Australian Government

Australian Maritime Safety Authority

National Standard for Commercial Vessels

Part C - Design and Construction

Section 5 – Engineering

Subsection 5B—Electrical

Edition 3.0

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Forward

Edition 1 of this Subsection was originally published in 2002 following a review of the Uniform Shipping Laws (USL) Code Section 9—Engineering and replaced Part 4—Electrical of that Section.

Edition 2 was published in 2005 and, in a major change to Edition 1, made it a requirement for vessels to comply with *AS/NZS 3000: Electrical installations* (known as the Australian/New Zealand Wiring Rules) (AS/NZS 3000).

In 2014, Australian Standards published a new standard within the AS 3000 series, specifically applicable to vessels, namely *AS/NZS 3004.2:2014, Electrical installations—Marinas and boats, Part 2: Boat installations*.

The principal change between Edition 2 and Edition 3 is the requirement for vessels to comply with:

- AS/NZS 3004.2 2014, and
- this Subsection and,
- the State or Territory Electrical Safety regulator's requirements as applicable in the relevant jurisdiction.

This Subsection no longer duplicates many of the requirements mentioned in AS/NZS 3004.2, and instead requires compliance with that standard.

Contents

Chapter 1 Preliminary

1.1 Scope

This Subsection provides standards for the design, construction, installation and repair of electrical installations for vessels.

This Subsection must be read in conjunction with NSCV Part B—General Requirements.

1.2 Application

This Subsection applies to all vessels with electrical installations, except:

a) special vessels as defined in Part F of the NSCV, which must comply with Part F and are not required to comply with this Subsection unless Part F specifies otherwise; and
b) non-survey vessels as defined in Part G of the NSCV, which must comply with Part G and are not required to comply with this Subsection unless Part G specifies otherwise.

1.3 Reference documents

Each document mentioned in the following table is:

a) referenced in this Subsection; and
b) the latest revision of the document, including amendments, unless stated otherwise.

Note Clause 1.7 in NSCV Part B provides that national, regional or international standards adopted or incorporated by reference in the NSCV are adopted or incorporated by reference as in force from time to time.

Publisher	Document	Available
Australian Maritime Safety Authority	*Marine Order 503 (Certificates of survey – national law) 2018* (Marine Order 503) National Standard for Commercial Vessels (NSCV): Part B—General requirements (NSCV Part B) Part C, Section 4—Fire safety (NSCV Section C4) Part C, Section 5—Engineering (NSCV Section C5) Part C, Subsection 5A—Machinery (NSCV Subsection C5A) Part C, Subsection 7B—Communications Equipment (NSCV Subsection C7B) Part C, Subsection 7C—Navigation Equipment (NSCV Subsection C7C) Part F, Subsection F2—Leisure craft (NSCV Subsection F2) National Law—Marine Surveyors Accreditation Guidance Manual 2014, Part 2—Survey of vessels (MSAGM) *Navigation Act 2012* (Navigation Act)	AMSA website at https://www.amsa.gov.au
Australian and New Zealand Standards	AS/NZS 1768—*Lightning protection* (AS/NZS 1768) AS/NZS 3000—*Electrical installations* (known as the Australian/New Zealand Wiring Rules) (AS/NZS 3000) AS/NZS 3004.2 *Electrical Installations—Marinas and Boats - Part 2: Boat Installations* (AS/NZS 3004.2)	SAI Global website at http://www.saiglobal.org

Publisher	Document	Available
	AS/NZS 3007 *Electrical equipment in mines and quarries - Surface installations and associated processing plant* (AS/NZS 3007) AS/NZS 3017—*Electrical installations - Testing and inspection guidelines* (AS/NZS 3017) AS/NZS 3187—*Approval and test specification - Mineral-insulated metal-sheathed cables* (AS/NZS 3187) AS/NZS 3760:2010 *In-service safety inspection and testing of electrical equipment* (AS/NZS 3760) AS/NZS 60529 *Degrees of protection provided by enclosures (IP Code)* (AS/NZS 60529) AS/NZS 61439 *Low-voltage switchgear and controlgear assemblies* (AS/NZS 61439)	
International Electrotechnical Commission	IEC 60364	IEC website at http://www.iec.ch
International Maritime Organisation	SOLAS Chapter II-I	IMO website at http://imo.org
International Standards Organisation	ISO 10134 Small craft – Electrical devices – Lightning protection systems	ISO website at http://www.iso.org
Recognised Organisations	Lloyds Register Guidance Note: *Battery Installations – Key hazards to consider and Lloyds's Register's approach to approval.* DNVGL Maritime Advisory: *Handbook for Maritime and Offshore Battery Systems.*	
Safe Work Australia	Model Work Health and Safety (WHS) Act and Regulations Model Code of Practice - *managing electrical risks in the workplace*	

1.4 Definitions

(1) In this Subsection:

Battery boxes means any housing, container or enclosure designed to store batteries and made from a chemically resistant material.

battery compartment means a room, locker or space used solely for the storage of batteries.

competent person means a person, who has acquired, through training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly.

electrical equipment means any apparatus, appliance, cable, conductor, fitting, insulator, material, meter or wire that:

a) is used for controlling, generating, supplying, transforming or transmitting electricity at a voltage greater than extra-low voltage; or
b) is operated by electricity at a voltage greater than extra-low voltage.

electrical propulsion equipment means all components of the power supply, control and drive train in a vessel driven by electricity.

electrical work means:

a) connecting electricity supply wiring to electrical equipment or disconnecting electricity supply wiring from electrical equipment, or
b) installing, removing, adding, testing, replacing, repairing, altering or maintaining electrical equipment or an electrical installation.

emergency switch board (ESB) means a switchboard supplied by the emergency source of power and from which the emergency electrical installation can be supplied.

inverter means a device that changes a direct current (d.c.) to alternating current (a.c.).

inverter/charger means a device that can operate in two modes: as an inverter or as a battery charger.

isolated earth system means a system of distribution in which no point is normally connected to earth.

main switch board (MSB) means a switchboard directly supplied by the main source of electrical power and from which the whole electrical installation can be supplied.

MEN or TN system means a multiple earth neutral or Terra Neutral system as per AS/NZS 3000, and:

The MEN system as installed in Australia and New Zealand differs from the IEC system. Both systems are identical in principal but vary in detail. For further details refer to AS/NZS 61439 and AS/NZS 3007. IEC 60364 series describes the MEN system as a TN-C-S system with the letters signifying:

T – the distribution system is directly connected to earth at the neutral point of the supply transformer;

N – the exposed conductive parts are connected to the earthed point of the distribution system – at the MEN connection;

C – the neutral and protective conductor functions are combined in a single conductor (the neutral conductor of the distribution system);

S – the protective conductor function is separated from the neutral – separate conductors within the installation.

residual current circuit breaker with overload (RCBO) means a device combining the function of an RCD with protection against overcurrent.

residual current device (RCD) means a device intended to isolate supply to protected circuits, socket-outlets or electrical equipment in the event of a current flow to earth that exceeds a predetermined value.

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

voltage means the difference in potential between conductors and between conductors and earth as follows:

a) **extra-low voltage** (ELV) – not exceeding 50 V a.c. or 120 V ripple-free d.c.

b) **low voltage** (LV) – exceeding extra-low voltage but not exceeding 1000 V a.c. or 1500 V d.c.

c) **high voltage** (HV) – exceeding low voltage.

Note The definition of voltage as defined in AS/NZS 3000.

(2) In this Subsection, the following terms have the meaning given by the Dictionary in NSCV Part B:

certificate of survey	certificate of classification (or classification certificate)	
Class 1 vessel	Class 2 vessel	Class 3 vessel
control station	domestic commercial vessel	freeboard deck
ISO	measured length	National Regulator
NSCV	operational area	
recognised organisation	vessel use category	

Note where there is any duplication in the terms defined in this Subsection and in AS/NZS 3000 or AS/NZS 3004.2, the definitions in this Subsection apply.

Chapter 2 Requirements for electrical installations

2.1 General requirements

The electrical installation of a vessel must be designed, constructed, installed and repaired so that the required outcomes mentioned in Schedule 1 are met.

2.2 Meeting the required outcomes

2.2.1 Vessels of measured length 35 metres or more

The electrical installations on vessels of measured length 35 metres or more will be taken to meet the required outcomes mentioned in Schedule 1 if:

a) a certificate of classification has been issued for the vessel; and
b) they comply with the State or Territory Electrical Safety regulator's requirements as applicable.

2.2.2 Vessels of measured length less than 35 metres

The electrical installations on vessels of measured length less than 35 metres will be taken to meet the required outcomes mentioned in Schedule 1 if the electrical systems of the vessel comply with;

a) the State or Territory Electrical Safety regulator's requirements as applicable; and
b) either:
   (i) the deemed to satisfy solutions mentioned in chapters 3 to 8 of this Subsection and AS/NZS 3004.2 including the items in Appendix A and B of that standard; or
   (ii) Class Rules (however described);

Note 1 Compliance with 2.2.1 (b) and 2.2.2 (a) is demonstrated by the obtaining of approval for the electrical installation in accordance with the local Electrical Safety regulator's requirements.

Note 2 A vessel must comply with Appendix A of AS/NZS 3004.2 in order to comply with clause 2.2.2(b)(i) of this Chapter.

Note 3 Vessels <35m which elect to comply with class rules and be surveyed in accordance with this subsection, are not required to obtain a certificate of classification.

Note 4 If the owner of the vessel wishes to meet the required outcomes by another equivalent means, he or she must apply to the National Regulator for approval of the equivalent means of compliance.

Chapter 3 Electrical safety

(Required outcomes: Schedule 1, Required Outcome A)

3.1 Protection against electrical shock and earth leakage

3.1.1 Requirement to fit protective devices in LV Installations

Any electrical risks associated with the supply of electricity must comply with ASNZS 3004.2 section 4.

3.1.2 Testing of protective devices

An RCD or RCBO used on a vessel must be tested regularly by a competent person in accordance with AS/NZS 3760:2010.

The vessel owner must keep a record of tests and results.

Note Local State and Territory WHS Laws may prescribe requirements for the installation and testing of RCDs in certain higher-risk workplaces, including those where the use of electrical equipment is exposed to operating conditions that involve exposure to moisture.

3.2 Equipment and accessories in exposed locations

Electrical equipment and accessories shall be fit for purpose, noting the location and likelihood of exposure to moisture. Electrical equipment and accessories installed less than 0.3 metres above the deck must have a suitable International Protection (IP) Rating. An example of a recognised standard for IP rating is AS/NZS 60529.

3.3 Information to be made available

Adequate information in the form of manuals, plans and drawings to enable the vessel to be operated and maintained safely must be available on board. Such information must be updated as necessary.

3.4 Lightning protection

A vessel's electrical installation design must consider hazards and risks associated with lightning, and address those risks with appropriate control measures.

Note Guidance for lightning protection can be found in AS/NZS 3004:2; AS/NZS 1768 Lightning protection; and ISO10134 Small craft – Electrical devices – lightning protection systems.

3.5 Electrical work

This Subsection imposes no electrical licencing requirements.

Note In Australia, State or Territory electrical licensing requirements must be fulfilled by any persons performing *electrical work* on *electrical equipment* (see definitions).

3.6 Emerging technology

If a vessel's electrical installation includes new and emerging technology components, they must meet the relevant required outcomes and the deemed to satisfy solutions in this Subsection. If the owner of the vessel wishes to meet the required outcomes by another equivalent means, he or she must apply to the National Regulator for approval of the equivalent means of compliance.

Examples of new and emerging technology are lithium-ion and other novel battery types, electric propulsion systems, and related control systems. Use of such technology on vessels presents new hazards and risks. Knowledge of effective control measures for the elimination or mitigation of any such new risks to a safe level is still maturing. A vessel's electrical installation design must consider hazards and risks associated with emerging technology used in electrical installations.

The owner must be advised of any essential operational safety controls identified at design stage, and those controls must be listed in the vessel's Safety Management System.

3.6.1 Electrically powered propulsion equipment

3.6.1.1 General

Where a vessel is driven by electrical propulsion equipment, the electrical components must:

a) comply with the relevant requirements of Chapters 3 to 8 of this Subsection, or
b) meet the requirements of the rules of a Classification Society or a recognised applicable national or international standard.

Note Requirements for machinery installations on vessels <35m are specified in NSCV C5A clause 1.2.2 and states: "if fitted with machinery other than reciprocating internal combustion machinery—meet the requirements of the rules of a Classification Society or a recognised applicable national or international standard".

Examples of other recognised applicable standards relating to new technology systems can be found in the referenced documents section of this Subsection.

3.6.1.2 Essential Monitoring

Where a vessel is driven by electrical propulsion equipment, the electrical components including any associated battery systems must:

a) be fitted with instrumentation to enable critical parameters, including whether the electric propulsion system is running, to be monitored from each control station. The instrumentation shall be:
    i) suitable for marine use;
    ii) capable of withstanding vibration and shock;
    iii) installed to be readily visible; and
    iv) illuminated if required to be read or operated in darkness.

3.6.1.3 Circuit protection and alarms

Where a vessel is driven by electrical propulsion equipment, the electrical components must be fitted with an overload alarm and short-circuit protection for the motors.

The alarm must be both audible and visible at each control station.

Short-circuit protection should be for not less than twice full load current of the motor or circuit so protected, and be provided with a manual override function that allows the operator of the vessel to maintain control in critical situations.

3.6.1.4 Reliability

Where a vessel is driven by electrical propulsion equipment, the electrical components must be designed, constructed and arranged to provide a level of reliability appropriate for their intended purpose.

3.6.1.5 Risk of fire to be controlled

Electrical propulsion equipment on a vessel must be designed, constructed and arranged to control the risk of fire or explosion associated with such installations.

3.6.1.6 Securing of machinery

Each item of machinery must be secured to the vessel's structure to prevent injury to persons, damage to components and excessive vibration.

3.6.1.7 Propulsive control

Propulsion machinery and controls must be arranged to provide and maintain control over the vessel's motion in both normal and abnormal conditions of operation.

Chapter 4 Emergency electrical installations

(Required outcomes: Schedule 1, Required Outcome F)

4.1 General requirements

a) the functionality and reliability of electrical installations and equipment necessary for the safe operation of the vessel and safety of persons on board must be maintained in the event of failure of the main electrical installation.
b) the vessel must have an emergency electrical installation designed, constructed, installed, maintained and serviced in accordance with:
    i) clauses 4.2 to 4.7; and
    ii) the requirements of Chapters 5, 7 and 8; and
    iii) The clauses of the AS/NZS 3000 series of standards that are relevant to emergency electrical installations.

Note Where there is any conflict between the requirements in NSCV Subsection C5B and AS/NZS 3000, the requirements in NSCV Subsection C5B apply.

4.2 General

4.2.1 Design and location

An emergency source of electrical power must be self-contained. Unless otherwise provided for in clause 4.3.3 the emergency source of electrical power, including any fuel required to supply that source must, if located within a space, comply with the following:

a) not be located forward of the collision bulkhead;
b) be located above the freeboard deck, or where there is no freeboard deck then above the water line, and must be accessible from the open deck;
c) be located and arranged so 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; and
d) the space in which it is located must be:
    i) protected from exposure to moisture; and
    ii) provided with ventilation sufficient to enable the emergency power source to operate at full power.

4.2.2 Operation

The emergency electrical installation must be capable of meeting the requirements of this Chapter when the vessel is rolling up to an angle of 22.5° either way and simultaneously pitching 10° by bow or stern; and including any combination of angles within those limits.

4.2.3 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, and, where this is the case, each installation must meet the requirements of this chapter.

4.3 Power source

4.3.1 Type of power source

The emergency source of electrical power must be either of a:

a) battery complying with clause 4.3.2; or
b) generator driven by a diesel engine complying with clause 4.3.3.

4.3.2 Battery

Where a Class 1 or Class 2 vessel has an emergency source of power from a battery only, the emergency lighting system must automatically come into operation upon failure of the main electrical supply.

The emergency source of electrical power for an operational area B vessel must not be the normal starting batteries.

Operational area C, D and E vessels may use the normal starting batteries provided those batteries are located in accordance with clause 4.2.1.

4.3.3 Diesel engines

4.3.3.1 General

Where a generator driven by a diesel engine provides the emergency source of power, the engine must be capable of being easily started in its cold condition at a temperature of 0°C.

4.3.3.2 Fuel

Fuel for an emergency generator engine must have a flashpoint of not less than 60°C.

4.3.3.3 Starting arrangements

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

a) the starting equipment must be capable of providing 3 starts. Starting methods can be electrical from batteries, compressed air, hydraulic, or other forms of stored energy;
b) a second source of energy capable of providing an additional 3 starts within a 30 minute period must be provided;
c) where compressed air is used as the sole means of starting an engine, a manually started, mechanically driven air compressor must 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 must be fitted with a non-return valve which must be located in the emergency generator space; and
e) where a hydraulic starter is used it must have both an engine driven and a manual pump for charging the accumulator.

4.3.3.4 Location of starting arrangements

The starting arrangements specified in clause 4.3.3.3 must not be situated in any of the following locations:

a) below the freeboard deck in the case of a Class 1 vessel or Class 2 vessel;
b) forward of the collision bulkhead;
c) in the space containing the main source of electrical power; and
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.

4.3.4 Temporary source of emergency power

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

a) supply emergency lighting continuously for 30 minutes; and
b) close electrically-operated watertight doors; and
c) operate any electronic alarms and indicators associated with the watertight doors.

Note All electrically operated watertight doors need not be closed simultaneously.

4.4 Emergency switchboard

4.4.1 General

An emergency switchboard may be supplied from the main switchboard in normal operation and must be supplied from an emergency supply in situations where the main supply has failed.

4.4.2 Location

Unless otherwise provided for in clauses 4.4.3 and 4.4.4, an emergency switchboard forming part of the emergency electrical installation must be installed adjacent to, or as near as possible to, the emergency source of electrical power.

4.4.3 Generators driven by diesel engines

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

4.4.4 Batteries

Where the emergency source of electrical power is a battery installed in a space, the emergency switchboard must not be installed in the same space as the battery.

4.5 Systems required to be supplied with emergency power

The electrically operated systems required to be supplied with emergency power are:

a) the following equipment as specified in NSCV Section C4:
   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 NSCV Subsection C7A.
c) signalling lamp as specified in NSCV Subsection C7B.
d) electronic navigational aids, navigation lights and sound signals as specified in NSCV Subsection 7C.
e) watertight doors and their associated indicators and alarms.
f) emergency lighting in accordance with clause 4.7.
g) any bilge pump relying on the emergency power source as its alternative power supply (see NSCV Subsection C5A).

4.6 Capacity of emergency power supply

The emergency power supply must be capable of operating continuously and simultaneously supplying all equipment required to be supplied with emergency power for the periods specified in Table 1.

Table 1—Capacity of emergency power supply

Service category	Minimum period for continuous and simultaneous operation of all equipment listed in clause 4.5	The vessels of each Service Category that Emergency lighting requirement in clause 4.7 applies to are:
Class 1A	12 hours	All.
Class 1B	12 hours	All.
Class 1C	3 hours	25 metres 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	25 metres and over in measured length.
Class 1E	2 hours	25 metres and over in measured length.
Class 2A	12 hours	All.
Class 2B	6 hours—for vessels that are either ≥125 metres in measured length or ≥5000 GT. 3 hours—for all other vessels.	50 metres 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	25 metres 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	25 metres and over in measured length or 500 GT and over.
Class 2E	2 hours	25 metres and over in measured length or 500 GT and over.
Class 3A	12 hours	All.
Class 3B	6 hours—for vessels that are either ≥125 metres in measured length or ≥ 500 GT. 3 hours—for all other vessels.	50 metres 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	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	2 hours	500 GT and over.
Class 3E	2 hours	500 GT and over.

Note State and Territory WHS laws may prescribe additional requirements for emergency lighting.

4.7 Emergency lighting

For vessels specified in Table 1 column 3, emergency lighting must generally be provided for the period specified in the second column of table 1, and 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 4.7(f);
h) public spaces, evacuation routes, exits and mustering areas;
i) lifeboat stations on deck;
j) stowage positions of life rafts for which launching devices are not provided;
k) life rafts and their launching devices during mustering and launching; and
l) the area of water into which life rafts are launched, for the period of time required for launching to be completed.

Chapter 5 Common requirements for electrical equipment and installations

(Required outcomes: Schedule 1, Required Outcomes B, C, D and E)

5.1 General requirements

The vessel's electrical equipment and installation must comply with the applicable requirements of this Chapter and of AS/NZ 3004.2.

5.2 Radios

The electrical power supply for radios must comply with the requirements of NSCV Subsection C7B clause F2 of Annex F.

5.3 Navigation lights and navigation equipment

5.3.1 General

Navigation lights, navigation equipment, and their sources of power must comply with NSCV Subsection C7C and clauses 5.3.2 and 5.3.3 of this Subsection.

5.3.2 Navigation lights

Each light must be wired by a separate circuit to a:

a) discrete section of a distribution board; or
b) panel dedicated to navigation lights.

The use of junction boxes in navigation light circuits must be limited to those needed to connect the navigation lights to fixed wiring. Navigation light circuits must not share wiring enclosures or junction boxes with other circuits.

Each light must be:

a) individually controlled; and
b) protected in each active pole by a fuse or a circuit breaker, mounted on the navigation light distribution board or panel.

5.3.3 Navigation light distribution board

The navigation light distribution board or panel must only be used for supplying power to the navigation lights. The board or panel must be connected either directly, or through a transformer, to the main switchboard (MSB) and/or the emergency switchboard (ESB).

If a separate emergency supply is used, there shall be two separate supplies to the navigation light distribution board or panel, one from the MSB and one from the ESB.

Any alternate supply change over (i.e. from the main to the emergency supply), and any change over for alternate navigation lights, must be operable from the wheel house or the helm position, and must be easily accessible to the watchkeeper.

5.3.4 Indicators and alarms

If the navigation lights are not visible from the vessel's deck then the lights shall be provided with an automatic indicator to give an audible or visual indication of lamp failure. The indicators shall be in the wheel house or at the helm position and placed to gain the attention of the watchkeeper.

If a visual indicator is connected in series with the navigation lamp then a means shall be provided to prevent failure of the navigation lamp in the case of failure of the indicator.

If an audible indicator is used, it shall be connected to a separate source of supply, and provision shall be made for testing this supply.

5.4 Engine room and cargo space ventilation

Each engine room and cargo space ventilation system must be supplied from a separate final sub-circuit. All ventilation systems must be capable of being stopped from a readily accessible position outside the ventilated space.

Note See NSCV Section C4 for requirements regarding remote stops for use in case of fire.

5.5 Commissioning – inspection and testing

5.5.1 Tests

At the conclusion of construction, modification, or repairs, the electrical installation, equipment or part must be inspected and tested in accordance with Part 2 of the Marine Surveyors Accreditation Guidance Manual.

Note Part 2 subsection (3) of the Marine Surveyors Accreditation Guidance Manual lists: a person who holds unrestricted electrical licence, or accredited marine surveyor who is accredited to perform electrical surveys.

Note Further information on inspection and testing is also available in AS/NZS 3017.

Details of the required commissioning tests and forms to be used are listed in Part 2 of the Marine Surveyors Accreditation Guidance Manual. Testing must at least include the correct operation (i.e. in accordance with manufacturer's specifications, and the objectives and requirements of this Subsection) of the following equipment where fitted:

a) generator operation including:
   i) engine governors;
   ii) parallel operation;
   iii) load sharing;
   iv) voltage regulator operation by instantaneous loading and unloading of generator; and
   v) safety devices, such as over speed trips, reverse power trips, over current trips, load shedding, together with associated controls and alarms; and
b) load testing of motors;
c) overload alarm circuits of essential service motors;
d) main engine safety alarms and trips;
e) machinery and equipment that incorporates remote controls, remote stops and limit switches;
f) emergency stop circuits;
g) alarm systems;
h) other systems and equipment installed in the vessel; and
i) redundancy of essential control and monitoring systems.

5.5.2 Test results

All test results must be recorded. Test results must be dated, accurate, legible, and remain with the vessel's documentation for the life of the vessel.

Chapter 6 High voltage (HV) systems

(Required outcomes: Schedule 1, Required Outcomes B, C, D and E)

6.1 Requirements for HV systems

HV systems must comply with, and be maintained in accordance with, the rules of a recognised organisation.

Note State or Territory electrical licensing requirements may apply to persons carrying out electrical work on high voltage electrical equipment.

Chapter 7 Low voltage (LV) systems

(Required outcomes: Schedule 1, Required Outcomes B, C, D and E)

7.1 General requirements

A vessel's low voltage electrical equipment and installation must comply with the applicable requirements of this Chapter and of AS/NZ 3004.2.

Note 1 Vessels with an LV system may also have ELV supply. AS/NZS 3000 contains provisions regarding the segregation of circuits of different voltage.

Note 2 Relevant State or Territory electrical licensing requirements may apply to persons performing electrical work on electrical equipment.

7.2 Generators – control and instrumentation

In addition to the requirements of AS/NZS 3004.2, the following provisions apply to generators.

Control

7.2.1 Overcurrent

Overload and short circuit protection for each generator must be provided by a circuit breaker. The generator manufacturer's specifications must be adhered to for circuit breaker ratings and time delay settings. If the manufacturer's specifications are unavailable, for the purpose of providing overload and short circuit protection the following settings must apply:

a) 110 per cent of rated output current — 15 minutes;
b) up to 150 per cent of rated output current — 2 minutes; and
c) 150 per cent or greater of rated output current — instantaneous.

Consideration should be given to providing an alarm warning for overloads of less than 110 per cent of rated output current.

7.2.2 Multiple earthed neutral (MEN/TN) system

Where a vessel uses a MEN system, the vessel's MEN link must be made at each generator.

Where a vessel uses a TN system, it must meet the requirements in AS/NZS 3004.2, clause 3.2.2.

Note This requirement avoids nuisance tripping of shore side RCD. The vessel's MEN point is switched out of the circuit by the shore supply change over switch.

7.2.3 Load shedding

Where essential and non-essential services are separated, consideration may be given to the provision of load shedding of non-essential services when one or more generators become overloaded.

Instrumentation

7.2.4 General

Instrumentation for generators must meet the requirements in AS/NZS 3004.2, clause 2.5.6.

7.3 Inverters

7.3.1 General

Where inverters are installed the installation must comply with AS/NZS 3004.2.

7.3.2 Inverters with outputs isolated from other electrical systems

Inverters supplying individual or multiple outlets isolated from other supply systems must comply with the provisions of AS/NZS 3000 relating to protection by electrical separation, including the provisions applying to protective earthing.

7.3.3 Inverters used to supply the vessel's power system

Inverters used to supply a vessel's LV system must comply with the requirements for generators. Inverters must have the capability to monitor, give alarm, and disconnect when 'out of specification' values of voltage, frequency and current are detected. Disconnection must occur in all live conductors, and neutral. Supply must comply with AS/NZS 3004.2.

Chapter 8 Extra-low voltage (ELV) systems and batteries

(Required outcomes: Schedule 1, Required Outcomes B, C, D, E and G)

8.1 General requirements

A vessel's extra-low voltage electrical equipment and its installation must comply with the applicable requirements of this chapter and AS/NZ 3004.2.

Note Requirements for the separation of ELV and LV electrical installations in vessels that have both are contained in AS/NZS 3000.

8.2 Provisions of AS/NZS 3000 not to apply

The provisions in AS/NZS 3000 for ELV that allow switches to 'operate in one less conductor than the number of conductors in the circuit' do not apply to vessels to which this Subsection applies.

Note 1 The relevant provisions are in clauses 7.7.8.2 (b) and 7.7.9 (b) in the 2000 edition of AS/NZS 3000.

Note 2 This means that isolated systems switches and circuit protection are required to interrupt all active conductors. (See also clause 8.4 below).

8.3 Engine starting cables

Engine starting cables must:

a) be protected from mechanical damage;
b) have their terminals protected from mechanical damage and from contact with conductive materials;
c) be as short in length as is compatible with the stowage arrangements of the starter motor batteries;
d) either be routed to avoid the possibility of coming into contact with petroleum products or be enclosed or sheathed with a material resistant to the effects of petroleum products;
e) be of adequate size for the expected cranking current and to minimise voltage drop;
f) be connected directly to the starter via the starting relay contacts; and
g) be suitably sealed at terminals in such a manner as to reduce corrosion.

Note Starter motor manufacturer specifications must be referred to for cable ratings.

The starting motor relay must be mounted either directly on the starter or adjacent to it.

8.4 Switches and circuit protection

In isolated systems, switches and circuit protection must interrupt all active conductors.

Double pole isolation of conductors is required in ELV above earth systems.

Single pole isolation of the positive active conductor is required in negative earthed ELV systems.

An appropriately rated circuit breaker or fuse is to be provided on the active positive conductor for both above earth and negative earthed systems.

8.5 Batteries and battery installations

8.5.1 General

In addition to AS/NZS 3004.2, which includes requirements for lithium-ion batteries, batteries and their installations must comply with this Subsection, and the relevant requirements of NSCV Subsection C5A (2.17 starting arrangements), NSCV Section C4 (5 fire protection measures), and NSCV Subsection C7B (Annex F).

Battery compartments and battery boxes must be labelled to identify the type of batteries installed. Owners and operators need to ensure that if a battery is replaced with a battery of a different chemical composition, the associated equipment (i.e. charger and cabling) are assessed as suitable for the battery's characteristics. The different types of batteries have differing charging requirements and modifying this can cause batteries to be operated outside their safe design parameters.

Note New and emerging battery technology presents efficiency gains and the elimination of some hazards associated with lead–acid batteries. However, it also presents new hazards from the different types of battery chemistry. AS/NZS 3004.2 clause 2.9.3 contains standards for the use of lithium ion batteries on vessels.

This clause 8.5 does not apply to batteries integral to particular equipment when those batteries do not feed into a vessel's distribution system.

Note Batteries integral to equipment may include those used in hand held and portable equipment, internal back up batteries for electronic navigation devices, fire detector back up batteries and batteries for stand-alone emergency lighting units.

8.5.2 Location and mounting of batteries

8.5.2.1 Location of starting batteries

To limit voltage drop in cables, starting batteries must be located as close as practicable to the engines they serve while minimising the risk of hydrogen released by the battery being ignited by a spark from the starter motor.

8.5.2.2 Mechanical protection

Batteries must be located and mounted in a:

a) suitably sized and well secured battery box with fitted lid and adequate ventilation that complies with clause 8.5.2.3; or
b) dedicated battery compartment or room that complies with clause 8.5.2.4.

Note This is to ensure a high level of protection against mechanical damage, exposure to moisture, and the possibility of short circuit caused by accidental contact with loose metal tools and other conductive articles.

8.5.2.3 Battery boxes

In addition to the requirements in AS/NZS3004.2, battery boxes for lead acid batteries must be capable of containing the whole volume of the electrolyte.

When a lead acid battery is stored in a battery box it must be ventilated in accordance with AS/NZS3004.2.

8.5.2.4 Battery compartments

In addition to the requirements in AS/NZS3004.2, batteries stored in dedicated battery compartments or rooms must be mounted in drip trays or containers of a chemically resistant material that are capable of containing the total volume of the electrolyte.

Battery compartments are to be ventilated in accordance with AS/NZS3004.2.

8.5.2.5 Housing of batteries

Batteries, or sets of batteries, charged by chargers where the sum of all chargers is greater than 2 kW in total must be housed in a compartment dedicated to batteries only. Battery compartments must be well ventilated to the open deck. Cable entries to battery compartments must be gas tight.

Batteries with different chemical compositions (Lead-acid / alkaline / lithium-ion) must not be housed in the same compartment or container, or in close vicinity to each other. It must not be possible to connect batteries of different chemistry together.

Batteries must not be housed in enclosed spaces such as a cabin or a wheel house or a void space unless they are in a container sealed from the accommodation space that complies with clause 8.5.2.3.

Note Alkaline electrolytes and acids react violently when in contact and noxious fumes may be generated.

8.5.3 Battery protection

Battery terminals must be protected from mechanical damage and from contact with conductive materials.

Batteries supplying essential services, excluding engine starting batteries, must have short circuit protection as a minimum protection for overcurrent.

Engine starting batteries must have either:

a) short circuit protection; or
b) mechanical protection of the starting cables.

For all other battery circuits, short circuit and overload protection must be provided.

Short circuit and overload protection must comply with the manufacturer's specifications. If manufacturer's information on prospective short circuit currents and fault current capacity is not available, for the purposes of providing protective devices the prospective fault current at the terminals must be considered to be:

a) for vented cells – 20 times the nominal battery capacity at the 3 hour rate; and
b) for sealed cells – 35 times the nominal battery capacity at the 3 hour rate.

8.5.4 Earth

Earth continuity between the vessel's earth and the shore earth must be maintained through the appropriate pin in a plug/socket shore power connection or by a dedicated earth terminal in a shore supply connection that uses terminals.

Schedule 1 Required Outcomes

(Chapter 2, clause 2.1)

A. Safety protection

Protection must be provided to prevent inadvertent contact by personnel and passengers with parts of the electrical installation that are live in normal service and those that may become live during fault conditions. Electrical equipment and installations must minimise the risk of fire, damage and physical injury when a vessel's electrical equipment is used with reasonable care. Minimisation must include overcurrent protection, appropriate insulation, appropriate construction, fault indication, safety trips, and effective operational and maintenance procedures.

B. Functionality and reliability

A vessel's electrical installation must be designed, and electrical equipment selected and installed, so as to maintain the functionality and reliability of the installation under operating conditions expected in the marine environment. The functionality and reliability of systems and equipment necessary for the safe operation of the vessel must be maintained during normal and emergency operations (e.g. avoidance of electromagnetic interference with navigation equipment). The vessel's electrical installation must be of a quality and standard that will limit the degradation of the installation from the extreme conditions expected in the marine environment (e.g. electrochemical corrosion).

C. Protection and overcurrent

Protection must be provided against damage due to excessive temperature rise or electromechanical stresses caused by over-currents that may arise in conductors.

D. Watertight and fire integrity

Where a wiring system passes through a deck or bulkhead that is required to be of watertight or fire-rated construction the integrity of the construction must be maintained. Where the routing of a wiring system requires the penetration of solid surfaces such as bulkheads or decks, the wiring system must be effectively protected from mechanical damage.

E. Isolation

Electrical installations, and parts of installations, must be provided with isolation devices to prevent or remove hazards associated with abnormal operation (e.g. faults such as short circuits) and to allow maintenance of electrical equipment.

F. Emergency Supply

Electrical services essential for personal safety, the safety of the vessel, and safety of navigation, must remain operational under emergency conditions.

G. Batteries

Battery installations must be designed and installed to eliminate or minimise risks associated with the emission of gases, corrosive fluids, electrochemical corrosion, movement, mechanical damage, thermal runaway, and exposed terminals.