Australian Government

Defence

AUSTRALIAN NAVAL CLASSIFICATION AUTHORITY MANUAL (VOLUME 2)

DIVISION 3: SHIP RULES

CHAPTER 02: STRUCTURE

PART 1: ANC RULES

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

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May 2024 Edition

ANCA Manual (Volume 2)

Division 3: Ship Rules, Chapter 02: Structure, Part 1: ANC Rules, May 2024 Edition

Developer:

Australian Naval Classification Authority

1 https://www.legislation.gov.au/Series/C1968A00063

2 https://www.legislation.gov.au/Series/C2004A04868

3 https://www.legislation.gov.au/Series/C2004A03712

4 http://drnet/AssociateSecretary/security/policy/Pages/dspf.aspx

AUSTRALIAN NAVAL CLASSIFICATION RULES

First issued	May 2024
Reissue date	N/A
Issued by	CN Dagg, CSC, AS ANCA
Document management	This volume will be reviewed periodically from the date of issue, but sooner if necessitated by business requirements, and to ensure it continues to meet the intent of Defence policy.
Availability	The latest version of this volume is only available from the Defence Australia website. Its currency cannot be guaranteed if sourced from other locations. It is available for public release.
Policy domain	Defence Seaworthiness
Accountable Officer	Australian Naval Classification Authority
Publication Owner	Defence Seaworthiness Authority (DSwA)
Policy contact	anca.communications@defence.gov.au
Structure	see Contents[5]
Cancellation	N/A
Definitions	Definitions that apply to this volume are located in the Division 1, Part 1 Annex A.

[5] https://www.defence.gov.au/business-industry/industry-governance/australian-naval-classification-authority/australian-naval-classification-rules

AMENDMENTS

Proposals for amendments to the ANCA Manual (Volume 2) may be sent to:

Australian Naval Classification Authority
Mail to: anca.correspondence@defence.gov.au

EDITIONS

Edition	Edition	Amendment type	Effective
May 2024	Original issue		May 2024

Division 3: Ship Rules
Part 1: ANC Rules

Chapter 02: Structure

Contents

Australian Naval Classification Rules

Rule 0. Goals

0.1 For the design life of the ship, the structure shall be designed, constructed and maintained to:

0.1.1 Provide weathertight and watertight integrity;

0.1.2 Permit embarked persons to carry out their duties safely;

0.1.3 Carry all foreseeable loads;

0.1.4 Protect the embarked persons and essential safety functions in the event of foreseeable emergencies and accidents, at least until the persons have reached a place of safety or the threat has receded;

0.1.5 Minimise the risk of loss of the ship; and

0.1.6 Provide the required post-damage capability.

Rule 1. General

Functional Objective

1.1 The purpose of this Rule is to outline the principles and framework of Chapter 02 *Structure*.

Purpose

1.2 Chapter 02 *Structure* is written as a *standard for the selection of standards* rather than a standard for direct application in a design office or construction/repair facility. As a consequence, the primary target audience for this Chapter is the Naval Vessel Operator (NVO).

Scope

1.3 This Chapter defines the requirements for the structure of ships. This is applicable to:

1.3.1 Hull structure and all structure required to meet the goal of this Chapter;

1.3.2 The structure when the ship is afloat, or when the ship is intentionally beached or aground; and

1.3.3 All strength related issues. Strength should not be considered as being synonymous with failure to carry load. The structure must not present a hazard in itself and may be limited by other criteria such as deflection (e.g., structural misalignment leading to premature buckling, mast deflection, etc).

Note: Some structural materials may present a hazard during manufacture, repair or when they degrade due to age.

1.4 Division 2 Chapter 01 *General Requirements* and Chapter 01 *Integrated Platform Survivability* apply to all chapters of the ANC Rules, as applicable to the design, and therefore in order to meet the Chapter 02 *Structure* goal, the requirements of both this Chapter, Chapter 01 and Division 2 Chapter 01 *General Requirements* shall be met.

Rule 2. Not Used

Rule 3. Structural Design

Functional Objective

3.1 The structural design shall be appropriate to meet the goal of this Chapter.

Performance requirements

3.2 The structure shall remain effective so that it meets the goals of this Chapter throughout the design life of the ship.

3.3 The materials selected for the design of the ship shall be appropriate for the role, function and environment.

Structural demand and capacity models

3.4 This Chapter expresses its requirements in terms of a rational philosophy, the limit state philosophy, for structural design and assessment. However, limit state methods are not mandated, and compliance with this Chapter relies upon the selection, and implementation of an appropriate standard, or coherent standards, to verify that the goals are met.

3.5 For safe operation:

$$Structural\ capacity\ \geq Structural\ demand \times Safety\ Margin_{Demand}$$

$$where: Structural\ capacity = (limit\ state)\ \times (Safety\ Margin_{Capacity})$$

3.6 For the analysis of damaged ships, it is valuable (but not obligatory), to keep the safety margins separately identified with both the capacity and demand so that the structure can be optimised against the response to non-structural threats such as manoeuvrability, speed, range and endurance.

3.7 Limit state design methods are not mandatory. Authoritative *allowable stress* methods are entirely valid and should be seen as a specific case of limit state design methods in which the partial factors of safety have been combined to a single margin against failure. Irrespective of the format, it must be possible to justify that the overall requirements expressed in these Rules are fulfilled for the ship's strength.

3.8 This Chapter requires due consideration to be given to designing damage tolerant structures. Adequate structural capacity is provided either by protecting the structure or providing alternative load paths.

Design for manufacture and repair

3.9 Consideration shall be given to the working practices and processes of the build yards, their suppliers, and their subcontractors.

Note: The design must be capable of being manufactured by the builder and repaired through the capability lifecycle, e.g. achievable dimensional tolerances or structural assembly sequence.

Design assessment – General

3.10 In addition to the normal demands that are expected for a ship of the type under consideration, all demands specified in the Operating and Support Intent (OSI) must be assessed where relevant to the structural capacity of the ship.

3.11 In determining the extent and depth to which a demand should be addressed, consideration should be given to the probability of its occurrence and the consequence if it does occur. Additionally, consideration is to be given to loads occurring in combination.

3.12 When selecting structural requirements, consideration should be given to the state of the art.

3.13 The performance requirements under this Rule are now divided into two requirements: normal operations and damage scenarios.

Design assessment – Normal Operations – natural environment

3.14 As a minimum, it is mandatory to demonstrate the structural capacity of all ships when subjected to the following demands, where specified in the OSI:

3.14.1 **Above water**: Wind, air temperatures (high and low), ice accretion, solar radiation;

3.14.2 **Sea surface**: Currents, waves, green seas, ice navigation, ship motions (including slamming); and

3.14.3 **Structural capacity:** The ship shall not suffer any structural damage. Rule 0 sub-goals 0.2 to 0.6 of this Chapter shall be fully met.

Design assessment – Normal Operations – built and man-made environment

3.15 As a minimum, it is mandatory to demonstrate the structural capacity of all ships when subjected to the following demands:

3.15.1 Anchoring, mooring and towing, beaching and grounding (where these are normal operations);

3.15.2 Docking/Slipping/Berthing, including variable functional loads where applicable;

3.15.3 Propulsion and Manoeuvring;

3.15.4 Lifting equipment/RAS rigs;

3.15.5 Flight deck loads;

3.15.6 Vehicle parking and manoeuvring;

3.15.7 Tug operations and cargo handling;

3.15.8 Human intervention, including:

3.15.8.1 **Permanent loads**: permanent weights, solid ballast;

3.15.8.2 **Variable functional loads**: from cargo, fuel and ballast, stores and equipment; and

3.15.8.3 Where applicable, loads from weapons, sensors and boarding operations.

3.16 **Structural capacity:** The ship shall not suffer any structural damage. Rule 0 sub-goals 0.2 to 0.6 of this Chapter shall be fully met.

Design assessment – Normal Operations – demands limited by structural capacity

3.17 **Structural capacity:** The ship shall not suffer any structural damage. Rule 0 sub-goals 0.2 to 0.6 of this Chapter shall be fully met.

Design assessment – Normal Operations – unquantifiable demands

3.18 Structural demands that are not practically quantifiable shall be addressed by providing adequate structural capacity, based upon proven records of satisfactory performance of a similar type of ship, in similar operating conditions.

3.19 As a minimum, it is mandatory to provide adequate structural capacity. Consideration is to be made for:

3.19.1 **Ruggedness**: cargo and equipment operations, berthing;

3.19.2 **Structural continuity**; and

3.19.3 **Environmental degradation**: corrosion, erosion.

3.20 **Structural capacity**: The ship may suffer minor structural damage. Rule 0 sub-goals 0.2 to 0.6 of this Chapter shall be fully met.

Design assessment – Normal Operations – access, layout and arrangement

3.21 The structure is to be designed so that it permits safe access by embarked persons to all areas required to undertake their normal duties in all foreseeable operating conditions, including:

3.21.1 The need for special arrangements to permit all persons (including shore-based surveyors and maintenance personnel) to undertake their duties safely is to be minimised;

3.21.2 All fixed arrangements provided for the survey of the structure are to be assessed; and

3.21.3 All fixed arrangements identified as requiring special consideration in order to satisfy the goals of other chapters of these rules shall be assessed.

3.22 Safe and practical access to the internal structure and all spaces for the purposes of inspection during the operational phase shall be ensured.

3.23 The structural capacity is to be assessed. Rule 0 sub-goals 0.2 to 0.6 of this Chapter shall be fully met.

Design assessment – Normal Operations – Disregarded demands and disregarded capacity

3.24 **Disregarded structural capacity**: The ship may be subject to demands that are so low in magnitude and/or effect that the structural capacity may be assumed without justification (e.g. machinery vibration in a heavily-built low-speed ship, movement of persons about the ship).

3.25 Structural capacity. There is no requirement to demonstrate structural capacity when subjected to disregarded demands.

Design assessment – Damage Scenarios - Foreseeable Damage

3.26 As a minimum it is mandatory to assess the structural capacity of all ships when subjected to the following demands:

3.26.1 **Foreseeable damage:** Events that should be avoided, but the possibility of their occurrence cannot be ignored in the design of the ship, including:

3.26.1.1 Navigation errors, including grounding, flooding, collision;

3.26.1.2 Fire and explosion;

3.26.1.3 Mal-operation;

3.26.1.4 Failure of a single structural member;

3.26.1.5 Emergency flight deck operations; and

3.26.1.6 Emergency towing.

3.27 **Structural capacity**: The ship may suffer structural damage from this event that requires unprogrammed remedial action. Rule 0 sub-goals 0.2 to 0.4 of this Chapter may be compromised, but sub-goals 0.1.4 to 0.1.6 shall be fully met.

Design assessment – Damage Scenarios – Extreme Threat Damage

3.28 As a minimum, it is mandatory to assess the structural capacity of all ships whose OSI includes combat operations or other exposure to extreme threat conditions when subjected to the following demands:

3.28.1 The realisation of extreme threats derived from the OSI and Division 03 Chapter 01 Integrated Platform Survivability. See also Rule 9 Military Features; and

3.28.2 Structural capacity: The ship may suffer structural damage from this event that requires unprogrammed remedial action. Rule 0 sub-goals 0.1.1 to 0.1.3 of this Chapter may be compromised, but sub-goals 0.1.4 to 0.1.6 shall be fully met.

Design assessment – All Damage Scenarios – access, layout and arrangement

3.29 The structure is to be designed so that it permits embarked persons to respond appropriately in the event of damage as safely as reasonably practicable.

3.30 All fixed arrangements identified as requiring special consideration in order to satisfy the goals of other parts of the ANC Rules shall be assessed.

3.31 The structural capacity is to be assessed. Rule 0 sub-goals 0.1.1 to 0.1.3 of this Chapter may be compromised, but sub-goals 0.1.4 to 0.1.6 shall be fully met.

Design assessment – All Damage Scenarios– Disregarded demands and disregarded capacity

3.32 **Disregarded demand**: The ship may suffer critical damage, but the safety risk for the embarked persons is minimised so far as reasonably practicable, even if the demand is disregarded. In such cases, there is no requirement to quantify the demand (though there may be a requirement to assess and document the hazard, or its credibility, under Division 2 Chapter 01 *General Requirements*.

3.33 **Structural capacity:** There is no requirement to demonstrate the structural capacity when subjected to disregarded demands.

Rule 4. Construction

Functional Objective

4.1 The quality of construction shall be consistent with the structural design requirements necessary to meet the goal of this Chapter.

Performance Requirements

Quality of materials and workmanship

4.2 The design standard will assume or require quality of construction, modification and repair. Ship structure is to be:

4.2.1 Constructed and repaired in compliance with the selected standard; and

4.2.2 Verified as having been so constructed and/or repaired.

4.3 Manufacturing organisations must be able to construct – and demonstrate they can construct – at least to:

4.3.1 Normal shipbuilding standards as defined in the industry's accepted quality standards; and

4.3.2 Where more onerous, a standard consistent with the design solution.

4.4 Standard quality of work and work processes are to be undertaken to the satisfaction of the ANC Authority, in accredited facilities, by appropriately experienced personnel.

4.5 A survey plan shall be developed for the construction phase of the ship, taking into account the ship type and design. The survey plan shall contain a set of requirements, including specifying the extent and scope of the construction survey(s) and identifying areas that need special attention during the survey(s), to ensure compliance of construction with mandatory ship construction standards.

4.6 Structural design information to support the survey, maintenance and repair of ships in service shall be maintained, including:

4.6.1 Welding/Joining records;

4.6.2 Pressure testing; and

4.6.3 Areas of deviation from design/as-built scantlings.

Rule 5. Ships in Service

Functional Objective

5.1 The ship shall be operated in a manner necessary to meet the goal of this Chapter, consistent with the design and material solutions, and with the material state of the ship continuing to meet the goal of this Chapter.

Performance Requirements

5.2 The survey, maintenance and repair philosophy to be adopted is to be considered at all stages, and any constraints imposed on the design by reason of the repair philosophy identified (e.g., if in-theatre repairs are envisaged).

5.3 **Survey**s and inspections: The ship shall be surveyed by a Competent Organisation in accordance with Division 1 Chapter 03 *Maintaining Naval Classification* and regularly inspected by the NVO between surveys. All repairs or modifications shall be undertaken to the satisfaction of the ANC Authority. Surveys and inspections are conducted for two primary reasons:

5.3.1 To ascertain that any structural degradation normal for the type of ship, and its material of construction, is identified before it gets to a stage at which the structural capacity of the ship is compromised (e.g., corrosion); and

5.3.2 To identify damages that have resulted from specific events (e.g., berthing damage) that may have gone unnoticed or unreported by the embarked persons.

Note: The scope of each successive survey and inspection should reflect the increased risk of significant structural degradation as the ship ages.

5.4 **Modification and repair**: The same standard of assurance is to be applied to work undertaken in the ships in the service phase as would be applied for new construction ships. Where defects arise because of inadequacies in design or construction, the NVO is to take action to improve the structural capacity.

Rule 6. Preservation Systems

Functional Objective

6.1 Preservation systems for the protection of structure shall be properly selected and applied, to protect the structure throughout the planned service life of such structure, taking into consideration the maintenance philosophy defined in the OSI for the same structure and overall platform.

Performance Requirements

6.2 All dedicated seawater ballast tanks and void spaces shall be coated during construction in accordance with the performance standard for protective coatings (IMO PSPC).

6.3 Coatings shall be applied and maintained in accordance with manufacturers' specifications concerning surface preparation, coating selection, application and maintenance.

6.3.1 Where coating is required to be applied, the design coating life shall be specified. The actual coating life may be longer or shorter than the design coating life, depending on the actual conditions and maintenance of the ship.

6.3.2 Coatings shall be selected as a function of the intended use of the compartment, materials and application of other corrosion prevention systems, e.g. cathodic protection or other alternatives.

6.4 Information on coating life and use of coatings shall be maintained, including:

6.4.1 Locations and/or spaces where coatings are required to be used;

6.4.2 Types of coating to be used for various spaces;

6.4.3 Required target useful life of the coating and explanation for selection; and

6.4.4 The coating performance standard to be followed (e.g., IMO PSPC).

6.5 The protective coatings selected for the ship shall be listed by the Australian Paint Approval Scheme.

Note: See Chapter 14 *Environmental Protection* for the environmental protection requirements related to protective coatings.

6.6 Coatings for potable water use shall not leach hazardous materials and shall not impart any taste or odour.

6.7 Coating systems for specialised or bolt on equipment, such as weapons systems, radomes and antennae, shall be as specified by the equipment manufacturer, provided the systems

have similar long-term performance for the coating durability and environmental conditions specified.

6.8 Where cathodic protection systems are fitted, they shall:

6.8.1 Be suitable for the intended location;

6.8.2 Be compatible with the coatings and materials of systems within their effective range; and

6.8.3 Meet the signature Rules of Chapter 01 *Integrated Platform Survivability*, where applicable to the OSI.

Rule 7. Additional Requirements for Ships with the Special Function of Bulk Fuel Carriage

Functional Objective

7.1 The structural survey of ships with the special function of bulk fuel carriage shall, as a minimum, meet requirements equivalent to those of SOLAS.

Performance Requirements

7.2 Ships with a special function of bulk fuel carriage shall be subject to an enhanced programme of survey. The scope of each successive annual, intermediate and renewal survey is to be tailored to reflect the increased risk of significant structural degradation as the ship ages and hence the increased risk of an escape of fuel from cargo spaces to the environment.

Rule 8. Provision of Operational Information

Functional Objective

8.1 Information required by the ship's crew pertaining to the structural strength of the ship shall be provided and maintained with the ship to facilitate its' safe operation in all foreseeable operating conditions.

Performance Requirements

8.2 The Commanding Officer shall be provided with information to maintain structural integrity of the ship. The content of this information shall contain, as a minimum, where applicable to the OSI:

8.2.1 Still water bending moments in hog and sag conditions;

8.2.2 Areas of operations and sea state limitations;

8.2.3 Loading and operating restrictions for bending and shear strength or other limit states;

8.2.4 Damaged structures information demonstrating ship survivability following foreseeable, extreme and extreme threat damage;

8.2.5 Ship deck loading limitations, including maximum wheel loads;

8.2.6 Details of any systems fitted to the ship to prevent degradation of structure;

8.2.7 Details of mooring arrangement;

8.2.8 Details of towing arrangement;

8.2.9 Locations and details of critical structure areas that have a high consequence in case of failure;

8.2.10 Details of known structural issues for the ship or wider class;

8.2.11 Procedures for navigating in ice or through ice, where applicable to the ship's OSI;

8.2.12 Maximum capacities of lifting points and appliances fitted;

8.2.13 Any specific procedures for operating in hot and cold weather; and

8.2.14 A set of as-built construction drawings and other plans showing any structural alterations.

Rule 9. Military Features

Functional Objective

9.1 The ship's structure and capacity shall meet the military demands specified in the OSI.

Performance Requirements

9.2 The Master Reference Plane (MRP) and centreline datum shall be defined in the design and permanently marked on the structure to enable accurate and safe combat system alignment.

9.3 Weapon foundations and their surrounding structure shall be designed to withstand the weapon's dynamic blast loads and missile efflux blast pressures without damage.

9.4 The design of the supporting structure of rapid-fire guns is to avoid resonant frequencies that may be triggered by the firing rate or recoil frequency.

9.5 Magazines shall be designed in accordance with Chapter 10 *Dangerous Goods* Rules.

9.6 Replenishment at sea systems are to be designed in accordance with Chapter 05 *Seamanship Systems* Rule 11 *Replenishment at Sea (RAS)*.

9.7 Where required by the OSI, the structure shall be designed to withstand the effect of underwater explosions in accordance with Chapter 01 *Integrated Platform Survivability*.

9.8 The shock and whipping loads on the hull structure and appendages are to be included in the structural demands of Rule 3 paragraph 3.29, and the global and detailed design shall minimise the damage to the hull structure and appendages from shock and whipping effects.

9.9 Masts are to be designed to survive loadings produced by underwater explosive and air blast loads, including retention of attached equipment and structure so they do not cause secondary damage.

9.10 Where required by the OSI, the structure shall be designed to withstand the effect of internal/external blast, in accordance with Chapter 01 *Integrated Platform Survivability*.

9.11 The maximum displacements experienced by all structures from an internal/external blast shall not compromise the structural integrity, watertight or gas-tight integrity, or functioning of critical items or equipment essential to the operation of the ship, to the extent necessary to provide the post-damage capability required by the OSI.

9.12 Where ballistic protection is required by the OSI, and in accordance with Chapter 01 *Integrated Platform Survivability*, any integration into the ship's structure shall be in accordance with the design standard selected as the solution to Rule 3.

9.13 Where fitted, the flight operations area structure shall be designed for the maximum landing loads exerted by the heaviest air system of (Australian Defence Force) ADF and Allied Forces, and required by the OSI, taking into account the dynamics of landing, tyre patch, ship motions and the capacity of the deck material. The design analysis shall confirm that the flight deck shall never be ruptured for any landing scenarios. This includes crash landing scenarios. See also Chapter 11 *Aviation Systems*.

9.14 Masts shall be designed to ensure that they provide adequate stiffness and strength for the equipment they support. The natural frequency of vibration shall be sufficiently clear of exciting hull frequencies and other exciting forces.

9.15 Structural stiffness shall be provided to satisfy the specification of defined naval systems i.e., masts, sensors, and weapons foundations.

Rule 10. Hull Marks

Functional Objective

10.1 The ship's hull shall be marked where necessary to:

10.1.1 Minimise the risk of damage to the ship during normal operations;

10.1.2 Minimise the risk of damage to vessels or personnel in the near vicinity of the ship during normal operations; and

10.1.3 Visibly identify the ship and ship condition during normal operations.

Performance Requirements

10.2 The hull shall be marked to:

10.2.1 Indicate the ship's draught and limiting draught;

Note: Draught mark requirements are given in Chapter 03 *Buoyancy and Stability*, Rule 3 *Reserve of Buoyancy*.

10.2.2 Warn of any danger to other vessels operating in the near vicinity, such as overhanging propellers, overhanging stabiliser fins, side thrusters, bulbous bows and any other protrusion or vulnerable area that may be damaged by tug and berthing operations;

10.2.3 Identify tug push points (if applicable); and

10.2.4 Identify the ship by way of pennant number and/or insignia.

10.3 The size, style and positioning of the hull marks shall be such that they are clearly legible from typical reading distances, such as from the dockside or a tug, and that they provide unambiguous information.

10.4 Where the same hull mark is needed on both sides of the vessel, the marks shall be positioned at the same longitudinal section perpendicular to the baseline of the vessel.

10.5 Where the position of hull marks could be lost due to abrasive cleaning or painting, reference marks shall be permanently fitted.

10.6 In the event of a conflict between hull marks, the ANC Authority shall be consulted for advice and approval.