Australian Transport Council

National Standard

for

Commercial Vessels

PART C

DESIGN AND CONSTRUCTION

SECTION 5

ENGINEERING

SUBSECTION 5B

ELECTRICAL

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FOREWORD

This Subsection of the National Standard for Commercial Vessels (NSCV) was developed following a review of the Uniform Shipping Laws (USL) Code Section 9: Engineering, and replaces Part 4: Electrical of that Section.

In reviewing the USL Code and preparing this Subsection, consideration was given to a number of factors including:

a) Current designs, practices and materials.

b) Relevant national and international standards.

c) Provisions no longer used.

d) Current survey practice, both formal and informal.

e) Discretionary requirements that rely on Authority approval.

f) Current technical standards format and style.

This Part of the National Standard for Commercial Vessels is intended to be read in conjunction with Part A—Safety Obligations and Part B—General Requirements.

This Subsection of the NSCV was drafted by the NMSC Secretariat in consultation with an industry reference group and a working group comprising representatives from the various State and Territory marine Authorities, and the Australian Maritime Safety Authority (AMSA).

The draft Subsection was released for public comment on 22 December 2000, along with a draft Regulatory Impact Statement (RIS). Public comments were received until the end of April 2001. A reference group comprising industry and government met in May 2001 to review the public comment and provide recommendations to the NMSC. The NMSC accepted the recommendations of the reference group on 30 May and the draft Subsection and RIS were revised accordingly.

The Office of Regulation Review provided an assessment of the final RIS in February 2002. NMSC approved this version of the Subsection February 2002, with the Australian Transport Council (ATC) endorsing the document for publication in July 2002.

CONTENTS

CHAPTER 1 PRELIMINARY

1.1 SCOPE

This Subsection of the NSCV specifies the following:

a) Common requirements for all electrical systems (Chapter 2).

b) Specific requirements for direct current, extra-low voltage systems (i.e. less than 50 V d.c.) supplied from accumulators (Chapter 3).

c) Specific requirements for low to medium voltage alternating current systems not exceeding 500 V a.c., and direct current systems greater than 50 V d.c. (Chapter 4).

d) Emergency electrical installations (Chapter 5).

This Subsection of the NSCV shall be read in conjunction with Part B– General Requirements of the NSCV.

1.2 APPLICATION

1.2.1 Vessels of measured length 35 m or more

The electrical installation on vessels of measured length 35 m or more shall—

a) meet the requirements of, and be assessed under, the rules of a Classification Society, or comply with Electrical and Electronic Equipment of Ships (as referenced under Clause 1.4); and

b) comply with Chapter 2 and Chapter 5 of this Subsection of the NSCV.

In addition the following shall apply:

i) Class 1A vessels shall comply with the requirements specified in Marine Orders Part 12 for SOLAS passenger vessels.

ii) Class 2A vessels of 500 GT and over shall comply with the requirements specified in Marine Orders Part 12 for SOLAS cargo vessels.

iii) Class 3A vessels shall comply with the International Convention for the Safety of Fishing Vessels.

1.2.2 Vessels of measured length less than 35 m

The electrical installation on vessels of measured length less than 35 m shall comply with the requirements of this Subsection of the NSCV.

In addition the following shall apply:

a) Vessels fitted with an electrical installation other than those specified in Chapter 3 and Chapter 4 shall meet the requirements of the rules of a Classification Society, or the Electrical and Electronic Equipment of Ships (referenced in Clause 1.4).

b) Class 1A vessels shall comply with the requirements specified in Marine Orders Part 12 for SOLAS passenger vessels.

1.2.3 Exceptions

Vessels specifically included in Part F of the National Standard are not subject to the requirements of this Subsection of the NSCV, except as might be provided for in the relevant Section of Part F.

NOTE: Such vessels include fast craft, hire and drive vessels and novel vessels.

1.2.4 Required outcomes

The Chapters in this Subsection of the NSCV specify required outcomes for various electrical systems and subsystems within a vessel. The required outcomes are mandatory to the extent that they are applicable to a vessel. The required outcomes within each Chapter are followed by solutions that are "deemed-to-satisfy" these required outcomes. Compliance with required outcomes may also be achieved through the application of the equivalent solutions that comply with the principles set out in Part B of this National Standard.

When developing an equivalent solution, it is a requirement of this National Standard that the overall system safety shall be maintained.

NOTE: A proposed solution that satisfies one or more required outcomes in isolation but has negative effects on compliance with other required outcomes would not be considered an equivalent solution under Part B of this National Standard.

1.3 OBJECTIVE

The objective of this Subsection is to protect against hazards arising from an electrical installation used with reasonable care and under normal conditions, having regard to the purpose for which the installation is intended.

1.4 REFERENCED DOCUMENTS

The following documents are referred to in this Subsection of the NSCV. Any documents referenced in this Subsection shall be considered to be the latest revision of the document, including amendments and supplements.

NATIONAL MARINE SAFETY COMMITTEE

National Standard for Commercial Vessels

Part B—General Requirements

Part C—Design and Construction

Section 4: Fire Safety

Section 5: Engineering

Subsection 5A—Machinery

Section 7: Equipment

Subsection 7A—Safety Equipment

Subsection 7B—Communication Equipment

Subsection 7C—Navigation Equipment

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

AS 1930—*Circuit-breakers for distribution circuits (up to and including 1000 V a.c. and 1200 V d.c.)*

AS 2006—*High voltage a.c. switchgear and control gear – Circuit breakers for rated voltages above 1000 V*

AS 2430.1—*Classification of hazardous areas – Explosive gas atmospheres*

AS 3004—*Electrical installations – Marinas and pleasure craft at low voltage*

AS 3178—*Approval and test specification – Electric cables – Silicone rubber insulated – For working voltages up to and including 0.6/1 kV*

AS 3190—*Approval and test specification – Residual current devices (current-operated earth-leakage devices)*

AS/NZS 1125—*Conductors in insulated electric cables and flexible cords*

AS/NZS 2430.3.1— *Classification of hazardous areas – Examples of area classification – General*

AS/NZS 2430.3.3—*Classification of hazardous areas – Examples of area classification – flammable liquids*

AS/NZS 2430.3.4—*Classification of hazardous areas – Examples of area classifications – flammable gases*

AS/NZS 3000—*Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 3008.1.1—*Electrical installations – Selection of cables – cables for alternating voltages up to and including 0.6/1 KV – Typical Australian installation conditions*

AS/NZS 3108—*Approval and test specification – Particular requirements for isolating transformers and safety isolating transformers*

AS/NZS 3112—*Approval and test specification – Plugs and socket-outlets*

AS/NZS 3187—*Approval and test specification – Mineral-insulated metal-sheathed cables*

AS/NZS 3191—*Approval and test specification – Electric flexible cords*

AS/NZS 5000.1—*Electric cables – Polymeric insulated – for working voltages up to and including 0.6/1 kV*

AS/NZS 60269.1—*Low voltage fuses – General requirements*

AS/NZS 61241.3—*Electrical apparatus for use in the presence of combustible dust – Classification of areas where combustible dusts are or may be present*

AUSTRALIAN MARITIME SAFETY AUTHORITY

Marine Orders Part 12 (Construction – Subdivision & Stability, Machinery and Electrical Installations)

INTERNATIONAL MARITIME ORGANIZATION

International Convention for the Safety of Fishing Vessels (known as the Torremolinos Convention)

INSTITUTION OF ELECTRICAL ENGINEERS OF THE UNITED KINGDOM
Electrical and Electronic Equipment of Ships

1.5 DEFINITIONS

For the purposes of this Subsection of the NSCV—

a) the definitions provided in Part B of the NSCV, in addition to those in this Clause, shall apply; and

b) where there is any duplication in the terms defined between this Clause and Part B, the definitions in this Clause shall apply.

active conductor—
any conductor of a supply system that is maintained at a potential different to that of the neutral or earthed conductor.

ambient temperature—
a temperature of 45ºC.

battery compartment—
a room, locker or box used for the storage of batteries.

residual current device (RCD)—
a device intended to isolate supply to protected circuits, socket outlets or equipment in the event of a current flow to earth exceeding a predetermined value.

NOTE: RCDs are classified in AS 3190 according to their rated residual current as follows:

Type (I) ≤ 10 mA
Type (II) > 10 mA, ≤ 30 mA
Type (III) > 30 mA, ≤ 300 mA (without selective tripping time delay)
Type (IV) > 30 mA, ≤ 300 mA (with selective tripping time delay)

shore supply—
a supply of electrical energy located onshore or at any other source external to a vessel.

short-circuit—
An overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions. The fault path may include the path from active via earth to the neutral.

1.6 ABBREVIATIONS

FRP—
Fibre-reinforced plastics

M.E.N—
multiple earthed neutral

MIMS—
mineral insulated and metal-sheathed (refers to cables)

RCD—
residual current devices

XLPE—
cross-linked polyethylene

CHAPTER 2 COMMON REQUIREMENTS FOR ALL ELECTRICAL SYSTEMS

2.1 SCOPE

This Chapter sets out the requirements for conductor switchgear and accessories that are common to all electrical systems intended for use in vessels.

2.2 OBJECTIVE

The objective of this Chapter is to ensure that all conductor switchgear and accessories that are common to all ship-based electrical services are suitable for their intended service.

REQUIRED OUTCOMES

2.3 CURRENT INDUCED ELEVATION OF TEMPERATURES

All components of the electrical system must be designed and installed to minimise the effects of current-induced temperature rise that might lead to fire or failure of one or more components.

2.4 CONTAINMENT OF ELECTRICAL CURRENT

All components of the electrical system must be designed and installed to prevent accidental discharge of electrical power that could endanger personnel, damage equipment or cause fire.

2.5 OVERLOAD

The electrical system of a vessel must be arranged to prevent or withstand current overload without endangering the health and safety of personnel, damaging equipment essential to the safety of the vessel or initiating fire.

2.6 ENVIRONMENTAL FIRE HAZARDS

The electrical system of a vessel must be designed and installed to minimise, and where possible eliminate, risks associated with potential fire hazards in proximity to the electrical installation.

2.7 FUNCTION AND RELIABILITY OF ESSENTIAL EQUIPMENT

The electrical system of a vessel must be designed and installed so as to enhance the function and reliability of electrical equipment essential to the safety of the vessel. The electrical system must not degrade from the function or reliability of essential electrical equipment and other equipment and components of the vessel essential for safety.

2.8 OPERATION AND MAINTENANCE

The electrical system of a vessel must be designed and installed to facilitate its identification, safe use, inspection and maintenance.

2.9 BATTERIES

Battery installations must be designed and installed to minimise or, where practicable, eliminate risks associated with the build-up of gases, spillage of corrosive materials and physical movement.

DEEMED-TO-SATISFY SOLUTIONS

2.10 COMPLIANCE

For the purpose of this National Standard, the common requirements for an electrical installation shall be deemed to have satisfied the required outcomes in Clauses 2.3 to 2.9 if they comply with Clauses 2.11 to 2.20 and the deemed-to-satisfy solutions contained in Chapter 3, Chapter 4 and Chapter 5 of this Subsection as applicable.

2.11 DESIGN AND CONSTRUCTION

All conductors, switchgear and accessories shall be of adequate size and construction for their intended service.

2.12 INSTALLATION AND LOCATION

Electrical equipment shall be installed or located in accordance with the following:

a) The equipment shall be accessible.

b) The equipment shall not be installed near flammable material.

c) The space containing the equipment shall be ventilated such that there is no possibility of accumulation of flammable gases within the space.

d) The space containing the equipment shall be adequately lit.

e) The equipment shall be protected from mechanical damage and exposure to moisture and petroleum products.

2.13 ADDITIONAL ELECTRICAL EQUIPMENT

Additional electrical equipment shall not be installed within an existing installation until it has been ascertained that the current-carrying capacity of the installation, and the existing accessories, conductors and switchgear, are adequate for the increased load required by the additional equipment.

2.14 RADIOS

The electrical power supply for radios shall comply with the relevant requirements of Part C Subsection 7B (Communication Equipment) of the NSCV.

2.15 FLUCTUATIONS

All electrical equipment shall operate satisfactorily under voltage fluctuations of plus 6 per cent and minus 10 per cent at rated frequency, and under frequency fluctuations of plus or minus 2.5 per cent at rated voltage.

2.16 CONTACTORS

Contactors and similar equipment shall not drop out at or above 85 per cent rated voltage.

2.17 INSULATION MATERIAL

Insulation material and insulated windings shall be resistant to cracking, and either resistant to or protected from the effects of moisture and petroleum products.

2.18 VIBRATION AND SHOCK LOADING

All electrical equipment shall be designed and installed to withstand the vibration and shock loading encountered during normal operations. All nuts and screws used in connection with current-carrying parts shall be locked to prevent slackening or backing-off, and shall be located and arranged to preclude the possibility of overheating under normal conditions of use.

2.19 INTERFERENCE WITH NAVIGATION AND MONITORING EQUIPMENT

Conductors and other electrical equipment shall be—

a) designed and manufactured such that the magnetic field associated with the equipment cannot affect adjacent navigation or monitoring equipment (e.g. magnetic compasses); or

b) installed or located at an appropriate distance from such equipment as to render the effects of the magnetic field negligible.

NOTE: The intensity of a magnetic field may increase when equipment is switched on and off.

2.20 HAZARDOUS AREAS

Where electrical equipment is required to be used in the hazardous areas as classified in AS/NZS 2430.1, AS/NZS 2430.3.3, AS/NZS 2430.3.4, and AS/NZS 61241.3, such equipment shall be suitable for use in those hazardous areas.

NOTE: AS/NZS 2430.3.1 provides guidance on the classification of several commonly occurring (and potentially hazardous) situations in which flammable liquids or gases are generated.

CHAPTER 3 SPECIFIC REQUIREMENTS FOR DIRECT CURRENT, EXTRA-LOW VOLTAGE SYSTEMS (LESS THAN 50 V D.C.) SUPPLIED FROM ACCUMULATORS

3.1 SCOPE

This Chapter sets out the requirements for conductors, switchgear and accessories for direct current systems of less than 50 V supplied from accumulators.

3.2 OBJECTIVE

The objective of this Chapter is to ensure that conductors, switchgear and accessories for direct current extra-low voltage systems supplied from accumulators are suitable for their intended service.

3.3 APPLICATION

This Chapter applies to vessels having an electricity supply, which does not exceed 50 V d.c. ripple-free, and which is supplied from an accumulator or accumulators. It does not apply to electricity supplied from generators.

REQUIRED OUTCOMES

3.4 REQUIRED OUTCOMES

The required outcomes given in Clauses 2.3 to 2.9 of Chapter 2 also apply to this Chapter.

DEEMED-TO-SATISFY SOLUTIONS

3.5 COMPLIANCE

For the purpose of this National Standard an extra-low voltage electrical installation shall be deemed to have satisfied the required outcome in Clause 3.4 if it complies with Clauses 3.6 to 3.10.

3.6 DISTRIBUTION

3.6.1 General

The distribution of electrical power shall be by the two-wire insulated system. A hull return shall not be used.

3.6.2 Maximum allowable voltage drop

The voltage drop in any circuit shall not exceed 10 per cent of the design voltage.

3.6.3 Maximum current rating

The maximum permissible current rating shall be in accordance with a relevant national or international standard, taking into account the

manufacturer's maximum rated conductor temperature and the insulation-derating factor.

NOTE: Annex A provides guidance on current ratings and temperature derating factors for electric cables with various insulation materials (see Clause 3.9.2).

3.6.4 Final sub-circuits

3.6.4.1 Rating

Circuits supplying two or more final sub-circuits shall be rated in accordance with the total connected load. Where spare ways are provided, allowance for future increases of load shall be made.

3.6.4.2 Essential services

A separate final sub-circuit shall be provided for every motor required for an essential service.

3.7 SWITCHBOARDS

3.7.1 Design and construction

Switchboards and their enclosures shall be constructed of material capable of withstanding the electro-mechanical stresses placed upon it during operation. Any insulating material used shall be flame-retardant and resistant to the effects of moisture. The surface finish shall be anti-tracking.

3.7.2 Location

Switchboards shall be installed in accessible, adequately ventilated positions and shall be protected from mechanical damage and exposure to moisture, petroleum products, flammable gases and acid fumes.

3.7.3 Identification

Switchgear and accessories on main switchboards, sub-switchboards or distribution panels shall be readily identifiable.

3.8 PROTECTION

3.8.1 General

The active conductor(s) of each individual circuit, with the exception of starter motor circuits, shall be fitted with overload protection by means of a fuse or circuit breaker. The main supply from the battery isolator switch to the house switchboard shall be protected.

3.9 CONDUCTORS, CABLES AND WIRING

3.9.1 Design and construction

All conductors in cables running between the source of supply and final sub-circuits, with the exception of mineral-insulated, metal sheathed (MIMS) cables, control wiring and instrumentation wiring, shall be of stranded, annealed copper, constructed in accordance with AS 1125.

3.9.2 Insulation

All conductors shall be insulated. Insulation material shall comply with the relevant requirements of the following:

a) AS/NZS 5000.1 for thermoplastic material (including PVC).

b) AS/NZS 5000.1 for elastomeric material other than silicone rubber.

c) AS/NZS 3187 for mineral insulation material.

d) AS 3178 for silicone rubber.

e) AS/NZS 5000.1 for cross-linked polyethylene (XLPE).

NOTE: Due to the varying properties of the insulation materials in Items (a) to (e) above, the temperature of the space through which a cable will pass should be taken into account prior to selecting the cable. Clause 4.14.1.3 specifies temperature limitations for the above insulation materials.

3.9.3 Engine starting cables

3.9.3.1 General

Engine starting cables shall be protected from mechanical damage. They should be as short in length as is compatible with the stowage arrangements for the batteries.

3.9.3.2 Routing

Engine starting cables shall either be routed to avoid the possibility of coming into contact with petroleum products or shall be sheathed with an impervious material resistant to the effects of petroleum products.

3.9.3.3 Configuration

The configuration of engine starting cables shall be as follows:

a) Conductors shall be of adequate size and shall be connected directly to the starter via the starting relay contacts.

b) The relay shall be mounted either directly on the starter or adjacent to it.

3.9.4 Cables and cable fittings

3.9.4.1 Cable support and fittings

Cables shall be adequately supported. Trays, cable clips, saddles and fixing screws used to support cables shall either be manufactured from corrosion-resistant material or shall undergo corrosion-inhibiting treatment prior to installation.

3.9.4.2 Penetration of watertight bulkhead or deck

Where the routing of a conductor or cable requires a watertight bulkhead or deck to be penetrated, the watertight integrity of the bulkhead or deck shall be maintained and the materials used for glands and bushes shall be corrosion-resistant.

3.9.4.3 Navigation lights

Navigation lights shall be individually protected by fuses or circuit breakers. Switches and protective devices for these lights shall be located in the wheelhouse.

3.9.4.4 Fittings in exposed positions

Plugs and sockets in exposed positions shall be protected from exposure to moisture, and sockets shall be provided with blank caps. External sockets shall be installed at least 300 mm above the deck.

3.9.4.5 Insulation resistance

The insulation resistance between conductors or conductors and earth, either of the complete installation or any part thereof, and measured with all fuse elements in place and all switches closed, shall not be less than 100 000 ohms. The value shall be obtained using a test voltage of not less than twice the supply voltage and not more than 250 V.

NOTE: Appliances, lamps and other electronic equipment that could be damaged during such tests should be disconnected.

3.10 BATTERIES AND BATTERY INSTALLATIONS

3.10.1 General

Batteries and their installations shall comply with this Subsection and the relevant requirements of Part C Subsection 5A, Part C Section 4, and Part C Subsection 7B of the NSCV.

NOTES:

1. Part C Subsection 5A (Machinery) specifies requirements for the capacity of batteries used for starting main engines.
2. Part C Section 4: Fire Safety specifies requirements for the capacity of batteries used in fire-detection and fire-suppression systems.
3. Part C Subsection 7B (Communication Equipment) specifies requirements for batteries used in radios.

3.10.2 Isolation of batteries

Means shall be provided to enable each bank of batteries to be electrically isolated. The isolator shall operate simultaneously in each live conductor.

3.10.3 Switching arrangements between battery banks

Where more than one bank of batteries is carried, arrangements shall be provided to enable switching to the second (or subsequent) bank of batteries.

3.10.4 Mounting of batteries

Batteries shall be securely mounted to prevent movement due to the motion of the vessel.

3.10.5 Location of batteries

Starting batteries should be located adjacent to the engine served. If the starting batteries are installed outside of the machinery space, they shall be located in a compartment ventilated in accordance with Clause 3.10.8.

In the case of a propulsion engine, the starting batteries shall not be located in any position where there is a risk of hydrogen emanating from the battery being ignited by a spark from the starter motor (e.g. below the starter motor).

3.10.6 Installation of batteries

Casings and terminals shall be protected from mechanical damage, damage from exposure to moisture, and short-circuiting. Any battery located on the open deck shall be protected from exposure to moisture.

Lead acid batteries shall be installed in liquid-tight trays not less than 100 mm deep, and shall either be manufactured from or lined with fibre-reinforced plastics (FRP) or other acid-resistant material.

NOTE: The volume of the tray should be of sufficient capacity to contain the total volume of electrolyte, plus an allowance for motion of the vessel.

Alkaline batteries shall be installed on insulating material.

3.10.7 Battery charging equipment

Suitable control equipment for battery charging equipment shall be provided, including ammeters, isolating switches, voltage regulators, cut outs and fuses or circuit breakers.

3.10.8 Ventilation of batteries and battery compartments

3.10.8.1 General

Batteries shall be arranged so as to enable air to circulate around them.

To preclude the possibility of accumulation of flammable gas, battery compartments shall either be naturally ventilated in accordance with Clause 3.10.8.2, or mechanically ventilated in accordance with Clause 3.10.8.3.

Battery compartments shall not be vented into accommodation spaces.

Exhaust ventilators should be located at the top of the compartment, and inlet ventilators should be located on or near the floor or bottom of the battery compartment.

NOTE: The gas emanating from batteries is lighter than air, and will therefore tend to accumulate in pockets at the top of the compartment in which they are stored.

3.10.8.2 Natural ventilation

Natural ventilation shall be run directly from the top of the compartment to the open air via ducts. These ducts shall not contain any appliances (e.g. flame-barriers) that may impede the free passage of air or gas mixture.

The minimum area of the exhaust ventilator for a naturally ventilated battery compartment shall be determined from Table 1.

Table 1 — Cross-section of exhaust ventilator

Charging Capacity (watts)	Cross-section of exhaust ventilator (cm^2)	
	Lead battery	Ni-cad battery
< 1000	80	120
1000 ≤ 1500	120	180
1500 ≤ 2000	160	240
2000 ≤ 3000	240	Clause 3.10.8.3
> 3000	Clause 3.10.8.3	Clause 3.10.8.3

NOTE: Battery compartments connected to a charging device with a power output of more than 2 kW should be mechanically ventilated.

The area of the inlet ventilator shall be the same or greater than that of the exhaust ventilator.

3.10.8.3 Mechanical ventilation

If adequate natural ventilation cannot be achieved, mechanical exhaust ventilation shall be installed independent of ventilation for other spaces and in accordance with the following formula:

$$Q_v = 0.006\, n\, I$$

where

Q_v = quantity of air expelled, in litres per second

n = number of battery cells

I = maximum output rating of the charger, in amperes

CHAPTER 4 SPECIFIC REQUIREMENTS FOR ALTERNATING CURRENT SYSTEMS NOT EXCEEDING 500 V A.C., OR DIRECT CURRENT SYSTEMS GREATER THAN 50 V D.C.

4.1 SCOPE

This Chapter sets out the requirements for conductors, switchgear and accessories for alternating current systems not exceeding 500 V a.c., or direct current systems greater than 50 V d.c.

4.2 OBJECTIVE

The objective of this Chapter is to ensure that alternating current systems not exceeding 500 V a.c., or direct current systems greater than 50 V d.c, are suitable for the intended service.

REQUIRED OUTCOMES

4.3 REQUIRED OUTCOMES

The required outcomes given in Clauses 2.3 to 2.9 of Chapter 2 shall apply to this Chapter.

DEEMED-TO-SATISFY SOLUTIONS

4.4 COMPLIANCE

For the purpose of this National Standard, an alternating current system not exceeding 500 V a.c., or a direct current systems greater than 50 V d.c., shall be deemed to have satisfied the required outcomes in Clause 4.3 if it complies with Clauses 4.5 to 4.19.

4.5 SYSTEMS OF SUPPLY

4.5.1 General

The generation and supply of electricity shall be through one of the following systems:

a) *Single-phase system*—Two wire, with either neutral earthed or both poles clear of earth.

b) *Three-phase system*—Three wire or four wire, with neutral earthed but without hull return.

In a system that does not include a neutral or earthed conductor, all conductors shall be considered active conductors.

4.5.2 Earthed neutral system

Where an earthed neutral system is employed—

a) the neutral terminal shall be solidly earthed at each alternator; and

b) the ship to shore changeover switch shall operate simultaneously in all phases and neutral.

4.5.3 Hull returns

Systems employing hull returns shall not be used.

4.5.4 System voltages

System voltages for both alternating current and direct current shall not exceed the following:

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

b) 250 V for lighting, heating in cabins and all other applications.

4.5.5 Control switch

Except in the case of switches and plugs associated with synchronising, all other equipment shall not remain live through the control circuits and pilot lamps when switched off by the control switch.

4.6 MAXIMUM DEMAND

Circuits supplying two or more final sub-circuits shall be rated in accordance with the total connected load. Where spare ways are provided on a section or distribution board, an allowance for future increase of load shall be made.

4.7 DISTRIBUTION

4.7.1 Final sub-circuits

4.7.1.1 Supply restrictions

A final sub-circuit of rating exceeding 15 A shall not supply more than one point. Unless otherwise provided for in Clause 4.7.1.5 the number of lighting points supplied by a final sub-circuit of rating 15 A or less shall not exceed 18.

4.7.1.2 Motors and three-phase outlets

Unless otherwise permitted by Clause 4.7.1.3, a separate final sub-circuit shall be provided for every motor and three-phase outlet.

4.7.1.3 Motors in group situations

Where two or more motors are in a group situation (e.g. for air-conditioning, refrigeration and ventilation systems), those motors may be supplied by the same final sub-circuit.

4.7.1.4 Engine room ventilation

Engine room ventilation systems shall be supplied from separate final sub-circuits.

4.7.1.5 Number of lighting points

The number of lighting points supplied by final sub-circuits for the following equipment is unrestricted, provided that the maximum operating current in the sub-circuit does not exceed 10 A:

a) Cornice lighting.

b) Panel lighting.

c) Electric signs, where the lamp-holders are grouped closely together.

4.7.1.6 Lighting

Lighting shall be supplied by final sub-circuits separate from those used for heating and power.

4.7.1.7 Socket outlets

The design of the socket outlet circuit shall ensure that the circuit does not have more outlets than either the current carrying capacity of the cable or the rating of the protective device.

4.7.2 Switches

4.7.2.1 Lighting in cargo spaces

Lighting in cargo spaces shall be controlled by switches situated outside these spaces. Means for locking such switches in the off position shall be provided at the principal control position.

4.7.2.2 Heating and cooking equipment

Each item of heating or cooking equipment shall be controlled as a complete unit by a switch located adjacent to the equipment.

4.7.3 Vessels having both extra-low and greater than extra-low voltage installations

Where a vessel is fitted with both an extra-low voltage installation and an installation greater than extra-low voltage, the following requirements apply:

a) All plug sockets supplied at extra-low voltage shall—

   i) have their rated voltage marked upon them; and

   ii) be of a form that will prevent insertion of an extra-low voltage plug into a plug socket connected to a circuit greater than extra-low voltage.

b) All parts of the installation that are supplied by a voltage greater than extra-low voltage shall be isolated from any wiring obtaining its supply from—

   i) a battery;

   ii) a bank of batteries;

   iii) an extra-low voltage alternator; or

   iv) a generator.

c) The wiring shall be arranged so that in the event of a conductor breaking away or becoming detached from a terminal, any exposed part of the conductor cannot come into contact with non-insulated parts of the system supplied by voltage greater than extra-low or vice versa.

4.8 NAVIGATION LIGHTS

4.8.1 General

Navigation lights shall be connected separately to a dedicated, accessible distribution board, and connected directly or through transformers to the main or emergency switchboard.

4.8.2 Protection

Each navigation light shall be controlled and protected in each insulated pole by a switch and fuse or circuit breaker on the distribution board.

4.8.3 Transfer from bridge

Where required by Chapter 5 (Emergency Electrical Installations) of this Subsection of the NSCV, the navigation lights shall be able to be transferred to an alternative circuit from the bridge.

4.9 EARTHING

4.9.1 General

Unless otherwise provided for in this Chapter, the earthing of every installation shall comply with the requirements of AS 3000.

4.9.2 Exposed metal parts

Exposed metal parts of electrical equipment shall be earthed. Earthing conductors shall be manufactured from copper or material of equivalent electrical and mechanical properties, and shall be protected from mechanical damage and electrolytic action where necessary.

4.9.3 Systems of earthing

The earthing system shall be in accordance with the requirements of the type of supply installed in the vessel, as specified in Clause 4.5.

4.9.4 Types of earthing

An earthing system shall be one of the following:

a) The multiple earthed neutral (M.E.N.) system, where both the earth and neutral conductor are solidly connected within the installation.

b) The direct earthing system, where both earth and neutral conductors are not connected within the installation.

NOTES

1. Where a M.E.N. system is installed on a vessel, there may be difficulty in using a shore power supply that has earth leakage circuit breakers installed. Re-positioning the neutral earth link may rectify this condition. Under no circumstances should the vessel's earth connection be broken or switched to avoid operation of the circuit breakers.
2. Due to the wide variety of types and sizes of vessels and their associated electrical systems, there is no single best method for treating the neutral point in marine electrical installations. Safe, correctly engineered installations may be achieved in a number of ways, and therefore each application should be considered and designed on its merits.
3. When selecting a method for a given application, the relative importance of all technical, operational and commercial factors should be assessed. Subjective

judgement is largely unavoidable, however the following should be taken into account when making this assessment:

a) Factors not significant to selection of neutral earthing.

b) Factors significant to selection of neutral earthing method.

c) Applicability of neutral earthing methods to marine electrical systems.

4.9.5 Supplementary protection devices

Current-operated earth-leakage circuit breakers, earth monitoring devices and residual current devices (RCDs) shall be fitted.

4.9.6 Method of earthing

The method of earthing shall be in accordance with the following:

a) If a M.E.N. system is used [see Clause 4.9.4 a)], it shall be connected in accordance with the following:

   i) In the case of a vessel with a hull constructed wholly of metal, the main earthing conductor shall be taken from the earth terminal, bar or link at the main switchboard to an earthing electrode solidly connected to the hull.

   ii) In the case of a vessel with a hull *not* constructed wholly of metal, the main earthing conductor shall be taken from the earth terminal, bar or link at the main switchboard to an earthing electrode solidly connected to an earthing plate.

   iii) Regardless of the method of connection of the M.E.N. system, the main earthing conductor shall be run in as direct a manner as possible and shall not be connected to a terminal of any other appliance.

b) If a direct earthing system is used [see Clause 4.9.4 b)], it shall be connected in accordance with the following:

   i) Where a vessel has a hull constructed wholly of metal, and where the system of supply is as specified in Clause 4.19.2(a), the main earthing conductor associated with each appliance shall be locally and directly connected by earthing electrodes to both the hull of the vessel and the associated accessory, luminary or appliance.

   ii) Where the hull of the vessel is *not* constructed wholly of metal, the installation of the main earthing conductor shall comply with the requirements of Clause 4.9.6 a) ii).

   iii) Any installation employing a direct earthing system shall be provided with a means of indicating the state of insulation from earth.

4.9.7 Size of main earthing conductor

The minimum size of the main earthing conductor shall be as specified in Table 2, having regard to either—

a) the size of the supply conductors to the main switchboard; or

b) the prospective earth fault current that may arise at a particular point in an installation.

Table 2 — Size of main earthing conductors

Size of active conductor (mm^2)	Normal size of main earthing conductor (mm^2)
1	1.5 (see Legend)
1.5	1.5 (see Legend)
2.5	2.5
4	2.5
6	2.5
10	4
16	6
25	6
35	10
50	16
70	25
95	25
120	35
150	50
185	70
240	95
300	120
400	120
500	120
630	120

LEGEND

1.5 mm² earthing conductors may be used only for the earthing of equipment where incorporated in the sheath of a cable or flexible cord with the active conductors supplying the equipment. At termination and joints a short length of such an earthing conductor can be used where the sheath is removed.

4.9.8 Earthing electrodes

An earthing electrode shall be designed to facilitate either—

a) connection of the earthing conductor as required by Clause 4.9.6 a); or

b) local direct connection of an earthing conductor associated with any appliance to the hull of the vessel as required by Clause 4.9.6 b).

4.9.9 Earthing plates

All electrical installations on vessels of non-metal hull construction shall incorporate an earthing plate in accordance with the following:

a) The earthing plate shall be manufactured from copper or other material of equivalent mechanical and electrical properties, and shall be securely attached with non-corrodible fastenings to the hull of the vessel.

b) The earthing plate shall be positioned such that it is immersed at all times during operation of the vessel.

c) The earthing plate shall have an area of at least 0.6 m^2, and shall be at least 3.2 mm thick.

d) A connecting bolt of suitable size and conductivity shall be fitted to the earthing plate to provide—

   i) a secure connection for the earth wire(s); and

   ii) an electrically continuous, non-corrodible connection between the connecting bolt and the earthing plate.

4.9.10 Insulation of earthing conductors

Earthing conductors shall have insulation in accordance with AS/NZS 5000.1 for single unsheathed cables.

4.9.11 Portable equipment

Metal frames of all portable electric lamps, tools and similar apparatus rated in excess of 32 V shall either be earthed, or equivalent protection shall be provided via double insulation, an isolating transformer or similar.

4.9.12 Items not required to be earthed

The following items do not need to be earthed:

a) Lamp caps.

b) Shades, reflectors and guards supported on lighting fittings manufactured from or shrouded in insulating material.

c) Metal parts or screws which, by their location in or through insulating material, are separated from current-carrying parts in such a way that they cannot become live or come into contact with earthed parts.

d) Portable appliances with double insulation.

e) Bearing housings, which are insulated in order to prevent circulation of current in the bearing.

f) Cable clips.

g) Clips for fluorescent lamps.

h) Fixed apparatus (or parts thereof), which is not shrouded but is guarded to preclude any possibility of persons coming into inadvertent contact with it, and which itself cannot come into contact with exposed metal.

4.9.13 Earth-indicating system

Where an earth-indicating system using either two or three lamps is used, the lamps shall be of a metal filament type, each not exceeding 30 W. They shall be of the same colour and placed not more than 125 mm apart.

Where generators are not operated in parallel, a means of detecting earth leakage is required for each generator in accordance with Clause 4.12.1.1.

4.10 SHORE SUPPLY

4.10.1 General

Where electricity is to be supplied from a shore supply—

a) inlet sockets and terminals on the vessel shall be protected from exposure to moisture; and

b) a circuit breaker and test facility shall be incorporated for checking the safe connection of the supply.

The installation on the vessel shall be controlled by a sealed over-current circuit breaker operating on all conductors (including neutral) other than earth. Each circuit shall be protected by a fuse, which shall be marked with its current-carrying capacity.

4.10.2 Circuit breakers

Where terminals are provided, the connection box shall incorporate a circuit breaker.

Where either a single-phase supply or multi-phase supply up to 100 A rating is used, the circuit breaker shall operate simultaneously in each live conductor.

NOTE: Where the supply is over 100 A rating, care should be taken to ensure correct connection of active and neutral conductors of the shore supply to the connection facility.

4.10.3 Connecting cables on vessel

The cables connecting the shore connection facility to the changeover switch at the main switchboard on the vessel shall be permanently fixed.

4.10.4 Changeover switch

The changeover switch shall operate simultaneously in each phase and in neutral.

4.10.5 Protection for connecting cables

Where electrical protection for the cables cannot be provided immediately adjacent to the shore connection facility, the cables shall either be armoured or provided with equivalent protection.

4.10.6 Capacity of connecting cables

The current-carrying capacity of the armoured (or protected) cables shall be at least equal to the current rating of the shore connection facility.

4.10.7 Earth terminal

An earth terminal shall be provided at the point of supply of the vessel for connecting the earth bar on the main switchboard to the shore earth.

4.10.8 Supply availability indication

A means of indicating the availability of the supply shall be provided in each phase at the main switchboard.

4.10.9 Checking of phase sequences

Means shall be provided for checking the phase sequences (for three-phase supply of the incoming supply) in relation to the vessel's system. Appropriate switchgear for rotating the phase sequence shall be provided.

4.10.10 Checking of polarity

In the case of a single-phase installation, a means of checking the polarity of the shore supply in relation to the vessel's system shall be provided. Appropriate procedures or arrangements to enable reversing of the polarity shall also be provided before shore power is connected.

NOTES:

1. State and Territory power supply authorities have regulations pertaining to the rotation of polarity.
2. An appropriate arrangement would be to have an electrician change the leads at the shore connection facility on the vessel.

4.10.11 Provision of information

A notice containing the following information shall be provided at the shore connection facility on the vessel:

a) All necessary information regarding the supply voltage.

b) All necessary information regarding the frequencies of the vessel's system.

c) The procedure for carrying out the connection.

4.10.12 Supply inlet plug

Means to prevent the accidental removal of the supply inlet plug (eg. a screw cap) shall be provided on the shore connection facility on the vessel.

4.10.13 Flexible cord or cable

The flexible cord or cable provided for connecting the vessel's electrical installation to the supply facility onshore shall be at least heavy duty, as defined in AS/NZS 5000.1 or AS/NZS 3191 as applicable. The current rating of the flexible cord or cable shall not be less than 15 A. The length of the flexible cord or cable shall be sufficient for the type and size of vessel and the area of operation, taking into account the range of tide.

NOTE: The flexible cord or cable provided for connecting the vessel to the supply facility onshore should be provided with a suitable storage arrangement.

4.10.14 Arrangement of shore connection

The shore connection shall be arranged by one of the following methods:

a) *A direct connection of active, neutral and earth to the vessel*.

If this method is employed, an earthing conductor shall be run as directly as possible and connected to the earth contact of the vessel's appliance inlet. The following items shall be connected to the earthing conductor:

i) The earth contact of all socket-outlets.

ii) The exposed metal parts of equipment, which shall be earthed in accordance with AS 3000.

b) *Connection through a shore-mounted isolation transformer, with the hull and metal parts bonded.*

If this method is employed—

i) the isolation transformer shall comply with AS 3108;

ii) the bonding system of the vessel shall not be connected to the earth of the shore supply;

iii) only one vessel shall be connected to each isolating transformer secondary winding; and

iv) the following items shall be connected to a bonding conductor:

A) Metal parts of the vessel in electrical contact with the water.

NOTE: More than one connection point will be required if the vessel's construction does not ensure continuity between parts.

B) The earth contact of all socket-outlets.

C) The exposed metal parts of equipment, which shall be earthed in accordance with AS 3000.

c) *A connection through an onboard isolation transformer with the hull of a metal-hulled vessel bonded*.

If this method is employed, the isolation transformer shall comply with AS 3108 and shall be an all-insulated Class II transformer. The bonding system of the vessel shall not be connected to the earth of the shore supply.

The following items shall be connected to a bonding conductor:

i) The hull of the metallic-hulled vessel.

ii) The earth contact of all socket-outlets.

iii) The exposed metal parts of equipment, which shall be earthed in accordance with AS 3000.

NOTE: AS 3004 contains additional information on shore-connection for vessels that have no onboard facilities for generating a.c. or ripple-free d.c. supplies exceeding 50 V.

4.11 SWITCHBOARDS, SWITCHGEAR, AND PROTECTIVE EQUIPMENT

4.11.1 Switchboards

4.11.1.1 Design and construction

Switchboards and their enclosures should be constructed of durable material. They shall be dead-fronted and capable of withstanding the electro-mechanical stresses applied during operation. Any insulating material used shall be flame-retardant, moisture-resistant and capable of withstanding the mechanical stresses applied to it during operation. The surface finish shall be anti-tracking.

4.11.1.2 Busbars

Busbars and their connections shall be manufactured from copper, and all connections shall be made so as to inhibit corrosion. Busbars and their supports shall be designed to withstand the mechanical stresses arising during short-circuits. The maximum permissible temperature rise for bar conductors shall not exceed 45º C.

For bare busbars, the minimum clearance distances in Table 3 shall be observed.

Table 3 — Clearance distances

Rated voltage (V)	Minimum clearance between phases and earth (mm)		Minimum clearance between phases (mm)
	Earthed neutral	Insulated neutral	
500	16	19	19

4.11.1.3 Distances between live parts

The distances between live parts and 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.

4.11.1.4 Tests prior to installation

Prior to their installation on a vessel, switchboards and their components (complete or in sections) shall be certified as having been tested in accordance with the following:

a) A high-voltage test shall be carried out on all switching and control apparatus. The test voltage shall be 100 V plus twice the rated voltage (minimum 200 V) applied for 1 minute at any frequency between 25 Hz and 100 Hz between—

   i) all current-carrying parts connected together and earth; and

   ii) current-carrying parts of opposite polarity or phases.

   NOTE: Instruments and ancillary apparatus may be disconnected during the high voltage test.

b) Immediately after the high-voltage test, the insulation resistance, when tested with a direct current voltage of at least 500 V, shall be not less than 1 megohm between—

i) all current-carrying parts connected together and earth; and

ii) current-carrying parts of opposite polarity or phase.

4.11.1.5 Installation

Switchboards shall be installed such that they are readily accessible, with ample space provided around the switchboard to facilitate maintenance. Where live parts on a switchboard are adjacent to a walkway, an insulated handrail shall be provided and non-conducting mats or grating fitted where maintenance personnel would be required to stand.

Section and distribution boards shall be enclosed or installed in a lockable cupboard or compartment.

NOTE: The space provided around a switchboard should be approximately 0.6 m, reduced to 0.5 m in way of stiffeners or frames.

4.11.1.6 Marking

All measuring instruments and apparatus-controlling circuits shall be clearly and indelibly marked. An indelible tag or label, marked with particulars of the full load current of the generator or cable that the fuse or circuit breaker protects, shall be permanently secured on or fitted adjacent to every fuse and every circuit breaker. The tags or labels for fuses designed to be rewired shall also be marked with the appropriate size of fuse element. Where inverse time limit or reverse current devices are provided in connection with a circuit breaker, the appropriate settings of these devices shall be stated on the tags or labels. Nameplates shall be manufactured from flame-retardant material.

4.11.1.7 Installation of piping in vicinity of switchboards

Piping should not be installed directly above, in front of or behind a switchboard. Where this is unavoidable, then suitable protection shall be provided.

4.11.2 Switchgear

4.11.2.1 Design and manufacture

Circuit breakers and switches shall comply with the requirements of AS 2006 or AS 1930 as applicable. Where enclosures for switchgear and fuse gear are manufactured from combustible material, they shall be lined with non-hygroscopic, fire-resistant material.

Circuit breakers shall be the ‘trip-free’ type.

4.11.2.2 Circuit-opening devices

Each circuit-opening device shall be arranged so that when it is placed in the *“off”* position, it cannot accidentally move so as to close the circuit.

4.11.2.3 Over-current release

The over-current release of circuit breakers for generators, and the setting of preference-tripping relays, shall either be adjustable or readily replaceable by others of different values.

Over-current releases shall be calibrated in amperes, and the setting marked on the circuit breaker.

NOTE: For preference-tripping systems, the following over-current settings are recommended (expressed as a percentage of the rated current of the generator or circuit to be protected):

a) Main generator circuit-breaker—150 per cent.

b) Preference tripping relays—110 per cent.

Time delays should be established in accordance with the nature of the load. The following values are given as an example:

i) First tripping circuit-breaker—5 seconds.

ii) Second tripping circuit-breaker—10 seconds.

iii) Third tripping circuit-breaker—15 seconds.

iv) Main generator circuit-breaker—20 seconds.

4.11.2.4 Reverse power protection

Where reverse power protection is provided, it shall be appropriate to the circumstances of reverse power between the limits of 2 per cent and 15 per cent of the full load that may be expected.

4.11.2.5 Handles and operating mechanisms

Handles and operating mechanisms shall be arranged such that the operator cannot come into inadvertent contact with live metal, or be placed at risk of injury due to arcing from the switch or circuit-breaker or the rupturing of a fuse. If switches are enclosed, their handles shall not operate through unprotected slots.

4.11.3 Protective equipment

4.11.3.1 General

Installations shall be fitted with equipment to provide protection against accidental over-currents, including short-circuiting. The protective devices shall ensure, where applicable—

a) continuity of service under fault conditions through discriminative action of the protective devices; and

b) elimination of the fault.

4.11.3.2 Overload protection

Circuit breakers and automatic switches provided for overload protection shall have tripping characteristics appropriate to the system. Overload protection shall be provided as follows:

a) Insulated three-phase a.c. systems—at least two phases.

b) Earthed three-phase a.c. systems—all three phases.

NOTES:

1. Fuses above 320 A should not be used for overload protection, but may be used for short-circuit protection.
2. For overloads less than 10 per cent, protection may consist of an alarm signal operated by a time-delayed relay set to approximately 110 per cent of the rated current of the generator.

4.11.3.3 Short-circuit protection

Protection against short-circuiting shall be provided by circuit breakers or fuses. Short-circuit protection shall be provided in each active conductor of the system.

The minimum operating current of every circuit-breaker in a circuit other than a motor circuit shall be not greater than twice the rating of the smallest conductor which it is installed to protect. In motor circuits (where short-circuit protection only is required), the minimum operating current of the circuit-breaker shall not be greater than three times the cable rating.

Switches and circuit breakers shall operate simultaneously on all active conductors. Fuses, switches and circuit breakers shall not be installed in an earthed conductor.

Circuit breakers, contactors and switches shall be provided with a means of isolation. Circuit breakers and contactors shall be installed so that their moving parts and associated relays are not live when the circuit breaker or contactor is in the "*off*" position.

In large installations where fault levels are high, circuit breakers shall be power-operated.

An isolating link may be fitted to an earthed conductor for test purposes only, provided that all other conductors are isolated.

The over-current setting of a circuit breaker will depend on individual arrangements, and in motor circuits should be matched to the load temperature characteristics of the motor.

EXAMPLE 1

Continuously rated circuits—25 per cent over-current.

EXAMPLE 2

Intermittently rated circuits—50 per cent over-current.

EXAMPLE 3

Steering gear and emergency circuits—200 per cent over-current.

4.11.3.4 Breaking capacity of protective devices

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

A circuit-breaker of breaking capacity less than the prospective short-circuit current at the point of installation may be used provided that it is preceded on the supply side by fuses, or by a circuit-breaker having the necessary

breaking capacity. The main circuit breakers shall not be used for this purpose.

Fused circuit breakers with fuses connected to the load side may be used provided the operation of the circuit breaker and fuses is coordinated. The characteristics of the arrangement shall be such that—

a) when the short-circuit current is broken, the circuit-breaker on the load side will not be damaged; and

b) when the circuit breaker is closed on the short-circuit current, the remainder of the installation will not be damaged.

NOTE: The circuit breaker on the load side may require servicing after the fault has been cleared.

4.11.3.5 Making capacity of circuit breakers and switches

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

4.11.3.6 Protective devices and contactors not intended for short-circuit interruption

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.

4.11.3.7 Fuses

Fuses shall be of the enclosed fuse link type and shall comply with the relevant requirements of AS/NZS 60269.1.

The breaking capacity of the fuse shall not be less than the prospective short-circuit current at the point of installation.

Fuses shall be capable of operating at ambient temperature. The temperature rise at the terminals shall be such that the maximum permissible temperature(s) of the connected cable(s) is not exceeded.

Fuse-links and fuse-bases shall be marked with their rated current and rated voltage. Each fuse position shall be permanently and indelibly marked with the current-carrying capacity of the circuit protected by it, and with the appropriate size of fuse or replacement element.

4.11.3.8 Short-circuit currents

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

a) Ten times full load current for generators normally connected (including spares)—symmetrical rms (root mean square).

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

4.11.3.9 Additional protection

In addition to over-current protection, the following protective gear shall be provided:

a) For generators not arranged to operate in parallel, a circuit-breaker shall be arranged to open simultaneously on all active poles.

NOTE: In the case of generators rated at less than 50 kW, a multi-pole-linked switch and fuse in each active pole may be used.

b) For generators arranged to operate in parallel, a circuit breaker shall be arranged to open simultaneously on all active poles. This circuit-breaker shall have reverse power protection with time delay, selected and set within the limit of 2 per cent to 15 per cent of full load to a value fixed in accordance with the characteristics of the prime mover.

c) The reverse power protection specified for such generators may be replaced by other devices, provided the prime mover is adequately protected.

d) Where generators are operated in parallel and essential machinery is electrically driven, arrangements shall be made for automatic disconnection of the excess non-essential load when the generators are overloaded.

NOTE: If required, this load shedding may be carried out in one or more stages.

e) All generators arranged for parallel operation with one another shall be provided with under-voltage release, which prevents the closing of the appropriate circuit breaker until the generator terminal voltage reaches at least 70 per cent of the rated voltage.

NOTES:

1. Consideration should be given to the fitting of an automatic trip to main generator circuit breakers, which will open the breaker on loss of excitation.
2. The installation of automatic circuit-opening devices other than for short-circuit protection is not recommended in exciter circuits.
3. In earth systems of large capacity, consideration should be given to providing protection against internal faults in the generator.
4. An ammeter should be fitted in exciter circuits.

4.11.3.10 Steering gear circuits

Steering gear circuits shall have short-circuit protection only and an overload alarm. The protective devices shall allow excess current to pass during the normal acceleration period of motors.

4.11.3.11 Motors

The following requirements apply for the protection of motors and the circuits supplying them:

a) Circuits supplying motors fitted with overload protection need only be provided with short-circuit protection.

b) Motors of rating exceeding 0.5 kW and all motors for essential services shall be protected individually against overload and short-circuit.

NOTES:

1. The short-circuit protection may be provided by the same protective device for the motor and its supply cable.

2. The overload protection may be replaced by an overload alarm where essential service motors are duplicated.

c) For motors intended to provide uninterrupted service, the protective gear shall have a delay characteristic to enable the motor to start, but shall operate on overload before the windings reach an unacceptably high temperature. The maximum current that the protective device will allow to pass indefinitely shall not exceed 125 per cent of the rated current.

d) For motors intended to provide intermittent service, the current setting and the delay shall be chosen in relation to the load factor of the motor.

e) When running alternating current motors from a shore supply of lower frequency, the terminal voltage at the motors shall be lowered in proportion to frequency in order not to overload the motors.

4.11.3.12 Lighting circuits

Lighting circuits shall be provided with overload and short-circuit protection.

4.11.3.13 Protection for miscellaneous equipment

Protection shall be provided for the following equipment:

a) Voltmeters.

b) Voltage coils of measuring instruments.

c) Earth indicating devices.

d) Pilot lamps, together with their connecting leads.

4.11.3.14 Pilot lamps

A pilot lamp installed as an integral part of another item of equipment need not be individually protected provided it is fitted in the same enclosure. Where a fault in a pilot lamp would jeopardise the supply to essential equipment, such lamps shall be individually protected.

4.11.3.15 Capacitors

Where capacitors for suppression of radio interference are fitted to busbars, generators, or steering gear, fuses of appropriate size shall be connected in the capacitor circuit.

4.12 SWITCHBOARD INSTRUMENTS AND INSTRUMENT RANGES

4.12.1 Instruments

4.12.1.1 Generators not operated in parallel

For generators not operated in parallel, each generator shall be provided with at least the following instruments:

a) A voltmeter.

b) A frequency meter located on the supply side of the main switch or main circuit breaker.

c) A wattmeter for generators above 50 kW.

d) Either an ammeter in each phase, or an ammeter with a selection switch to enable the current in each phase to be measured.

e) A means of detecting earth leakage.

4.12.1.2 Generators operated in parallel

For generators operated in parallel, each generator shall be provided with—

a) a wattmeter; and

b) either an ammeter in each phase, or an ammeter with a selector switch to enable the current in each phase to be measured.

4.12.1.3 Paralleling

For paralleling purposes, the following instrumentation shall be provided:

a) Two voltmeters.

b) Two frequency meters.

c) A synchronising device comprising either a synchroscope and lamps, or an equivalent arrangement.

One voltmeter and one frequency meter shall be connected to the busbars, the other voltmeter and frequency meter shall be switched to enable the voltage and frequency of any generator to be measured.

4.12.2 Range of instruments

4.12.2.1 Voltmeters

The upper limit of the range of a voltmeter shall be 120 ± 5 per cent of the normal rated voltage of the circuit in which it is installed. The normal rated voltage of the circuit shall be clearly indicated on the voltmeter.

4.12.2.2 Ammeters

The upper limit of the range of an ammeter shall be 130 ± 5 per cent of the normal rated current of the circuit in which it is installed. The normal full load current shall be clearly indicated on the ammeter.

4.12.2.3 Wattmeters

Wattmeters used on generators that may be operated in parallel shall be capable of indicating 15 per cent reverse power.

4.13 ELECTRIC MOTORS

4.13.1 Start and stop controls

The means of starting and stopping an electric motor shall be readily located and easily operated.

4.13.2 Other control equipment

A motor rated above 0.5 kW shall be provided with the following control equipment:

a) Means to prevent undesired restarting after a stoppage due to low voltage or complete loss of volts.

NOTE: This requirement does not apply to any motor that has to be continuously available for the safety of the vessel.

b) Means of isolating the motor, so that all voltage may be cut off from the motor and any associated apparatus, including any automatic circuit breaker.

c) Where the primary means of isolation (i.e. that provided at the switchboard, sub-board or distribution fuse board) is not adjacent to a motor, one of the following shall be provided:

   i) An additional means of isolation fitted adjacent to the motor.

   ii) A means of locking the primary means of isolation in the "*off*" position.

   iii) Means to readily remove the fuse in each line.

d) With the exception of steering motors (see Clause 4.11.3.10), means of automatic disconnection of the supply in the event of excess current due to mechanical overloading of the motor.

e) Where fuses are used to protect polyphase motor circuits, means to protect the motor against unacceptable overload in the case of single phasing.

   NOTE: When selecting motor control gear, its current rating should not be less than the full load rating current of the motor.

4.13.3 Master starter systems

Where a single, master starter system (e.g. a starter used for starting a number of motors successively) is used, the following shall be provided for each motor:

a) Under-voltage protection.

b) Overcurrent protection.

c) A means of isolation at least equal to that required for systems using a separate starter for each motor.

4.13.4 Automatic starting

Where a motor is started automatically, a means of starting the motor manually shall be provided.

4.13.5 Stopping

Means shall be provided for stopping the following equipment:

a) Ventilation fans servicing machinery and cargo spaces.

b) Independently driven pumps delivering oil to main propulsion machinery for bearing lubrication.

c) Fuel oil pumps and similar, independently driven fuel pumps.

The means of stopping shall include controls situated outside the space in which the equipment is located in order that the equipment may be stopped from outside the space if required (e.g. in the event of a fire in the space).

4.14 CONDUCTORS, CABLES AND CABLE INSTALLATIONS

4.14.1 Conductors

4.14.1.1 Construction

All conductors, except those in mineral insulated and metal-sheathed (MIMS) cables, shall be stranded, annealed copper complying with AS 1125.

4.14.1.2 Terminations

The ends of all conductors shall be fitted with soldering sockets, compression type sockets or mechanical clasps. Corrosive fluxes shall not be used.

4.14.1.3 Insulating materials

Insulating materials shall be as specified in Clause 3.9.2. The maximum rated conductor temperatures for those insulating materials shall be as follows:

a) For thermoplastic insulation material, including PVC and PE—50°C

b) For elastomeric insulation material (other than silicone rubber) and XLPE—75°C

c) For silicone rubber or mineral insulation material—85°C

NOTE: Refer to Annex A.

4.14.2 Cables

4.14.2.1 Maximum continuous load

The maximum, continuous load carried by a cable shall not exceed the current-carrying capacity specified by the manufacturer or that specified in AS 3008.1.1.

NOTE: See Clause 4.6.

4.14.2.2 Allowable voltage drop

When the cables are carrying maximum current under normal conditions of service, the voltage drop from the main switchboard busbars to any point in the installation shall not exceed 6 per cent of the normal voltage.

4.14.2.3 Current rating of lighting circuits

In assessing the current rating of lighting circuits, each lamp-holder shall be assessed at the maximum load likely to be connected to it. The minimum load shall be considered as 60 W, unless the fitting is designed to take only a lamp rated at less than 60 W.

4.14.2.4 Cables for heavy-duty applications

Cables supplying cargo winches, cranes, windlasses, capstans, motors and other heavy-duty equipment shall be rated accordingly. Unless the duty is such that a longer time rating is required, cables for winch or crane motors may be half-hour rated on the basis of the hour kilowatt power of

the motors. Cables for windlasses and capstan motors shall be not less than one-hour rated on the basis of the one-hour kW power of the motor.

In all cases, the rating shall be subject to the voltage drop being within the specified limits.

4.14.3 Cable installations

4.14.3.1 General

Cables shall be accessible. Cable runs shall be as straight as possible.

4.14.3.2 Duplicate supply

Where a duplicate supply is required, the two cables shall be routed separately.

4.14.3.3 Cable insulation

Cables having insulating materials with different maximum-rated conductor temperatures should not be bunched together. If this is unavoidable, the temperature rating shall be that of the lowest rated cable in the bunch. Any cable having a protective covering that may damage the covering of other cables shall not be bunched with those other cables.

4.14.3.4 Minimum bend radius

The minimum internal radius of bend of cables shall be in accordance with AS 3000.

4.14.3.5 Protection of cables

Where neither the protective covering of a cable nor the structure of the vessel provides sufficient protection from mechanical damage, the cable shall be routed in channels or casing, or shall be enclosed in steel conduit.

NOTES:

1. Cargo holds are generally considered to be the locations where there is the greatest risk of mechanical damage to cables.
2. Metal casing for the mechanical protection of cables should be protected against corrosion.

4.14.3.6 Earthing of cables

Except in final sub-circuits, where earthing at the supply end only of a metal-covered cable is adequate, the metal covering of cables shall be earthed at both ends of the cable.

NOTE: This requirement need not apply to instrumentation cables, where single-point earthing may be desirable for technical reasons.

4.14.3.7 Electrical continuity

Metal coverings for cables shall have electrical continuity throughout the length of the cable.

NOTE: Joints and tappings will require special attention.

4.14.3.8 Cable support

Cables shall be adequately supported and secured for their entire length in accordance with AS 3000. Cable supports and accessories shall be manufactured from corrosion-resistant material, or shall undergo corrosion-inhibiting treatment prior to installation.

The material used for cable supports and accessories in engine rooms, other spaces of elevated temperatures and in refrigerated spaces shall be capable of maintaining strength in that atmosphere.

NOTE: Metal is generally suitable for high and low temperature applications.

4.14.3.9 Penetration of watertight bulkheads or decks

Penetration of watertight bulkheads or decks shall be carried out with either individual watertight glands or with packed watertight boxes carrying several cables. The watertight integrity of the bulkhead or deck shall be maintained.

Cables passing through decks shall be protected by deck tubes or ducts.

4.14.3.10 Penetration of non-watertight bulkheads or decks

Where cables pass through non-watertight metal bulkheads or structural metal plating, the holes shall be fitted with bushes to prevent abrasion and electrolytic reaction. Bushes shall be installed such that they cannot be pulled out. The material used for bushes and glands shall be non-corrodible.

NOTES:

1. Except in the case of aluminium boats, lead is generally considered to be a suitable bushing material for such applications.
2. Where the metal plating is 6 mm thick or greater, the edges and corners may be rounded as an alternative to fitting bushes.

4.14.3.11 Cables installed in pipe or conduit

Where a cable is installed in a pipe or conduit the following requirements apply:

a) Unless otherwise provided for in Clause 4.14.3.6, metal conduit systems enclosing single, insulated cables shall be earthed at both ends and shall have mechanical and electrical continuity across each joint.

b) The internal radius of bends in piping and conduit of 64 mm diameter and under shall be not less than that specified for cables in AS 3000. The internal radius of bends for piping and conduit exceeding 64 mm diameter shall be not less than twice the diameter of the pipe or conduit.

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

d) High-voltage cables (such as those used for supplying cold cathode luminous discharge lamps) shall not be installed in metal conduit unless such cables are protected by a metal covering.

e) Non-metallic ducting or conduit for electric cables shall be manufactured from flame-retardant material.

PVC ducting or conduit shall not be used in refrigerated spaces or open decks.

4.14.3.12 Cable installations in refrigerated spaces

Cables installed in refrigerated spaces shall be insulated and sheathed with materials appropriate for the temperature within the space. They shall have an impervious sheath and shall be protected from mechanical damage. If such protection is provided by non-galvanised armour, the armour shall be protected against corrosion by a further, moisture-resistant covering.

Cables entering a refrigerated space shall pass directly through the wall or lagging and shall be protected by a tube sealed at each end. Alternatively, the cable may be passed through solid doorframes provided the necessary holes are sealed at each end.

4.14.3.13 Single-core cables in circuits rated in excess of 20 A

Where single-core cable is used for circuits rated in excess of 20 A, the following requirements apply:

a) Armouring material shall be non-magnetic.

b) Cables belonging to the same circuit shall not be installed in the same pipe or conduit, unless the conduit or pipe is manufactured from non-magnetic material.

c) Two, three or four single-core cables forming respectively single-phase, three-phase and neutral circuits shall not be in contact with one another.

d) Where a single-core cable of current rating exceeding 250 A is run along a steel bulkhead, the cable shall not come into contact with the steel.

4.14.3.14 Mineral-insulated cables

Cables having a hygroscopic installation (e.g. mineral-insulated cables) shall have their ends sealed to prevent the ingress of moisture.

4.14.3.15 Cables with supplementary insulation

Cables with a supplementary insulating belt beneath the protective sheath shall have additional insulation at any point where there is a risk of the insulation material of a core making contact with earthed metal.

4.14.3.16 Joints in fixed wiring

Joints in fixed wiring shall be located to minimise the risk of exposure to moisture. All conductors shall be adequately secured, insulated and protected against the ingress of moisture. Terminals or busbars shall be of an appropriate size for the cable rating.

4.14.3.17 Cables from extra-low and greater than extra-low voltage installations in the same enclosure

Where a vessel has both an extra-low voltage installation and an installation greater than extra-low voltage, and the cables of the different installations are brought together in an enclosure, then one of the following shall apply:

a) The insulation of the conductors in the extra-low voltage installation shall be equivalent to that of the conductors in the greater than extra-low voltage installation.

b) The cables of the greater than extra-low voltage installation shall be sheathed.

c) The wiring of connections to the different installations shall be separated by barriers or partitions of insulating material, with such barriers or partitions secured to prevent the possibility of dislodgement.

4.15 DERATING FACTORS FOR CURRENT RATING

Derating factors shall be in accordance with one of the following:

a) Manufacturer's recommendations.

b) AS 3008.1.1.

c) Annex A.

Where more than six cables, which may be expected to operate simultaneously at their full rated capacity, are bunched together such that free air cannot circulate around them, a derating factor of 0.85 shall be applied.

4.16 LIGHTING

All lighting essential for the operation of the vessel shall comply with the following:

a) Lamp-holders shall be manufactured from flame-retardant, non-hygroscopic material.

b) All metal parts should be of robust construction.

c) Large lamp-holders shall be provided with means for locking the lamp in the holder.

d) The maximum allowable temperature of cable connections shall be as follows:

   i) For cables with thermoplastic insulation material, including PVC and PE—50°C

   ii) For cables with elastomeric insulation material (other than silicone rubber) and XLPE—75°C

   iii) For cables with silicone rubber or mineral insulation material—85°C

   NOTE: Refer to Annex A.

e) Fittings, reactors, capacitors and other auxiliary equipment associated with fluorescent lighting shall be capable of operating at

ambient temperature. They shall not be mounted on surfaces subject to high temperatures.

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

g) Inductors and high-reactance transformers shall be installed adjacent to their associated discharge lamps.

h) A warning notice, clearly marked with the appropriate operating voltage, shall be displayed at the access point of each cold cathode luminous discharge lamp with a normal operating voltage greater than 250 V.

i) In bathrooms, galleys and laundries, either—

   i) totally enclosed fittings shall be used; or

   ii) any parts of a lamp-holder with which a person may come into inadvertent contact shall be manufactured from or shrouded in insulating material, and shall be fitted with a protective shield.

j) Lamps in spaces used for the storage of explosive or flammable materials shall be totally enclosed.

k) Live parts of fluorescent lighting installations shall be screened with earthed metal or insulating material.

4.17 ACCESSORIES

4.17.1 Enclosures

Enclosures shall be manufactured from metal or equivalent, flame-retardant material. If manufactured from metal, the enclosures shall be earthed.

4.17.2 Inspection and draw boxes

The inspection and draw boxes in metal conduit systems shall be manufactured from metal, and shall be securely attached and electrically connected to the conduit.

4.17.3 Socket outlets and plugs

4.17.3.1 General

Unless otherwise provided for in Clause 4.7.1.7, all socket-outlets shall incorporate earthing facilities and shall comply with AS 3112. All socket outlets shall also comply with the following:

a) They shall be provided with a switch.

b) Where they are located in areas that may be exposed to rain, spray or water from any source (e.g. on weather decks, galleys, laundries and machinery spaces), they shall be shielded to prevent the ingress of water.

c) The temperature rise on the live parts shall not exceed 30°C. They shall also be manufactured so that—

   i) they cannot be radially short-circuited, regardless of whether the plug is in or out; and

   ii) a pin of the plug cannot be made to earth either pole of the socket outlet.

d) Where differing distribution systems are used, they shall be designed to preclude the possibility of incorrect connection.

e) They shall be provided with an earthing contact. This contact shall make contact before the live pins when the plug is inserted.

4.17.3.2 Specific requirements for extra-low voltage socket outlets

If a vessel's electrical installation includes socket outlets supplied at both extra-low voltage and low to medium voltage, then all socket-outlets supplied at extra-low voltage, irrespective of their source, shall—

a) have their voltage clearly and indelibly marked upon them; and

b) be of such a form as to preclude the possibility of an extra-low voltage plug being inserted into a socket outlet connected to a circuit supplied at a voltage higher than extra-low voltage.

4.18 HEATING AND COOKING EQUIPMENT

4.18.1 Space heaters

Space heaters shall be designed, manufactured and installed to prevent the possibility of clothing, bedding and other flammable material coming into contact with them.

4.18.2 Water heaters

Water heaters shall be provided with over-temperature energy cut-outs, which shall operate in all live conductors.

4.18.3 Isolating switches

Isolating switches shall be mounted in a readily accessible position and easily operated.

4.18.4 Element connections

Unless self-supporting and secured in position, connections between elements and between elements and terminals to which insulated cables may be connected shall be continuously insulated with incombustible material.

4.18.5 Guarding

Heating elements shall be guarded to prevent persons coming into inadvertent contact with them. Live parts of cooking appliances shall be protected so that cooking utensils cannot come into contact with them.

4.19 PRE-COMMISSIONING TESTING

4.19.1 General

Prior to either a new installation or a modified existing installation being commissioned, a competent person, whose qualifications are recognised by the appropriate state electrical or marine authority, shall carry out the tests specified in Clauses 4.19.2 to 4.19.12.

NOTE: These tests are in addition to any acceptance tests specified or carried out by the manufacturer.

4.19.2 Insulation resistance

The insulation resistance shall be measured using a self-contained instrument (e.g. a direct reading ohmmeter of the generator type), and shall be as specified in Clause 4.19.2 a) to b):

a) *Power and lighting circuits*

For power and lighting circuits, the insulation resistance shall be not less than 1 megohm—

i) between all insulated poles and earth; and

ii) where applicable, between poles.

NOTE: The installation may be subdivided and appliances may be disconnected if initial tests produce results less than this figure.

b) *Switchboards, sub-boards and distribution boards*

For switchboards, sub-boards and distribution boards, the insulation resistance shall be not less than 1 megohm—

i) between each busbar and earth; and

ii) between busbars.

NOTE: To avoid the possibility of damage, this test should be carried out with all circuit-breakers and switches open, all fuse links for pilot lamps, earth fault-indicating lamps, voltmeters, etc., removed and voltage coils temporarily disconnected.

c) *Generators and motors*

For generators and motors, the insulation resistance of generator and motor cables, field windings and control gear shall be not less than 1 megohm in normal working conditions and with all parts in place.

NOTE: This test should be carried out with the machine hot.

The voltage applied for insulation resistance tests shall be not less than that calculated from the following formula:

$$V_t = [100 + (2 \times V_s)]$$

where

V_t = test voltage applied, in volts

V_s = supply voltage, in volts

NOTE: Where a circuit incorporates capacitors of more than 2 microfarads total capacitance, a constant-voltage type instrument should be used to ensure accurate test readings.

4.19.3 Continuity of the earthing system

The resistance of protective earthing conductors shall be low enough to permit the passage of current necessary to operate the over-current protective device.

The resistance of the main earthing conductor or any equipotential bonding conductor shall be not more than 0.5 ohms.

NOTE: As described in Appendix B of AS 3000, maximum allowable resistance of the protective earthing conductor associated with any particular circuit depends on the

type and rating of the protective device and the impedance of the live conductors that comprise the circuit.

4.19.4 Polarity

All active, neutral and protective earthing conductors in the electrical installation shall be proven to be correctly connected to the corresponding terminals of electrical equipment so that—

a) there is no transposition of conductors that could result in the electrical equipment becoming unsafe when it is connected to supply, particularly where appliances are connected by socket-outlets; and

b) switches do not operate independently in the neutral or earthing conductor.

4.19.5 Correct circuit connections

The active, neutral and protective earthing conductors of each circuit shall be proven to be correctly connected so that there is no—

a) short circuit between the conductors;

b) transposition of conductors which could result in the earthing system and any exposed conductive parts of the electrical installation becoming energised; or

c) interconnection of conductors between different circuits.

4.19.6 Generator performance

The satisfactory performance of each generator shall be established by running the generator at full-rated load.

4.19.7 Temperature

The temperature of joints, connections, circuit breakers and fuses shall be confirmed as maintaining an acceptable level.

4.19.8 Operation of safety devices

The satisfactory operation of engine governors, synchronising devices, over-speed trips, reverse-power trips, over-current trips and other safety devices shall be established.

4.19.9 Voltage regulation of generators

The voltage regulation of every generator when full rated load is suddenly thrown off shall be established as satisfactory.

4.19.10 Parallel operation of generators

The parallel operation and kilovolt amps (kVa) load sharing of all generators capable of being operated in parallel at all loads up to normal sea or harbour-working load shall be established as satisfactory.

4.19.11 Performance of essential motors and other equipment

The performance of all essential motors and other important equipment shall be established as satisfactory by operating such equipment under service conditions for an appropriate length of time.

NOTE: Such operation need not be at full load or simultaneously for all equipment.

4.19.12 Voltage drop at appliances

The voltage drop shall be measured at each appliance to verify that this is not excessive (see Clause 2.15).

CHAPTER 5 EMERGENCY ELECTRICAL INSTALLATIONS

5.1 SCOPE

This Chapter sets out the requirements to ensure that an emergency source of power capable of providing electric energy to essential services is suitable for the intended service.

5.2 OBJECTIVE

The objective of this Chapter is to supply an emergency source of power capable of providing electric energy to essential services.

REQUIRED OUTCOMES

5.3 GENERAL

The required outcomes given in Clauses 2.3 to 2.9 of Chapter 2 also apply to this Chapter.

5.4 FUNCTION OF ESSENTIAL SERVICES TO BE MAINTAINED

The electrical system must be designed and installed so that power can be supplied and maintained to all services essential for safety under abnormal conditions of operation.

5.5 CONCURRENT OPERATION

Sufficient power must be provided during abnormal conditions of operation to enable concurrent operation of essential services to the extent needed to maintain safety.

5.6 PERIOD OF OPERATION

Electrical power essential for the safety of the vessel and persons on board must be maintained during emergency situations for a period sufficient for the emergency to be overcome or evacuation of the vessel.

5.7 EMERGENCY LIGHTING

Sufficient lighting must be provided to facilitate the initiation, undertaking and completion of appropriate emergency responses during abnormal conditions of operation.

DEEMED-TO-SATISFY SOLUTIONS

5.8 COMPLIANCE

For the purpose of this National Standard, an emergency electrical installation shall be deemed to have satisfied the required outcomes in Clauses 5.3 to 5.7 if it complies with Clauses 5.9 to 5.14.

5.9 GENERAL

5.9.1 Design and location

An emergency source of electrical power shall be self-contained. Unless otherwise provided for in Clause 5.9.3, the emergency source of electrical power (including any fuel required to supply that source) shall be located in accordance with the following:

a) It shall not be located forward of the collision bulkhead.

b) It shall be located above the uppermost continuous deck.

c) It shall be located such that a fire or other unplanned occurrence in the propulsion machinery space will not interfere with the supply or distribution of emergency power outside that space.

d) The space in which it is located shall be—

   i) protected from exposure to moisture; and

   ii) provided with ventilation sufficient to enable the emergency power source to operate at full power.

5.9.2 Operation

The emergency generator and its prime-mover, and any emergency accumulator battery, shall be capable of operating at full power when the vessel is—

a) upright;

b) rolling up to an angle of 22.5º either way and simultaneously pitching 10º by bow or stern; or

c) is in any combination of angles within those limits.

5.9.3 Duplication of main source of electrical power

Where a vessel is designed with two, non-contiguous machinery spaces having separate electrical installations with separate distribution systems, each installation may be considered as the emergency source of electrical power for the other.

5.10 POWER SOURCE

5.10.1 Type of power source

An emergency source of electrical power shall be either—

a) an accumulator battery complying with Clause 5.10.2; or

b) a generator driven by a compression ignition engine complying with Clause 5.10.3.

5.10.2 Accumulator battery

An accumulator battery shall be capable of carrying the total emergency load in accordance with Table 4. Where a Class 1B vessel has an emergency source of power from an accumulator battery only, the emergency lighting system shall automatically come into operation upon failure of the main electrical supply.

The emergency source of electrical power may be the normal starting batteries for the following vessels, provided those batteries are located in accordance with Clause 5.9.1.

a) Class C vessels.

b) Class 2B and Class 3B vessels that are less than 50 m in length and less than 500 GT.

NOTE: Chapter 3 of this Subsection of the NSCV specifies requirements for the installation and ventilation of batteries and battery compartments.

5.10.3 Compression ignition engines

5.10.3.1 General

Where a generator driven by a compression ignition engine provides the emergency source of power, the engine shall be capable of being readily started in its cold condition at a temperature of 0ºC.

5.10.3.2 Fuel

Fuel for a compression ignition engine shall have a flashpoint of not less than 60ºC.

5.10.3.3 Starting arrangements

Where an engine is not designed to be started manually, the following requirements apply:

a) The starting equipment shall be capable of providing 3 consecutive starts.

b) A second source of energy capable of providing an additional 3 starts within a 30-minute period shall be provided.

c) Where compressed air is used as the sole means of starting an engine, a manually started, mechanically driven air compressor shall be provided.

d) Where an air receiver for an emergency generator is supplied from the main or auxiliary compressed air system, the air supply line shall be fitted with a non-return valve, which shall be located in the emergency generator space.

5.10.3.4 Location of starting arrangements

The starting arrangements specified in Clause 5.10.3.3 shall not be situated in the following locations:

a) Below the bulkhead deck in the case of a Class 1 vessel or below the uppermost continuous deck in the case of a Class 2 vessel.

b) Forward of the collision bulkhead.

c) In the space containing the main source of electrical power.

d) In a space that would be rendered inaccessible or uninhabitable by a fire or other incident in the space containing the main source of electrical power.

5.10.3.5 Temporary source of emergency power

Unless an emergency generator is designed to start and come on load automatically, Class 1B vessels and all other vessels of 25 m and over in measured length, which carry berthed passengers, shall be provided with a temporary source of emergency power. This temporary source of emergency power shall consist of an accumulator battery of sufficient capacity to—

a) supply emergency lighting continuously for 30 minutes;

b) close electrically-operated watertight doors; and

c) operate any electronic alarms and indicators associated with the watertight doors.

NOTE: Electrically operated watertight doors need not all be closed simultaneously.

5.11 EMERGENCY SWITCHBOARD

5.11.1 General

An emergency switchboard may be supplied from the main switchboard in normal operation.

5.11.2 Location

Unless otherwise provided for in Clauses 5.11.3 and 5.11.4, an emergency switchboard forming part of the emergency electrical installation shall be installed adjacent to or as near as possible to the emergency source of electrical power.

5.11.3 Generators driven by compression ignition engines

Where the emergency source of electrical power is a generator driven by a compression ignition engine, the emergency switchboard shall be located in the same space as the generator, except where the operation of the emergency switchboard would be impaired by such a location.

5.11.4 Accumulator batteries

Where the emergency source of electrical power is an accumulator battery, the battery shall not be installed in the same space as the emergency switchboard.

5.12 EQUIPMENT REQUIRED TO BE SUPPLIED WITH EMERGENCY POWER

5.12.1 General

The electrically operated equipment required to be supplied with emergency power shall be as follows:

a) The following equipment as specified in Part C Section 4: Fire Safety of the NSCV:

   i) Fire alarms.

   ii) Emergency fire pumps.

   iii) Fixed fire-extinguishing systems.

iv) Remote stops.

v) Communications equipment other than radios (e.g. PA systems).

b) Mustering alarm as specified in Part C Subsection 7A (Safety Equipment) of the NSCV.

c) Signalling lamp as specified in Part C Subsection 7B (Communication Equipment) of the NSCV.

d) Electronic navigational aids, navigation lights and sound signals as specified in Part C Subsection 7C (Navigation Equipment) of the NSCV.

e) Watertight doors and their associated indications and alarms.

f) Emergency lighting in accordance with Clause 5.14.1.

g) Any bilge pump relying on the emergency power source as its alternative power supply [see Part C Subsection 5A (Machinery)].

5.13 CAPACITY OF EMERGENCY POWER SUPPLY

5.13.1 General

The emergency power supply for each Class of vessel shall be capable of operating continuously and simultaneously all equipment required to be supplied with emergency power for the periods specified in Table 4.

Table 4 — Capacity of emergency power supply

Class of vessel	Minimum period for continuous and simultaneous operation of all equipment	
	Hours	Requirement
Class 1A	As specified in Marine Orders Part 12 for SOLAS passenger vessels.	As specified in Marine Orders Part 12 for SOLAS passenger vessels.
Class 1B	12 hours	—
Class 1C	3 hours	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 25 m and over in measured length or 500 GT and over. Signalling lamps need only be supplied with emergency power where such lamps are normally operated from the main electrical power source.
Class 1D	3 hours	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 25 m and over in measured length.
Class 1E	1 hour	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 25 m and over in measured length.
Class 2A	As specified in Marine Orders Part 12 for SOLAS cargo vessels.	As specified in Marine Orders Part 12 for SOLAS cargo vessels.

(*continued…*)

Table 3 (*continued*)

Class of vessel	Minimum period for continuous and simultaneous operation of all equipment	
	Hours	**Requirement**
Class 2B	6 hours—for vessels that are either ≥125 m in measured length or ≥5000 GT. 3 hours—for all other vessels.	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 50 m and over in measured length or 500 GT and over. Signalling lamps need only be supplied with emergency power where such lamps are normally operated from the main electrical power source.
Class 2C	3 hours	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 25 m and over in measured length or 500 GT and over. Signalling lamps need only be supplied with emergency power where such lamps are normally operated from the main electrical power source.
Class 2D	3 hours	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 25 m and over in measured length or 500 GT and over.
Class 2E	1 hour	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 2 5m and over in measured length or 500 GT and over.
Class 3A	As specified in the International Convention for the Safety of Fishing Vessels.	As specified in the International Convention for the Safety of Fishing Vessels.
Class 3B	6 hours—for vessels that are either ≥125 m in measured length or ≥ 5000 GT. 3 hours—for all other vessels.	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 50 m and over in measured length or vessels 500 GT and over. Signalling lamps need only be supplied with emergency power where such lamps are normally operated from the main electrical power source.
Class 3C	3 hours	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 500 GT and over. Signalling lamps need only be supplied with emergency power where such lamps are normally operated from the main electrical power source.
Class 3D	1 hour	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 500 GT and over.
Class 3E	1 hour	The requirement for emergency lighting in accordance with Clause 5.14 applies only to vessels 500 GT and over.

5.14 EMERGENCY LIGHTING

5.14.1 General

Where required, emergency lighting shall be situated to illuminate the following:

a) Service alleys, accommodation alleyways, stairways, exits and personnel lift cars.

b) The machinery spaces and main generating stations, including their control positions.

c) Control stations and all machinery control rooms.

d) The stowage positions for fire-fighting equipment.

e) The steering gear.

f) Pumps for fixed fire extinguishing systems, emergency fire pumps and any bilge pump relying on the emergency power source as its alternative power supply.

g) The starting positions for the motors of the pumps specified in Clause 5.14.1 f).

h) Public spaces, evacuation routes, exits and mustering areas.

i) Lifeboat stations on deck.

j) Stowage positions of liferafts for which launching devices are not provided.

k) Liferafts and their launching devices during mustering and launching.

l) The area of water into which liferafts are launched, for the period of time required for launching to be completed.

ANNEX A CURRENT RATINGS AND DERATING FACTORS

A1 SCOPE

This Annex provides ratings and derating factors for a range of insulating materials. It forms an informative part of this document, unless designated as mandatory by the Authority.

This Annex is referenced in Clause 4.15.

A2 GENERAL

Tables A1 and A2 below may be used to calculate cable current ratings and derating factors for different insulating materials. The current ratings in Table A.1 are based on an ambient temperature of 45°C. For other ambient temperatures, the derating factors in Table A.2 should be applied.

Table A.1 — Current ratings for normal operation based on ambient temperature of 45°C

Nominal cross-section (mm)	Continuous rms. current rating (amperes)								
	Thermoplastic material, including PVC and PE			Elastomeric material (other than silicone rubber) and XLPE			Silicone rubber or mineral insulation material		
	1 Core	2 Core	3-4 Core	1 Core	2 Core	3-4 Core	1 Core	2 Core	3-4 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

(Continued…)

Table A1 (*continued*)

Nominal cross-section (mm)	Continuous r.m.s. current rating (amperes)								
	Thermoplastic material, including PVC and PE			Elastomeric material (other than silicone rubber) and XLPE			Silicone rubber or mineral insulation material		
	1 Core	2 Core	3-4 Core	1 Core	2 Core	3-4 Core	1 Core	2 Core	3-4 Core
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 A.2 — Derating factors

Insulation material	Derating factor for ambient air temperatures										
	35°C	40°C	45°C	50°C	55°C	60°C	65°C	70°C	75°C	80°C	85°C
Thermoplastic material, including PVC and PE	1.29	1.15	1.00	0.82	—	—-	—	—	—	—-	—
Elastomeric material (other than silicone rubber) and XLPE	1.12	1.06	1.00	0.94	0.87	0.79	0.71	0.61	0.50	—	—
Silicone rubber or mineral insulation material	1.10	1.05	1.00	0.95	0.89	0.84	0.77	0.71	0.63	0.55	0.45