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AUSTRALIAN NAVAL CLASSIFICATION AUTHORITY MANUAL (VOLUME 2)

DIVISION 3: SHIP RULES

CHAPTER 04: ENGINEERING SYSTEMS

PART 1: ANC RULES

This document is issued for use by Defence and Defence Industry personnel and is effective forthwith.

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AUSTRALIAN NAVAL CLASSIFICATION RULES

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Division 3: Ship Rules
Part 1: ANC Rules

Chapter 04: Engineering Systems

Contents

Australian Naval Classification Rules

Rule 0. Goal

0.1 The engineering systems shall be designed, constructed, operated, and maintained to:

0.1.1 Enable their operation in all Foreseeable Operating Conditions;

0.1.2 Minimise risks to embarked persons in all Foreseeable Operating Conditions So Far As Reasonably Practicable (SFARP);

0.1.3 Operate in a predictable manner with a level of integrity commensurate with operational requirements;

0.1.4 Ensure the watertight and weathertight integrity of the hull, and meet the requirements of Chapter 03 *Buoyancy and Stability*;

0.1.5 Enable the restarting of shut-down systems and equipment necessary to provide essential safety functions ("dead ship" starting) without external aid in all Foreseeable Operating Conditions;

0.1.6 Minimise the risk of fire, explosion or contamination of the atmosphere;

0.1.7 Provide support to the embarked persons and provide essential safety functions in the event of all foreseeable damage at least until the persons have reached a place of safety or the threat has receded; and

0.1.8 Enable the maintenance and repair in the ship's maintenance plan.

0.2 Additional systems or equipment not directly covered by this Chapter, shall not impact on the ship's Engineering or Safety Systems.

Rule 1. General

Functional Objective

1.1 The purpose of this Rule is to outline the principles and framework of Chapter 04 *Engineering Systems* and its application.

Scope

1.2 The scope of this Chapter is to describe the Goal, Functional Objectives and Performance Requirements for engineering systems on ships. It includes general elements including but not limited to the provision of information, essential safety functions, control, safety, systems integration etc. as well as individual systems such as propulsion, piping, electrical generation & distribution etc.

1.3 Division 2 Chapter 01 *General Requirements* and Chapter 01 *Integrated Platform Survivability* applies to all chapters of the ANC Rules, as applicable to the design, and therefore in order to meet the Chapter 04 *Engineering Systems* goal, the requirements of both this Chapter, Chapter 01 and Division 2 Chapter 01 *General Requirements* shall be met.

1.4 Where the requirements of other chapters, such as Chapter 06 Fire Safety, Chapter 07 *Escape, Evacuation & Rescue*, Chapter 14 *Environmental Protection* etc., impact on the considerations of the items described in this Chapter, then the over-riding requirements shall

be derived in order to meet the relevant Functional Objectives and Goals for both Chapters. Specifically, on the interface with Chapter 10 *Dangerous Goods*, Chapter 04 *Engineering Systems* contains the overarching requirements for Engineering Systems which apply to the carriage, and use of Dangerous Goods (Class 1-9) and Chapter 10 *Dangerous Goods* supplements Chapter 04 *Engineering Systems* by providing additional requirements applicable to Class 1 Dangerous Goods (Explosives).

Application

1.5 In addition to the requirements contained elsewhere in the present Rules, ships shall be designed, constructed and maintained in accordance with the structural, mechanical and electrical requirements of a classification society whose rules and procedures are recognised and validated by the ANC Authority, or through alternative standards prescribed by the ANC Authority which provide an equivalent level of safety.

1.6 Chapter 04 *Engineering Systems* is written in a goal-based format that specifies high-level objectives and relies upon verification against an agreed standard for compliance.

1.7 For certain ship types, novel craft or for operational reasons the compliance in full with the requirements of this Chapter may not be required subject to justification and acceptance by the ANC Authority.

Rule 2. Not Used

Rule 3. Provision of Operational Information

Functional Objective

3.1 Operators shall be provided with adequate information and instructions for the safe operation and maintenance of all machinery and systems.

Performance Requirements

3.2 Information and instructions shall be supplied to the operator to ensure the safe operation, fault finding and maintenance of machinery, under all Foreseeable Operating Conditions. For essential safety functions, clear system diagrams and instructions shall be provided detailing the changeover procedures and the actions to be completed in the event of machinery breakdown.

3.3 Instructions shall define the safe operating limits and make it clear that operation outside these limits is unsafe and can damage equipment and systems.

3.4 Instructions shall be presented in English and in a format that can be understood by the operator in the context in which it is required.

Rule 4. Propulsion

Functional Objective

4.1 The propulsion machinery shall enable the ship to manoeuvre as and when required by the Command but still remain within the designed or imposed limitations as and when required by the Command but still remain within the designed or imposed limitations.

Performance Requirements

4.2 To enable the ship to manoeuvre, this Rule shall be applied in conjunction with Rule 5, *Manoeuvring*.

4.3 Redundancy of propulsion equipment shall be provided as required by Chapter 01 *Integrated Platform Survivability* Rule 6 *Zoning, Separation and Redundancy*. The ANC Authority shall give consideration to the reliability of single essential propulsion components on application.

4.4 The requirements for manoeuvrability as required by Chapter 09 *Navigation* Rule 11 *Collision Avoidance* and Rule 12 *Controllability* apply in addition to these requirements.

4.5 Effective means of communicating orders from the normal and emergency conning positions to any position from which the speed and direction of thrust of the propellers can be controlled shall be provided.

4.6 Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative.

4.7 Means shall be provided to ensure that the propulsion machinery can be brought into operation from the dead ship condition without external aid.

4.8 Fuel supply arrangements from internal storage tanks shall be such that a reserve of fuel is available to provide continuous running for a period specified by the OSI without continuous transfer of fuel, and that means are provided to ensure that the quality of the fuel shall not cause damage to the propulsion equipment.

4.9 Propulsion Systems (e.g., Diesel Engines, Gas Turbines, Gearboxes and Shafting Arrangements) are to be capable of operation in damage conditions as specified by the OSI.

4.10 Machinery spaces and exhaust systems shall be designed to attenuate noise and vibration from engines and turbines to meet the requirements of Chapter 12 *Habitability* and Chapter 14 *Environmental Protection*.

4.11 For ships exposed to extreme threat conditions, propulsion systems shall be designed to meet the signature requirements of Chapter 01 *Integrated Platform Survivability* Rule 3 *Signature Reduction*.

Rule 5. Manoeuvring

Functional Objective

5.1 The manoeuvring equipment shall enable the ship to manoeuvre as and when required by Command whilst remaining within the design or imposed limitations.

Performance Requirements

5.2 Machinery and systems required for manoeuvring shall meet the relevant requirements of Chapter 09 *Navigation* Rule 11 *Collision Avoidance* and Rule 12 *Controllability*.

Note: Consideration should be given to the effects of the failure of stabilisers (if fitted) and use of steering gear for roll compensation.

5.3 The manoeuvring equipment system shall exhibit sufficient redundancy to cope with single failures without the loss of manoeuvring capability.

5.4 Operation of the manoeuvring equipment shall be possible from a number of locations.

5.5 The operational status of the manoeuvring equipment shall be clearly visible at each control station.

5.6 The manoeuvring equipment control system shall exhibit sufficient redundancy to cope with single failures of components and electrical supply.

5.7 Effective means of communicating orders from the normal and emergency conning positions to any position from which the speed and direction of thrust of propulsors can be controlled shall be provided.

5.8 The motive power supply shall exhibit a level of redundancy, diversity, and capacity to ensure that the manoeuvring equipment remains operational and shall exhibit a level of continuity to ensure continuous operation.

Note: This is to include provision of supplies and control in the event of damage to the platform.

5.9 The manoeuvring equipment shall fail-safe and exhibit alternative modes of operation to fulfil the manoeuvring requirements during a failure.

Rule 6. Pressure and Piping Systems

Functional Objective

6.1 Pressure vessels and associated piping systems and fittings shall be of a certified design and construction adequate to safely contain media, taking account of the anticipated pressure and temperature profiles and the service for which they are intended.

Note: Requirements for specific systems are given at the end of this Chapter.

Performance Requirements

6.2 The system shall be designed and constructed to operate safely in static and transient conditions.

6.3 Surface temperatures of pipes shall not pose a danger to embarked persons or become a source of ignition in case of flammable fluid leaks.

Note: Pressure vessel and piping system shall also meet the prevention of ignition of flammable substance requirement of Chapter 06 *Fire Safety* Rule 4 *Risk of Ignition*.

6.4 Provision shall be made to reduce to a minimum the entry of contaminants into pressure systems and to provide drainage points for systems as required.

6.5 Where media quality is required to be maintained, system materials and system operation shall be compatible with the media. Means of testing and treatment shall be provided.

6.6 Valves associated with maintaining watertight integrity shall be operable from a position as defined in Chapter 03 *Buoyancy and Stability*.

6.7 Precautions against the build-up of electrostatic charges shall be provided.

6.8 Pressure relief arrangements shall be fitted to prevent overpressure in excess of the design pressure in any part of a pressure system. The relief setting, quantity, location and flow capacity of the pressure relief devices installed shall mitigate the consequences of excessive overpressure.

6.9 Pressure relief arrangements shall not pose a danger to embarked persons, the environment or any other ship system. Where the media contained poses a safety hazard to embarked

persons or the environment, arrangements shall be put in place to minimise the risk following release.

6.10 Failure of a joining arrangement shall not pose a further risk (e.g., due to atomisation of hydrocarbons, leakage of water onto electrical equipment etc.).

6.11 The design of piping systems, including supports, couplings and valves, shall be made of fire-resistant and corrosion-resistant materials.

6.12 Each pipe and valve shall be clearly marked, identifying the system it serves. The system identification method used shall be consistent throughout the platform.

6.13 Pipe fittings shall be readily accessible for maintenance purposes.

6.14 Piping systems shall not obstruct passageways, working and recreation areas, or accesses for maintenance of equipment or structure.

6.15 Machinery spaces shall be dry-bilge areas so all leaks that may occur from engines and their supporting systems shall be captured before reaching the bilge and appropriate drainage arrangements provided.

Rule 7. Ship Stabilising Systems

Functional Objective

7.1 Where fitted, Motion Control Systems shall stabilise the ship to motion limits compatible with embarked person's endurance and OSI sea-keeping requirements under all load conditions.

Performance Requirements

7.2 The requirements for manoeuvrability, as required by Chapter 09 *Navigation* Rule 12 *Controllability*, apply in addition to these requirements.

7.3 The requirements for watertight integrity and stability required by Chapter 03 *Buoyancy and Stability* Rule 2 *Watertight Integrity* and Rule 4 *Reserve of Stability* apply in addition to these requirements.

7.4 Ship Stabilising Systems shall not impede the operation of survival and rescue craft.

7.5 The ships stability requirements shall not be reliant on ship stabilising systems.

7.6 The operation of ship stabilising systems shall not result in an unsafe condition for the vessel, equipment or crew.

7.7 Control systems shall be in accordance with Rule 16 *Machinery Control*.

7.8 Alerts and indicators shall be in accordance with Rule 17 *Alerts and Safety Systems*.

7.9 It shall be possible to lock the stabiliser fins in a known position. Mechanical locking due to a single failure shall be considered and accommodated.

7.10 Failure of any part of the stabiliser unit or its control system shall not result in an unsafe condition which will have detrimental effect on the ship's operating, sea-keeping capability or safety of embarked persons.

7.11 The stabilisation system shall operate effectively across the full range of load conditions of the ship, covering extremes of displacement and metacentric height.

Rule 8. Not Used

Rule 9. Other Essential Safety Functions

Functional Objective

9.1 The ship's machinery outfit shall provide services for essential safety functions not described elsewhere in the ANC Rules.

Performance Requirements

9.2 Arrangements for the continuous supply of energy to essential machinery and services shall be provided.

9.3 A fire main system shall be available which is capable of providing essential safety functions required by Chapter 06 *Fire Safety* Rule 9 *Fire Fighting*.

9.4 Where a ship is expected to receive low flash point fuels, a suitable system is required for its storage, use or safe disposal.

Note: The requirements for the carriage of low flash point fuels are given in Chapter 06 *Fire Safety* Rule 14, *Carriage of Low Flash Point Fuels.*

9.5 Bilge pumping arrangements shall comply with the requirements of Chapter 03, *Buoyancy and Stability*. Bilge pumping and piping arrangements shall comply with the requirements of Chapter 01 *Integrated Platform Survivability* Rule 2 *Post Damage Capability*.

9.6 Where operation of essential safety functions is reliant on the continuous removal of heat, they shall be provided with appropriate redundancy or an alternative method of cooling.

Rule 10. Electrical Generation and Power Supplies

Functional Objective

10.1 Sufficient electrical power shall be provided to supply the required services and habitability requirements during all operational conditions without recourse to the emergency electrical supply.

10.2 Sufficient electrical power shall be provided to supply services for essential safety systems for the duration of the emergency conditions.

10.3 Transitional power supplies shall be provided where no interruption of the electrical supply to essential safety systems is required.

Performance Requirements

10.4 Electrical generation and distribution arrangements shall supply electricity to consumers in all operating and environmental conditions defined in the OSI.

10.5 The Quality of Power Supply (QPS) shall account for the following:

10.5.1 All operational and environmental conditions as defined in the OSI;

10.5.2 Without any requirement to use emergency supplies; and

10.5.3 Electromagnetic Interference (EMI) from ship's equipment and/or external environmental conditions.

10.6 The electrical power generation and power supplies shall be designed and arranged with a high level of integrity and availability to achieve the requirements of the OSI.

10.7 Redundancy arrangements shall be provided to supply mission-critical and essential safety functions in the event of the loss or unavailability of any one generator.

10.8 Protection measures shall be provided in accordance with Rule 15 *Electrical Protection Arrangements*.

10.9 Consumer equipment shall be safeguarded from excessive power from electrical generation and supply equipment to minimise damage to equipment or impacts to essential safety functions.

10.10 Where required by the OSI, facilities to safely connect shore side electrical power shall be provided.

10.11 Facilities shall be provided to regain sufficient power to restore essential safety functions from a dead ship condition.

10.12 Arrangements for the safe installation and use and maintenance of energy storage devices shall be provided.

10.13 In the event of failure of the Main Electrical Supply, a means to supply sufficient electricity to supply the Essential Electrical Services shall be provided.

10.14 Where a main generator is used in lieu of the emergency generator, subject to complying with necessary requirements, the requirements of the emergency source of power shall be applied to the main source of power.

10.15 For Mission Critical Functions and Essential Safety Functions for which an interruption to supply is unacceptable, transitional electrical supplies with sufficient capacity and duration to ensure continuous operation shall be provided.

10.16 The power supply to Escape, Evacuation and Rescue systems shall be provided as per the requirements of Chapter 07 *Escape, Evacuation & Rescue* Rule 14 *Power Supply to Escape, Evacuation and Rescue Systems*.

10.17 Electrical power generation capacity and energy storage systems shall be sized and designed to include a growth margin in line with the ship's margin policy required by Division 2 Chapter 01 *General Requirements* Rule 12 *Margins Management*.

10.18 The ships electrical power supply shall have interface commonality and interface compatibility with RAN shore power facilities, as required by the OSI.

Rule 11. Not Used

Rule 12. Not Used

Rule 13. Electrical Distribution and Equipment

Functional Objective

13.1 Electrical power shall be distributed safely to consumers.

Performance Requirements

13.2 Electrical equipment shall meet the requirements of Rule 10 *Electrical Generation and Power Supplies*, paragraph 10.5, in terms of suitability for the Quality of Power Supply (QPS).

13.3 Electrical equipment and distribution systems shall meet the requirements of Rule 15 *Electrical Protection Arrangements*.

13.4 The electrical system voltages and frequencies shall ensure safe provision of electrical power to systems and to minimise the risk of exposure to embarked persons.

13.5 The design of the type and configuration of the distribution system, including earthing arrangements as necessary, shall minimise the risk to embarked persons and equipment under normal and foreseeable abnormal conditions.

13.6 The number, size, installation and arrangement of electrical switchboards and distribution centres shall be suitable for the functional requirements of the vessel.

13.7 The distribution system shall be designed and arranged with a high level of Integrity and availability, as specified in the OSI.

13.8 Cables shall be installed such that risk of injury to embarked persons or damage to the system is minimised when equipment is operating in foreseeable or under fault conditions.

13.9 Main and emergency supplies, where required for a single consumer, shall be separated as widely as possible.

13.10 The continuity of supply to Mission Critical Functions and Essential Safety Functions shall be ensured.

13.11 Arrangements for the isolation and switching of distribution circuits shall be provided.

13.12 Installation of cables shall not cause mutual interference between systems. Also, electrical and electronic equipment shall not be impaired in its function by electromagnetic energy.

13.13 Suitable protection arrangements for the use of portable or temporary electrical equipment shall be provided.

13.14 Effective means of communication, complying with the requirements of Chapter 08 *Communications* Rule 7 *Internal Communications*, shall be provided between all switchboards.

13.15 Where a damage control emergency distribution system is installed, it shall not introduce an additional risk of harm to embarked persons, equipment or the platform.

13.16 Ships with a requirement for increased survivability shall provide accommodation for damage control emergency distribution systems (also known as casualty power distribution systems) and post-damage quick and safe installation of damage control cabling to safety and mission essential consumers in accordance with Chapter 01 Integrated Platform Survivability Rule 2 Post Damage Capability.

13.17 Electrical power distribution system shall be sized and designed to include a growth margin in line with the ship's margin policy required by Division 2 Chapter 01 *General Requirements* Rule 12 *Margins Management*.

13.18 Electrical power distribution equipment and consumers shall be clearly marked and uniquely identifiable for the end user and/or maintenance personnel as appropriate.

13.19 The electrical distribution system should ensure interoperability with in-service ADF systems and equipment.

13.20 The design of the electrical distribution system for hotel services, domestic appliances or personal electrical and electronic equipment shall have interface commonality and compatibility with Australian Standard electrical equipment.

13.21 Cables shall be selected, designed, and installed, in such a way that satisfy the emanation security requirements in Chapter 13 *Combat Systems* Rule 11 *Internal Communications Systems*.

13.22 All electrical conductors and cables shall be clearly distinguishable visually and identified to indicate their intended function.

Rule 14. Lighting

Functional Objective

14.1 Illumination shall be provided appropriate for location and operational requirements in both normal and emergency conditions.

Definitions

14.2 For the purpose of this Rule the following descriptions of lighting systems have been used to provide a common vocabulary (Reproduced from Division 1 Annex A *Definitions and Abbreviations*):

14.2.1 Primary lighting: Fixed lighting provided for safe access around the ship and those compartments accessed during normal operations. Carrying out operations at control stations;

14.2.2 Secondary lighting: Fixed replacement lighting in event of primary lighting failure. This may be at a lower illumination level;

14.2.3 Tertiary lighting: Fixed independent lighting system to provide a minimum level of illumination on failure of primary and secondary lighting;

14.2.4 Transitional lighting: Fixed lighting provided upon loss of primary lighting and prior to the operation of the secondary lighting, where a level of continuous illumination must be maintained for operational purposes;

14.2.5 Escape, evacuation and rescue lighting: A combination of secondary and tertiary lighting specifically arranged to enable escape, evacuation and rescue;

14.2.6 Operational lighting: Fixed lighting as required for special purposes with different levels of illumination from primary and secondary lighting;

14.2.7 Portable lighting: non-fixed, portable lighting which may be used to support other lighting systems; and

14.2.8 Dark adaption lighting: Lighting to a level provided in selected areas to ensure that the night vision of personnel is not compromised.

Performance Requirements

14.3 The light fittings selected for a particular space shall be appropriate for the hazardous zone classification of the space. Refer to Division 2 Chapter 01 *General Requirements* Rule 7 *Hazardous Areas*.

14.4 Illumination levels shall be appropriate for all foreseeable operating conditions.

14.5 Lighting systems shall permit the ship to be operated in accordance with the OSI.

14.6 Primary lighting systems shall provide a suitable level of illumination:

14.6.1 To allow safe access to areas of the ship that require it for normal operations; and

14.6.2 To allow operation and control of the ship.

14.7 The lighting system shall be arranged such that a single failure will not cause total loss of illumination in any compartment or control location.

14.8 In the event of loss of primary lighting, at locations where a level of illumination must be maintained for operational control and damage control purposes, transitional lighting shall be provided until the secondary lighting is operational.

14.9 Operational lighting shall be provided in areas where there is an operational requirement for different levels of illumination from that provided by the primary system.

14.10 To meet operational requirements, lighting levels shall be controllable locally.

14.11 Siting of light fittings shall consider the transfer of heat to adjacent surfaces.

14.12 Lighting required for escape, evacuation and rescue shall be as defined in Chapter 07 *Escape, Evacuation & Rescue* Rule 15 *Lighting During Escape, Evacuation and Rescue Emergencies* and Rule 18 *Way Finding System*.

14.13 Navigation lights shall be as defined in Chapter 09 *Navigation* Rule 11 *Collision Avoidance*.

14.14 Where provided, lighting systems including portable lighting shall be appropriate for the hazardous zone classification of the compartment in which it will be used. Refer to Division 2 Chapter 01 *General Requirements* Rule 7 *Hazardous Areas*.

14.15 The lighting system design and ship arrangement shall enable a darkened ship scenario in which the ship can continue operations at night with no light being visible at any time from outside the ship.

14.16 The lighting system design and ship arrangement shall allow any personnel requiring night vision to carry out their duties and move between specified compartments with minimal loss of their night vision.

14.17 On ships which carry out aircraft operations, all lightings that is externally visible shall also comply with the requirements of Chapter 11 *Aviation Systems*.

14.18 Lighting systems in medical facilities shall be as defined in Chapter 15 *Medical Facilities*.

Rule 15. Electrical Protection Arrangements

Functional Objective

15.1 All electrical equipment shall be suitably protected against damage to itself under normal, reasonably foreseeable abnormal and fault conditions and to prevent injury to embarked persons or damage to other equipment.

Performance Requirements

15.2 Exposed conductive parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live shall be earthed or arrangements provided to protect embarked persons.

15.3 A means to automatically detect, locate and alert of insulation breakdown with respect to earth within equipment and the ungrounded electrical power system shall be provided without requiring isolation of essential safety or mission critical consumers.

15.4 Arrangements shall be provided to minimise the effects and likelihood of arc flash on embarked persons and provide protection for personnel and equipment against arc flash, during operation or while undergoing maintenance.

15.5 Suitable protection arrangements from the ingress of solids, liquids and gases shall be provided for all electrical equipment and distribution systems.

15.6 Efficient means, suitably located, shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger.

15.7 Suitable arrangements for the protection of mechanically connected equipment due to the effects of electrical overloads shall be provided.

15.8 Suitable arrangements for the protection of electrical equipment due to the effects of mechanical overloads shall be provided.

15.9 Mission Critical Functions and Essential Safety Functions shall be supplied using fire-resistant cable.

15.10 Electrical equipment and distribution systems shall be suitably protected from mechanical damage.

15.11 Suitable Security arrangements to prevent unauthorised access to live electrical connections and electrical control shall be provided.

15.12 Suitable protection arrangements for lightning strikes shall be provided.

15.13 Alternative arrangements for cooling of essential machinery and systems in the event of a primary cooling system failure shall be provided.

15.14 Suitable arrangements shall be provided to minimise the effects of radiation hazards to embarked persons.

15.15 Efficient protection shall be provided for protecting personnel from electric shock and earth leakage in accordance with relevant Commonwealth and State Legislation.

15.16 Capacitance on ungrounded distribution systems shall be limited to fulfil EM Emission requirements in Chapter 01 *Integrated Platform Survivability* Rule 3 *Signature Reduction*, to ensure on first earth fault, continuity of supply is maintained to mission critical and essential safety systems, and no hazardous touch voltage is generated.

15.17 Design of grounded distribution systems shall limit the magnitude of harmful circulating current in ship structure in normal and fault conditions.

15.18 Arrangements shall be made to limit the propagation of the fault between equipment and systems, assure continuity of power supply and quality of power supply.

15.19 Arrangements of administrative signage to minimise the risk of electric shock shall be provided in accordance with relevant Commonwealth and State Legislation to minimise risk of injury to embarked persons.

15.20 Protection system shall ensure the continuous availability of mission critical, essential and emergency services under fault conditions.

Rule 16. Machinery Control

Functional Objective

16.1 Main and Auxiliary Machinery & Systems essential for the safety of the ship and embarked persons shall be provided with effective means for its operation and control during all operational conditions defined in the OSI.

Performance Requirements

16.2 The requirements for control stations required by Division 2 Chapter 01 *General Requirements* Rule 10 *Control Stations* apply in addition to these requirements.

16.3 The control system shall operate essential machinery & systems in a safe, controlled and stable manner throughout the machinery's/systems defined operational limits and shall recover automatically in a safe manner after a loss of power supply.

16.4 Audible and visual indications of impending slow-down / shut-down of essential machinery and systems shall be provided at applicable locations with provision to take alternative actions if approved.

16.5 Automated control systems which utilise stored energy to start essential machinery shall be configured not to exhaust the stored energy completely and to provide an alert when the stored energy is below a critical limit.

16.6 The monitoring system for system parameters shall have integrity appropriate for its intended purpose. Where it is not considered practical to have the normal machinery control system with sufficiently high integrity to provide the required level of safety, sufficient direct reading gauges shall be provided to enable potentially hazardous fault conditions or abnormal conditions to be identified and to allow the machinery to be operated safely.

16.7 For unattended machinery spaces, a machinery control and alarm position shall be provided.

16.8 The control system shall fail-safe. The fail-safe conditions are to be derived and documented.

Note: Except for the propulsion engine overspeed shutdown, fail-safes are to be able to be manually overridden when machinery required for manoeuvring is in automatic or remote control mode during close navigation or action states.

16.9 Operators shall have an independent, high integrity method to disconnect all energy sources that shall put machinery for essential safety functions into a known safe state.

16.10 Machinery control systems with automation shall include provisions for manually overriding the automatic controls. Failure of any part of the systems shall not prevent the use of the manual override.

Rule 17. Alerts and Safety Systems

Functional Objective

17.1 The alert system shall inform operators as soon as reasonably practicable of deviations from normal operation of machinery and systems during all ship operations.

17.2 A safety system shall be installed to ensure that any serious malfunctions of machinery or system which present an immediate danger shall initiate a corrective action where appropriate to remove the risk of danger.

Performance Requirements

17.3 An alert system shall be arranged with necessary panels at all Control Stations.

17.4 The design, construction and operation of the alert and safety systems shall consider human element requirements.

17.5 Alert systems shall include the following characteristics:

17.5.1 The operational status of the computer based system shall be easily recognisable;

17.5.2 Alerts shall be visually and audibly presented with priority over other information in every operating mode of the system and shall be clearly distinguishable from other information; and

17.5.3 When using general purpose graphical user interfaces, only functions necessary for the respective process shall be available.

17.6 The alert system and safety system shall be provided with a continuous supply of power.

17.7 The alert and safety systems shall prevent unauthorised changes being made to system's parameters.

17.8 The status of an alert shall be clearly visible and a means to accept it from all appropriate locations shall be provided.

17.9 Visual indication of the alarm shall remain until the fault is cleared.

17.10 Machinery and Systems shut-down by the safety system shall be reset by operator action before allowing a restart.

17.11 Where the function of a safety system may lead to a greater hazard than the loss of the equipment, an override feature may be acceptable to the ANC Authority.

17.12 The status of operating and standby machinery & systems shall be indicated at appropriate control stations.

17.13 As far as reasonably practicable the alert and safety systems shall be designed to fail to a safe state.

Rule 18. Systems Integration

Functional Objective

18.1 Essential safety functions shall be designed such that risks of harm to embarked persons, damage to the platform or the environment are eliminated or minimised SFARP, both in normal operation and under fault conditions. Functions shall be designed to fail safe.

Performance Requirements

18.2 The integrity of Mission Critical and Essential Safety systems, during normal operation and fault conditions shall be demonstrated.

18.3 Any imposed equipment limitations shall be reflected in system design.

18.4 Systems shall be designed such that they will not unduly affect any other system (even under failure conditions).

18.5 Failure of one part of the integrated system shall not affect the functionality of other parts except for those functions directly dependant on the defective part.

Rule 19. Heating, Ventilation and Air Conditioning (HVAC)

Functional Objective

19.1 Internal ambient conditions shall be controlled to suit machinery requirements.

19.2 Internal ambient conditions shall be controlled for crew habitability.

19.3 Ventilation shall be provided for hazardous areas.

Performance Requirements

19.4 Suitable internal ambient conditions in spaces containing machinery or equipment shall be maintained.

19.5 Suitable internal ambient conditions shall be maintained in all manned and accessible spaces in accordance with Chapter 12 *Habitability* Rule 2 *Internal Environment*.

19.6 The ventilation requirements of Chapter 06 *Fire Safety* and Chapter 09 *Navigation* Rule 2 *Bridge Working Environment* shall be met. Ventilation arrangements shall comply with the requirements of Chapter 01 *Integrated Platform Survivability* Rule 2 *Post Damage Capability*.

19.7 HVAC Systems shall not compromise the boundaries of the following:

19.7.1 Fire Zones (See Chapter 06 *Fire Safety*);

19.7.2 Watertight Zones (see Chapter 03 *Buoyancy and Stability*);

19.7.3 Gastight Zones (see Chapter 01 *Integrated Platform Survivability*); and

19.7.4 CBRN-D Zones (see Chapter 01 *Integrated Platform Survivability*).

19.8 Provisions to "Crash Stop" ventilation in case of fire shall be provided.

19.9 Hazardous areas and areas where noxious odours may regularly occur shall be provided with appropriate ventilation systems.

19.10 For remote controlled ventilation machinery & systems, appropriate indication, monitoring, alerts and protection shall be provided.

19.11 Continuity of operation of essential safety functions in the event of a ventilation failure shall be provided. See also Chapter 4 *Engineering Systems* Rule 9 *Other Essential Safety Functions*.

19.12 The routing of ventilation systems for spaces with hazardous atmospheres shall not pose a risk to other spaces.

19.13 Where the OSI specifies CBRN Defence capability, the requirements for this capability are stated in Chapter 01 *Integrated Platform Survivability* Rule 13 *Chemical, Biological, Radiological and Nuclear (CBRN) Defence*.

19.14 HVAC systems redundancy shall be in accordance with Chapter 01 *Integrated Platform Survivability* Rule 6 *Zoning, Separation and Redundancy* and the OSI.

Rule 20. Tanks

Functional Objective

20.1 Bulk fluids, required for machinery systems and crew habitability, shall be safely stored.

Performance Requirements

20.2 Suitable arrangements to safely determine the level of fluid in a tank shall be provided.

20.3 Tanks shall be provided with suitable arrangements to prevent overpressure and under pressure during all operational evolutions.

20.4 Vent pipes for oil fuel service, settling and lube oil tanks shall be located or protected to minimise the risk of damage and subsequent ingress of seawater or rainwater.

20.5 The loading or discharge connections and vent pipes/overflows associated with fuel oils, lubricating oils, hydraulic oils and other oils shall be fitted with drip trays of suitable capacity so as not to cause a hazard to the environment or adjacent equipment.

20.6 Suitable arrangements to prevent the ignition of vapours in a tank shall be provided.

20.7 Arrangements to prevent contamination of fluids in tanks shall be provided.

Rule 21. Not Used

Rule 22. Not Used

Rule 23. Refrigeration Systems

Functional Objective

23.1 Refrigeration Systems shall provide safe and efficient cooling to the temperature ranges required by the equipment, stores or activities in a space and efficiently maintain those temperatures.

Performance Requirements

23.2 Refrigeration systems shall be designed and constructed to cool and maintain refrigerated spaces or equipment at a set temperature.

23.3 Refrigeration systems shall be provided with redundant machinery in order to provide continuous cooling of the spaces or equipment in case of failure of one piece of machinery.

23.4 Refrigerants and materials used in refrigeration systems shall comply with Chapter 14 *Environmental Protection.*

23.5 A refrigerant gas detection and alarm system shall be provided in any compartments in which refrigerant gas is stored, used or piped through. The detection and alarm system shall be connected to the integrated control system and sound at a manned location.

23.6 Refrigerated spaces shall be arranged so that no person can be trapped inside and walk-in refrigerated spaces shall be fitted with an alarm button inside to alert a manned space in case of entrapment.

23.7 Refrigerating system machinery spaces shall be well ventilated and meet the habitability requirements of Chapter 12 *Habitability*.

23.8 Refrigeration systems shall be arranged with suitable means of isolation so that maintenance, servicing or repair work may be conducted, minimising the release of the refrigerant into the atmosphere.

Rule 24. Sea Water Systems

Functional Objective

24.1 Sea Water Systems shall be designed to consistently deliver the required pumping and delivery capacities, and pressures throughout the vessel in all operating conditions specified by the OSI.

Performance Requirements

24.2 Sea Water Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* in addition to the following requirements.

24.3 For ships exposed to extreme threat conditions, seawater inlets, discharges and pump location and characteristics shall be designed to meet the signature requirements of Chapter 01 *Integrated Platform Survivability* Rule 3 *Signature Reduction*.

24.4 Sea water inlets shall not be located where they may lose suction during the ship's most extreme normal manoeuvres (e.g. hard turns, hard astern).

24.5 Sea water discharges shall not be located where they may interfere with operations such as small boat operations, embarkation or pilot ladders.

24.6 Sea water systems shall provide seawater at the quality required by the equipment it serves.

24.7 Layout of spaces, equipment and pipework shall allow for ease of access for cleaning of seawater filters, strainers and coolers.

24.8 Sea water systems shall be designed to prevent bio-fouling of the system.

24.9 The High-Pressure Sea Water (HPSW) System shall be configured in accordance with Chapter 06 *Fire Safety* and, for ships exposed to extreme threat conditions, Chapter 01 *Integrated Platform Survivability* Rule 11 *Damage Control*.

24.10 Ballasting and de-ballasting systems shall meet the requirements of Chapter 14 *Environmental Protection*.

24.11 Provision shall be made to maintain a supply of seawater to the ship while alongside, in dock or under any other operational condition.

24.12 Where the OSI specifies operations below 0°C, the seawater system shall be winterised accordingly.

24.13 Sea water inlets and discharges shall not be located where they may reduce the effectiveness of the ship's underwater sensors.

Rule 25. Fresh Water Systems

Functional Objective

25.1 Fresh Water Systems shall consistently provide fresh water at the required quality, temperature and pressure in all operational conditions and environments.

Performance Requirements

25.2 Fresh Water Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* in addition to the following requirements.

25.3 Fresh Water Systems shall provide potable cold and hot water and technical water at the quality required by the purpose it serves.

25.4 There shall be separate potable water and technical water storage and distribution systems. Technical water may be made from water taken from potable water tanks.

25.5 Fresh water storage tanks shall be kept secure from tampering.

25.6 Fresh water sampling points shall be located at the storage tanks and other appropriate locations throughout the water generation and distribution system in order to monitor water quality and locate any source of contamination.

25.7 Provision shall be made to receive fresh water from external sources.

Rule 26. Fuel and Lube Oil Systems

Functional Objective

26.1 Fuel and Lube Oil Systems shall safely and efficiently provide oil to equipment at the required quality, temperature, pressure and flow rate in all operational conditions and environments.

Performance Requirements

26.2 Fuel and Lube Oil Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* in addition to the following requirements.

26.3 Materials and equipment for fuel and lube oil systems shall be selected for safety and compatibility with all foreseeable grades of fuel and lube oil to be used in the systems.

26.4 Engine fuel systems shall be designed to safely accommodate the high-pressure pulses which are generated by the fuel injection pumps.

26.5 Fuel and lube oil treatment systems shall be provided where necessary to supply oil at the quality, temperature, pressure and flow rate required by the equipment it serves.

26.6 Oil, fuel and lubricating oil pressure pipe joints shall be shielded or otherwise suitably protected to avoid, as far as practicable, oil spray or leakages onto hot surfaces, electrical equipment or into machinery air intakes.

26.7 Waste oil systems shall be provided for the safe collection, retention on board and transfer to designated reception facilities of waste oil, oil residue and oily waste in accordance with Chapter 14 *Environmental Protection*.

26.8 Waste Oil System capacity shall meet the endurance requirements specified in the OSI.

26.9 Oily Bilge Systems shall comply with the requirements of Chapter 14 *Environmental Protection*.

26.10 Dedicated oily bilge water systems shall be provided in machinery spaces where both sea/fresh water and oil systems are located.

26.11 The oily bilge system shall be designed to prevent progressive flooding in accordance with Chapter 03 *Buoyancy and Stability*.

26.12 The oily bilge water system shall not serve as the emergency dewatering system required to meet the flood control requirements of Chapter 01 *Integrated Platform Survivability* Rule 12 *Flood Control*.

Rule 27. Hydraulic Systems

Functional Objective

27.1 Hydraulic Systems shall safely and efficiently provide fluid to actuation equipment at the required pressure and flow in all operational conditions and environments.

Performance Requirements

27.2 Hydraulic Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* as well as the following requirements.

27.3 Materials and equipment for hydraulic systems shall be selected for safety and compatibility with all foreseeable grades of hydraulic fluid to be used in the systems.

27.4 Hydraulic oil treatment systems shall be provided where necessary to supply oil at the quality, temperature, pressure and flow rate required by the equipment it serves.

27.5 Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative. Special consideration shall be given to the malfunctioning of the hydraulic means for control in main propulsion machinery including controllable pitch propellers.

27.6 Hydraulic Systems shall be provided with appropriate safety devices, alarms and indicators.

27.7 Hydraulic Systems shall reliably deliver hydraulic fluid under pressure for the actuation of hydraulically driven machinery and for the operation of remote-controlled equipment.

Rule 28. Compressed Air Systems

Functional Objective

28.1 Compressed Air Systems shall safely and efficiently provide air to equipment and systems at the required purity and pressure in all operational conditions and environments.

Performance Requirements

28.2 Compressed Air Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* as well as the following requirements.

28.3 Electrically powered air compressors for recharging breathing apparatus air cylinders shall be designed, manufactured and installed to be powered by the main and emergency electrical power sources.

28.4 Materials and equipment for compressed air systems shall be selected for safety and compatibility with the air temperatures and pressures found in the systems.

28.5 The air supply system for air compressors shall be designed to prevent contaminants from entering the compressor.

28.6 Compressed air systems shall supply air at the purity, pressure and temperature required by the equipment it serves.

28.7 Ship's general service low pressure air systems shall be provided with facilities to receive low-pressure air from shore.

28.8 Compressed air systems shall be provided with drains at appropriate locations in the system.

28.9 Compressed air systems shall be provided with relief valves or fusible plugs at appropriate locations in the system to prevent the system from exceeding maximum design pressures. Discharging air from the relief systems shall be directed to a safe location.

Rule 29. Other Compressed Gas Systems

Functional Objective

29.1 Other Compressed Gas Systems shall be safely stored and efficiently provide specified compressed gases when required to equipment and systems at the required pressure and quality.

Note: This Rule covers compressed gas systems, excluding air, and includes gases such as firefighting media, medical oxygen, technical oxygen, acetylene, and refrigerant gases, etc.

Additional rules for refrigerant gases are provided in Rule 23 *Refrigeration Systems*.

Performance Requirements

29.2 Other Compressed Gas Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* in addition to the requirements specified in this Rule.

29.3 Pressure vessels used in Other Compressed Gas Systems shall be designed, constructed and certified to operate safely in all operating conditions.

29.4 Other compressed gas storage locations and facilities shall be designed to minimise potential hazards to the ship, taking into account the specific properties of the stored gases.

Rule 30. Black and Grey Water Systems

Functional Objective

30.1 Black and Grey Water Systems shall safely and efficiently provide collection, treatment and removal at the required level of treatment in all operational conditions and environments.

Performance Requirements

30.2 Black and Grey Water Systems shall comply with the requirements of Rule 6 *Pressure and Piping Systems* as well as the following requirements.

30.3 Failure of any part of black and grey water systems or its control systems shall not result in an unsafe condition that will have a detrimental effect on the environment or safety of embarked persons.

30.4 Black and grey water systems shall be suitably sized to maintain embarked persons' habitability. System capacity shall meet the endurance requirements specified in the OSI.

30.5 Watertight Integrity (see Chapter 03 *Buoyancy and Stability*) boundaries are not to be compromised by Black and Grey Water systems.

30.6 Black and grey water systems shall comply with the requirements of Division 2 Chapter 01 *General Requirements* Rule 7 *Hazardous Areas*.

30.7 Means of access to black and grey water piping systems shall be provided to allow inspection and cleaning.

30.8 Black and grey water system discharges and vents shall be located to minimise the risk of toxic gases being drawn back into the ship and shall not pose a danger to other vessels alongside.

Rule 31. Ship's Integrated Control System

Functional Objective

31.1 The ship's Integrated Control Systems (ICS) shall provide fault tolerant control and monitoring functions of ship machinery and systems whilst maintaining the overall safety of the ship and protection of embarked persons.

Performance Requirements

31.2 The Ship's ICS shall provide control and monitoring to all mission critical, essential services and safety systems, and provide operational status of each connected system, at all Control Stations. Systems integrated to ICS shall include, but not limited to: Propulsion Systems, Manoeuvrability and Steering Systems, Damage Control Systems, Power Generation and Distribution Systems, and HVAC Systems.

31.3 The Ship's ICS shall operate machinery and systems in a safe, controlled and stable manner throughout the defined operational limits. Failure of the Ship's ICS shall not cause the loss of control to systems that could impact on the safety of embarked persons and seaworthiness of the ship.

31.4 It shall be possible to disable the local, automatic or remote control operation of machinery, equipment and systems from the ship's ICS to allow inspection, maintenance tasks and damage control to be safely performed.

31.5 The Ship's ICS shall form part of the ship's Incident Management System and provide the functionalities as required in Chapter 01 *Integrated Platform Survivability* Rule 10 *Incident Management*.

31.6 The design, construction and installation of Integrated Control Systems shall incorporate the ergonomics requirements of Division 2 Chapter 01 Rule 8 *Human Factors Engineering*.

31.7 A continuous electrical supply for the ICS shall be provided in the event of failure of primary power supplies.

31.8 An audible and visual alert shall be raised locally and at all control stations in the event of the failure of any of the power supplies to the ICS.

31.9 The Ship's ICS shall recover automatically from failure conditions. When recovering from fault conditions, the ship's ICS shall return to a predetermined safe state.

31.10 The Ship's ICS connectivity's and data storage capacity shall be sized and designed to include a growth margin in line with the ship’s margin policy required by Division 2 Chapter 01 *General Requirements* Rule 12 *Margins Management*.

31.11 The onboard Ship's ICS and the ICS' remote pier-side monitoring system (if specified by the OSI) shall comply with the cyberworthiness requirements in Division 2 Chapter 02 *Cyberworthiness*.

31.12 The Ship's ICS shall provide the facilities to conduct onboard training of the ICS operations and functions using a fully simulated environment of the ship's systems, if specified by the OSI.