3.4. The current rating of equalizer connections and equalizer switches shall be not less than half the rated full load current of the generator. The current rating of equalizer busbars shall be not less than half the rated full load current of the largest generator in the group.

1.3.5. Busbars and busbar connections shall be so supported as to withstand the electromagnetic force resulted from short-circuiting.

1.4 Circuit and Switchboard Wiring Arrangement

1.4.1. Wiring.

a) All the wiring on the switchboard for the voltmeter, wattmeter, voltage coil, synchroscope, pilot lamp (if any) and earth lamp shall be protected by a fuse on each insulated pole.

b) The instrument and the control wiring shall be of the stranded type, heat-resisting and flame retarding insulation. Wiring from the hinged panel shall be of extra flexible type. The secondary winding of instrument transformers shall be earthed.

c) flame-retardant materials shall used for ducts and straps for wiring.

d) Insulated wires for control and instrument circuits shall not to be bunched together with wires for main circuits and not to be in the same duct. However, if the rated voltages and maximum permissible temperatures of conductors are the same each other and no injurious effects are imposed by the main circuits, this requirement shall not be applied.

1.4.2. Fuses, except those for instruments and control circuit, shall be mounted on or be accessible from the front of the switchboard.

1.4.3. Switches, circuit breakers and contactors are, whenever practicable shall be so connected that their blades or moving parts are not alive in the off or de-energized position.

1.4.4. The switch and fuse fitted on the same pole shall be so arranged that the fuse is not alive when the corresponding switch is in the off position.

1.4.5. Metal frames, metal cases of instruments and the secondary winding of instrument transformers of switchboards shall be effectively earthed.

1.4.6. If rheostats or other devices that shall operate at high temperature are amounted on the switchboard, they shall be naturally ventilated, isolated by barriers or separately mounted from the switchboard as necessary in order to prevent excessive temperature of adjacent device.

1.5 Electromagnetic Contactors and Circuit-Breakers

1.5.1. Circuit-breakers shall comply with IEC Publication 947-1 and 947-2, or 158-1 or equivalent therto, amended when necessary for ambient temperature, and also to comply with the requirements in (a) and (b).

a) The construction of circuit-breakers shall comply with the following:

i) All circuit-breakers shall be of trip-free type and depending upon the field of their application, the trip attachments shall have a time-delay or an instantaneous overcurrent trip feature or both of them.

ii) The main contacts of the circuit-breakers shall be such as to have no undue burning or pitting. Arcing contacts except those of the moulded case circuit-breakers shall be readily renewable.

iii) Instantaneous trip devices other than those of electronic type having suitable testing arrangements shall be of a construction capable of tripping the associated breaker directly by short-circuit current.

iv) Circuit-breakers shall be such that no accidental opening and closing occur due to the vibration of a ship, and furthermore, no malfunction is caused by the list of an angle of 30 ºC in any direction.

v) The fused circuit-breakers of moulded-case type shall be so constructed that single phasing does not occur in the event of blowing of fuses and that the fuses can be readily replaced without the risk of accidental touch for the operating personnel to their live-parts.

vi) On each circuit-breaker the rated (operational) voltage and rated (thermal) current, and in addition rated breaking capacity, rated making current and rated short-time current shall be clearly indicated according to its kind. Each time-delay overcurrent trip device shall be indicated of its operating characteristics, except the moulded-case circuit-breakers.

b) Performance of circuit-breakers shall comply with the following:

i) The temperature rise in the connecting terminals of cables shall not to exceed 45ºC at an ambient temperature of 45 ºC when 100% of the rated current is carried there through.

ii) All circuit-breakers are, according to their kind, to be such as to be able to securely break the over-current not more than the rated breaking capacity and safely make the circuit to carry the current not more than the rated

making current under the circuit conditions specified in the standards referred to [1.5.1] above.

iii) The time-delay over-current trip devices of circuit-breakers for generator circuits shall be such that the readjustment of the current setting does not cause remarkable change to the time-delay feature.

iv) The characteristics of the time-delay overcurrent trip devices are not to be affected excessively by ambient temperature Circuit-breakers of moulded-case type shall be mounted or arranged in such a manner that the breakers shall be removed from the front without disconnecting conductors or de-energizing the supply to the breakers.

1.5.2. Circuit-breakers of moulded-case type shall be mounted or arranged in such a manner that the breakers shall be removed from the front without disconnecting conductors or de-energizing the supply to the breakers

1.5.3. Electromagnetic contactors shall comply with IEC publication 947-1 and 947-4, or 158-1 or equivalent thereto, amended when necessary for ambient temperature, and also to comply with the requirements in (a) and (b).

a) The construction of electromagnetic contactors shall comply with the following:

i) Electromagnetic contactors shall be such that no accidental opening and closing occur due to the vibration of the ship, and furthermore, no malfunction is caused by the list of an angle of 30^{o} in any direction.

ii) The contact pieces and magnetic coils shall be readily replaceable.

iii) Each electromagnetic contactor shall be clearly indicated of its rated operational voltage, rated capacity or full load current corresponding to rated capacity, rated operational voltage and frequency for control circuits, interruption current capacity and closed circuit current capacity. Such indication shall be made in terms of value or symbol.

b) The performance of electromagnetic contactors shall comply with the following:

i) The temperature rise in the connecting terminals of cables is not to exceed 45 ºC at an ambient temperature of 45 ºC when the full load current corresponding to the rated capacity is carried there through.

ii) Electromagnetic contactors shall have a suitable interruption current capacity and closed-circuit current capacity depending on their application.

iii) Electromagnetic contactors are not to accidentally open the circuit at a voltage exceeding 85% of the rated voltage.

1.6 Fuses

1.6.1. Fuses shall comply with IEC Publication 269 or equivalent thereto, amended when necessary for ambient temperature, and also to comply with the requirements in (a) and (b).

a) The construction of fuses shall comply with the following:

i) Fuses shall be of enclosed type and the construction shall be such that its enclosure is not broken nor burnt and the adjacent insulation is not deteriorated by flowing of fused metal or emitting of gases, when the fuse element has blown out.

ii) Fuses shall be readily replaceable with spares without the risk of causing electric shock or burn on setting fuses in and out.

iii) Each fuse shall be clearly indicated of its rated voltage and rated current, and in addition rated breaking capacity, fusing characteristics and current-limiting characteristics according to its kind. Such indication shall be made in terms of value or symbol.

b) The performance of fuses and fuse-holders shall comply with the following:

i) The temperature rise in the connecting terminals of cables is not to exceed 45ºC at an ambient temperature of 45ºC when the fuses and fuse-holders have been fitted to the normal working condition and 100% of the rated current is carried there through.

ii) Fuses shall have the fusing characteristics corresponding to their kind, and under the circuit conditions specified in the standards referred to in (a), they shall be capable of breaking securely all currents whichever is below the rated breaking capacity and above the fusing current

1.7 Instruments

1.7.1. The limit of the scale of every voltmeter shall be approximately 120% of the normal voltage of the circuit.

1.7.2. The limit of the scale of every ammeter shall be approximately 130% of the current rating of the circuit in which the ammeter is connected. Ammeters for use with D.C. generators or wattmeters for use with A.C. generators which shall operate in parallel shall be capable of indicating a reverse current or power of at least 15% of the rated full load current or power of the generator respectively.

1.7.3. The minimum number of instruments provided for every main or emergency switchboard shall be as follows:

a) 2-wire D.C. system:

i) For each generator not arranged for parallel operation:

(1) 1 ammeter, and
(2) 1 voltmeter.

ii) For generators arranged for parallel operation:

(1) 1 ammeter for each generator, and
(2) 1 voltmeter for each generator with voltmeter switch to enable it to indicate generator voltage, bus voltage. One of these voltmeter switches shall indicate shore connection voltage.

b) 3-wire D.C. system:

i) For each generator not arranged for parallel operation:

(1) 2 ammeters for each generator, 1 in positive and 1 in negative line, and
(2) 1 voltmeter provided with switch for connecting the voltmeter to indicate generator voltage positive to negative, positive to neutral and neutral to negative.

ii) For generators arranged for parallel operation:

(1) 2 ammeters per generator, and

(2) 1 voltmeter for each generator with switch for connecting the voltmeter to indicate generator voltage, positive to negative, positive to neutral and neutral to negative, and bus voltage positive to negative. One of these voltmeter switches shall indicate shore connection voltage, positive to negative, positive to neutral, and neutral to negative.

c) 3-phase A.C. system:

i) For each generator not arranged for parallel operation:

(1) 1 voltmeter for each generator with switch to indicate voltage between phases,
(2) 1 ammeter provided with selector switch to indicate the current of each phase,
(3) 1 frequency meter provided with selector switch to indicate the frequency of any generator, and
(4) 1 wattmeter for each generator (it shall be omitted for 50 kVA or less).

ii) For generators arranged for parallel operation:

(1) 1 voltmeter for each generator with a selector switch to indicate the voltage of each phase of the generator and one phase of the bus. One of these voltmeter switches shall indicate voltage of shore connection,
(2) 1 ammeter for each generator provided with a selector switch to indicate the current of each phase,
(3) 1 indicating wattmeter for each generator,
(4) 1 synchroscope and synchronizing lamp provided with selector switch of synchroscope for paralleling in any combination when more than 2 generators are installed,
(5) 2 frequency meters provided with selector switch to indicate the frequency of any generator and bus bar, and
(6) 1 ammeter for exciter per generator, if necessary.

1.8 Tests and Inspection

1.8.1. The temperature rise of the switchboard equipment and bus bars under rated current, rated voltage and rated duty operation shall be ascertained that they are not to exceed the values as specified in Table 4.1.1 and Sect 1[1.3.2 [of this Chapter.

1.8.2. The dielectric strength of switchboards shall be tested by continuous application of 50 or 60 Hz alternating sine wave e.m.f. between all current carrying parts and earthed frame, and between current carrying parts of opposite polarity or phase according to the requirements as shown in Table 4.1.2

1.8.3. Immediately after completion of the dielectric strength test, the insulation resistance of switchboards between current carrying parts of each polarity and earth, and between current carrying parts of opposite polarity or phase shall be not less than 1 MΩ when tested with D.C. voltage of approximately 500V tester. The test shall be made with circuit breakers and switches connected to the outgoing circuit in open position and the fuse link for the pilot lamp, earth lamp, voltmeter, etc. removed. Voltage coils normally connected to bus bars shall be temporarily disconnected while the test between poles is being made.

1.8.4. Functions of instruments, circuit-breakers, switchgears, etc. on switchboards shall be confirmed normal.

Table 4.1.1
Limits of Temperature Rise of Electrical Appliances for Switchboard
(Based on ambient temperature 45°C**)**

Items and parts			Limit of temperature rise(°C)	
			Thermometer	Resistance
Coils	Class A insulation		45	65
	Class E insulation		60	80
	Class B insulation		75	95
	Bare windings of single layer		75	--
Contact pieces	Mass form	Copper or Copper alloy	40	--
		Silver or Silver alloy	70	--
	Multilayer form	Copper or Copper alloy	25	--
	Knife form	Copper or Copper alloy	25	--
Terminals for external cables			45	--
Metallic resistors	Moulded-case type		245	--
	Those other than Moulded-case type	For continuous service	295	--
		For intermittent service	345	--
	Exhaust (approx. 25 mm above the exhaust		170	

Table 4.1.2

Dielectric Strength Test of Switchboards

Rated voltage (V)	Testing voltage (V)	Testing period (s)
60	500	60
250	1500	60
500	2000	60

SECTION 2 BATTERIES

Contents

2.1 Construction and Arrangement

2.1.1. Batteries used for power, lighting or internal communication shall be so constructed as to prevent spilling of the electrolyte due to the motion of the ship to the surrounding objects and to be installed permanently in adequately ventilated spaces not subjected to the extremes of temperature.

2.1.2. Batteries shall not to be placed in sleeping quarters.

2.1.3. Lead type batteries and alkaline type batteries shall not to be placed in the same compartment.

2.1.4. Large batteries shall be installed in a compartment assigned to them only. A box on deck would meet this requirement if adequately ventilated and provided with means to prevent ingress of water.

2.1.5. Engine starting batteries shall be located as close as practicable to the engine(s) served. If such batteries cannot be accommodated in the battery compartment, they shall be installed so that adequate ventilation is ensured.

2.1.6. Battery compartments shall be ventilated by an independent ventilating system.

2.1.7. Natural ventilation shall be employed if ducts can be run directly from the top of the compartment to the open air with no part of the duct more than 45° from the vertical. If natural ventilation is impracticable, mechanical ventilation shall be provided. Interior surfaces of ducts and fans shall be painted with corrosion-resistant paint. Fan motors are not to be located in the air stream. Ventilating fans shall be so constructed and to be of such a material as to render sparking impossible in the event of the impeller touching the fan casing.

2.1.8. Every battery shall be so arranged that each cell is readily accessible for replacing, inspection, testing, replenishing and cleaning.

2.1.9. Switches, fuses and other electrical equipment liable to cause an arc are not normally be installed in battery compartments. If such equipment necessary for operational reasons, the equipment shall be certified for group IIC gases and temperature Class T1 in accordance with IEC Publication 79: Electrical apparatus for explosive gas atmospheres, or an acceptable and relevant National Standard.

2.1.10. The exposed metal in the space or compartment used for the storage of batteries such as shelf, vent fan and duct (if used) shall be protected with corrosion resistance paint. The deck, shelf, locker or box where acid batteries are placed shall have a watertight lining of lead sheet of 1.6 mm. thick and not less than 100 mm. deep at all sides. For alkaline batteries the shelf shall be similarly lined with steel, not less than 0.8 mm. thick.

2.2 Charging Facilities

2.2.1. Suitable means, including ammeters and voltmeters, shall be provided for controlling the current with which batteries shall be charged and to protect against accidental discharge into the charging circuit. Fuses shall be used for the protection of emergency lighting batteries instead of circuit breakers up to and including 400 A rating.

2.2.2. If a battery connected for floating service or if it is used for supplying power whilst it is being charged, the maximum battery voltage shall not to exceed the permissible voltage of any of the connected appliances.

2.2.3. If a low-voltage battery connected for floating service, all connected apparatus should be capable of withstanding the line voltage to earth and a device shall be provided for preventing excessively high voltages in the battery circuit.

2.2.4. The charging equipment, except rectifiers, for all batteries with a voltage more than 20% of the line voltage shall provide automatic protection against reversal of current.

2.2.5. The charging equipment shall be such that a completely discharged battery can be completely charged within 10 hours unless a shorter time is necessary. The maximum permissible current shall not be exceeded during charging

CHAPTER 5 MOTOR CONTROLLERS AND LIGHTING

CONTENTS

SECTION 1 MOTOR CONTROLLERS

Contents

1.1 Construction

1.1.1. Except when installed on ship's service switchboards or section boards or in compartments assigned primarily to electric control equipment shall be protected by enclosing cases of strong cast or welded construction.

1.1.2. The types of enclosing case for control apparatus shall be governed by the surroundings generally as follows:

a) Waterproof enclosing cases shall be used unless the apparatus is mounted in the deck house or the deck below.

b) Waterproof or drip proof enclosing cases shall be used when the apparatus is mounted in the engine room or other spaces below the deck where the equipment shall be subjected to mechanical injury, dripping of water or oil, etc.

c) Arrangement shall be made for ventilation when a resistor is in use.

1.1.3. Manual controllers of waterproof type shall be arranged for operation without opening enclosing cases.

1.1.4. Nameplates or permanent labels shall be attached to each controller identifying the purpose or effect of control including the rotation of the handle or hand wheel. The cover of the controller shall have a diagram showing its complete wiring including external connection.

1.1.5. Contactors, relays and other electromagnets shall be capable of functioning satisfactorily even when the line voltage falls to 80% of the normal bus bar voltage for D.C. equipment or 85% of the normal voltage for A.C. equipment. Coils shall not to be damaged when the voltage rises 10% above the normal voltage and on A.C. supply when the frequency varies up to 5% from the normal for prolonged periods.

1.1.6. The voltage drop across series coils such as overload trips shall not to be such as to reduce materially the voltage at the motor terminal.

1.1.7. Resistors.

a) Resistors shall be self-supporting, rigidly fixed, or supported throughout the length with non-ignitable and non-absorbent insulating material.

b) The element of resistors shall be thoroughly protected against the corrosive action of salt water and atmospheric moisture, either by effective rust proof process, or being embedded in a material which will protect it against corrosion, or it shall be of corrosion resistance materials.

1.2 Protection of Motors

1.2.1. Every electric motor shall be provided with an effective controller for starting, stopping, reversing or speed controlling as necessary and so placed as to be easily accessible to the person controlling the motor.

1.2.2. Generally, every controller shall be provided with undervoltage and over load protections for motors rated at 0.5 kW or above except steering gear motors which need not have overload protection.

1.2.3. Means shall be provided to prevent undesired restarting after stoppage due to low voltage or complete loss of voltage. This requirement does not apply to motors, continuous availability of which is essential to the safety of the ship and the automatic operation.

1.2.4. Primary means of isolation shall be provided so that all voltages shall be cut off from the motor, except where means of isolation (that provided at the switchboard, section board, distribution board, etc.) are adjacent to the motor.

1.2.5. Means for automatic disconnection of the power supply shall be provided in the event of excessive current due to mechanical overloading of the motor.This requirements does not apply to the motors for steering gear.

1.2.6. Where the primary means of isolation is remote from the motor, either of the following means or the equivalent shall be provided:

a) An additional means of isolation fitted adjacent to the motor shall be provided.

b) Provision is made for locking the primary means of isolation in the "off" position.

1.2.7. If fuses are used to protect polyphase A.C. motor circuits, consideration shall be given to protect against single phasing.

1.2.8. If controllers for motors of essential services installed in duplicate are built in a grouped starter panel, the busbars, appliances and others shall be so arranged that one fault on the appliances and circuits do not render the motors for the same use unusable simultaneously.

1.2.9. Transformers for power supply to control circuits shall be provided to each motor or each group of motors incorporated in an apparatus.

1.2.10. Running indicators and overload alarms for motors for steering gear shall comply with the requirements in Chapter 2 , Sect 3 of this Part.

1.3 Temperature Rise

1.3.1. The maximum permissible temperature rise limit to the principal parts of controllers is not to exceed the values mentioned in Table . 5.1.1

1.3.2. The contacts, magnet cores and other parts not mentioned above whether insulated or not, shall not to reach a temperature which might injure themselves or cause damage to the adjacent parts or material.

1.3.3. If the temperature of any part of the enclosure is likely to exceed 60 □C the apparatus shall be so located or guarded as to prevent it from being inadvertently touched.

1.4 Tests

1.4.1. The temperature rise test of controllers and their resistors shall be carried out under normal working condition, and the temperature rise of each is not to exceed the values mentioned in [1.3] above of this Section.

1.4.2. Controllers and resistors shall be tested with high voltages applied between the current carrying part and the earthed frame or case, and between each circuit of different potentials with all covers in normal position at any frequency between 25 and 100 Hz maintained for 1 minute. The test voltage shall be as follows:

a) The control gear rated at 60 V or less shall be tested at 500 V.

b) The control gear rated above 60V shall be tested at twice the rated voltage plus 1000 V, with a minimum of 1500 V.

1.4.3. The operation test of the controller shall be carried out to confirm the requirements of [1.1.6], [1.2.3] and [1.2.4] of this Section.

1.4.4. Immediately after the completion of the dielectric test the insulation resistance of the control gear between poles, and between the current carrying part and the earthed frame or case shall be not less than 1 MΩ when tested with D.C. voltage of approximately 500 V tester.

Table 5.1.1
Limit of Temperature Rise of Controllers
(Based on ambient temperature 45 °C)

Items and parts				Limit of temperature rise (°C)	
				Thermometer method	Resistance
Coils (Air)	Class A insulation			60	80
	Class E insulation			75	95
	Class B insulation			85	105
	Class F insulation			110	130
	Class H insulation			135	155
	Class C insulation			no limit	no limit
	Single layer enamel windings	Class A insulation		80	--
		Class E insulation		95	--
		Class B insulation		105	--
		Class F insulation		130	--
		Class H insulation		155	--
		Class C insulation		no limit	--
Contact piece	Mass form	Continuous use over 8 hours	Copper or copper	40	--
			Silver or silver	70	--
		Switch on and off one or more in about 8 hours	Copper or copper	40	--
			Silver or silver	60	--
	Multilayer form or knife form		Copper or copper	35	--
Busbar and connecting conductor (Bare or Class A insulation and				60	--
Terminals for external cables				45	--
Metallic resistors	Moulded-case type			245	--
	Those other than molded-case type	For continuous use		295	--
		For intermittent use		345	--
		For starter use		345	--
	Exhaust (approx. 25 mm above exhaust port)			170	--

Notes:
1. Measurement of temperature of voltage coil is in principle to be made by resistance method only.
2. Where the insulation of single layer enamel windings is higher in class than that of the adjacent parts the temperature rise associated with the class of insulation for the adjacent parts shall be applied.
3. For single layer bare windings, the temperature rise associated with the class of insulating material on the adjacent parts shall be applied.
4. Moulded-case type metallic resistor means such type as to be buried in the insulating material so that no surface of metallic resistor is exposed.

SECTION 2 LIGHTING

Contents

2.1 General

2.1.1. Lighting fittings shall be designed and constructed as follows:

a) The passage for the insulated conductor shall be of ample size and free from rough projection sharp angles and bends. The outlet for cables shall have well rounded edges or be suitably bushed.
b) Insulated conductors are so installed that the stress is not to be applied to terminals to which conductors are connected.
c) Enclosures shall be made of metal with corrosion resistant finish or durable flame-retarding insulating materials. The inside of metallic enclosures shall be coated or painted with an insulating paint or compound.
d) Live parts or their insulation shall be so fixed that dust and moisture cannot accumulate.
e) Weatherproof or waterproof type shall be perfect water tightness and capable of withstanding a hose test of 4500 mm water head at 2000 mm away for a period of 15 seconds.
f) Means shall be provided to ground effectively the external metal parts which are liable to touch.

2.1.2. Lighting fittings shall be so arranged as to prevent temperature rises which could damage cables and wiring, and to prevent surrounding materials from becoming excessively hot.

2.2 Accessories

2.2.1. The live part of the joint box shall be mounted on the durable non-ignitable and non-hygroscopic insulating material of permanent high dielectric strength. The live part shall be so arranged by suitable spacing or shielding with non-ignitable insulating material that conductors of opposite polarity cannot be readily short circuited.

2.2.2. Receptacles and plugs of different electrical rating or distribution system shall be such that a wrong connection cannot be made. Socket outlets and plugs shall be so proportioned that their average temperature rise does not exceed 30 °C when the normal working current is flowing through them continuously.

2.2.3. Socket outlets having a current rating of 15A or more shall be provided with a switch, and it shall be interlocked to such a way that it is impossible to insert or withdraw the plug when the switch is in the "ON" position. Socket outlets and plugs fixed on the weather deck or machinery space or places exposed to drips or sprays shall be of weather proof type.

2.3 Light Fittings

2.3.1. Lamp holders shall be constructed wholly of flame-retarding and non-hygroscopic materials, and supports for live parts shall be of non-ignitable materials. All metal parts shall be of robust proportion

2.3.2. Lighting fittings shall be so designed as to provide adequate dissipation of heat from lamps, and insulated conductors connected to the fittings shall be suitably protected from the effect of high temperature.

2.3.3. Lamps exposed to mechanical injury shall be enclosed in fittings of solid construction and provided with strong guards. Lighting fittings or portable lamps for the battery room or such other spaces where inflammable vapour or gas shall be normally liable to accumulate, shall be of explosion proof type approved by the

Society.

2.3.4. Portable lighting fittings.

a) Portable lighting fittings for the illumination of decks, holds, the engine room and other similar spaces shall be provided with lamp holders enclosed in insulating materials or so protected by metal guards insulated from the holders that live parts cannot be touched.

b) Portable lighting fittings shall be provided with a hook or ring or other suitable attachment to enable them to be hung up and so prevent strain on the connection.

c) Switches are not to be incorporated in portable lighting fittings.

d) Frames of portable lighting fittings shall be grounded by means of the earth continuity conductor of the cord.

2.3.5. Navigation lights shall be of metal filament lamps of weather proof type. The lens and shapes shall be in accordance with the international maritime requirements.

2.4 Fluorescent Lamps

2.4.1. Fittings, reactors, capacitors and other auxiliaries shall not to be mounted on surfaces which are subject to high temperatures.

2.4.2. Capacitors of 0.5 microfarads and above shall be provided with a means of prompt discharge on disconnection of the supply.

2.4.3. Inductors and high reactance transformers shall be installed as close as practicable to the associated discharge lamp.

2.5 Search Lights

2.5.1. Search lights shall be of either incandescent or arc type.

2.5.2. Arc lamps are not to be fitted in spaces in which inflammable goods are stored, or where explosive dust, vapour or gas shall liable to accumulate, and the circuits shall be provided with a circuit breaker.

2.5.3. When series resistance is used with search lights, the control gear shall have a multi-pole switch with fuse, fitted on the supply lead to the resistance.

2.5.4. The frame of every search light supplied by a system having a voltage of 50V or more shall be provided with a suitable terminal to which an earth conductor shall be connected.

CHAPTER 6 TRANSFORMERS

CONTENTS

SECTION 1 GENERAL

Contents

1.1 Application

1.1.1. The requirements of this Chapter are normally applicable to marine use transformers having a rated output of 1 kVA or more for single phase and 5 kVA or more for 3-phase.

1.1.2. Transformers, unless otherwise approved, shall be rated at their continuous maximum rating expressed as the kVA output on non-inductive load when carrying rated current on the output side with rated voltage applied on the input side.

1.1.3. If transformers are an essential part of the propulsion or ship's service supply system, the system shall be arranged to ensure at least the same continuity of supply as required in Chapter 8 ,Sect 1 [1.2.1] of this Part.

1.2 Construction

1.2.1. Transformers in accommodation spaces shall be of dry, naturally cooled type. In machinery spaces they shall be of oil-immersed, naturally cooled type.

1.2.2. Transformers except those for motor starting shall be double wound (two separate windings).

1.2.3. Oil-immersed transformers rated at 10 kVA or more shall be provided with oil gauges and drain cocks or plugs, and those rated at 75 kVA or more with thermometers in addition.

1.3 Voltage Regulation

1.3.1. The secondary terminal voltage difference between no load and the rated current with a unity power factor, expressed as a percentage of the no load secondary voltage, shall not to exceed the following values:

a) For up to 5 kVA per phase 5%
b) For 5 kVA and over per phase 2.5%

1.3.2. The percentage error of the voltage ratio shall be within 0.5% of the declared ratio, or equal to 110 of the percentage impedance voltage at rated load, whichever is the smaller.

1.4 Temperature Rise Test

1.4.1. The maximum permissible temperature rise at the continues maximum rating shall not to exceed the limit mentioned in Table 6.1.1. The reference ambient temperature is based on temperature of cooling fluid equal to 45 °C for air.

1.5 Other Tests

1.5.1. Every transformer while in service shall be capable of withstanding short circuit without injury at normal working voltage for the time period given in Table .6.1.2 Transformers having an impedance voltage less than 4% shall be capable of withstanding, under service condition, 25 times normal full load current for 2 seconds. These shall be conducted as a type test.

1.5.2. The high voltage test shall be carried out immediately after the temperature rise test, by the continuous application for 1 minute of alternating voltage specified in Table 6.1.3 and under the frequency of 50 to 60 Hz.

a) The test voltage as mentioned in Table 6.1.3 shall be applied between the primary winding under test and the secondary winding and core all connected to earth.

b) The test voltage as mentioned in Table 6.1.3 shall be applied between the secondary winding under test and the primary winding and core all connected to earth.

1.5.3. A test voltage shall be applied to a winding of a transformer at approximately twice the rated frequency for a duration of 60 seconds to induce voltage to a magnitude twice of the normal working voltage of the winding not connected to the exciting source. When the test frequency exceeds twice the rated frequency the duration of the test shall be equal to

$$60 \times \frac{2 \times \text{Rated frequency}}{\text{Test frequency}} \quad \text{seconds}$$

but in no case the duration of the test shall be less than 15 seconds.

1.5.4. In the case of repaired transformer the above dielectric and induced high voltage tests shall be carried out using test voltage equal to 75% of [1.5.2] and [1.5.3] above.

Table 6.1.1
Limit of Temperature Rise for Transformer
(Based on ambient temperature 45°C)

Part	Cooling system oftransformer	Limit of temperature rise (°C)					
		Measure dby	Class A Insulatio	Class B Insulatio	Class E Insulatio	Class F Insulatio	Class H Insulation
Windings	Dry natural coolingor dry air blast	Resistance Method	55	75	70	95	120
	Oil immersed	Resistance Method	60	-	-	-	-
Oil	-	Thermometer	45				
Core	-	The temperature rise when measured by thermometer on the external surfaceof the core is not to exceed that permitted for the adjacent					

Table 6.1.2
Time Period of Short Circuit

Impedance voltage (%)	Time period of short circuit(s)
4	2
5	3
6	4
7 and above	5

Table 6.1.3
High Voltage Test

Rated voltage(V)	Test voltage(V)
up to 250	1500
over 250	1000 + 2 x maximum voltage between lines

CHAPTER 7 CABLES

CONTENTS

SECTION 1 GENERAL

Contents

1.1 General

1.1.1. Cables shall comply with IEC Publication 92 or equivalent thereto. Installation of cables shall comply with the requirements in this Chapter.

1.1.2. The rated voltage of any cable is not be lower than the nominal voltage of the circuit for which it is used.

1.1.3. Separate cables are, as a rule, to be used for a power supply circuit requiring individual short-circuit and overcurrent protection.

1.2 Applications

1.2.1. The maximum rated conductor temperature of the insulating material for normal operation shall be at least 10 °C higher than the maximum ambient temperature liable to be produced in the space where the cable is installed.

1.2.2. The application of insulating materials for cables shall be in accordance with Table 7.1.1.

1.2.3. Cable shall be protected by sheath and/or armour in accordance with the following requirements:

a) Cables fitted up on weather decks, in bath room, in cargo holds, in machinery spaces or in any other location where water condensation or oil vapour shall be present, shall have a metallic sheath or an impervious sheath (polyvinylchloride compound or polychloroprene compound).

b) In permanently wet situations, metallic sheaths shall be used for cables with hygroscopic insulation.
c) Cables shall be armoured except cables fitted up in living quarters or in any other location where they are not exposed to risk of mechanical injury.

1.2.4. All electric cables and wiring external to equipment shall be at least of a flame retardant type and shall be so installed as not to impair their original flame retarding properties. Where necessary for particular applications INTLREG shall permit the use of special types of cables such as radio frequency cables, which do not comply with the foregoing.

1.3 Current Rating of Cables

1.3.1. The diversity factor of the individual loads shall be taken into account in estimating the maximum continuous load.

1.3.2. The voltage drop from main or emergency switchboard busbars to any current under normal conditions of service, shall not to exceed 6% of the nominal voltage. For supplies from batteries with a voltage not exceeding 55 volts, these figures shall be increased to 10%. For navigation lights and radio apparatus, lower voltage drops shall be considered.

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

1.3.4. In case of motors of windlasses and capstans are for short time duty, the current rating of the cables shall be allowed to increase according to their duty.

1.3.5. Current ratings of cables for continuous services shall not to exceed the values mentioned in Table 7.1.2.

1.3.6. If more than six electric cables, which shall be expected to operate simultaneously at their full rated capacity, are laid close together in a cable bunch in such a way that there is an absence of free air circulation around them, a correction factor of 0.85 shall be applied. Signal cables shall be exempted from this requirement.

1.3.7. The current ratings of Table 7.1.2 are based on an ambient temperature of 45 °C. For other values of ambient temperature the correction factors mentioned in Table 7.1.3 shall be applied.

1.3.8. Current ratings of cables for short-time services and intermittent services shall be corrected as follows:

a) The current rating of cables for short-time services (30 minutes or 60 minutes) shall be increased by multiplying the value mentioned in Table 7.1.2 by the following correction factor

$$\text{correction factor} = \sqrt{\frac{1.12}{1 - e^{\frac{-ts}{T}}}}$$

where:
ts = 30 or 60 (min)
$T = 0.245d^{1.35}$ where d is the overall diameter of the cable, in mm

b) The current rating of cables for intermittent service (for periods of 10 minutes, of which 4 minutes are with a constant load and 6 minutes without load) shall be increased by multiplying the value mentioned in Table 7.1.2 by the following correction factor.

$$\text{correction factor} = \sqrt{\frac{1 - e^{\frac{-10}{T}}}{1 - e^{\frac{-4}{T}}}}$$

where:
$T = 0.245d^{1.35}$ where d is the overall diameter of the cable, in mm

c) The current rating for other intermittent ratings shall be deemed appropriate by the Society.

1.3.9. The cross sectional area of the conductors shall be sufficient to ensure that, under short circuit conditions, the maximum rated conductor temperature for short circuit operation is not exceeded, taking into consideration the time current characteristics of the circuit protective device and the peak value of the prospective short circuit current.

1.3.10. In case of cables , supply two or more final sub-circuits account shall be taken of any diversity factors which shall apply (Refer Chapter 2,Sect 1 [1.1.4])

1.4 Cables Installation

1.4.1. Cables and wiring shall be installed and supported in such a manner so as to avoid chafing or other damage. Cable runs shall be, as far as possible, straight and accessible.

1.4.2. The installation of cables across expansion joints in the ship's structure shall be, as far as possible, avoided. If such installation is unavoidable, a loop of cable of length proportional to the expansion of the joint shall be provided. The internal radius of the loop shall be at least 12 times the external diameter of the cable.

1.4.3. Electric cables shall be as far as practicable installed remote from sources of heat. If installation of cables near sources of heat cannot be avoided and there is a risk of damage to the cables by heat, suitable shields, insulation or other precautions shall be installed.

1.4.4. Cables having insulating materials with different maximum rated conductor temperatures shall not to be bunched together, or, where such bunching is unavoidable, the cables shall be operated so that no cable shall reach a temperature higher than that permitted for the lowest temperature rated cable in the group.

1.4.5. Cables having a protective covering which shall damage the covering of other cables sahll not to be bunched together with those cables.

1.4.6. In case a duplicate supply is required, the two cables shall follow different routes which shall be as far apart as practicable.

1.4.7. When installing cables, the minimum inside radius of bend shall be in accordance with the following:

a) Armoured rubber insulated and PVC insulated cables : 6d
b) Unarmoured rubber insulated and PVC insulated cables : 4d (d ≤ 25 mm) , 6d (d > 25 mm)
c) Mineral insulated cables: 6d
b) Overall diameter of the finished cable

1.4.8. Intrinsically safe circuits shall be installed complying with the followings;

a) The cables for intrinsically safe circuits associated with intrinsically safe type electrical equipment shall be of exclusive use, being installed separately from cables for general circuits.

b) Intrinsically safe circuits associated with different intrinsically safe type electrical equipment are, as a rule, shall be wired individually using different cables. Where it is necessary to use a multi-core cable in common, a cable which has shields by each core or each pair of cores shall be used, having such shields earthed effectively. However, intrinsically safe circuits associated with category "ia" intrinsically safe type electrical equipment shall not to be contained in a cable associated with category "ib" intrinsically safe type electrical equipment.

1.5 Precaution against Fire

1.5.1. Where electric cables are installed in bunches, provision shall be made to limit the propagation of fire, which shall be achieved by the use of suitably located fire stops. Alternative arrangements shall be considered.

1.5.2. All cables for power, lighting, internal communications, signals and navigational aids of essential and emergency services shall be so far as practicable routed clear of machinery spaces of category A and their casings, galleys, laundries and other high fire risk areas. Cables connecting fire pumps to the emergency switchboard shall be of a fire resistant type when they pass through high fire risk areas. All such cables shall be so far as practicable run in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads that shall be caused by a fire in an adjacent space.

1.6 Cables in Hazardous Areas

Where cables which are installed in hazardous areas introduce the risk of fire or explosion in the event of an electrical fault in such areas, special precautions against such risks shall be taken to the satisfaction of the Society.

1.7 Mechanical Protection of Cables

1.7.1. Cables exposed to risk of mechanical damage shall be protected by metal channels or casings or enclosed in steel conduct.

1.7.2. Cables in cargo holds and other spaces where there is exceptional risk of mechanical damage shall be suitably protected, even if armoured.

1.7.3. Metal casings for mechanical protection of cables shall be efficiently protected against corrosion.

1.7.4. Non-metallic duct or conduit shall be of flame retardant material. PVC conduit is not to be used in refrigerated spaces or on open decks.

1.8 Installation of Cables in Pipes and Conduits

1.8.1. Metallic pipes and conduits shall be effectively earthed and shall be mechanically and electrically continuous across joints.

1.8.2. The internal radius of the bend of pipes and conduits is not to be less than the values specified in [1.4.7] above. Where, however, pipes exceed 64 mm in diameter, the internal radius of the bend shall not to be less than twice a diameter of the pipe.

1.8.3. The drawing-in factor (ratio of the sum of the cross-sectional areas of the cables to the internal cross- sectional area of the pipe) shall not to exceed 0.4.

1.8.4. Horizontal pipes or conduits shall have suitable drainage.

1.8.5. Where pipe arrangement is long, expansion joints shall be provided where necessary.

1.9 Bulkheads and Decks penetration

1.9.1. Penetration through bulkheads and decks, which are required to have some degree of strength and tightness, shall be so effected as to ensure that the strength and tightness shall not impaired.

1.9.2. Penetration through bulkheads and decks, which are required to have some degree of fire integrity, shall be so effected as to ensure that the fire integrity shall not impaired.

1.9.3. Where cables pass through non-watertight bulkheads or steel structure, holes shall be bushed with lead or other suitable materials in order to avoid damage to cables. If the thickness of the steel is sufficient and there is no risk of damage to cables, adequately rounded edges shall be accepted as the equivalent of bushing.

1.10 Earthing and Securing of Cables

1.10.1. Metallic coverings of cables shall be effectively earthed at both ends, except that in final sub-circuits earthing shall be at the supply end only. This does not necessarily apply to instrumentation cables where single point earthing shall be desirable for technical reasons.

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

1.10.3. Lead sheath of lead-sheathed cables shall not to be used as the sole means of earthing the non-current carrying parts of electrical equipment.

1.10.4. Cables except those for portable appliances and those installed in conduits, shall be fixed by means of clips or saddles or hangers and bands made of corrosion resistant metal or other nonhygroscopic incombustible materials or suitably corrosion inhibited, all having a large surface area and smooth edges so rounded off that the cables remain tight without their covering being damaged.

1.10.5. The distances between supports shall be chosen according to the type of cable and the probability of vibration and are not to exceed 400 mm. For a horizontal cable run, fixings shall be provided to restrain the cable movement where the cables are laid on cable supports in the form of trays or plates, separate support brackets, hangers or ladder rack fixings. The spacings between the fixing points shall be up to 900 mm provided that there are supports with maximum spacing as specified above.

This relaxation is not to be applied to cable runs on decks or in areas which can be subjected to forces of seawater impingement.
Where cables are installed below cable ways or supports, the fixing distances for securing the cable shall be in accordance with those mentioned in Table 7.1.4

1.11 Cables passing through Refrigerated Spaces

1.11.1. Cables shall not to be installed in refrigerated spaces, as far as possible. Where cables are installed by necessity in such spaces, wiring shall be in accordance with the following requirements:

a) PVC insulated cables shall not to be used.
b) Cables shall have a lead sheath or cold resisting impervious sheath.
c) Cables are not to be, as a rule, embedded in structural heat insulation
d) Where cables have to pass through structural heat insulation, they shall be installed at right angle to such insulation and shall be protected by a pipe, preferably fitted with a watertight stuffing tube at each end.
e) Cables shall be installed so as to leave a space behind the face of the chamber or air duct casings and shall be supported by plating, hangers or cleats.
f) Supporting strips, plating or hangers used for securing the cable shall be galvanized or otherwise protected against corrosion.

1.12 Cables for Alternating Current

1.12.1. Where it is necessary to use single-core cables for alternating current circuits rated in excess of 20A, the following requirements shall be applied:

a) Cables shall be either non-armoured or armoured with non-magnetic material.
b) Where installed in pipe or conduit, cables belonging to the same circuit shall be installed in the same pipe or conduit unless the metallic pipe or conduit is of non-magnetic material.

c) Cable clips shall include cables of all phases of a circuit unless the clips are of non-magnetic material.
d) Where two or three single-core cables forming respectively single-phase circuits or three-phase circuits are installed, the cables shall be as near as possible each other. In any case, the clearance between the adjacent cables is not to be greater than one diameter.
e) Where single-core cables of current rating greater than 250A are run along steel bulkheads, the cables shall be run apart from the steel, as far as practicable.
f) Where single-core cables of large sectional area and exceeding 30 meters in length are used, the phases shall be transposed at regular intervals of approximately 15 meters in order to obtain the same degree of impedance of circuits.
g) In the case of circuits involving several single-core cables in parallel per phase, all cables shall have the same length and the same sectional area.
h) 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 shall pass through a plate or gland so made that there is no magnetic material between the cables and the distance between the cables and the magnetic material is not to be less than 75 mm wherever practicable.

1.13 Joints and Branches

1.13.1. Cables shall be jointed by terminals. Soldering fluxes containing corrosive substances shall not to be used.

1.13.2. Terminals shall have sufficient contacting surface and pressure. The length of soldered parts of copper tube terminals and other terminals shall not to be less than 1.5 times the diameter of conductors.

1.13.3. Joints or branches of cables shall be carried out in a suitable box, except where method of connection causes no possible risk of deteriorating waterproof characteristics, flame retardation, mechanical strength or electrical characteristics of cables.

1.13.4. Terminations and joints in all conductors shall be so made as to retain the original electrical, mechanical, flame retarding and, where necessary, fire resisting properties of the cable.

1.13.5. Terminals and conductors shall be of dimensions adequate for the cable rating.

1.13.6. Cables not having a moisture-resistant insulation (e.g., mineral insulation) shall have their ends effectively sealed against ingress of moisture.

SECTION 2 TESTS AND INSPECTIONS

Contents

2.1 Procedures

2.1.1. The tests and inspections described below shall be carried out under the supervision of the Surveyor. The tests of cables of same kind, size and manufactured at same time, shall be limited to the samples selected by the Surveyor except high voltage and insulation tests which shall be carried out to every length of them. In the event of any of the materials proved unsatisfactory in the course of being installed in the ship, such materials shall be rejected, notwithstanding any previous certificate of satisfactory testing.

2.1.2. **Constructional inspections**.

The dimensions and construction of cables shall be inspected in a specimen of suitable length.

2.1.3. **Conductor resistance tests**.

The conductor resistance per drum or mandrel shall be measured and its value, corrected to 20 °C, shall not to exceed the value obtained from the following formula:

$$R = \frac{17.241 k_1 k_2 k_3}{0.7854 N d^2}$$

where:
R = Conductor resistance, in Ω/km at 20 °C.
N = Number of strands.
D = Diameter of strand, in mm.
k_1 = Correction factor for variations in diameter and conductivity as follows:

Conductor	Dia. of conductor D (mm)	k_1	
		Tinned copper	Plain copper
Stranded	$0.10 < D \leq 0.31$	1.07	1.04
	$0.31 < D \leq 0.91$	1.04	1.02
	$0.91 < D$	1.03	1.02
Solid	$0.31 < D \leq 0.91$	1.05	1.03
	$0.91 < D$	1.04	1.03

k_2 = Correction factor for the laying-up of strands,
=1.04 for diameter of strand less than 0.6 mm, and =1.02 for diameter of strand above 0.6 mm.
k_3 = Correction factor for the laying-up of cores,
=1.00 for single-core cables,
=1.02 for multi-core cables,
=1.05 for multi-core cords, and
=1.03 for telephone cables

2.1.4. **High voltage tests.**

a) The dielectric strength test of cable insulation shall be carried out on cables of 660 V rating with 2500 V A.C. of sine wave form at a frequency between 25 and 100 Hz for a period of 5 minutes. For 250 V rating cables, the test voltage shall be 1500 V A.C. The high voltage shall be applied on the entire length of the cable by immersing the insulation cable in water for a period of 12 hours and tested while still immersed, when the cable is of non-conductive covering. For the cable with conductive covering, the test shall be carried out by grounding of the conductive covering.

b) For multi-conductor cables, the voltage shall be applied between conductors and between the outer surface and the conductor.

2.1.5. **Insulation resistance tests**.

The insulation resistance of cables shall be measured after the high voltage test and then the value corrected to 20 °C shall not to be less than the value obtained from the following formula:

$$R_i = K_i \log_{10} \frac{D}{d}$$

where:

R_i = Insulation resistance, in M-km.
d = Overall diameter of conductor, in mm.
D = d + 2 t, in mm.
t = Thickness of insulation, in mm.
K_i = Insulation resistance constant. The values in parentheses shall be used as the constant at the maximum rated conductor temperature.

Natural rubber	1500
Butyl rubber	3670
EP rubber 3670	(3.6)
Silicon rubber	1500
PVC	200 (0.2)
Mineral insulation	5000

2.1.6. **Leakage resistance tests.**

The leakage resistance between metal foil bands placed 50 mm apart, measured with a voltage of approximately 300 V, D.C., on a sample immediately after exposure for 16 hours at a temperature of 25 °C to 35 °C to atmosphere of humidity of 100%, shall not to be less than 1 MΩ per 25 mm length per 25 mm of circumference. This test shall be applied only to switchboard wires

2.1.7. **Bending tests**.

a) For switchboard wires:
A specimen of suitable length taken from the finished wire shall be bent, at room temperature, 90° at 2 points about 50 mm apart in the same direction around a mandrel having the same diameter as the wire, and the specimen shall show no rupture of the covering, and it is not to break down at less than 5000 V applied gradually on the bending part. This test shall be enforced to wire of which the sectional area of conductor does not exceed 8 mm^2.

b) For mineral insulated cables:

A specimen of suitable length taken from the finished cable shall be capable of being bent, at room temperature, 180° around a mandrel having a diameter of 12 times the diameter of the cable. The specimen is then to be straightened and bent 180° in opposite direction around the same mandrel. This cycle shall be repeated three times, making a total of 6 bends (3 in each direction). After bending, the specimen shall be immersed in water for 2 hours

and then shall be capable of successfully withstanding the test voltage of 1500 V, A.C. for 5 minutes.

2.1.8. **Flattening tests for mineral insulated cables.**

Two specimens of suitable length taken from the finished cable at a portion at least 300 mm apart from the cable ends shall be flattened until the thickness of the flattened portions is two-thirds of the nominal diameter and no crack is found on the sheath. In addition, the flattened samples shall be immersed in water for one hour and then capable of successfully withstanding for 2 minutes the test voltage of 1500 V, A.C. applied between conductors and between each conductor and the sheath.

2.1.9. **Flammability tests.**

Finished cables shall be tested in accordance with IEC publication 332-3, IEEE Std. 45 (1983) or other recognized standards. In regard to flammability tests, the installation of cables complying with IEC Publication 331 and 332-1 shall be subject to special consideration

Table 7.1.1
Permissible Temperature of Insulating Materials

Insulating material	Maximum rated conductor temp.(°C)	Maximum ambient temp. (°C)
Polyvinylchloride compound	60	50
Polyethylene	60	50
Cross-linked polyethylene	85	75
EP rubber	85	75
Silicon rubber	95 (150)	–
Mineral	95 (unlimited)	–

Notes:
1. The values in parentheses are permitted when installed where they are not liable to be touched by ship's personnel. When silicon rubber cables are sheathed with lead, above value shall be reduced to 120 °C.
2. Polyvinylchloride compounds are applied to PVC sheathed cord and telephone cable

Table 7.1.2
Electric Cable Current Ratings for Continuous Services, Based on Ambient Temperature 45 °C

Nominal cross section	Continuous r.m.s. current rating, in amperes								
	Thermoplastic, PVC, PE			EP rubber and cross linked PE			Silicon rubber or mineral		
	single core	2 core	3 or 4 core	single core	2 core	3 or 4 core	single core	2 core	3 or 4 core
0.75	6	5	4	13	11	9	17	14	12
1	8	7	6	16	14	11	20	17	14
1.25	10	8	7	18	15	13	23	19	16
1.5	12	10	8	20	17	14	24	20	17
2	13	11	9	25	21	17	31	26	21
2.5	17	14	12	28	24	20	32	27	22
3.5	21	18	14	35	30	24	39	33	27
4	22	19	15	38	32	27	42	36	29
5.5	27	23	19	46	39	32	52	44	36
6	29	26	20	48	41	34	55	47	39
8	35	30	24	59	50	41	66	56	46
10	40	34	28	67	57	47	75	64	53
14	49	42	34	83	71	58	94	80	66
16	54	46	38	90	77	63	100	85	70
22	66	56	46	110	93	77	124	105	87
25	71	60	50	120	102	84	135	115	95
30	80	68	56	135	115	94	151	128	106
35	87	74	61	145	123	102	165	140	116
38	92	78	64	155	132	108	175	149	122
50	105	89	74	185	153	126	200	175	140
60	123	104	86	205	174	143	233	198	163
70	135	115	95	225	191	158	255	217	179
80	147	125	103	245	208	171	278	236	195
95	165	140	116	275	234	193	310	264	217
100	169	144	118	285	242	199	320	272	224
120	190	162	133	320	272	224	360	306	252
125	194	165	134	325	280	230	368	313	258
150	220	187	154	365	310	256	410	349	287
185	250	213	175	415	353	291	470	400	329
200	260	221	182	440	375	305	494	420	346
240	290	247	203	490	417	343	570	485	400
300	335	285	235	560	476	392	660	560	460

Table 7.1.3
Correction Factors

Insulation material	Correction factor for ambient air temperature of °C										
	35	40	45	50	55	60	65	70	75	80	85
PVC, Polyethylene	1.29	1.15	1.00	0.82	-	-	-	-	-	-	-
EPR, XLPE	1.12	1.06	1.00	0.94	0.87	0.79	0.71	0.61	0.50	-	-
Mineral, Silicon rubber	1.10	1.05	1.00	0.95	0.89	0.84	0.77	0.71	0.63	0.55	0.45

Table 7.1.4
Maximum Spacing of Clips or Straps for Securing Cables

External diameter of cable		Non-armoured cables	Armoured cables	Mineral insulated cables
exceeding	not exceeding			
mm	mm	mm	mm	mm
-	8	200	250	300
8	13	250	300	370
13	20	300	350	450
20	30	350	400	450
30	-	400	450	450

CHAPTER 8 MAIN AND EMERGENCY SOURCE OF ELECTRICAL POWER

CONTENTS

SECTION 1 MAIN AND EMERGENCY POWER

Contents

1.1 General

1.1.1. This chapter describes the requirements for the design of installations of main source of electrical power and emergency source of electrical power.

1.1.2. Electrical installations shall comply with the following:

a) All electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions and other electrical services as deemed necessary by the Society shall be ensured without recourse to the emergency source of electrical power;
b) Electrical services essential for safety shall be ensured under various emergency conditions; and
c) The safety of passengers, crew and ship from electrical hazards will be ensured.

1.2 Main Source of Electrical Power

1.2.1. Main Source of Electrical Power.

a) A main source of electrical power of sufficient capacity to supply all those services specified in [1.1.2] (a), above shall be provided. This main source of electrical power shall consist of at least two generating sets.
b) The capacity of these generating sets shall be such that in the event of any one generating set being stopped it will still be possible to supply those services necessary to provide normal operational conditions of propulsion and safety and other electrical services as deemed necessary by the Society. Minimum comfortable conditions of habitability is also to be ensured which include at least adequate services for cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water.
c) The arrangements of the ship's main source of electrical power shall be such that the services referred to the requirement in [1.1.2] (a) above, shall be maintained regardless of the speed and direction of the propulsion machinery or shafting.
d) 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 shall 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 shall sufficient to provide at the same time those services required shall be supplied by the requirements in [1.3.2] (a) to (b) below.

1.2.2. Power management.

a) Arrangements shall be made to disconnect automatically, after an appropriate time delay, circuits of the categories noted in (b), when the generator(s) is/are over loaded; sufficient to ensure the connected generating set(s) is/are not overloaded;

b) The circuits that shall be disconnected by the load shedding system are:

i) Non-essential circuits.
ii) Circuits feeding services for habitability, such as cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water.

c) If required this load shedding shall be carried out in one or more stages in which case the non-essential circuits shall be included in the first group to be disconnected.
d) Consideration shall be given to providing means to inhibit automatically the starting of large motors, or the connection of other large loads, until sufficient

generating capacity is available to supply them.

1.2.3. Lighting Systems.

a) A main electric lighting system supplied from the main source of electrical power shall be provided in spaces or compartments where crew and personnel use and normally work on duty.
b) The main electric lighting system shall be so arranged as not to be impaired in the event of a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, the emergency switchboard and the emergency lighting switchboard.
c) Emergency lighting shall provide sufficient illumination necessary for the safety as the requirements in [1.3.2] (a) below
d) The emergency electric lighting system shall be so arranged as not to be impaired in the event of a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, the main switchboard and the main lighting switchboard.

1.3 Emergency Source of Electrical Power

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

1.3.2. 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:

a) For a period of 12 hours, emergency lighting:

i) at embarkation station and over sides.
ii) in alleyways, stairways and exits, giving access to embarkation stations;
iii) in the machinery spaces and main generating stations including their control positions;
iv) in all control stations, machinery control rooms, and at each main and emergency switchboard;
v) at the steering gear.

b) For a period of 12 hours:

i) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force;
ii) radio installations;
iii) all internal communication equipment required in an emergency;
iv) the shipborne navigational equipment as required by Governmental Regulations; where such provision is unreasonable or impracticable the Society may waive this requirement;
v) the fire detection and fire alarm system (if provided); and
vi) for intermittent operation of the daylight signaling lamp, the ship's whistle, the manually operated call points and all internal signals that are required in an emergency

CHAPTER 9 TESTS AFTER INSTALLATION ON BOARD

CONTENTS

SECTION 1 TESTS

Contents

1.1 General

1.1.1. Before a new installation or a modification of or an addition to an existing installation is put into service, the appropriate trials specified in this Chapter shall be made in the presence of the Surveyor.

1.2 Insulation Tests

1.2.1. The insulation resistance test referred to [1.2.2 to [1.2.4] hereunder shall be carried out by means of a self-contained instrument such as a direct reading ohmmeter of magnet type applying a D.C. voltage of not less than 500V. Where a circuit incorporates capacitors of more than 2 microfarads total capacitance, a constant-voltage instrument shall be used in order to ensure accurate test reading.

1.2.2. Insulation resistance of circuits.

a) The insulation resistance to every distribution circuit between all insulated poles and earth and between poles is not to be less than 1 MΩ.

b) Each interior communication circuit operating at voltages of 50V or above, shall have an insulated resistance between conductors and between each conductor and the earth of not less than 1 MΩ. For circuits below 50 volts the insulation resistance shall be not less than .1 ÷ 3 MΩ

1.2.3. The insulation resistance of switchboards and distribution panels between each bus bar and the earth shall be not less than 1 MΩ.

1.2.4. The insulation resistance of each generator and motor under working temperature shall be in accordance with the requirements in Chapter 3,Section 1[1.8.2] of this Part.

1.3 Performance Tests

1.3.1. Switches, circuit breakers and associated equipment on switchboards, section boards and distribution panels shall be operated on load to demonstrate that they are mechanically and electrically fitted in satisfactory condition.

1.3.2. Generating sets shall be run at full load for a sufficient duration to demonstrate that temperature rises, the operation of the speed governor, over speed trip, reverse current (or power) trip, other safety devices, lubrication and the balance of vibration are satisfactory. If generators are intended to operate in parallel, they shall be tested to demonstrate that the voltage regulation, synchronizing device, load share and the parallel operation are satisfactory.

1.3.3. Each motor with its accessory and control gear shall be run under the operating condition for a sufficient length of time to demonstrate that the wiring, alignment, capacity, direction of rotation, speed, commutation and the temperature are satisfactory. Cargo winch and windlass motors shall be satisfactory at their specified hoisting and lowering loads

1.3.4. Lighting fittings, receptacles and other connecting appliances on lighting circuits, ranges, bake ovens, other heating and cooking appliances on the heating power system, engine room telegraph, docking telegraph, rudder angle indicator, fire alarm, Morse telegraph light, navigation light indicator panels and telephone system of internal communication system are all to be tested to demonstrate that their suitability and function of operation are satisfactory in all respects.

1.3.5. All electric equipment located in hazardous areas shall be examined to ensure that it is of a type permitted by the Rules, has been installed in compliance with its certification, and that the integrity of the protection concept has not been impaired.

1.3.6. Additional tests are to be carried out if deemed necessary by the Surveyor.