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NAVAL SUBMARINE CODE: GOALS, FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS

Edition B Version 1

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

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NATO LETTER OF PROMULGATION

18 October 2022

1. The enclosed Allied Naval Engineering Publication ANEP-102, Part 1, Edition B, Version 1, NAVAL SUBMARINE CODE: GOALS, FUNCTIONAL OBJECTIVES AND PERFORMANCE REQUIREMENTS, which has been approved by the nations in the NATO NAVAL ARMAMENTS GROUP, is promulgated herewith. The recommendation of nations to use this publication is recorded in STANREC 4838.

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CHAPTER	RECORD OF RESERVATION BY NATIONS
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INTRODUCTION

The Naval Submarine Code (NSubC) provides a goal-based framework that enables naval submarines to be certified within a navy's safety management system as safe to operate. It includes processes goals, functional objectives, performance requirements for the defined technical areas which can be applied to any submarine, within the context of its operational requirements. Its development has been facilitated by the International Naval Safety Association (INSA), a group of like-minded navies and classification societies. The Code has been derived from ANEP 77, the Naval Ship Code, which provides for the safety management of naval surface ships.

Overall submarine safety is dependent on other factors, such as manning, organisation and operation, which are outside the scope of the Code and these must also be in place in order that the safety of naval personnel can be assured to be in line with a navy's safety policy.

The Code does not address environmental protection legislation that a submarine would also be expected to comply with.

To cover the various operating practices of different submarines within a navy or similar organisation, the Code is 'goal based'. This means that, in developing the Code, risks and issues that may have an impact on safety have been considered and then aggregated into high-level goals' that need to be addressed through the application of suitably justified technical standards, or by a robust engineering argument that the solution meets the safety targets of the Naval Administration. It requires that a clearly articulated Concept of Operations Statement (ConOpS) must be available, against which the relevance of the acceptance criteria chosen (the technical standards, etc.) can be validated and then the design, construction and through-life upkeep can be verified for compliance.

To satisfy the top-level goal of the Code, all of the lower-level goals, functional objectives and performance requirements need to be met. Because of its structure, the Code is very flexible in the way that certification can be achieved. Use of only parts of the Code is not recommended because many of the hazards are interdependent. Compliance with the Code should be applied throughout a vessel's lifecycle, but can be initiated at any time; either at concept or after the submarine has entered into service.

The Code may be used by any navy that wishes to apply the process to their submarines. They are strongly encouraged to join INSA in order that they have full access to the underlying philosophy and development decisions that have shaped the Code into its present arrangement and to share their experience of naval submarine safety with existing members.

Application of the Code is achieved through the use of a General Information Section and Chapters 0–XII inclusive, with Chapter I describing how a Naval Submarine Safety Certificate is issued. The General Information Section provides guidance as to how certification this is achieved overall as well as a list of Definitions and Abbreviations used in the Code.

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PART 1 GENERAL INFORMATION: USING THE NAVAL SUBMARINE CODE

Contents

1. Purpose of the Code

The Naval Submarine Code ('The Code') provides a goal-based structure against which a submarine can be certified by a Naval Administration to demonstrate that, materially, it is safe to operate in accordance with the navy's safety policy objectives. This chapter provides a detailed description of the philosophy of the Code, and guidance on how to apply it to a submarine in order to issue a Naval Submarine Safety Certificate.

The Code is derived from the Naval Ship Code (ANEP 77) in order that a navy can demonstrate that a submarine is materially safe to operate, subject to the scope of the Code itself and the operational practices implemented on board. As such, it provides a tool for the management of material safety of naval submarines.

It includes goals associated with both routine and foreseeable damage conditions associated with operations during peacetime and maritime security roles of a submarine; it excludes damages inflicted from Extreme Threat Conditions[1] or when involved in combat operations (see Figure P1-0-1). Links are contained in the Code such that a Naval Administration can extend the scope of the vessel's certification to cover these excluded areas if required.

	Peacetime Operations	Maritime Security	Combat Operations
Intended Operating Conditions	Included within the scope of the Code	Included within the scope of the Code	Not Applicable
Foreseeable Damage Conditions	Included within the scope of the Code	Included within the scope of the Code	To be defined by the Naval Administration
Extreme Threat Conditions	Not Applicable	To be defined by the Naval Administration	To be defined by the Naval Administration

Figure P1-0-1: Applicability of the Naval Submarine Code

[1] Extreme Threat Conditions and other capitalised terms are defined in Part 1 Definitions & Abbreviations

2. Limitations

The Code does not cover all aspects of a submarine but it is considered applicable to submarines with all types of propulsion plant.

It does not address aspects associated with a vessel's combat or weapon system; the competences necessary to operate a vessel safely; aspects of workplace health and safety; living conditions; manning levels; or protection of the environment. These items will need to be included as part of the wider safety (and environmental protection) management system that a navy implements as part of its safety and environment policy.

The Code assumes that the majority of persons normally embarked on a submarine are able-bodied, have a fair knowledge of the layout and have received training in safety procedures and the handling of the submarine's safety equipment.

Compliance with this Code does not replace the responsibility to comply with International Maritime Organization (IMO) conventions and other international and national treaties, conventions and regulations including the UN Convention of the Law of the Sea (UNCLOS) applied through national and international laws.

3. Management of Naval Submarine Safety

To demonstrate that the safety of a naval submarine meets agreed criteria, a number of processes need to be in place, including:

- a safety (and environmental protection) policy endorsed by the navy;
- a safety (and environmental protection) management system;
- a through-life verification process for revalidation of certification.

The Code assumes that the navy has established an appropriate safety management system and has identified a Naval Administration or similar to manage the application and implementation of the Code.

How the Code fits into this concept is shown in Figure P1-0-2.

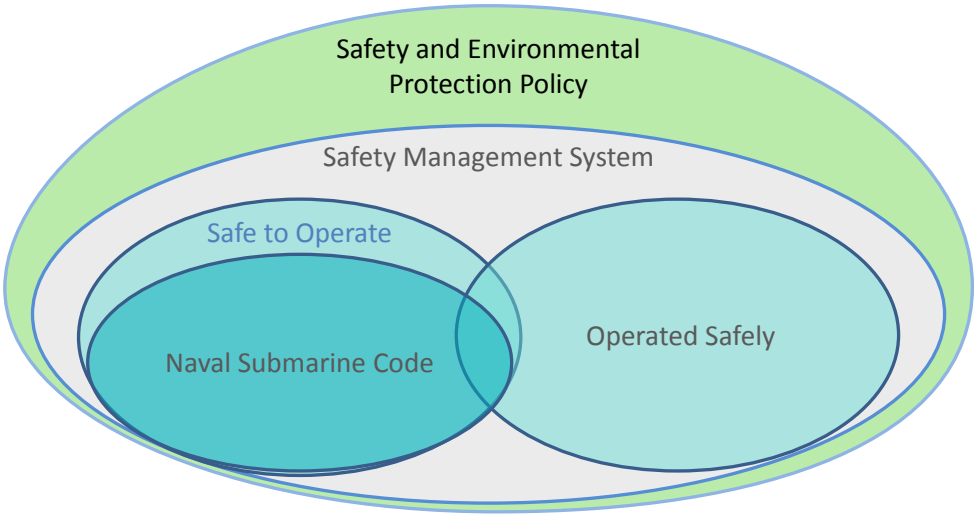

Figure P1-0-2: Relationship between elements of naval safety assurance

4. The Naval Administration

The role of the Naval Administration includes, but is not limited to:

- control of the application and implementation of the Code;
- implementation of a system for verification of the submarine's construction and equipment by adequate means of reviews, testing and inspection to confirm compliance with the Code;
- application of periodic survey arrangement(s) to ensure that compliance with the Code and its safety goal is maintained;
- implementing and maintaining procedures for the delegation, appointment and auditing of recognised organisations carrying out duties on behalf of the Naval Administration, e.g. classification societies.

The Naval Administration would be expected to be subject to the wider safety (and environmental protection) management system adopted by the navy.

5. Arrangement and Principles of the Code

Part 1 contains the Naval Submarine Code, Part 2 contains the Solutions to the Naval Submarine Code (not populated) and Part 3 contains the Justification and Guidance on the Naval Submarine Code, as shown in Figure P1-3.

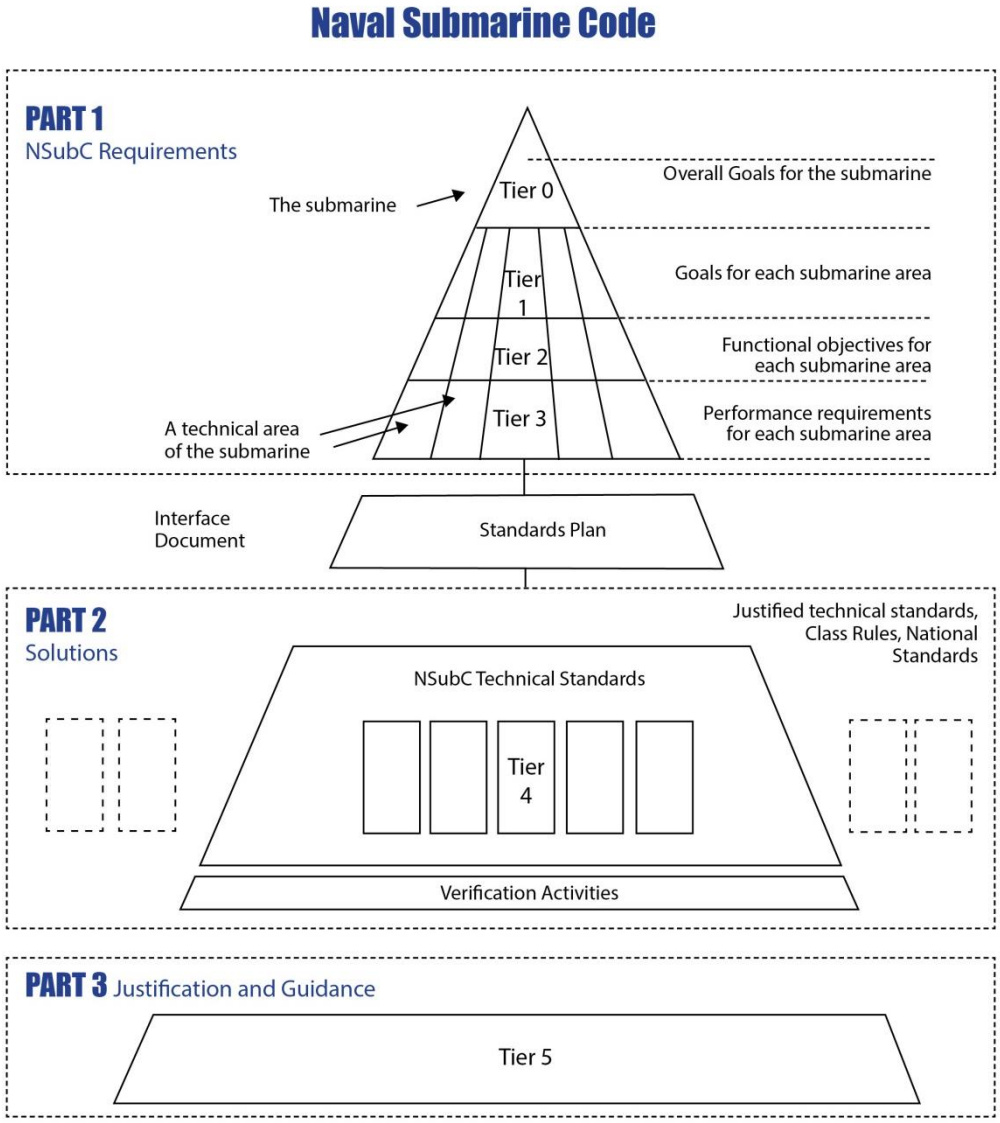

Figure P1-3: Arrangement of the Naval Submarine Code

- Part 1 is the Naval Submarine Code and specifies mandatory requirements is separated into chapters, is separated into Chapters, each addressing a specific functional area. At the highest level, an overall safety Goal for the vessel is defined in Chapter 0 (Tier 0). Each subsequent chapter then has a goal for the specific subject area, Tier 1, a set of Functional Objectives (FO's), Tier 2 and Performance Requirements (PR's), Tier 3 that in greater levels of detail, describe the issues that need to be addressed in order to meet the overall Goal of the Code. Chapter 0 of the Code provides a process by which a Naval Administration may demonstrate compliance with the remainder of the Code (Chapters I to XII inclusive).

- Part 2, Tier 4 is not populated with solutions for the Naval Submarine Code.

- Part 3, Tier 5, provides INSA guidelines and justifications on the Naval Submarine Code and is informative only.

6. Documenting Compliance with the Naval Submarine Code

To demonstrate that a submarine is compliant with the Code the following approach is to be applied:

i. A concept of operations statement (ConOpS) document, agreed with the Naval Administration, is to be developed by the operators of the submarine covering the aspects set out in Chapter 0, Regulation 3.

ii. Justification of a set of technical standards that meet the Functional Objectives and Performance Requirements of the Naval Submarine Code. This is normally described as the Standards Plan.).

iii. Agreement by the Naval Administration for each submarine project that the justified technical standards are appropriate for the basic design of the submarine and the ConOpS. Technical standards can include a variety of sources, including the INSA Solutions to the Naval Submarine Code.

iv. The design, construction, materials and equipment are certified by a competent organisation against the referenced standards to attest to the material condition of the vessel. This will include a comprehensive set of tests and trials to prove that equipment and systems function safely. This is this is termed Verification.

v. A certificate attesting to the process described above can then be issued with a defined period of validity and conditions under which the validity remains. The Certificate will demonstrate that the vessel has met the Goals, Functional Objectives and Performance Requirements of the Code and any additional criteria imposed by the Naval Administration.

vi. A Technical File for the submarine, describing the above would also be delivered as part of this process and should be available on-board the vessel to which it applies and be accessible to all stakeholders.

7. Deviations from Code Requirements

A submarine design or arrangement not conforming to a particular requirement in the Code is considered equivalent if it satisfies the requirements of higher tiers by way of compensating or alternative measures. The acceptance of an equivalent solution shall be based on an engineering analysis. A template for this is given in Part 3.

An equivalent (technical) solution will require the agreement of the Naval Administration and the Owner. Deviations from goals, functional objectives or performance requirements to justify an equivalent technical solution will require the agreement of the Naval Administration.

A Naval Administration which allows equivalent technical solutions or deviations from tiers 1–3 is encouraged to share the particulars and justification with other navies applying the Code through the International Naval Safety Association (INSA).

8. Exemptions from Code Requirements

The basis for certification against the Code is that all the relevant performance requirements are fulfilled. In some cases, the performance requirements may not be appropriate or the Naval Administration may exempt submarines from parts of the Code. In all cases, noncompliance with the Code should be justified and documented in the Standards Plan. Exemptions from Code requirements may result in the safety goal in Chapter 0 not being reached'. Where the Naval Administration allows such an exemption, it is encouraged to share the technical justifications and reasons with other Naval Administrations for their information.

PART 1 GENERAL INFORMATION DEFINITIONS AND ABBREVIATIONS

Term	Definition	Source Chapter
abandonment	Leaving a severely damaged and/or sinking surfaced submarine.	VII
accident	Defined as an identifiable event or series of events which can be foreseen but which is unexpected.	III
accommodation spaces	Crew spaces such as corridors, heads and bathrooms, cabins, offices, mess decks, hospitals, pantries containing no cooking appliances and similar spaces.	VII
activation	The intended use of a dangerous good (Class 1).	X
afloat	For the waterline not to exceed the submergence limit.	III
agreed	Documented confirmation between the owner, the designer and the Naval Administration.	I
agreed standard	The standard selected by the owner and agreed by the Naval Administration, compliance with which will be deemed to meet the requirements of this Code.	II
alarm	A means of providing information to the operator that a parameter has deviated from a norm by a defined amount, has reached a safety-critical level and requires instant response.	VI, VII
ALARP	As low as reasonably practicable.	IV, VI, XII
alert system	A means of providing information to the operator that a parameter has deviated from a norm by a defined amount.	IV
ammunition spaces	*See* dangerous goods stowage areas.	VI
anchoring and mooring equipment	Fixed and non-fixed devices to hold a submarine in position such as anchors, windlasses, bollards, fairleads, chains and mooring ropes.	V
anniversary date	The day and the month of each year which will correspond to the date of expiry of the relevant certificate.	I
anti-exposure suit	Protective suit for use by rescue crews and crew who work on the casing.	VII
approved	Approved by the Naval Administration and/or a recognised organisation.	I
approved type	A device that is approved by the Naval Administration.	I
atmospheric contaminant	Any substance contained in the enclosed atmosphere of the submarine which is not a life gas. Atmospheric contaminants may take any form, typically as gases, vapours, particulates or aerosols. They may also coexist, for example particles may contain within their structure adsorbed chemicals.	XII
bridge	Small observation area on top of the fin/conning tower.	IX
bridge navigational watch alarm system (BNWAS)	An automatic system which sounds an alarm if the watch officer on the bridge of a submarine falls asleep, becomes otherwise incapacitated or is absent for too long.	IX
broaching	When the submarine breaks through the surface as an unwanted event.	III
Building Block (cyber)	Sub-systems, hardware or software that are an integral part of a defined system	I
built-in breathing system (BIBS)	*See* emergency breathing system (EBS).	VI
capsize	Roll, heel or list to the point of angle of vanishing stability.	III
carriage and use/carriage or use	All activity associated with the stowage, handling, movement, transport, transfer, preparation and activation of dangerous goods under normal and fault conditions. Note: 'Use' is assumed to include any activity involving the dangerous goods for any purpose other than to transfer it.	X
CASEVAC	Casualty evacuation.	VII

Term	Definition	Source Chapter
casing	A structure that is built up and over the upper surface of the pressure hull of a submarine.	V, VII
casualty	A person killed or injured in or on the submarine.	VI, VII
casualty potential	The number of people that can be injured as the result of a fire or the release of fire extinguishing media.	VI
casualty threshold	The casualty threshold, in the context of a fire, includes: • loss of the space of origin up to the nearest 'A' class boundaries, which may be a part of the space of origin if the space of origin is protected by a fixed fire-extinguishing system; • loss of the space of origin and adjacent spaces up to the nearest 'A' class boundaries, which are not part of the space of origin.	VI
catastrophic failure	Failure which diminishes to below an acceptable level the proper operation of any escape, evacuation and rescue measure.	VII
CBRN	Chemical, biological, radiological and nuclear (also known as NBC).	VI
classification	Compliance with the regulations of the classification society throughout the life of the submarine.	I
classification of dangerous goods (*see also* dangerous goods)	As defined in the UN Recommendations on the Transport of Dangerous Goods – Model Regulations.	X
closure	A device for ensuring an opening in a watertight structure can be closed watertight.	III
the Code	The regulations and guidance contained in this document.	Intro
COLREGs	International Regulations for Preventing Collisions at Sea.	V
combustible material	Any material other than a non-combustible material.	VI
communications equipment	All communications equipment, whether portable or fixed.	VIII
compartment	A subdivided volume within the pressure hull of the submarine which separates different functional areas. Compartments may be required to be fitted with fire detection and extinguishing appliances and, depending upon their use and the use of adjoining compartments, provide a degree of structural fire protection between adjacent compartments. If determined by the Naval Administration, compartments may also be built smoke and/or gastight.	II
compatibility	Defined in the UN Recommendations on the Transport of Dangerous Goods – Model Regulations.	
complex electronic component	Refers to software and hardware. A complex electronic component is generally part of a larger system, but there may be cases where the entire technological system is composed of complex electronic components. Complex electronic components include, but are not limited to: • all forms of electronically executed algorithm(s) and associated data (such as configuration data, digital maps, look-up tables); • bespoke software, including both embedded and computer-platform-type elements; • databases, spreadsheets and other data; • firmware, including all forms of programmable logic and associated data; • COTS software and other legacy software elements that would fall into one of the above categories if they were being used in the development of a project; • bespoke hardware and hardware that is modifiable after manufacture; • COTS hardware (including processors and computer-platform hardware) and custom-manufactured hardware, including application-specific integrated circuits.	IV

Term	Definition	Source Chapter
condition of certification	A notice (from the Naval Administration or its recognised organisation) to the submarine owner advising of a non-compliance with the relevant rules, standards, criteria or convention which requires permanent rectification but does not need to be addressed immediately. Note: A due date is always to be associated with a condition of certification. Failure to complete permanent rectification of a condition of certification by the due date will invalidate the certificate.	I
condition of classification	A condition of classification is imposed on a submarine where: • the validity time of the class certificate, including the time window, is expired; • any of the regular surveys shows essential non-conformance with class rules.	I
conning position	A location where personnel can direct the manoeuvring of the submarine.	IX
conning tower	A raised, enclosed observation post, often being a means of entrance to the interior; *see also* fin, bridge.	V, VI, VII
ConOpS	Concept of Operations Statement	I
consumable polygon	Graphically presents all anticipated departures in deadweight mass and longitudinal moment from the reference loading condition, for all foreseeable operating conditions; *see also* tank polygon, trim polygon.	II, III
control room	The main area where command and control of the submarine is exercised.	I
control station	A location from where the machinery or equipment can be operated or from which operations can be directed; *see also* control room.	I
crew members	*See* embarked persons.	I
damage	Damage is an abnormal state that has resulted in physical harm to a submarine or its systems. Note: Part 1, Chapter I, Regulation 1a, paragraph 1a.4, and for foreseeable operating conditions and extreme threat conditions, for the purposes of this Code: **foreseeable damage**: Damage that can be foreseen for the type of submarine. Foreseeable damage includes damage that could be caused by one's own materials or weapons, navigational hazards (collision, grounding), naval exercises (certain types of navigational exercise, replenishment at sea, etc.), system failures, mal operation and some types of terrorist attack. **extreme threat damage:** Damage that may result under extreme threat conditions. Note: Extreme threat damage includes damage that could be caused by extreme weather conditions, weapon attacks and extreme acts of aggression.	I
dangerous goods (*see also* classification of dangerous goods)	Dangerous goods are substances, mixtures or articles that because of their physical, chemical (physico-chemical) or acute toxicity properties present an immediate hazard to people, property or the environment. An alternative term within some navies is 'dangerous materiel'. Materiel is defined in NATO AECTP-100 Environmental Guidelines for Defence Materiel as 'A generic term covering military systems, sub-systems, equipment, supplies and associated packaging'.	VI, X
dangerous goods incident	A dangerous goods incident includes: • any accident – an occurrence involving dangerous goods that results in or contributes to personal injury or death, material losses or damage to the environment;	X

Term	Definition	Source Chapter
	• any unintended event or action that affects the inherent safety of the dangerous goods; • a near miss – any unintended event or action that could have affected the inherent safety of the dangerous goods; • the theft or loss of dangerous goods; • the failure of dangerous goods or their system to function in their intended manner.	
dangerous goods preparation area	A part of the submarine where dangerous goods are worked on and during such activity the safety risk is modified compared to the level of risk associated with stowage of the item.	X
safety management system (for dangerous goods)	This relates to the submarine arrangements and supporting body of evidence that demonstrates that the risks associated with the dangerous goods are managed to an acceptable level.	X
dangerous goods stowage area	A designated part of the submarine specifically designed, assessed and operated for the stowage of dangerous goods.	X
datum	Any numerical or geometrical quantity or set of such quantities which may serve as reference or base for other quantities. For SAR purposes, a geographic point, line or area used as a reference in submarine search planning.	VII
datum area	Area where it is estimated that the search object is most likely to be located.	VII
depth-dependent system test pressure	Systems subject to deep-diving depth pressure (DDDP) in normal operation and hull and back-up valves which may be required to hold against DDDP are tested to a pressure equivalent to, or slightly greater than, that at the minimum collapse depth of the submarine hull.	IV
depth below keel	The distance between the keel and the seabed.	I
design life	The nominal period that the submarine is assumed to be exposed to operating and/or environmental conditions and/or the corrosive environment, which is used for selecting appropriate submarine design parameters. The submarine's actual service life may be longer or shorter depending on the actual operating conditions and maintenance of the submarine throughout its lifecycle.	II
designer	The organisation charged with responsibility for designing the submarine.	I
distress	Any operational situation that constitutes a requirement for assistance to be rendered or provided.	III, VII, VIII, IX
distressed submarine (DISSUB)	A submarine in distress on the seabed and unable to surface. It may also include a surfaced submarine requiring assistance following an incident.	VII, XII
disturbance	Any event (internal or external to the submarine) that has the potential to change the equilibrium state of the submarine, including but not limited to: environment (wind, waves, ice build-up, navigational obstructions), cargo, towing, lifting, crowding, turning, conditions of no or reduced load (lightship, minimum operating condition), entrained water, loss of watertight integrity and collision not causing loss of watertight integrity (such as grounding or use of tug boats).	III

Term	Definition	Source Chapter
diving depth	All diving depths are measured in [m] and are related to a standard datum, normally the lower edge of the pressure hull or keel. **collapse diving depth**: The diving depth decisive for the design of the pressure hull, where a collapse of the pressure hull is to be expected. **deep diving depth (DDD)/operational diving depth**: The maximum water depth for which the submarine is allowed to operate within the safe operating envelope. **minimum collapse depth (MCD)**: The depth at which the submarine has an acceptably small probability of failure, taking into account all uncertainties associated with the strength of the structure. **safety depth**: The minimum depth at which the submarine operates without risk of collision with a large draught surface ship or any floating installation (typically 30–40 metres). **test diving depth**: The water depth not exceeding minimum collapse depth to which the submarine is designed to be tested after completion of construction and/or after major repairs or modifications; may be used to relieve, reduce and redistribute internal stresses due to fabrication or modification of the structure.	II
due date	*See* condition of certification.	I
duty holder	*See* owner.	I
electrical items (related to dangerous goods)	Electrical items shall be taken to include electrical installations and equipment, where 'installations' refers to permanent or fixed items within the dangerous goods area and 'equipment' refers to portable or non-permanent items taken into a dangerous goods area.	X
embarkation station	Location on board from which embarked persons can safely evacuate into survival craft. These locations may not be designated for evacuation purposes only.	V
embarked persons	Embarked persons shall fall into one of two categories: • Crew members. These are persons carried on board the submarine to provide navigation and maintenance of the submarine, operation and maintenance of its machinery and systems (including weapon and radio-communication systems), and arrangements essential for propulsion and safe navigation, or to provide services for other embarked persons. Crew members are expected to be well-disciplined and able-bodied, and to have an excellent knowledge of the layout of the submarine and its safety equipment. • Non-crew. This includes special personnel, wounded personnel and passengers for whom permanent accommodation is provided on board: - Special personnel. Persons who are not members of the crew and who are carried on board in connection with the special purpose of the submarine or the special work being carried out aboard the submarine. Special personnel (which may include scientific staff, embarked forces, trials personnel and equipment engineers, surveyors and persons under training) are expected to be fit and well-disciplined and have a fair knowledge of the layout of the submarine and its safety equipment; - Other persons. Persons embarked who are not employed or engaged in any capacity on board the submarine and who do not fall into any of the other categories. Passengers and other embarked persons	I

Term	Definition	Source Chapter
	may include visiting dignitaries and families. If they are embarked, they shall have a basic knowledge of the submarine and its safety procedures. Note: Unless specifically stated otherwise, this Code makes no specific provision for passengers and other embarked persons, and it is the responsibility of the Naval Administration to determine the need for such provision and be satisfied that the arrangements are adequate.	
emergency	A serious, unexpected and often dangerous situation requiring immediate action.	I
emergency breathing system	A fixed system for the distribution of safe breathable air to some or all compartments of the submarine. The system comprises a means of storing safe, breathable air; distribution pipes; valves; reducing stations; quick-release connection points in the nominated compartments; and masks or other breathing apparatus for embarked persons, which can be connected to the system by an airtight, quick-release coupling allowing the user to breathe air from a safe source.	VI, VII
emergency escape breathing devices (EEBD)	EEBDs are provided to enable embarked persons in a casualty compartment to have a safe supply of breathable air to breathe while they escape to a place of relative safety where they can access the submarine's supply of safe, breathable air or fresh air.	XII
emergency life support stores (ELSS)	Items of stores for use by the personnel in the DISSUB to enable them to survive while awaiting rescue. Stores include such items as carbon dioxide absorbent, oxygen candles and medical stores for emergency treatment of casualties. The ELSS are pre-stored on board the submarine and may be resupplied to the DISSUB by pod posting.	VII
emergency operation	A machine or system has suffered a failure and functionality is reduced to the minimum level required to maintain the safety of the system or submarine.	IV
enclosed volume of the submarine	The volume contained by the pressure hull of the submarine including all towers, chambers or shelters which may be entered while the submarine is submerged in any condition. Note that since submarines have restricted openings, atmospheric conditions shall be monitored during periods alongside for maintenance, repair, training or exercise to ensure safety to life.	VII, XII
engineering systems	Machinery and its associated control, auxiliaries and support systems, including electrical generation, distribution, lighting and other electrical services.	IV
environmental conditions	The environmental conditions in which the naval submarine is expected to operate. This covers the external environment (from sea state, temperature, humidity, wind, precipitation, ice through to airborne particles, wildlife and land mass) and the internal environment (temperature, humidity, submarine motion, noise, etc.).	
environmental data	Data relating to the environment in which the submarine is or expects to operate including, but not limited to, meteorological, oceanographic and electromagnetic signal propagation.	IX
escape	The emergency movement of personnel in a submerged DISSUB to the surface.	VII
escape compartment	A pressure-resisting, watertight and gastight space, for which the intended purpose is refuge by the crew during the survival time of a distressed submarine.	VII
escape route	A designated route ultimately leading from a compartment to the escape compartment.	VII
essential safety functions	Essential safety functions include propulsion, machinery control, manoeuvring (steering and diving gear, etc.), electrical installations, anchoring (including mooring and embarkation arrangements), fire	I

Term	Definition	Source Chapter
	prevention, detection and extinguishing systems, escape and rescue, communication of the surfaced and submerged submarine, navigation, watertight closing devices (including doors, hatches, vents, gates, sea chests and their actuating systems), atmosphere control and other services to ensure functions that safeguard life in both foreseeable operating conditions and extreme threat conditions and systems supporting safe areas; *see* Chapter VI, Regulation 10.	
essential systems	System(s) essential to the survival of the submarine and its crew. The Naval Administration shall be consulted for further guidance.	IV
evacuation	The movement of persons to a place of relative safety on board the submarine following an emergency.	VII
exception	Refers to an action that is not part of ordinary operations or standards.	I
exemption certificate	A certificate which exempts the submarine from (parts of) the Code.	I
exostructure	The external structure, supports and fixtures outside the pressure hull, such as external tanks, casing, fin and appendages, which protect equipment, improve seamanship and provide hydromechanic performance. The structure does not significantly contribute to the pressure hull structure.	II, IV, VI
external communication system	Includes all Global Maritime Distress and Safety Systems, flares, radios, transponders, daylight signalling lamp, etc.	VII
external subdivision	An enclosed watertight compartment outside of the pressure hull which is not free-flooding (including but not limited to MBTs, fuel tanks).	II
extreme event	An event beyond foreseeable operating conditions.	I
extreme threat conditions	Abnormal operating conditions resulting from the deliberate exposure of a naval submarine to extreme natural events or extreme hostile acts deliberately created by other persons.	I
fail safe	Fail to the least hazardous or known state to prevent further damage to the equipment, platform or personnel.	IV
fin	An appendage extending from the casing of the submarine, usually housing the conning tower and masts, etc.	II, IX
fire load	The fire load in an area is the added mass of each type of material present in the area and its specified heating value.	VI
fire-resisting division	A division formed by bulkheads and decks which complies with the following: • It shall be constructed of non-combustible or fire-restricting materials which by insulation or inherent fire-resisting properties satisfy the requirements of this Code. • It shall be suitably stiffened. • It shall be so constructed as to be capable of preventing the passage of smoke and flame up to the end of the appropriate fire-protection time. • Where required it shall maintain load-carrying capabilities up to the end of the appropriate fire-protection time. • It shall have thermal properties such that the average temperature on the unexposed side will not rise more than 140°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature during the appropriate fire-protection time. • A test of a prototype bulkhead or deck to the satisfaction of the Naval Administration in accordance with the FTP Code or other standard agreed by the Naval Administration shall be required to ensure that it meets the above requirements.	VI

Term	Definition	Source Chapter
Fire Safety Systems Code	The International Code for Fire Safety Systems, as amended, as adopted by the International Maritime Organisation.	VI
fire zone	A fire zone is defined as an enclosed, limited area where fire-extinguishing agent and smoke will be retained for a specified time period before they can spread to any adjacent compartments.	IV, VI
fixtures and fittings on escape routes	Doors, hatches, stairways, ladders, scuttles, panels, handrails, etc.	VII
flag state administration	The administration as defined in the Annex to the IMO SOLAS Convention.	I
flammable liquid	A flammable liquid or mixtures of liquids that contain solids in solution or suspension which give off a flammable vapour. It includes IMDG Class 3 Flammable Liquids and Combustible Liquids in accordance with Section 1.7 of NFPA 30. Flammable liquids include the following: • oil fuel; • lube oil; • low-flashpoint fuel; • other flammable liquids. Fuels for military use are specified in STANAG 1135.	VI
flashpoint	The temperature in degrees Celsius (closed-cup test) at which a product will give off enough flammable vapour to be ignited, as determined by an approved flashpoint apparatus. The term 'low flashpoint' refers to a flashpoint of less than 60˚C. The flashpoints of common NATO fuels are given in STANAG 1135 Interchangeability of Fuels, Lubricants and Associated Products Used by Armed Forces of the North Atlantic Treaty Nations, Edition 5. The flashpoint of other common products is defined in the IMDG Code.	I
foreseeable damage	*See* damage.	I
foreseeable operating conditions	Conditions in which the submarine can be foreseen to operate in an intact, degraded, aged and/or damaged state, normally defined in the Concept of Operations Statement. Subject to Naval Administration approval, foreseeable operating conditions will generally also be limited by the conscious imposition of environmental or other operating restrictions (e.g. a sea state/speed restriction, a restriction on navigating sea ice, limiting the number of persons that may be embarked, specification of the submarine's life, reversionary modes, etc.).	I
formal safety assessment	A rational and systematic process for assessing the risks associated with shipping activity and for evaluating the costs and benefits of IMO's options for reducing these risks.	Intro
freeboard	The minimum distance from the edge of the casing to the maximum depth of submergence of the intact submarine.	III
galleys	Enclosed spaces containing cooking facilities with exposed heating surfaces, or which have any cooking or heating appliances each having a power of more than 5 kW.	VI
general emergency alarm system	An alarm which is used to notify all embarked persons of an emergency incident.	VII
geo	Of, or relating to the Earth	IX
geospatial	Pertaining to the location and characteristics of natural or constructed features and boundaries on, above or below the Earth's surface; especially referring to data that is geographic and spatial in nature.	IX
Global Maritime Distress and Safety System (GMDSS)	An internationally agreed set of safety procedures, types of equipment, and communication protocols used to increase safety and make it easier to rescue distressed ships, boats and aircraft. In this particular case this recognises the requirement for redefined equipment and communications capability for submarine fits, to enable the reception and communication of distress radio traffic.	VIII

Term	Definition	Source Chapter
green seas	Wash and waves that break over the casing and exposed submarine parts.	III
guard book	A guard book is a collection of rules, regulations and operating procedures for the crew of a DISSUB. The book is issued by the Naval Administration for a given class of submarine or an individual submarine. In the event of a DISSUB, the guard book provides guidance to embarked persons on how to assess, monitor and control the situation and how to plan for escape or rescue.	VII
handling	The manipulation of an item and the associated equipment to enable safe movement, transport or transfer.	X
hazardous area	Any space that represents a risk to personnel or platform. This could be as a result of, but is not limited to, the following: • flammable atmospheres, including dust laden atmospheres; • areas that contain electrical and electronic equipment; • confined spaces or spaces where oxygen content may be depleted; • gas storage rooms; • areas of high noise level; • areas with equipment that may move unexpectedly; • refrigeration spaces; • cleaning or chemical stores • areas with radiation hazards (including sonar dome spaces, antennas etc.); • all areas where dangerous goods are stowed, handled, maintained or used.	IV
high-pressure air system (HP air)	A system comprising of highly pressurised air, roughly 270 Bar, which contains enough capacity for essential and non-essential systems. Essential systems have their own independent supply.	IV
inherent safety	The ability of an item to retain its safety under specified accidental or intended stimuli due to its design, safety features and goods employed as an inseparable part of its system.	X
INSA	International Naval Safety Association.	I
in service	A submarine is in service at all times after delivery unless: • it is in for repairs or lay-up (either at anchor or in port); • it is in for conversion; • it is declared not in service by the Naval Administration.	I
inspection	The examination of a submarine, equipment or system to ascertain compliance or otherwise against a defined specification, standard or drawing.	I
inspection and maintenance	All measures for the preservation and/or restoration of the original conditions of the technical elements of a system as well as measures for the determination and evaluation of the actual conditions.	I
integrated bridge system (IBS)	A combination of systems which are interconnected in order to allow centralised access to sensor information or command/control from workstations, with the aim of increasing safe and efficient submarine management by suitably qualified personnel.	IX
integrated navigation bridge system (INBS)	An IBS that incorporates INS functionality.	IX
integrated navigation system (INS)	A composite navigation system which performs, at least, collision avoidance and route monitoring, thus providing 'added value' for the operator to plan, monitor and safely navigate the progress of the submarine.	IX
integrity	Capability of a system to satisfactorily perform the required functions under all the stated conditions within a stated period of time.	IV
internal communications	All communications equipment (including broadcasts and alarms) that enable the internal transfer of voice or other audio communications.	VIII

Term	Definition	Source Chapter
internal subdivision	An enclosed, watertight compartment into which the pressure hull of the submarine is divided so as to preserve the maximum amount of buoyancy following damage consistent with the convenient working of the submarine. Bulkheads providing internal subdivision are: • watertight up to the pressure defined by the Naval Administration; • able to provide structural fire protection; • smoke tight; • gas tight if so determined by the Naval Administration.	III
international voyage	A voyage from a country to a port outside of said country, or the converse. It also includes any voyage that takes the vessel outside of its own country's territorial waters.	I
isolation	The disconnection, separation and dissipation of every source of energy from the equipment in such a way that this disconnection and separation is secure.	IV
justification	The process of validation of solutions against performance requirements, functional objectives and goals. It is required for Code solutions and external solutions such as classification society rules in Tier 4. Justification is normally undertaken against the adjacent tier, for example Tier 4 against Tier 3 and Tier 3 against Tier 2 etc. Part 3 Chapter 1 provides guidance on the process to be followed. *See also* validation, verification.	I
ladders	In accordance with ANEP 26 Ergonomic Data for Shipboard Space Design in NATO Surface Ships, Edition 1, acceptance angles for ladders are 75°–90°.	VII
launching arrangements	The launching station and its equipment.	VII
launching equipment	Equipment designated for transferring survival, life and rescue craft from its stowed position safely to the water and from the water to the stowed position.	V, VII
lay up	Submarine removed from operational life and which is kept following a decision to either bring back into operation of disposal.	I
life gases	Those gases which are necessary to support human life or products of respiration.	XII
lifting and hoisting appliance	Fixed or non-fixed equipment used to lift a mass from a horizontal surface. This includes loose gear such as strops, ropes, slings, hooks, D-rings etc.	V
lifting appliance	Fixed or non-fixed equipment used to lift a mass from a horizontal surface. This includes loose gear such as strops, ropes, slings, hooks, D-rings etc.	IV
lower explosive limit (LEL)	The lowest concentration of vapours from a flammable material that can cause an explosion. A concentration below LEL is defined as ‘too lean’.	XII
low flashpoint	The temperature in degrees Celsius (closed cup test) at which a product will give off enough flammable vapour to be ignited, as determined by an approved flashpoint apparatus. The term ‘low flashpoint’ is a flashpoint of less than 60˚C. The flashpoints of common NATO fuels are given in STANAG 1135 Interchangeability of Fuels, Lubricants and Associated Products Used by Armed Forces of the North Atlantic Treaty Nations, Edition 5. The flashpoint of other common products is defined in the IMDG Code.	VI
low flame-spread	Where the surface adequately restricts the spread of flame, this being determined in accordance with the FTP Code or other standards agreed by the Naval Administration.	VI
LSA Code	IMO Resolution MSC.48(66) International Life-Saving Appliance Code.	VIII
lube oil	Petroleum fractions, vegetable oils or synthetic liquids with a flashpoint greater than 60°C used for the lubrication of machinery onboard.	VI

Term	Definition	Source Chapter
machinery control position	An area or areas within the machinery spaces from which the propulsion and manoeuvring machinery may be directly monitored and controlled.	IV
machinery control room	An area or room, other than the navigation area, from where the propulsion and manoeuvring machinery may be remotely monitored and controlled.	I
machinery spaces	Machinery spaces and other spaces containing propulsion machinery, internal combustion engines, generators and major electrical machinery, refrigerating ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces. Also included are spaces with steering and diving systems, spaces with diving equipment, compressors and other spaces containing hydraulic power equipment which use flammable hydraulic fluids.	IV
main broadcast system	A system that permits one-way verbal communication to all embarked persons, known in merchant shipping as a public address system. Where in any referenced IMO documents the term 'public address system' is used, it shall be read to mean 'main broadcast system' for the purpose of the Code.	VII
main dimensions	The main dimensions of a submarine are to be measured in [m] and are to be defined as follows: **draught:** In surfaced condition this is the maximum vertical distance between the underside of the keel and the water surface. **displacement:** The displacement is measured in tonnes: • The displacement of the surfaced submarine ready for surfaced operation is the surfaced displacement. • The displacement of the fully submerged submarine with fully lowered periscopes, masts and snorkels is the submerged displacement.	II, III
main electrical services	All electrical loads required for maintaining the operational status of the submarine and habitable crew conditions.	IV
mal operation	The faulty or incorrect operation of a device, process or system.	I
manned spaces	Spaces on the submarine that persons would frequently occupy.	I
manoeuvring equipment	Includes the use of conventional electric and electro-hydraulic steering gear and hydroplanes as well as, but not limited to, Azimuthing Thrusters, Athwartships thrusters, water jets and propulsion machinery in the case of submarines fitted with more than one shaft.	IV
maritime safety information	Navigational and meteorological warnings, meteorological forecasts and other urgent, safety-related messages broadcast to ships.	VIII
material	A generic term covering military systems, subsystems, equipment, supplies and associated packaging.	X
material state	The condition of all structures, systems and equipment.	I
memorandum item	A record within the survey records of the ship which documents either: • an unusual feature which should be noted for future reference; • that there is a non-compliance with the relevant rules, standards, criteria or convention but the arrangement has been justified as fully equivalent to the intent of the standard in accordance with Part 1, Chapter I, Regulation 7.	I
movement	To change the location or orientation of an item within a dedicated space.	X
muster station	An area of relative safety where embarked persons can be gathered in the event of an emergency and prepared for evacuation. Muster stations may coincide with evacuation stations and are also known as emergency or assembly stations.	VII
Naval Administration	The department of government of the state responsible for providing safety regulation for naval submarines. The Naval Administration may be assisted or supported by other government departments or agencies	I

Term	Definition	Source Chapter
	who, by mutual agreement of the Naval Administration and the department or agency concerned, have agreed to enact this Code for specified submarines of that department or agency.	
navigation	The process of planning, recording and controlling the movement of a vessel from berth to berth, including operations and evolutions undertaken during the voyage.	IX
navigation area	The navigation area is defined as the areas in the submarine from which navigational control is exercised when the submarine is under way. These areas will depend upon the size, type and intended use of the submarine and will include the control room, bridge or conning position on the fin, periscope watchkeeping position, or any other platform, deck, compartment or part of the submarine which may be used for, or contributes to, the conduct of safe navigation, whether dived or surfaced.	IX
navigation system	Systems, equipment and aids used to assist in navigation.	IX
NBC	*See* CBRN.	VI
neutrally buoyant	A state of hydrostatic equilibrium in which the weight of the submarine is equal to the buoyancy.	III
non-destructive examination	*See* non-destructive testing.	II
non-destructive testing	A range of analysis techniques used to evaluate the properties of a material, component or system without causing damage.	II
non-combustible material	Material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750°C, this being determined in accordance with the FTP Code or other standard agreed by the Naval Administration.	VI
non-crew	*See* embarked persons.	I
normal operation	Full functionality of the machinery or system is available.	IV
novel arrangements	Any piece of equipment or system with an unconventional design, construction, installation or operation, as agreed with the Naval Administration.	IV
Officer of the Watch (OOW)	A person who, for the time being, has been delegated responsibility for the conduct of safe navigation and conning (manoeuvring) the submarine.	IX
oil fuel	Liquid petroleum product with a flashpoint greater than 60°C (closed cup) that is carried on board and used for the role of the submarine e.g. propulsion or power generation.	VI
on-board documentation	Posters, plans and other guidance information on any escape, evacuation and rescue measures.	VII
on-board two-way communication system	System providing two-way verbal transmission; may include fixed or portable system or a combination of both.	VII
operator	An individual utilising, programming, manipulating or deriving information from a system or equipment.	I
organisations	**designer:** The organisation charged with responsibility for designing the submarine. **duty holder:** The organisation charged as the authority with responsibility for complying with safety policy relevant to the vessel; normally a part of the Ministry of Defence (or equivalent). Note that this responsibility may be delegated to a number of organisations, in which case a nominated lead is to be identified with responsibility for compliance changes during the service life of a vessel. **Naval Administration:** The department of government of the state responsible for providing safety regulation for naval submarines. The Naval Administration may be assisted or supported by other	Intro, I, II

Term	Definition	Source Chapter
	government departments or agencies who, by mutual agreement of the Naval Administration and the department or agency concerned, have agreed to enact this Code for specified submarines of that department or agency. **flag state administration:** The administration as defined in the Annex to the IMO SOLAS Convention. **owner:** This is normally the nominated government of the state or may be an industry supplier. They are (from an accounting perspective), the 'beneficial owner'. They are ultimately responsible for the safety policy of the vessel, but are likely to have both delegated and made responsible the duty holder for compliance with the policy. **recognised organisation:** An organisation authorised to undertake certain activities on behalf of the Naval Administration.	
other flammable liquids	Petroleum fractions, vegetable oils or synthetic liquids carried on board and used for the role of the submarine. This includes hydraulic oil, medical spirits, seed oil, paints and cooking oils.	VI
out-of-circularity	A measure of shape imperfection based on the deviation between the as-built structure and an idealised axisymmetric constant radius cross section as appropriate for the design solution methodology.	II
passengers and other embarked persons	*See* embarked persons.	I
personal thermal protection suits	Suits that are designed to prevent hypothermia and/or cold shock, i.e., immersion suits, anti-exposure suits.	VII
personnel spaces	Spaces such as corridors, heads and bathrooms, cabins, offices, mess decks, hospitals.	VI
plan appraisal	Technical review of the platform design plans and related documents to verify compliance with the rules or standards to which the submarine or system has been designed. The responsibility for undertaking plan appraisal activity lies with the Naval Administration or its recognised organisation.	I
planned maintenance system	A paper and/or software-based system which allows submarine owners or operators to carry out maintenance at intervals according to manufacturers and relevant rules and regulations.	I
pod posting	The function of delivering ELSS to the DISSUB; this is normally by pressure-tight pods 'posted' via escape towers by divers or other rescue assets.	VII
portable lighting	Non-fixed, portable lighting which may be used to support other lighting systems.	IV
personal protective equipment (PPE)	Protective equipment that may be worn and/or carried e.g. fireman outfit, firefighting equipment, EEBDs, life jackets, thermal protection aid or anti-exposure suit.	VI, VII
preparation	The modification of an item that affects its inherent safety parameters.	X
prescriptive requirements	The construction characteristics, limiting dimensions, or specific systems, specified in the Code and in standards.	I
pressure hull	The main element of the submarine, which accommodates embarked persons, machinery and systems at atmospheric pressure and resists the diving pressures and other defined loads.	II, III, IV, V, VI, VII, X, XII
pressure system	A system containing pressure other than at atmospheric, which may include boilers, piping, heat exchangers, accumulators, pumps, compressors and valves.	IV
pressurised tank	A tank, inside or outside the pressure hull, affected by a significant differential pressure.	IV
propulsion machinery	All the equipment and systems required to generate thrust including, but not limited to:	IV

Term	Definition	Source Chapter
	• the prime mover (internal combustion engine, e.g. diesel engine, electric motors, steam turbine); • combined propulsion and manoeuvring devices (including, but not limited to, azimuth thrusters, athwartship thrusters, water-jets); • steam generators; • gearing; • shafting and couplings; • propellers (fixed pitch or controllable pitch); • auxiliaries (generators, fuel-oil supply, sources of lube oil pressure, sources of water pressure, combustion air supply (if applicable), starting systems, main propulsion control systems (hydraulic, pneumatic, electrical)).	
quality assurance	The internal quality management system, which shall be in accordance with a recognised national or international standard.	I, II
'quick-look' survey	A short survey, to address the issues relevant to the submarine, with the purpose of extending a certificate for a longer period than its validity. This is only done to allow the submarine to complete its immediate programme.	I
recognised organisation	An organisation authorised to undertake certain activities on behalf of the Naval Administration.	I
record of equipment	A record which lists all relevant equipment on board.	I
relocation	The act of changing the location of the item between spaces.	X
replenishment at sea (RAS)	The operations required to make a transfer of personnel and or supplies when at sea.	V
RAS station	A location on the submarine where fluids, stores and personnel are received or delivered by an RAS operation.	V, VI, IX
rescue	The survival and recovery of persons to a safe haven which offers an equivalent or higher level of safety than that prior to the incident.	VII
rescue arrangements	The rescue station and equipment.	VII
rescue equipment	Any equipment that may be used for the recovery of persons from the sea and/or survival craft, ladders, climbing nets, life buoys, light markers, harnesses, etc.	VII
reversionary operation	A machine or system is reconfigured to maintain the agreed level of functionality.	IV
rules	Standards.	II
SAS	Surface abandonment suits.	VI, VII
safe area	A safe area in the context of a casualty is, from the perspective of habitability, any area(s) which is not flooded or which is outside the main vertical zone(s) in which a fire has occurred such that it can safely accommodate all embarked persons to protect them from hazards to life or health and provide them with basic services.	VI
seamanship	Seamanship is the practice of safekeeping and using the submarine in interaction with the environment, i.e. the sea, the land, other vessels, people and goods.	II, III, V
sensitiveness	The degree to which the dangerous goods will respond to external stimuli outside of its design mode.	X
SESSPE	Submarine escape and surface survival personnel equipment.	VII
shall	The word 'shall' means that the requirement is compulsory.	All Chapters
ship	A surface vessel or a submarine.	I
SMERAS	Submarine escape, rescue, abandonment and survival.	IV, VI, VII
SMERAS lighting	Both normal and emergency lighting which are installed for use during SMERAS situations. This system may be incorporated in the general lighting system.	VII

Term	Definition	Source Chapter
SMERAS stowage	Stowages such as containers, brackets, racks and other similar stowage locations designated for any escape, evacuation and rescue equipment.	VII
smoke tight or capable of preventing passage of smoke	A division made of non-combustible or fire-restricting materials which is capable of preventing the passage of smoke demonstrated in accordance with a suitable standard defined by the Naval Administration. Note: Standards could include smoke-tight standards (suitable smoke-tight standards include ISO 5925/1 (2007) NFPA 105 (2013) UBC 7-2/2 (1997) DIN 18095-2 (1991) BS 476-31.1 (1983) EN 1634-2 (2008) EN13501-2 (2010)) or gas-tight standards for CBRN. The Naval Administration may require smoke-tight penetrations to pass smoke and toxicity tests.	VI
speeds	**speed surfaced:** The maximum operational speed of the surfaced submarine according to the maximum continuous propulsion power surfaced. **speed submerged:** The maximum operational speed of the dived submarine according to the maximum continuous propulsion power submerged. **cruise speed:** The expected economic, continuous ahead cruising speed of the submerged submarines, which provides the maximum radius of action.	II, III
SRS	Submarine rescue system.	Intro, I, VII
SSE	Submerged signal ejector	VII, VIII, XII
stairs	In accordance with ANEP 26 Ergonomic Data for Shipboard Space Design in NATO Surface Ships, Edition 1, acceptable angles for stairs are 20°–50°.	V
standard or standards	Includes rules, standards, specification, drawings, criteria and convention against which the design, construction, maintenance and procedures are assessed.	I
standards plan	A document, agreed by the Naval Administration, listing the standards, specifications, conventions etc. or other criteria that are being used to demonstrate that a vessel meets the performance requirements, functional objectives and goals of the technical areas of Part 1 of the Code. The plan includes the roles and responsibilities of organisations undertaking verification and certification activities.	I
state of the art	Refers to the highest level of general development of a device, technique or scientific field achieved at a particular time.	I
stowage	The act of storing an item such that its inherent safety parameters are preserved.	X
structural capacity	Structural strength of the submarine defined in terms of, but not limited to the following: deflection, corrosion, buckling, yielding and fatigue.	II
structural demand	The maximum combined loading that the system can be expected to experience.	II
structural record	A through-life compilation of relevant design, build and in-service information that provides objective evidence for the ongoing integrity of the submarine's structure.	II
submarine	A submarine is understood as a naval submarine and refers to an autonomous, manned vehicle on the sea surface and in fully or partly submerged condition, without physical link with a surface or underwater ship or installation. It is operated by a crew under military command and is also engaged in special military operations **new submarine:** A submarine the keel of which is laid or which is at a similar stage of construction on or after the date defined by the Naval Administration. **existing submarine:** A submarine which is not a new submarine.	All Chapters

Term	Definition	Source Chapter
submarine arrangements	The physical, positional and procedural processes for equipment, systems, structure and personnel whose design and operation ensures the management of the safety risks associated with the carriage and use of Dangerous Goods. • It is in a defined period of repair or lay-up. • It is in for conversion. • It is declared to be 'not in service' by the Naval Administration.	X
survey (*see also* inspection)	The examination of the design and/or material state of a submarine, equipment or system to ascertain whether it is in compliance or otherwise with one of the following: • the intent of a defined specification, standard or drawing; • the intended duties of the submarine, system or equipment. Note: A survey is said to be complete when the deficiencies or other departures have been rectified or justified as adequate.	I
survival	Recovery of embarked persons on the surface after abandonment of the submarine and while awaiting rescue by ship or aircraft, or survival on board a distressed submarine.	VII, VIII
survival craft	Any type of craft, such as a life raft or sea rescue vessel, capable of sustaining the lives of persons within, following the abandonment of the submarine.	VII
trim polygon	A graphical presentation for assessing the submarine's static control capabilities, consisting of a tank polygon and (multiple) consumable polygons that are all to stay within the tank polygon. *See also* consumable polygon, tank polygon.	
tank polygon	Plots changes in mass and longitudinal moment by filling all trim and compensation tanks one by one, and subsequently emptying them one by one. *See also* consumable polygon, trim polygon.	III
tower	*See* fin.	IX
transfer	The act of moving an item and the responsibility for its safety to and from the submarine.	X
Transitional phase	The phase between submerged and surfaced and vice versa.)	III
upright	For intact, near vertical; for damaged, the angle of list acceptable to the Naval Administration.	III
validation	The process of demonstrating that the standards plan nominated for a specific ship or submarine is acceptable to the Naval Administration. Validation will demonstrate that the nominated standards and acceptance criteria against which the design is being verified (whether it adopts the Part 2 solution, classification rules, international convention or other set of criteria) are appropriate for the Concept of Operations Statement. Note: Performance criteria such as classification rules, international conventions, national standards or defence standards that have been justified as meeting the performance requirements, functional objectives and goals, and the sample ConOpS is not significantly different to the ship's ConOpS, will not need to be revalidated. *See also* justification, verification.	0
verification	The process of ensuring that a ship or submarine meets the Code solution agreed by the Naval Administration, which may include Tier 4 of the Code. Evidence of the verification can be in the form of plan approval, analysis, testing or survey. The verification evidence is to be maintained for the life of the ship or submarine. *See* Part 1 Chapter I Regulation 6. *See also* justification, validation.	I
WAIS	Warship automatic identification system.	IX
water density	The mass of water per unit volume in [kg/m3].	III

Term	Definition	Source Chapter
watertight	Prevents the passage of water in either direction with a head of water commensurate with the submergence limit in all foreseeable operating conditions.	III
wayfinding system	Any system which is provided to enable embarked persons to find escape routes and escape exits.	VII
WECDIS	warship electronic chart display and information system.	IX

PART 1 CHAPTER 0: NAVAL SUBMARINE SAFETY CERTIFICATION

Contents

Regulation 0 General

0.1 The purpose of this chapter is to define the overall safety goals for the submarine, and to formally define the regulatory elements that are needed to document compliance with the overall safety goals. The main regulatory elements in the certification process are shown in Figure P1-0-1.

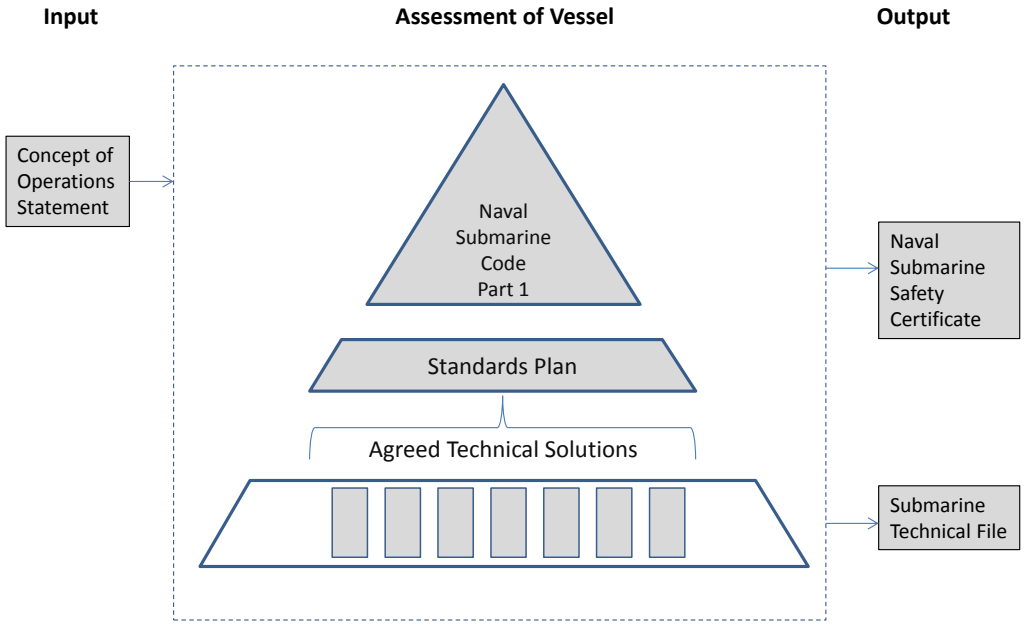

Figure 1-0-1: Main regulatory elements in the certification process of submarines

Solutions (Part 2) are not applicable to Chapter 0.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 1 Goals for the Submarine

1.1 Submarines shall be designed, constructed and maintained throughout life, so that when properly operated the following goals are fulfilled:

1.1.1 For the defined operating conditions, the submarine shall be safe to operate and prevent injury of persons on board.

1.1.2 For all foreseeable damage events, the submarine may have reduced capability, but is to maintain availability of essential safety functions for persons on board.

1.2 For special submarine concepts where the sub-goals in paragraphs 1.1.1 and 1.1.2 are not reasonably possible to achieve, the goals may be modified from that of Regulation 1 where agreed by the Naval Administration. In that case the risk levels are to be kept as low as reasonably practicable.

Solutions (Part 2) are not applicable to Chapter 0.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 2 Submarine Goals Imposed by Naval Administration

2.1 In addition to the mandatory goals for all submarines in Regulation 1, submarines shall be designed, constructed and maintained throughout life so that, when properly operated, the following goals are also fulfilled:

2.1.1 to maintain additional safety functions for persons on board for all foreseeable damage events, as required by the Naval Administration;to comply with specified damage and post-damage requirements for all extreme threat conditions required by the Naval Administration.

2.2 For hazards occurring under extreme threat conditions, the code requires the Naval Administration to determine acceptable solutions.

Solutions (Part 2) are not applicable to Chapter 0.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 3 Concept of Operations Statement

3.1 The certification of the submarine shall be based on a Concept of Operations Statement (ConOpS) defining the submarine's function, operational areas and characteristics.

3.2 The ConOpS is the formal basis for certification against this Code.

3.3 The ConOpS is a standardised table that lists:

3.3.1 the particulars;

3.3.2 the Owner;

3.3.3 the Naval Administration;

3.3.4 the primary and secondary roles;

3.3.5 the submarine attributes;

3.3.6 the operational area;

3.3.7 the environment;

3.3.8 the operating philosophy;

3.3.9 the survey, maintenance and disposal philosophy.

Solutions (Part 2) are not applicable to Chapter 0.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 4 Standards Plan

4.1 Meeting Regulations 1 and 2 shall normally be achieved by using technical standards justified against the goals, functional objectives and performance requirements that have been validated by the Naval Administration recognising the ConOpS of this Code. This includes applicable requirements of INSA Part 2 Solutions to the Naval Submarine Code and/or applicable requirements of a classification society, or other solutions (standards or first principles) that have been accepted by the Naval Administration.

4.2 Applicable requirements mean technical standards that are relevant to the specific submarine and its operation, and have been shown to fulfil the goals, functional objectives and performance requirements through a formal justification process.

4.3 The list of the technical standards used as basis for Tier 4 Solutions shall be collated in a standards plan.

Solutions (Part 2) are not applicable to Chapter 0.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 5 Management of a Submarine's Technical Information

5.1 A s technical file, with specific information on how the requirements of this Code have been applied for the submarine design and construction, shall be made. The technical file shall be provided upon delivery of a new submarine, and updated as appropriate throughout its lifetime.

5.2 Typical information in a submarine's technical file includes, but is not limited to:

Main data

5.2.1 the main data of the submarine;

5.2.2 a copy of ConOpS;

5.2.3 other important design information;

Compliance with NSubC Goals

5.2.4 applicable NSubC chapters;

5.2.5 a list of standards used for each NSubC chapter (table);

5.2.6 a list of other relevant standards;

5.2.7 a list of special interpretations of NSubC;

5.2.8 a list of Naval Administration instructions/interpretations;

5.2.9 a list of important assumptions;

Class Information

5.2.10 a list of class notations and class remarks;

Statutory Certificates

5.2.11 a list of statutory certificates and remarks;

Specified Data

5.2.12 a list of specified loads;

5.2.13 a list of docking conditions;

5.2.14 a list of special operating conditions;

Design Limitations

5.2.15 a list of operating limitations;

5.2.16 a list of deviations;

Operating Information

5.2.17 reference to operational info documents as defined in the Code;

5.2.18 reference to other info documents.

Solutions (Part 2) are not applicable to Chapter 0.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 6 Safety Certification

6.1 A submarine's compliance with the overall requirements in Regulations 1 and 2 shall be demonstrated by Naval Submarine Safety Certification (NSubC).

6.2 The NSubC shall confirm that the submarine complies with the goals in Regulation 1 and with goals in Regulation 2 (if specified), see Figure P3-I-2. The NSubC shall refer to: functions and characteristics as specified in the ConOpS; the technical standards as listed in the standards plan; and assumptions, evaluations and deviations as listed in the submarine technical file.

6.3 The NSubC shall be endorsed and renewed at regular intervals as required by the Naval Administration during the operation of the submarine, including periods of trials. If significant changes are made to the operation (as specified in the ConOpS) or construction of the submarine, the NSubC may need to be updated to reflect this.

6.4 The NSubS shall give unambiguous references to how the submarine has been approved, and what technical standards the submarine has been approved to. This includes any operational limitations, deviations, assumptions and technical standards.

6.5 Where a Naval Administration issues certification for a part or parts of the Code, the Naval Administration is responsible for ensuring the integration of all safety certification at the ship level within the context of the safety management system.

6.6 For items where compliance with the Code has been based on technical solutions deduced directly from the goals, functional objectives or performance requirements without the use of a technical standard, the NSSC or the compliance document shall give reference to an unambiguous line of reasoning for the chosen solution.

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PART 1 CHAPTER I GENERAL REQUIREMENTS

Contents

Regulation 0 Scope and Application

0.1 This Chapter contains general ship and system design requirements which apply to all chapters of the Code. This Chapter cannot be certified out of context. Compliance with the regulations of this Chapter shall be certified within the Goal of each of Chapters II to XII.

0.2 If there is a conflict between the requirements of this Chapter and the requirements in another Chapter of the Code, the Naval Administration shall decide which requirements take precedence.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 1 Systems Architecture

Functional Objective

1.1 The systems architecture shall be designed, constructed and maintained to enable the submarine to operate in all Foreseeable Operating Conditions, provide a high level of integrity and availability and maintain safety functions following any single failure.

Performance Requirements

1.2 The systems architecture shall consider the following modes of operation and these shall be as required by the Concept of Operations Statement:

1.2.1 Normal operation;

1.2.2 Reversionary operation;

1.2.3 Emergency operation.

1.3 These three modes shall include operations while surfaced, submerged and at periscope depths. Some submarines may also be required to operate under ice.

1.4 For all systems installed, the choice of materials and components; the system design and equipment location shall be made in accordance with the environmental, maintenance and operating conditions to ensure the continued function of the system during all Foreseeable Operating Conditions and reduce the risk of:

1.4.1 Harm to embarked persons;

1.4.2 Damage to the equipment, the system it is contained within or adjacent equipment and systems;

1.4.3 Damage to the submarine;

1.4.4 Damage to third parties.

1.5 Safe access shall be provided to all system equipment and components to enable inspection and maintenance.

1.6 The availability of safety functions shall be sustained or restored by means of reliability and/or redundancy.

1.7 Where the required availability of safety functions is achieved through the use of reconfigurable systems, the safe means of achieving the reconfiguration shall be ensured.

1.8 Inadvertent reconfiguration of systems shall be prevented.

1.9 The submarine and its systems shall be designed, constructed and maintained to operate, within acceptable safety limits, in all environmental conditions as defined in the Concept of Operations Statement.

1.10 The submarine and its systems shall be designed and arranged to operate in a predictable manner with a level of integrity commensurate with operational requirements.

1.11 Essential safety functions shall be continuously available following one single operational error and/or system/equipment fault.

1.12 For safety functions, 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.

1.13 Systems shall be designed such that they will not unduly affect any safety functions (even under failure conditions).

1.14 Any hazardous area which has the potential for embarked persons to become inadvertently trapped shall have a means to escape.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 2 Material Selection

Functional Objective

2.1 Materials for submarine construction and outfitting shall be suitable for the intended use and not pose a hazard to the embarked persons in all Foreseeable Operating Conditions.

Performance Requirements

2.2 Materials shall be suitable for the intended use in all Foreseeable Operating Conditions including Foreseeable Damage Conditions. Particular consideration shall be given to the selection of matierials which have properties that change under the effects of extremes of temperature, including fire.

2.3 Materials shall be selected and maintained to withstand the anticipated internal and external environmental conditions in all foreseeable operating conditions.

2.4 The submarine shall be designed and constructed of materials, or combinations of materials, that do not pose any unnecessary risks to human health and/or the environment without compromising the safety and operational efficiency of the submarine.

Note: The Naval Administration may permit the use of materials restricted by para 2.4 for operational reasons, based on a suitable justification being provided and mitigations to manage the hazards being put in place.

2.5 Materials, especially hazardous materials, shall be managed effectively to identify, reduce or mitigate adverse affects.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 3 Equipment Selection

Functional Objective

3.1 Onboard equipment shall support safe operation of the submarine and shall operate safely under all Foreseeable Operating Conditions.

Performance Requirements

3.2 Equipment shall function as intended for its use under all Foreseeable Operating Conditions.

3.3 Equipment shall operate in a predictable manner with a level of reliability commensurate with that required by the system.

3.4 Flammable liquids with a low flash point as defined in Part 1 Definitions and Abbreviations, shall not be used in the submarine's systems.

3.5 The Naval Administration may permit low flashpoint fuels for use in air-independent power (AIP) supply systems in accordance with Chapter IV, Regulation 12.

3.6 Means shall be provided to ensure isolation of equipment and systems (and where necessary dissipation of stored energy) to allow maintenance to take place safely.

3.7 Computer-based systems shall comply with EMC requirements such that electrical and electronic equipment shall not be impaired in its function by electromagnetic energy.

3.8 The Naval Administration may require identified submarine functions to remain operational where the submarine has an operational shock requirement according to Concept of Operations Statement.

3.9 Where the submarine has an operational shock requirement, all equipment shall either:

3.9.1 Be designed to remain captive at the maximum shock design level for the submarine;

3.9.2 Be designed to remain safe at the maximum shock design level for the submarine.

3.9.3 Be provided with secure stowage so that it cannot injure persons, damage essential equipment or obstruct access/escape routes within compartments.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 4 Hazardous Areas

Functional Objective

4.1 The submarine design shall minimise the number and size of Hazardous Areas and the resulting risk to embarked persons and the submarine.

Performance Requirements

4.2 The categorisation of hazardous areas with potentially flammable or explosive atmospheres shall be in accordance with a national or international standard.

4.3 Electrical machinery and systems shall not normally be located in spaces with potentially flammable or explosive atmospheres, however, where required for operational purposes it shall be of a type suitable for the environment in which it will be operated. Where machinery is operated in a potentially flammable or explosive atmosphere, a means shall be provided to detect any abnormal parameters which may lead to ignition of the atmosphere.

4.4 Any failure that can increase the level of risk in a space shall be indicated by an alert.

4.5 The hazardous area shall be designed so as to not compromise the safety of the adjacent space.

4.6 Suitable indication of the nature of the potential hazards shall be provided at the entrance(s) to the space, area and/or on the equipment where applicable.

4.7 Arrangements to prevent unauthorised or inadvertent access to hazardous or potentially hazardous areas or equipment shall be provided in accordance with Naval Administration requirements.

4.8 Embarked persons, equipment and platform shall be protected from the risk of static electricity.

4.9 Embarked persons shall be protected from damaging exposure to radiation hazards.

4.10 Where embarked persons can access an exposed area where there is a risk of falling, that area shall have fall arrest features.

4.11 Hazardous areas shall be provided with appropriate boundaries, detection and ventilation systems in cases where there is a risk of toxic and/or flammable gases.

4.12 Measures shall be taken to reduce noise in the space of origin and transmitted noise to adjacent spaces to acceptable levels.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 5 Cyber Security

Functional Objective

5.1 Systems shall be designed, installed and operated in such a way that software and hardware cyber resilience are implemented to support safe operation of the submarine.

Performance Requirements

5.2 Systems shall be developed to allow an organisation the ability to identify, and manage cybersecurity risk to assets (platform, systems, people, information, etc) and capabilities during an adverse cyber incident.

5.3 Systems shall have safeguards to ensure continued operations of critical capabilities and services during an adverse cyber incident.

5.4 Systems shall be designed to assist in the detection of adverse cyber incidents.

5.5 Systems shall be developed to allow an organisation the ability to contain the impact of a detected or suspected adverse cyber incident.

5.6 Systems shall be developed to allow an organisation the ability to restore capabilities or services that were impaired by an adverse cyber incident.

5.7 Systems shall be delivered with the relevant documentation to allow an organisation the ability to perform independent forensics analysis following an adverse cyber incident.

5.8 Systems covered by this Regulation shall undergo a cybersecurity risk assessment during design and development.

5.9 Systems shall undergo risk-based verification by testing after implementation.

5.10 Systems shall be designed to allow the ability of the organisation to establish, enforce and monitor Role Base Access Control (RBAC) on the systems.

5.11 Systems shall be designed to allow the ability to log system events based on the Naval Administration's requirements.

5.12 Component building blocks shall be designed and implemented to fulfil identification and authentication control requirements.

5.13 Component building blocks shall be designed and implemented to fulfil user control requirements.

5.14 Component building blocks shall be designed and implemented to fulfil system and data integrity requirements.

5.15 Component building blocks shall be designed and implemented to fulfil data confidentiality requirements.

5.16 Component building blocks shall be designed and implemented to fulfil restricted dataflow requirements.

5.17 Component building blocks shall be designed and implemented to fulfil timely response to events requirements.

5.18 Component building blocks shall be designed and implemented to fulfil resource availability requirements.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 6 Software Systems

Functional Objective

6.1 For any systems or equipment dependent on software, the risks associated with software and its integration into the system or equipment shall be properly managed to ensure that the software is safe to use.

Performance Requirements

6.2 A failure or unspecified behaviour of the software shall not result in:

6.2.1 an event that escalates to a hazard;

6.2.2 impairment of the mitigation of a hazard;

6.2.3 impairment of recovery from a hazard.

6.3 Where there is portential for software to be a stimulus event to a hazard, impair the mitigation of a hazard, or impair recovery following such a hazardous event, this shall be communicated to the appropriate parties.

6.4 Evidence that software safety requirements have been considered throughout the project alongside the functional requirements shall be provided.

6.5 Systems shall be categorised based on the effect on system function. The required level of confidence depends upon the criticality of the system.

6.6 Evidence shall be generated in order to provide information software is performing according to agreed rules, functional descriptions, and recognized standards.

6.7 Evidence shall be generated in order to provide information that the software is reacting safely in case of failures originated internally or by devices external to the system.

6.8 Integrated software dependent system;

6.8.1 Testing shall be undertaken prior to software installation onboard.

6.8.2 Evidence shall be generated providing information that the systems are interacting safely with other implemented systems.

6.9 The production of software shall be managed so that the safety risks arising from the software production are reduced to an acceptable level and shall be in accordance with a national or international standard.

6.10 A system safety justification shall be developed to include the risks posed by the use of software and how those risks are reduced to an acceptable level.

6.11 The configuration status of the software on each submarine shall be captured and recorded, and the record maintained up-to-date for the life of the submarine.

6.12 The development and testing of changes to the software and data, including specific arrangements for on-board testing, shall be managed so that safety of the system, sub-system or equipment is not compromised.

6.13 Software shall have safeguards to ensure continued operations of critical capabilities and services during maintenance. The retention and release of earlier versions of software shall be managed to enable restoration of a previous known and trusted state when necessary.

6.14 The release and installation of software to each submarine shall be appropriately and actively managed so that changes to software are controlled. The installation process shall include a strategy for managing a failed installation.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 7 Human Factors Engineering

Functional Objective

7.1 The systems shall be designed to address the needs of the embarked persons in order to be safe to operate.

Performance Requirements

7.2 The physical dimensions of systems and workstations shall conform to the anthropometric and physical characteristics of embarked persons in combination with consideration of tasks to be performed.

7.3 All workstations shall have means to assist embarked persons to remain in position and conduct their duties.

7.4 The design of the submarine, systems and workstations shall:

7.4.1 address compatibility requirements with operational clothing and equipment worn by embarked persons;

7.4.2 take account of the sensory capabilities and limitations of embarked persons;

7.4.3 meet the verbal and non-verbal communication needs of embarked persons;

7.4.4 take account of the cognitive capabilities and limitations of the relevant embarked persons;

7.4.5 provide appropriate means of information presentation to the embarked persons;

7.4.6 provide safe working spaces for embarked persons;

7.4.7 facilitate maintenance activities required to ensure and maintain safe operation.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 8 Control Stations

Functional Objective

8.1 The design of the control stations shall consider the human such that systems important to safety in all Foreseable Operating Conditions are easy to operate and are tolerant to human error.

8.2 Special operating modes (e.g. onboard training, maintenance mode, diagnostic mode etc) as deemed required by the Naval Administration, shall be implemented in a safe manner.

Performance Requirements

8.3 The process used to justify the number, hierarchy, type and location of the control stations shall be defined.

8.4 The number, type and location of control stations shall be sufficient to ensure the safe operation of the submarine and its systems in all Foreseeable Operating Conditions.

8.5 Control stations that operate Essential Safety Functions shall continue to function in all foreseeable operating conditions.

8.6 It shall not be possible for more than one control station to control the same operation from more than one location simultaneously.

8.7 Where a secondary and/or an additional control station is available, all related control stations shall provide a clear and unambiguous indication of their status as primary (i.e., in control) or secondary/additional (i.e., passive).

8.8 The means of transfer of control from one control station to another shall minimise the opportunity for, and reduce the consequence of, human error.

8.9 Transfer of control from one control station to another shall be indicated with clear and unambiguous visual and audible indications on all related control stations.

8.10 Transfer of control from one control station to another shall not affect the equipment and systems being controlled.

8.11 Failure of any control station for essential safety functions shall initiate an apropriate audible and visual alert at the relevant control stations.

8.12 A secondary and/or an additional control station shall be available in case of loss of the primary control station for all essential safety functions.

8.13 Alternative control stations shall be separated from the primary control station in terms of physical location, power supply, network, HVAC, redundant functionalities, etc. to ensure sufficient redundancy under all Foreseeable Operating Conditions.

8.14 Control stations shall clearly and unambiguously indicate the operational status of automated functions and integrated components, systems and/or sub-systems.

8.15 The design of control stations shall:

8.15.1 be as simple as reasonably possible, consistent with the desired human-machine system functions, and compatible with expected maintenance and operational tasks;

8.15.2 minimise the opportunity for, and reduce the consequence of, human error;

8.15.3 ensure appropriate means for human operators to make correct control inputs to the system;

8.15.4 enhance the vigilance of, and reduce the fatigue of, the human operator.

8.16 The design of control station displays shall enhance the usability of systems and equipment, reduce human error, enhance situational awareness and support safe and effective monitoring and control.

8.17 The design of control station controls shall enhance the usability of systems and equipment, reduce human error, and support safe and effective monitoring and control.

8.18 The design of control stations alert systems shall take into account the visual and auditory limitations of the human operator and shall have a means to prioritise alerts consistent with their priority to the safe operation of the submarine.

8.19 Automation shall not adversely effect human performance in carrying out the intended task.

8.20 Control stations shall provide an easy and timely means for the human operator to disable automation and control the system manually if necessary.

8.21 Switching to the special operating mode or training mode shall not prevent availability of Essential Safety Functions or the capacity to keep control on the submarine general operations.

8.22 While operating in the special operating mode, adequate control and monitoring of the submarine general operations and essential safety functions, shall remain available at all times.

8.23 Control stations shall indicate, without any ambiguity, the particular special operating mode which is activated.

8.24 Usage of special operating modes shall be strictly limited to authorised users in accordance with the requirements of Paragraph **Error! Reference source not found.**.

8.25 Control stations shall be designed to offer the user help functions and access to documentation in a manner that supports the user of the system without diminishing the safety of the system.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 9 Documentation

Functional Objective

9.1 Information and instructions shall be provided to support safe operation and maintenance during the full lifecycle of the submarine.

Performance Requirements

9.2 The submarine shall be provided with documentation to assure that the embarked persons are provided with all information and guidance for safe operation in all foreseeable operating conditions.

9.3 Documentation shall be provided to ensure the configuration management of the submarine throughout its life.

9.4 The documentation shall be consistent with the design solution and be readily understood.

9.5 All documentation shall be provided in a form (digital, paper or IETM (Interactive Electronic Technical Manual) that supports the method of working as defined by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

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PART 1 CHAPTER II STRUCTURE

Contents

Regulation 0 Goal

0.1 The structure shall be designed, constructed and maintained to provide in all operational conditions and in the event of all foreseeable emergencies and accidents:

0.1.1 watertight integrity;

0.1.2 the capacity to carry all design-pressure loads and all other foreseeable loads required to meet the defined Concept of Operations Statement (ConOpS);

0.1.3 a setting in which the embarked persons can carry out their duties as safely as reasonably practicable;

0.1.4 protection to the embarked persons and essential safety functions at least until the persons have reached a place of relative safety or the threat has receded.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter II Structure.

Purpose

1.2 Chapter I General Requirements applies to all chapters of the Code, as applicable to the design, and therefore in order to meet the Chapter II goal, the requirements of both this chapter and Chapter I shall be met.

1.3 Chapter II 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 Administration.

Application

1.4 In addition to the requirements contained elsewhere in the present regulations, a submarine’s structure shall be designed, constructed and maintained in compliance with the structural requirements of applicable national standards of the Naval Administration that have been demonstrated to provide a satisfactory level of safety or with a classification society whose rules and procedures are recognised by the Naval Administration as meeting the goal of this chapter.

Solutions for this regulation are contained in Part 2.

Justification & Guidance for this regulation are contained in Part 3.

Regulation 2 Materials

Functional Objective

2.1 Materials shall be suitable for the intended application and manufacturing process for the submarine.

2.2 Materials shall be specified to an approved standard that is consistent with the structural design and fabrication process.

Performance Requirements

2.3 Rolled or forged steels and steel castings with guaranteed ductility and toughness are usually used for pressure hull construction. Therefore, this Code primarily considers submarines constructed of steel. Where it is intended to construct submarines of other materials (e.g. aluminium, titanium, composite material) these shall be specifically proven to be suitable for the intended application. If no recognised standards for the selected material are available, appropriate specifications and justification shall be submitted to the Naval Administration for approval.

2.4 The specified and selected material joining techniques (welding, etc.) shall be proven to suit the expected loading regimes providing particular qualification against through-life fatigue loading. Other novel material joining methods shall be demonstrated as suitable for the intended application and subject to approval by the Naval Administration.

2.5 A material certification process shall be employed that suitably guarantees the quality and performance of the material used in structurally effective components and supports objective through-life verification and validation of material properties and performance.

2.6 The material and joining techniques shall be selected, protected and maintained so as to negate through-life performance degradation from environmental hazards (corrosion, temperature, etc.) and specified loads.

2.7 The materials used in the construction of the submarine shall be manufactured, tested and accepted in accordance with a recognised standard agreed by the Naval Administration.

2.8 Forgings and castings:

2.8.1 The materials proposed for forgings and castings connected to the pressure hull shall have similar minimum properties to the pressure hull material while also proving resistant to the corrosion and erosion mechanisms associated with flowing or stagnant sea water under the specified environmental conditions. They shall also be suitable for the proposed method of attachment to the pressure hull without increasing the potential for corrosion.

2.9 Materials protection:

2.9.1 All material shall be protected against corrosion and other potential degradations in the intended service environment in accordance with a maintenance philosophy agreed by the Naval Administration Where dissimilar materials are employed, measures are to be incorporated to preclude galvanic corrosion.

Solutions for this regulation are contained in Part 2.

Justification & Guidance for this regulation are contained in Part 3.

Regulation 3 Loads and Load Cases

Functional Objective

3.1 The loads relevant to the structural design shall be thoroughly defined and combined within load cases that meet the requirements of the Owner's defined ConOpS.

Performance Requirements

3.2 Load case I. For the surfaced or near-surface submarine (e.g. periscope depth or snorting operations) the following loads shall be considered:

3.2.1 pressure load according to draught;

3.2.2 slamming;

3.2.3 resistance according to maximum operational speed;

3.2.4 wave loads/Green Seas;

3.2.5 wind forces;

3.2.6 loads from towing, mooring, anchoring and berthing (to include consideration of loads due to tug push);

3.2.7 ice accretion;

3.2.8 loads due to accelerations from submarine movement including rolling and pitching;

3.2.9 load from the propeller and shaft;

3.2.10 forces on and imposed by rudders, fins and other appendages;

3.2.11 loads on decks including static and inertial loads from large items of equipment;

3.2.12 loads on tanks including static and dynamic pressure due to internal fluids;

3.2.13 local loads for lifting points and supports;

3.2.14 vibration (consideration is to be given to structural vibration either from cyclic sea loads, machinery or other sources; appropriate measures are to be taken to accommodate fatigue loads and eliminate high stress or resonance resulting from such phenomenon);

3.2.15 loads due to external rescue vessels;

3.2.16 other loads, to be defined case by case.

3.3 Load case II. For the submerged submarine the following loads shall be considered:

3.3.1 pressure load according to operational diving depth, test diving depth and collapse diving depth are to be analysed;

3.3.2 fatigue load for a number of full or partial cycles to operational diving depth and other depths as defined by the ConOpS;

3.3.3 hydrodynamic and hydrostatic loads according to maximum operational speed submerged;

3.3.4 loads due to accelerations from submarine movement including rolling and pitching;

3.3.5 load from the propeller and shaft;

3.3.6 forces on and imposed by rudders, fins, masts, periscopes and other appendages;

3.3.7 loads on pressure-resisting bulkheads;

3.3.8 loads on decks including static and inertial loads from large items of equipment;

3.3.9 loads due to the trapped water in free-flood spaces that occurs when the submarine surfaces quicker than the free-flood spaces can drain (e.g. water in fin, casing, rudder);

3.3.10 local loads for lifting points and supports;

3.3.11 intentional bottoming of the submarine;

3.3.12 loads on tanks including static and dynamic pressure due to internal fluids, with particular attention to be paid to tanks where different loads may be experienced on diferent boundaries simultaneously;

3.3.13 loads due to operational equipment;

3.3.13.1 vibration (consideration is to be given to structural vibration either from water flow (e.g. vortex-induced vibration), machinery or other sources; appropriate measures are to be taken to accommodate fatigue loads and eliminate high stress or resonance resulting from such phenomenon);

3.3.14 ice loads on the extremities and pressure hull when surfacing under ice;

3.3.15 loads due to external rescue vessels;

3.3.16 other loads, to be defined case by case.

3.4 Load case III. For docking, the following loads shall be considered:

3.4.1 limiting docking conditions imposed by the hull structure are to be identified in a docking plan;

3.4.2 loads imposed by the worst docking condition, taking account of any overhang at bow or stern.

3.5 Load case IV. For foreseeable damage, the following loads shall be considered:

3.5.1 the loads created by events that shall be avoided, but the possibility of their occurrence cannot be ignored in the design of the submarine; these may be navigation errors, fire or explosion, mal operation, etc.;

3.5.1.1 The extent of damage shall be such that only the exostructure and/or equipment is damaged and the pressure hull itself remains intact. The assumed speeds, power, etc. are to be defined by the Naval Administration.

3.5.2 loads due to flooding after damage.

3.6 Load case V. For military loads and extreme threat damage, the following loads may be considered:

3.6.1 the demand is to be defined in the ConOpS;

3.6.2 military loads, such as shock loads, etc., are to be defined by the Naval Administration;

3.6.3 accidental loadings for example detonation of pyrotechnics or Special Forces weapons.

3.7 Further load cases may be requested case by case by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 4 Structural Design of the Pressure Hull

Functional Objective

4.1 The structural design of the pressure hull shall serve as the primary means of meeting the goals of this chapter.

4.2 The structural design of the pressure hull shall provide for accessibility during operations and maintenance.

Performance Requirements

4.3 The pressure hull shall be designed to withstand the load cases as per Regulation 3, with sufficient safety margin to account for variances in loads, design, fabrication and operation.

4.4 Rational and proven methodologies for structural design and assessment are to be used. An appropriate standard or coherent set of standards shall be selected and implemented.

4.5 The standards of design, the design methodology and the required workmanship and fabrication procedures shall form part of the structural record.

4.6 The design shall consider all the loads and environmental conditions to which the submarine may be subjected over its lifetime. The resulting stresses, deformation and failure after damage are to be within acceptable limits as appropriate to the calculation method employed and the requirements of the Naval Administration.

4.7 Allowance shall be made for deviations from the ideal shape; the standards for out-of-circularity and other dimensional tolerance checks are to be defined and validated in support of the design requirements.

4.8 Non-destructive examination (NDE) procedures shall be required to gain assurance that the as-built material geometries and properties are in accordance with the design assumptions. Records of NDE shall form part of the structural record. The NDE methods used shall be at an appropriate level for the task and of a validated technique. The standards and methods are to be approved by the Naval Administration.

4.9 All software used to develop the design, construction, maintenance and testing shall be validated to a level relevant to the use of the software and fit for purpose. An auditable trail of the design model characteristics, particularly for load cases and load combinations, along with the engineering interpretation of the results shall be prepared and maintained for the lifetime of the submarine. The user of the software shall have a working knowledge of the formulas at the core of the software tools.

4.10 For all relevant load cases and combinations, according to Regulation 3, the structural capacity is to exceed the structural demand by a defined factor of safety.

Note: The structural capacity is defined as the inherent ability of the structure to resist load and is generally based on the most unfavourable structural, material, geometric and environmental characteristics for a particular failure mechanism. The structural demand is defined as the maximum combined loading that the system can be expected to experience.

4.11 A typical pressure hull shall be designed such that:

4.11.1 cylindrical, conical, spherical and toroidal shells of the pressure hull withstand overall and interframe buckling at collapse diving pressure;

4.11.2 interframe and overall collapse are balanced within the design process and take into account inaccuracies in fabrication and in the design calculations;

4.11.3 for interframe buckling, a proof of stability against local frame tripping on the basis of a stress and buckling calculation has been performed in the maximum deformed condition;

4.11.4 frame stability in the worst buckling mode and with the maximum out-of-circularity is to be achieved and proven down to collapse diving depth.

4.11.5 unmeasureable stresses from fabrication shall be accounted for through the use of appropriately justified safety factors.

4.12 Safety factors acceptable to the Naval Administration are to be specified, justified and verified as being met.

4.13 Detailed analysis of pressure hull end-closure designs shall be conducted to justify the structural capacity, particularly at geometric transitions and for end-closures with significant numbers of penetrations. The collapse sensitivity of end-closures may be different from the cylindrical pressure hull, therefore design-specific standards and safety margins shall be considered.

4.14 The pressure hull shall be designed to facilitate the free movement of personnel within the pressure hull, enabling them to conduct their full range of duties as safely as practicable. Maintenance accessibility to both the internal and external surfaces of the pressure hull shall be considered in design to support through-life material state assurance.

4.15 Penetrations shall be minimised in size and number where possible and shall be designed structurally compensated so as not to reduce the strength and buckling stability of the pressure hull and to maintain watertight integrity. All watertight closures shall meet the requirements of Chapter III, Regulation 2.

4.16 The requirements for equipment installation and removal routes to support the through-life maintenance programme shall be considered in the design.

Solutions for this regulation are contained in Part 2.

Justification & Guidance for this regulation are contained in Part 3.

Regulation 5 Structural Design of Other Structures

Functional Objective

5.1 The exostructure surrounding the pressure hull shall allow for the location and protection of systems and arrangements outside the pressure hull, for improvement of flow and resistance characteristics, and for practical seamanship on deck.

5.2 Structures internal to the pressure hull (e.g. decks, platforms, tank structures, watertight and non-watertight partitions) shall provide subdivision of the submarine's internal spaces and provide locating and securing of all systems and equipment.

5.3 Accessibility during operations and maintenance as well as repairability considerations shall be integral to the structural design of these structures.

Performance Requirements

Structure outside the pressure hull

5.4 The exostructure shall be designed to withstand appropriate loads as defined in Regulation 3.

5.5 The exostructure shall be designed to meet the requirements of Chapter III. The exostructure shall have enough flooding and venting openings to permit diving and surfacing in due time according to the ConOpS, without exceeding stability criteria as required by Chapter III.

5.6 The exostructure shall be of damage-tolerant construction to protect the pressure hull against foreseeable damage. It shall also provide additional stiffening/strength to protect special equipment, such as diving/ballasting tanks, containers for life rafts.

5.7 Arrangements are to be provided to allow personnel to safely access the submarine and conduct practical seamanship operations outside of the pressure hull as defined in Chapter V.

5.8 The fin, casing, rudder(s) and diving planes shall be designed to withstand loads that may be encountered by a surfaced submarine.

5.9 In addition to the loads defined in Regulation 3, the fin shall adequately support the loads from the bearing of the periscopes, electronic masts, etc., and of the detection and location devices situated in the fin.

5.10 The structural stiffness shall not compromise the stiffness of the pressure hull, and connections shall be designed such that stress concentrations are reduced to a minimum.

5.11 Appropriate measures are to be taken at the connection between the exostructure and the pressure hull to avoid stress concentrations and to ensure that crack propagation shall be terminated prior to reaching the pressure hull.

Note: Maintenance and inspection access is to be considered for all exostructure connections and corrosion protection of the pressure hull shall be guaranteed in these areas.

5.12 Foundations for rudders and diving planes shall provide adequate strength with an accepted margin of safety to carry appropriate loads as defined in Regulation 3 Loads and load cases.

5.13 Structures supporting any bollard or deck fitting used for anchoring, mooring or towing shall withstand the appropriate loads as defined in Regulation 3 Loads and load cases.

5.14 The structure shall be designed not to be damaged before the weakest point in the anchoring, mooring or towing system fails by taking into account the rupture load of the specified chains and wire ropes.

5.15 All external tanks that are bounded by the exostructure shall be designed to withstand all relevant combinations of load cases as per Regulation 3 Loads and load cases and protect against breach, as necessary, based on the risk to platform safety and/or the environment.

Internal structure

5.16 All internal structures shall be designed not to compromise the pressure hull as a result of increased local stiffness.

5.17 A method of sealing internal bulkheads, decks and platforms around openings for pipes, cables and access ladders/stairs shall be provided to protect from progressive flooding and/or smoke propagation as required in the design.

5.18 Pressure-tight bulkheads (watertight) could be a part of the pressure hull, and if applicable shall be designed to withstand a lateral pressure sufficient to meet the requirements of an escape compartment as per Chapter VII.

5.19 Where applicable, foundations are submitted to the sole mass of the equipment they are supporting in accordance with Load case V from Regulation 3 Loads and load cases. In addition, motion of the submarine is to be taken into account by adding inertial loads. Foundations shall not compromise the pressure hull by increasing local stiffness.

5.20 Internal tanks not subjected to diving pressure are to be designed for fluid loads as per Regulation 3 Loads and load cases.

Solutions for this regulation are contained in Part 2.

Justification & Guidance for this regulation are contained in Part 3.

Regulation 6 Construction

Functional Objective

6.1 The quality of construction shall be consistent with structural design, material, joining (welding, etc.) and non-destructive testing (NDT) requirements to meet the goals of this chapter.

6.2 Objective quality evidence shall be retained for the life of the submarine demonstrating verifiable achievement against this chapter.

Performance Requirements

6.3 The design standards as per Regulations 4 Structural Design of the Pressure Hull and 5 Structural Design of Other Structures, will assume or require a defined quality of construction, modification and repair. Achievement of this quality shall be confirmed in construction and form part of the structural record.

6.4 Manufacturers shall be able to construct – and demonstrate that they can construct – at least to:

6.4.1 appropriate submarine-building standards consistent with the design solution;

6.4.2 the satisfaction of the Naval Administration, in facilities that are appropriately accredited by persons who are suitably competent. The manufacturer shall be subjected to regular surveys and audits to ensure that the required quality is achieved.

6.5 A quality assurance system, such as ISO 9001 or equivalent, is required.

6.6 Material-state assurance shall be recorded where required by the design solution via tests, trials and inspections. Evidence, such as material traceability, joining (welding, etc.) and NDT records, structural

surveys, etc., shall form part of the structural record and be retained and available for reference for the life of the submarine.

Joining

6.7 Welding of and conducted on submarine structures shall be subject to approval and in accordance with standards defined by the Naval Administration.

6.8 Manufacturing contractors and subcontractors shall have approved welding procedures for the type of weld and material being used. Manufacturing contractors and subcontractors shall be approved by the Naval Administration.

6.9 Other novel material-joining methods shall be demonstrated as suitable for the intended application and subject to approval by the Naval Administration.

Non-destructive testing

6.10 NDT shall be in accordance with standards approved by the Naval Administration.

6.11 Defect acceptance criteria shall be in accordance with the requirements of the design and approved by the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification & Guidance for this regulation are contained in Part 3.

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PART 1 CHAPTER III - BUOYANCY, STABILITY AND CONTROLLABILITY

Contents

Regulation 0 Goal

0.1 The buoyancy, freeboard, sub-division, stability and manoeuvring and control characteristics of the submarine shall be designed, constructed and maintained to:

0.1.1 provide watertight integrity; the systems and equipment on the submarine that are exposed to sea pressure in all foreseeable operating conditions are to be designed, constructed, maintained and operated to prevent unintended ingress of water;

0.1.2 provide an adequate reserve of buoyancy in all foreseeable operating conditions, in the environment for which the submarine is to operate;

0.1.3 provide adequate means to control depth and trim;

0.1.4 provide adequate stability to avoid capsizing in all foreseeable operating conditions, in the environment for which the submarine is to operate, under the precepts of good seamanship;

0.1.5 permit embarked persons to carry out their duties as safely as reasonably practicable;

0.1.6 protect the embarked persons and essential safety functions in the event of foreseeable accidents and emergencies at least until the persons have reached a place of safety or the threat has receded including preventing the malfunction of the lifesaving systems and equipment;

0.1.7 peable the submarine to be capable of independent manoeuvring in both surfaced and submerged operating modes;

0.1.8 minimise the risk of exceeding the operational diving depth, broaching, grounding and collision;

0.1.9 provide emergency arrangements to be used in the event of a failure of manoeuvring systems.

Justification and Guidance for this Regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this Regulation is to outline the principles and framework of Chapter III Buoyancy, Stability and Controllability and its application.

Purpose

1.2 Chapter I General Safety Requirements applies to all chapters of the Code, as applicable to the design, and therefore in order to meet the Chapter III goal, the requirements of both this chapter and Chapter I shall be met.

1.3 Adequate reserve of buoyancy and stability shall be provided to safeguard life and property at sea whilst maintaining freedom of manoeuvre.

1.4 In addition to the normal shipping hazards and underwater manoeuvring hazards, the risk of collision from operation in close proximity to other shipping or underwater vehicles, particularly during replenishment at sea, blockade, interdiction or multi-platform operations shall be considered in determining foreseeable damage.The ability to be deployed to any area of interest defined in the Concept of Operations Statement shall be maintained.

General Performance Requirements

1.5 The submarine shall:

1.5.1 Be capable of operating in the environment defined in the Concept of Operations Statement;

1.5.2 Have a level of inherent seaworthiness including motions tolerable by equipment and embarked Persons, controllability and the ability to remain at the required depth, or afloat and not capsize;

1.5.3 Be designed to minimise the risk faced by the submarine including but not limited to:

1.5.3.1 the impact of the environment causing dynamic capsize;

1.5.3.2 damage to crew and equipment;

1.5.3.3 loss of watertight integrity;

1.5.3.4 depth exceedence or broaching;

1.5.3.5 collision;

1.5.3.6 grounding;

1.5.3.7 hostile acts;

1.5.3.8 static capsize due to changing loading conditions;

1.5.3.9 errors in ship handling.

1.5.4 Be designed to support the goals of Chapter VII;

1.5.5 Be provided with operator information and guidance, as required in Regulation 8 Provision of Operational Information and Guidance, to facilitate safe handling of the submarine.

1.6 Any changes to the submarine during design, construction or through life that impacts on the compliance with this Chapter shall be approved by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 2 Watertight Integrity

Functional Objective

2.1 The submarine shall have watertight boundaries that prevent the uncontrollable ingress and spread of water in all Foreseeable Operating Conditions.

Performance Requirements

2.2 The structure of any internal or external sub-division shall ensure that all watertight boundaries satisfy the Functional Objectives of this Chapter in all Foreseeable Operating Conditions.

2.3 Watertight boundaries shall be designed to meet the requirements of the safety philosophy as outlined in the Concept of Operations Statement.

2.4 The fore and aft regions of the submarine shall provide protection to the remainder of the submarine (extending from keel to casing) from the consequences of a collision (also see Chapter II).

2.5 In the case of damage to or loss of any appendage to the submarine, the loss of watertight integrity to any internal or external subdivision shall be minimised.

2.6 Where openings are required to be opened at sea, they shall limit the ingress of water from weather or waves in any Foreseeable Operating Condition.

2.7 Openings in the pressure hull and any internal and external watertight boundary shall be fitted with closures that shall be approved by the Naval Administration to provide the same level of watertight integrity as the surrounding structure when closed.

2.8 Moving parts penetrating any internal and external watertight boundary are to be fitted with watertight sealing arrangements that are approved by the Naval Administration.

2.9 Penetrations (for all piping, cabling, ducting or other purpose) shall:

2.9.1 provide the same level of watertight integrity as the surrounding structure and meet the relevant requirements of Chapter II;

2.9.2 prevent the flow of water through watertight boundaries unless specifically designed to allow for the passage of water and approved by the Naval Administration.

2.10 A system capable of removing liquid from all internal sub-divisions shall have at least the capacity to remove liquid at the rate approved by the Naval Administration.

2.11 The submarine shall have a liquid leakage detection system for spaces where flooding will cause danger to the submarine and shall provide remote indication to a main control station and other control stations as required by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 3 Reserve of Buoyancy and Freeboard

Functional Objective

3.1 The submarine on the surface shall have sufficient freeboard and reserve of buoyancy to safeguard life while maintaining the freedom to manoeuvre.

Performance Requirements

3.2 In all Foreseeable Operating Conditions the submarine shall:

3.2.1 have sufficient freeboard that allows the crew to safely operate on the casing within the limits of the Concept of Operations Statement;

3.2.2 have sufficient freeboard to minimise shipping of green seas so access hatches can be opened within the limits of the Concept of Operations Statement;

3.2.3 have sufficient reserve of buoyancy in order to surface from all operating depths.

3.3 Buoyancy in all foreseeable operating conditions shall be preserved by sub-division or an equivalent method agreed with the Naval Administration.

3.4 The submarine shall have, in all foreseeable operating conditions, sufficient reserve of buoyancy and sub-division or any other mechanism to ensure an sufficient freeboard.

3.5 The submarine shall have the means to determine and record its loading condition and the sea water density.

3.6 All exposed decks shall be free draining.

3.7 The Naval Administration shall approve reserve of buoyancy and freeboard at the end of construction and at acceptable through life intervals.

3.8 Any standards, models, calculations, tests, trials or procedures used to determine the reserve of buoyancy and freeboard shall be justified to and approved by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 4 Static Control

Functional Objective

4.1 For all Foreseeable Operating Conditions, the submarine shall have sufficient tank capacity in order to stay neutrally buoyant at zero speed and at even keel.

Performance Requirements

4.2 The submarine shall be able to accommodate all foreseeable changes in seawater density, displaced volume, lightweight and deadweight mass and corresponding longitudinal centre of gravity.

4.3 Static control (based on approved lightship weight and centre of gravity) shall be approved at the end of construction and through life at intervals acceptable to the Naval Administration.

4.4 Any standards, models , calculations, tests, trials or procedures used to determine static control shall be justified to and approved by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 5 Reserve of Stability

Functional Objective

5.1 The submarine shall have adequate resistance to inclination to prevent capsize when disturbed, and adequate restoring energy to return to upright, or safe buoyant position, once the disturbance is removed, in all Foreseeable Operating Conditions.

Performance Requirements

5.2 In all Foreseeable Operating Conditions the submarine shall:

5.2.1 adequately resist roll and pitch caused by a disturbance to an extent that permits embarked persons to carry out their duties as safely as reasonably practicable and does not exceed machinery operating limits as defined by the Naval Administration;

5.2.2 return to equilibrium from a roll, heel, list, pitch or trim caused by a disturbance subsequent to the removal of that disturbance;

5.2.3 have a reserve of stability (based on approved lightship weight and centre of gravity) that has been approved at the end of construction and through life at intervals acceptable to the Naval Administration.

5.2.4 any standards, models , calculations, tests, trials or procedures used to determine the reserve of stability shall be justified to and approved by the Naval Administration.

5.2.5 limit itsseakeeping behaviour shall be limited to levels acceptable to the Naval Administration during all Foreseeable Operating Conditions.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 6 Transitional Stability

Functional Objective

6.1 The submarine shall have adequate reserve of stability in the transition phase for all foreseeable operating conditions.

Performance Requirements

6.2 In all Foreseeable Operating Conditions the submarine shall:

6.2.1 have an adequate reserve of stability in the transitional phase to ensure safe operating conditions whilst non-emergency surfacing and diving.

6.2.2 have sufficient drainage of the exostructure to ensure that the submarine will regain an adequate reserve of stability after an emergency surfacing or any other kind of rapid surfacing operation.

6.3 If required the submarine shall have an adequate reserve of stability to ensure safe operating conditions in a semi-submerged state to satisfy operational requirements.

6.4 The requirements of Chapter II Regulation 5 Structural Design of Other Structures shall be met.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 7 Controllability and manoeuvring

Functional Objective

7.1 In all foreseeable operating conditions the submarine shall have adequate controllability to maintain and change speed, depth and heading.

Performance Requirements

7.2 The hydrodynamic design of the outer hull form of the submarine including all appendages shall provide adequate directional stability in both the horizontal and vertical direction.

7.3 The hydrodynamic design and actuator performance of all control surfaces, shall provide dynamic control in both the horizontal and vertical direction.

7.4 The main propulsion system shall provide control of speed in both forward and reverse directions.

7.5 The main ballast tank blowing system shall be able to assist the control of the submarine's ascent.

7.6 The Distressed Submarine (DISSUB) on the surface shall be able to be taken under tow for all foreseeable operating conditions.

7.7 The directional stability and manoeuvring performance and directional stability of the submarine shall be approved at the end of construction and through life at intervals acceptable to the Naval Administration.

7.8 Any standards, models calculations, tests, trials or procedures used to determine the manoeuvring performance and directional stability shall be justified to and approved by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 8 Safety of Embarked Persons

Functional Objective

8.1 The submarine shall behave in a manner that allows embarked persons to carry out their duties as safely as reasonably practical, in all foreseeable operating conditions.

Performance Requirements

8.2 The behaviour of the submarine in foreseeable operating conditions shall;

8.2.1 be optimised considering the requirements of stability, seakeeping and manoeuvring in six degrees of freedom and the safety of embarked persons;

8.2.2 be assessed to determine any limitations to safe operation;

8.2.3 not prevent embarked persons from operating the safety functions.

8.3 Where embarked persons can access an exposed deck, that deck shall have means of preventing a person falling from that deck.

8.4 Both internal and external access routes to all work spaces and emergency positions shall have means to assist movement about the ship by embarked persons in foreseeable operating conditions.

8.5 Arrangements shall be provided that that allow embarked Persons to remain in position and safely conduct normal activity in foreseeable operating conditions.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

Regulation 9 Provision of Operational Information and Guidance

Functional Objective

9.1 Information required by the submarine's crew, pertaining to buoyancy, stability and controllability of the submarine, shall be provided and maintained with the submarine to facilitate its safe operation in all Foreseeable Operating Conditions and for SMERAS.

Performance Requirements

9.2 The submarine shall be provided with information to maintain :

9.2.1 watertight integrity;

9.2.2 static control;

9.2.3 buoyancy;

9.2.4 freeboard;

9.2.5 stability

9.2.6 seakeeping

9.2.7 controllability;

9.3 If a stability or loading computer is fitted to the submarine then it is to reflect the requirements of this regulation.

9.4 If the stability or loading computer is the main source of compliance, then a duplicate backup facility shall be provided onboard.

9.5 The submarine shall be provided with information pertaining to the controllability of the submarine to assist in the avoidance of collisions and groundings and safe recovery to the surface.

9.6 A Safe Operating Envelope shall be developed for the submarine and this shall be justified to and approved by the Naval Administration.

Solutions for this Regulation are contained in Part 2.

Justification & Guidance for this Regulation are contained in Part 3.

PART 1 CHAPTER IV ENGINEERING SYSTEMS

Contents

Regulation 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 danger to embarked persons in all foreseeable operating conditions;

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

0.1.4 ensure the watertight integrity of the pressure hull, and meet the requirements of Chapter III Buoyancy, Stability and Controllability;

0.1.5 ensure the continued function of the equipment during 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, provide power to the essential safety functions and sustain life in the event of all foreseeable emergencies at least until the persons have reached a place of relative safety or the threat has receded;

0.1.8 enable the maintenance and repair in the submarine's maintenance plan.

0.2 Additional systems or equipment not directly covered by this chapter shall not impact on the submarine's engineering or safety systems.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter IV 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 submarines. It includes general elements including but not limited to the Concept of Operations Statement (ConOpS), provision of information, essential safety functions, control, safety, systems integration and health, as well as individual systems such as propulsion, piping and electrical generation and distribution.

1.3 Chapter I General Requirements applies to all chapters of the Code, as applicable to the design, and therefore in order to meet the Chapter IV goal, the requirements of both this chapter and Chapter I shall be met.

1.4 Where the requirements of other chapters, such as Fire Safety or Atmosphere Control, impact on the considerations of the items described in this chapter, then the overriding requirements shall be derived in order to meet the relevant functional objectives and goals for both chapters. Specifically, on the interface with Chapter X Dangerous Goods, Chapter IV contains the overarching requirements for engineering systems which apply to the carriage and use of dangerous goods (Class 1–9) and Chapter X supplements Chapter IV by providing additional requirements applicable to Class 1 Dangerous Goods (Explosives).

Application

1.5 In addition to the requirements contained elsewhere in the present regulations, submarines 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 Naval Administration, or with applicable standards of the Naval Administration which provide an equivalent level of safety.

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 2 Concept of Operations Statement

Functional Objective

2.1 The ConOpS is the Owner's vision of how the engineering systems of the submarine are to be operated and maintained throughout the life of the submarine and shall be shared with the Naval Administration and, where appointed, its recognised organisation.

Performance Requirements

2.2 The scope of the information to be provided is defined in Chapter I of the Code. For the purposes of this chapter, particular importance is to be attached to:

2.2.1 mobility: within the operational requirement, a submarine's ability to manoeuvre, as and when required by the Command but still remaining within the designed or imposed limitations;

2.2.2 operating and maintenance procedures: documentation relating to equipment and systems, operating and maintenance procedures and requirements, including reversionary modes and breakdown drills;

2.2.3 persons: including all individuals whose intervention is relied upon to maintain safety.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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 a language and format that can be understood by the operator in the context in which it is required.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Propulsion

Functional Objective

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

Performance Requirements

4.2 To enable the submarine to manoeuvre, this regulation shall be applied in conjunction with Regulation 5 Manoeuvring.

4.3 Where practical, redundancy of propulsion equipment shall be provided. The submarine shall have the ability to maintain heading and position following any single failure or loss of access to the compartment caused by a flood or fire. The Naval Administration shall give consideration to the reliability of single essential propulsion components or other mitigation.

Note: For example, the availability of tugs.

4.4 Machinery and systems required for propulsion shall meet the relevant requirements of Chapter IX Regulation 9 Collision Avoidance.

4.5 It shall be possible to operate the propulsion equipment from a number of locations (to be agreed with the Naval Administration).

4.6 Effective means of communicating orders from all conning positions to any position from which the speed and direction of thrust of the propellers can be controlled shall be provided. At least one of the means of communication shall be independent of the submarine's normal electrical supply. This regulation shall meet the relevant requirements of Chapter VIII Regulation 6 Internal Communications.

Note: Conning positions include the control room and the bridge.

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

4.8 The motive power supply shall exhibit a level of redundancy, diversity and capacity to ensure that the propulsion and manoeuvring equipment remains operational and shall exhibit a level of continuity to ensure continuous operation according to the requirements of the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 5 Manoeuvring

Functional Objective

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

Performance Requirements

5.2 Machinery and systems required for manoeuvring shall meet the relevant requirements of Chapter III Buoyancy, Stability and Controllability and Chapter IX Regulation 9 Collision Avoidance.

5.3 Where practical, redundancy of manoeuvring equipment shall be provided. The submarine shall have the ability to maintain heading and position following any single equipment failure or loss of access to the

compartment caused by a flood or fire. The Naval Administration shall give consideration to the reliability of single essential manoeuvring components or other mitigation.

Note: For example, the availability of tugs.

5.4 It shall be possible to operate the manoeuvring equipment from a number of locations (to be agreed with the Naval Administration).

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 all conning positions to any position from which the action of the hydroplanes can be controlled shall be provided. At least one of the means of communication shall be independent of the submarine's normal electrical supply. This regulation shall meet the relevant requirements of Chapter VIII Regulation 6 Internal Communications.

Note: Conning positions include the control room and the bridge.

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.

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 6 Pressure and Piping Systems

Functional Objective

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

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 persons or become a source of ignition in case of flammable-fluid leaks.

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 Suitable precautions against the build-up of electrostatic charges shall be provided.

6.7 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 be suitable to mitigate the consequences of excessive overpressure.

6.8 Pressure-relief arrangements shall not pose a danger to persons, the environment or any other submarine system. Where the media contained poses a safety hazard to persons or the environment, arrangements shall be put in place to minimise the risk following release.

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

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 7 Not Used

Regulation 8 Control of Depth, Buoyancy and Trim

Functional Objective

8.1 The submarine shall have the ability to operate safely at the surface, at various depths and under definite buoyancy and trim conditions.

Performance Requirements

8.2 The crew shall be able to operate the submarine safely on the surface under all foreseeable operating conditions.

8.3 It shall be possible to check the safety relevant systems before initiating the diving procedure.

8.4 At periscope depth, the submarine shall be enabled to keep this depth as required by the Naval Administration.

8.5 The submarine shall be capable of returning safely to the surface.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 Other Essential Safety Functions

Functional Objective

9.1 The submarine's machinery outfit shall provide services for essential safety functions not described elsewhere in the Code.

Performance Requirements

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

9.3 A high-pressure seawater service shall be available which is capable of providing safety functions as required by Chapter VI Regulation 9 Fire Fighting.

9.4 Where a submarine is expected to receive low-flashpoint fuels, a suitable system is required for its storage, use and safe disposal.

9.5 Bilge-pumping arrangements shall comply with:

9.5.1 the requirements of Chapter III Buoyancy, Stability and Controllability;

9.5.2 the de-watering requirements at a pressure equivalent to depth-dependent system test pressure.

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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.

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

10.3 A continuous supply to equipment or systems shall be maintained where an interruption to the power supply is unacceptable.

Performance Requirements

10.4 Suitable arrangements shall be provided for the supply of electricity sufficient to supply the consumers agreed by the Naval Administration.

10.5 The quality of power supply shall be agreed by the Naval Administration.

10.6 The electrical power generation and power supplies shall be designed and arranged with a high level of integrity and availability.

10.7 Suitable redundancy arrangements shall be provided toessential safety functions in the event of loss or unavailability of the normal power supply.

10.8 Suitable protection measures shall be provided in accordance with Regulation 15 Electrical Protection Arrangements.

10.9 No electrical generation and supply equipment shall be put into use where the supplied equipment's strength and capability may be exceeded in such a way as may give rise to danger or may affect safety functions.

10.10 Where applicable, facilities to safely connect shoreside electrical power supply and battery charging shall be provided.

10.11 Suitable arrangements for the safe installation, use and maintenance of energy storage devices shall be provided.

10.12 In the event of failure of the power supply to essential systems, an alternative supply is to be immediately connected for the duration required by the Naval Administration.

10.13 For essential safety functions for which an interruption to supply is unacceptable, transitional electrical supplies with sufficient capacity and duration, as accepted by the Naval Administration, shall be provided.

10.14 The power supply to submarine escape, rescue, abandonment and survival (SMERAS) systems shall be provided as per the requirements of Chapter VII Regulation 13 Power Supply to SMERAS Systems.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 11 Battery System and Battery Charging

Functional Objective

11.1 The electrical power produced on board shall be stored for flexible operation of the submarine in times with no or insufficient electrical power generation.

Performance Requirements

11.2 Proof of adequate storage capacity of electrical power and its charging facility shall be furnished, e.g. by a power balance.

11.3 Storage batteries shall be installed only in spaces where the necessary environment for safe operation without explosion hazard is guaranteed by the auxiliary systems.

11.4 Ageing effects on the performance of the batteries shall be considered over the lifetime of the submarine.

11.5 Battery chargers shall be rated such that the tolerances of the limited and the constant characteristics are adhered to irrespective of external disturbance effects.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 12 Air-Independent Power Supply

Functional Objective

12.1 Where an AIP supply system is selected for the submarine, it shall enable delivery of power to systems without compromising safety.

Note: AIP is often used to refer to air-independent propulsion by industry.

Performance Requirements

12.2 The AIP system shall comply with the applicable requirements in Chapter VI Fire Safety and Chapter XII Atmosphere Control.

12.3 Hazards introduced into the submarine due to the installation and operation of the AIP system shall be identified and a means of mitigation put in place.

12.4 Fuel shall be contained, supplied and consumed safely, dependably and without leakage. If fuel is stored outside the pressure hull it is to be protected by the exostructure.

Note: See also Chapter VI Regulation 13 regarding the carriage of low flashpoint fuels.

12.5 Effluents, wastes, by-products and other items produced by the AIP system shall be contained, managed and stored and/or disposed of safely and without leakage.

12.6 Safety systems shall be provided for the management and control of the AIP system, including during fault conditions.

12.7 A means of managing loss of power shall be provided.

12.8 Pressure and piping systems for AIP systems shall be in accordance with Regulation 6.

12.9 Suitable materials shall be selected to contain fuel, effluents, wastes, by-products and other items produced by the AIP system, giving consideration to corrosion, material compatibility and other adverse effects.

12.10 Means to allow for safe fuelling, refuelling, defuelling and removal of effluents, wastes, by-products and other items produced by the AIP system shall be provided.

12.11 The AIP system shall be designed and arranged with the requisite level of integrity and availability and/or provided with sufficient redundancy to meet the requirements of the ConOpS.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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 Regulation 10 Electrical Generation and Power Supplies, paragraph 10.5 in terms of suitability for the for the quality of power supply.

13.3 Electrical equipment and distribution systems shall meet the requirements of Regulation 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 reasonably foreseeable abnormal conditions and is to be agreed by the Naval Administration.

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

13.7 The distribution system shall be designed and arranged with a high level of integrity and availability.

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

13.9 The continuity of supply to safety functions shall be ensured.

13.10 Suitable arrangements for the isolation and switching of distribution circuits shall be provided.

13.11 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. Electromagnetic compatibility (EMC) shall be achieved by application of a policy and/or standard agreed with the Naval Administration.

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

13.13 Effective means of communications shall be provided between all switchboards.

13.14 Where a damage-control emergency distribution system is installed, it shall not introduce additional risk of harm to persons, equipment or the submarine.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 14 Lighting

Functional Objective

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

Performance Requirements

14.2 The light fittings selected for a particular space shall be appropriate for the potentially hazardous atmosphere in the space. Refer to Chapter I, Regulation 4 Hazardous Areas.

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

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

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

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

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

14.8 Where provided, portable lighting shall be appropriate for the potentially hazardous atmosphere of the compartment in which it will be used. Refer to Chapter I, Regulation 4 Hazardous Areas.

Note: Navigation lights shall be as defined in Chapter IX and SMERAS lighting as defined in Chapter VII Regulation 9.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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 shall be provided to protect embarked persons.

15.3 A means to detect and alert of insulation breakdown with respect to earth within equipment and distribution systems shall be provided.

15.4 Suitable arrangements shall be provided to minimise the effects of arc flash on embarked persons.

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 Safety functions, as agreed by the Naval Administration, 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 the cooling of essential machinery and systems in the event of a forced cooling system failure shall be provided.

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

15.15 All cables shall be of a low-smoke, zero-halogen type, unless agreed otherwise by the Naval Administration, and managed in accordance with **Error! Reference source not found.** Materials.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 16 Machinery Control

Functional Objective

16.1 Machinery and systems essential for the safety of the submarine and embarked persons shall be provided with effective means for their operation and control during all operational conditions defined in the ConOpS.

Performance Requirements

16.2 The requirements for control stations required by Chapter I Regulation 8 Control Stations apply in addition to these requirements.

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

16.4 Indications of impending slowdown/shutdown 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 shall be derived and agreed with the Naval Administration.

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.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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 essential machinery and systems during all submarine operations.

17.2 A safety system shall be installed to ensure that any serious malfunctions of machinery or systems which presents 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 key locations as agreed with the Naval Administration.

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

17.5 The operational status of the computer-based system shall be easily recognisable. 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. 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 Where parameters of the alert system can be adjusted, the integrity of the system shall be maintained.

17.8 The status of an alert shall be clearly visible and a means to accept it from all appropriate locations, as agreed with the Naval Administration, shall be provided. Visual indication of the alarm shall remain until the fault is cleared.

17.9 Machinery and systems shut down by the safety system shall be manually reset before allowing a restart.

17.10 Where the function of a safety system may lead to a greater hazard than the loss of the equipment, the Naval Administration may agree to an override feature.

17.11 The status of standby machinery and systems shall be indicated at appropriate control stations, as agreed with the Naval Administration.

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 18 Systems Integration

Functional Objective

18.1 Safety functions shall be designed such that risks of harm to embarked persons and damage to the platform or the environment are reduced to a level acceptable to the Naval Administration, both in normal operation and under fault conditions. Functions shall be designed to fail safe.

Performance Requirements

18.2 The integrity of essential machinery or systems, during normal operation and fault conditions, shall be demonstrated.

18.3 Any imposed equipment limitations shall be reflected in the 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 dependent on the defective part.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 19 Heating, Ventilation and Air Conditioning

Functional Objective

19.1 Ambient conditions shall be controlled to suit machinery requirements.

19.2 Ambient conditions shall be controlled for crew habitability.

19.3 Ventilation shall be provided for hazardous areas.

Note: This regulation shall be read in conjunction with Chapter XII.

Performance Requirements

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

19.5 Suitable ambient conditions for all accessible spaces shall be maintained.

19.6 The ventilation requirements of Chapter VI shall be met.

19.7 Watertight integrity (see Chapter III) and fire zone (see Chapter VI) boundaries are not to be compromised by heating, ventilation and air conditioning (HVAC) systems.

19.8 Means to ‘crash stop’ ventilation in case of fire shall be provided.

19.9 Hazardous areas shall be provided with appropriate ventilation systems.

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

19.11 Continuity of operation of safety functions in the event of a ventilation failure shall be provided. See also Regulation 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.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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 underpressure during all operational evolutions.

20.4 The overflows from a vent shall be directed to a receptacle of suitable capacity so as not to cause a hazard to adjacent equipment.

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 21 Maintaining Crew Health

Functional Objective

21.1 The submarine's machinery, outfit and systems shall provide services essential to maintain the health of all embarked persons for the required period of endurance.

Performance Requirements

21.2 Fresh water:

21.2.1 The submarine shall have the ability to supply a sufficient quantity of water, of appropriate quality, for all embarked persons for direct consumption, food preparation and personal hygiene.

21.2.2 When facilities exist to produce fresh water on board, the inlet for the seawater supply shall be positioned to minimise the ingestion of any waterborne contaminants.

21.2.3 Arrangements and connections for fresh-water tanks shall be designed and positioned to reduce the risk of cross-connection to other fluid systems.

21.3 Food-storage facilities:

21.3.1 Food-storage facilities capable of storing sufficient food for the embarked persons and for the required duration shall be provided.

21.3.2 The storage shall maintain a suitable environment (temperature and humidity) to control bacterial growth and other forms of degradation in quality.

21.3.3 Cold and cool room temperatures shall be routinely monitored when in use.

21.3.4 The storage shall be designed to prevent the cross-contamination of different food types.

21.3.5 The storage shall be protected from contamination with all other ships' systems.

21.4 Food preparation:

21.4.1 Suitable facilities shall be provided for the hygienic preparation of meals for the embarked persons.

21.5 Sanitary:

21.5.1 Sanitary facilities shall be provided on board for all embarked persons.

21.5.2 The sanitary systems shall be designed to hygienically store or process crew waste.

21.5.3 The sanitary systems shall be designed to limit the spread of unpleasant odours.

21.6 Waste storage or disposal:

21.6.1 Facilities shall be provided for the hygienic storage or disposal of food waste and packaging.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

PART 1 CHAPTER V SEAMANSHIP SYSTEMS

Contents

Regulation 0 Goal

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

0.1.1 enable recovery of persons from the sea;

0.1.2 ensure the watertight integrity of the pressure hull and meet the requirements of Chapter III;

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter V Seamanship Systems and its application.

Scope

1.2 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter V goal, the requirements of both this chapter and Chapter I shall be met.

1.3 The Naval Submarine Code excludes training requirements. Chapter V Seamanship Systems assumes all embarked persons have an appropriate level of competence for the operation of the installed systems. Part 3 contains some guidance on typical training requirements.

General Performance Requirements

1.4 The availability of seamanship systems associated with essential safety functions shall be sustained or restored by means of:

1.4.1 reliability, especially of any single points of failure;

1.4.2 redundancy to minimise single points of failure.

1.5 Means shall be provided to ensure isolation of equipment and systems to allow maintenance to take place safely.

1.6 The provision of a robust maintenance and inspection schedule to support equipment (such as lifelines and life jackets) used in casing operations shall meet the approval of the Naval Administration.

1.7 The submarine shall be capable of meeting any safety requirement imposed by a supporting organisation appointed by the Duty Holder, Naval Administration or other authority.

1.8 Appliances and equipment for use in the escape and evacuation of a casualty submarine are covered in Chapter VII. Where discrepancies exist between this chapter and Chapter VII the requirements of Chapter VII take precedent.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 2 Concept of Operations Statement

Functional Objective

2.1 The Concept of Operations Statement is the owner's vision of how seamanship systems are to be operated and maintained throughout the life of the submarine. The Naval Administration may share this information when appointed its recognised organisation.

Performance Requirements

2.2 The scope of the information to be provided is defined in Chapter I and Chapter I Annex A. For the purposes of this chapter, particular importance is to be attached to defining the following as they relate to seamanship systems:

2.2.1 hazards created by the natural environment;

2.2.2 hazards created by the man-made and built environment (operations, accidents and malicious acts);

2.2.3 survey and maintenance philosophy.

2.2.4 The environmental operating limits of a seamanship capability which comprises of disparate elements and functions as system of systems.

2.3 Seamanship systems shall provide for mooring, anchoring, towing and the transfer of embarked persons within the environmental envelope defined in the Concept of Operations Statement. These capabilities shall be preserved if the submarine is without power.

2.4 Special emphasis is to be placed on systems for the effective and expeditious recovery of personnel from the water. These capabilities shall be preserved if the submarine is without power.

2.5 Operating documentation, procedures and signage should all emphasise the importance of remaining within the design limits of the equipment or system in use.

The Naval Administration may impose additional requirements where it determines that the Concept of Operations Statement is inadequate and does not give a satisfactory safety level for the submarine or also represents a risk to other vessels.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 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 seamanship systems.

Performance Requirements

3.2 Information and instructions shall be supplied to the operator to provide for the safe operation, fault-finding and maintenance of seamanship systems, under all foreseeable operating conditions.

3.3 Information and instructions shall define safe operating limits.

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

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Access to the Casing and Working on the Casing

Functional Objective

4.1 Accessibility to and from the casing shall enable the embarked persons to safely fulfil their tasks as and when required by the Command.

Performance Requirements

4.2 To enable access to the casing, stairs, ladders, doors and hatches shall be provided and safely used or operated within the operation limits defined by the Concept of Operations Statement.

4.3 Redundancy of access points shall be provided. The Naval Administration may give consideration to the reliability of alternative routes to access the casing.

4.4 Access to equipment systems and the casing shall be designed, constructed and maintained to minimise risk to embarked persons in all foreseeable operating conditions:

4.4.1 Hatches and doors for access to the casing shall be capable of being opened from both sides when the door or hatch is not secured from the inside.

4.4.2 Means shall be provided to ensure that access hatches and doors can be opened and closed manually.

4.4.3 For hatches used in submarine escape and rescue situations, the requirements of Chapter VII Regulation 4 Access Hatches shall be met.

4.5 Where required, access to seamanship systems and equipment with an essential safety function shall be continuously available.

4.6 Sufficient lighting shall be provided at access points to the casing and at fin doors leading onto the upper surface of the casing, taking into consideration any night-vision requirements.

4.7 The requirements for watertight integrity and the safety of embarked persons as defined by Chapter III and Chapter VII apply in addition to the requirements of this chapter.

4.8 Effective means shall be provided for communicating orders from the normal and emergency conning positions to any position from which access to the casing can be controlled.

4.9 At least one hatch or door shall be arranged to be opened without any unwanted ingress of water (within sea states prescribed in the Concept of Operations Statement) when the submarine is in an established surface condition in any permitted condition of trim.

4.10 There shall be sufficient space on the casing for the requisite embarked persons to undertake functions associated with their role defined in the Concept of Operations Statement.

4.11 There shall be a means of preventing personnel on the casing from being lost overboard without impeding their ability to carry out functions associated with their role defined in the Concept of Operations Statement.

4.11.1 Submarines shall be capable, where required, of safely accommodating leisure activities of embarked persons on the casing.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 5 Embarkation and Disembarkation

Functional Objective

5.1 The submarine shall be capable of safely embarking and disembarking persons and/or stores in all operating conditions covered by the Concept of Operations Statement.

Performance Requirements

5.2 Means shall be provided for the safe embarkation and disembarkation of persons and/or stores for port-related operations. The Naval Administration may impose additional requirements for civilians.

5.3 Means shall be provided for the safe embarkation and disembarkation of persons and/or stores from submarines whilst not alongside but not underway.

5.4 Means shall be provided for the safe embarkation and disembarkation of persons from submarines while underway.

5.5 Where the Concept of Operations Statement requires the capability to conduct a mass recovery of persons in response to a SOLAS incident, the submarine shall be provided with equipment for the recovery of mass casualties.

5.6 Where such transfers are achieved by Boat the requirments of Regulation 12 of this Chapter shall be observed.

5.6.1 Where such transfers are achieved by Helicopter the requirments of Regulation 13 of this Chapter shall be observed.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 6 Pilot Transfer Arrangements

Functional Objective

6.1 The submarine shall provide a safe means of embarkation and disembarkation acceptable to civilian pilots.

Performance Requirements

6.2 Effective means of communication shall be provided between the normal and emergency conning positions, the pilot-transfer submarine and the pilot-embarkation point.

6.3 The pilot-transfer station shall be located such that it provides unobstructed access for embarkation and disembarkation from the submarine.

6.4 Arrangements permitting pilot access to or egress from the submarine shall be either available on both sides of the submarine, or capable of being transferred for use on either side.

6.5 Arrangements for the embarkation and disembarkation of pilots using a Pilot ladder shall be located in the postion which best aids the use of the Pilot ladder against the side of the ship.

6.6 Adequate lighting shall be provided to illuminate the transfer arrangements over the side of the submarine and the position on deck used for embarkation and disembarkation.

6.7 All equipment used in the transfer operation shall be maintained and tested in accordance with manufacturers' specifications or to a recognised standard.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 7 Man Overboard Recovery

Functional Objective

7.1 Rescue arrangements shall enable persons to be rescued from the sea.

Performance Requirements

7.2 Rescue arrangements shall permit effective and expeditious rescue of persons from the water, and where the Concept of Operations Statement requires, rescue units or survival craft;

7.3 A means of fulfilling the requirements of paragraph 7.2 shall be provided which is independent of power.

7.4 Effective means of communication shall be provided between the primary conning position, and designated rescue party.

7.5 When employing a boat, the requirements of Regulation 12 are to be met.

7.6 When operating with a helicopter, the requirements of Regulation 13 are to be met.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Mooring

Functional Objective

8.1 Submarines shall be capable of being secured and maintained in position alongside or to a buoy without the use of their own propulsion machinery.

Performance Requirements

8.2 The submarine shall, where a line based system is used, be provided with the necessary number and length of appropriate mooring lines to provide for safe mooring in all foreseeable operating conditions as stated the Concept of Operations Statement

8.3 The securing points on the submarine shall be available independent of the submarine's own power.

8.4 Where winches are provided to tension the mooring lines, the controls shall be in a position such that the operation of the winch may be directly observed by the operator.

8.5 Where mooring lines are carried by the submarine, means shall be provided to securely stow them when not in use.

8.6 Consideration shall be given to Regulation 10 Towing if the mooring equipment may be used for towing.

8.7 Provison shall be arranged such that where an element of a system fails due to the safe working load being exceeded the mode of failure minimises risk to embarked persons.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 Anchoring

Functional Objective

9.1 Submarines shall be capable of being secured in position without the use of propulsion machinery when at sea in limited water depths and environment conditions.

Performance Requirements

9.2 The Concept of Operations Statement shall define the depths of water and environmental limits within which the submarine is to be capable of anchoring.

9.3 Means shall be provided to allow the controlled deployment of the anchor, independent of the submarine's power. This is to include an indication of the length of anchor chain deployed.

9.4 Means shall be provided to lock the anchor in the desired position, independent of the submarine's power.

9.5 Means shall be provided to abandon the anchor, independent of the submarine's power.

9.6 The anchor system shall be arranged such that when the design limit is exceeded the system fails in such a way that the remaining elements of the system slows the progress without causing damage to the structure of the submarine.

9.7 Consideration shall be given to Regulation 8 Mooring and Regulation 10 Towing if the anchoring equipment may be used for mooring or towing.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 10 Towing

Functional Objective

10.1 A means shall be provided to allow the submarine to tow or be towed.

Performance Requirements

10.2 The operational scope of the use of towing equipment shall be defined in the Concept of Operations Statement.

10.3 The safe working load of equipment is to meet or exceed the maximum design load which may be imposed in all foreseeable operations within the operating envelope defined in the Concept of Operations Statement.

10.4 Emergency towing equipment shall be available in all forseeable conditions.

10.5 The towing system shall be arranged such that when the design limit is exceeded the system fails in such a way that the remaining elements of the system does not endanger personel or damage the structure of the submarine.

10.6 Systems or devices for the safe cutting of the towing connection shall be installed:

10.6.1 At least one method, which is independent of the vessels own power supplies, of safely releasing the tow while under strain shall be provided.

10.7 The Naval Administration may require that cutting of the towing connection in accordance with paragraph 10.6 is undertaken by remote control.

10.8 Appliances used for towing shall comply with the requirements of Regulation 15 Lifting and Hoisting Appliances.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 11 Replenishment at Sea

Functional Objective

11.1 Submarines shall be capable, where required, of transferring solid stores, munitions, liquids or personnel between submarines while underway.

Performance Requirements

11.2 The Concept of Operations Statement shall define the environmental limits within which the submarine is to be capable of conducting various RAS operations.

11.3 The Naval Administration may, where interoperability is required, identify a recognised naval, national or international standard to be applied.

11.4 Effective means of communications, complying with the requirements of Chapter VIII, are to be provided between:

11.4.1 submarine to submarine conning stations;

11.4.2 submarine to submarine replenishment at sea (RAS) stations;

11.4.3 RAS station and conning position;

11.4.4 RAS station and equipment operating positions.

11.5 Submarines shall have sufficient space for the anticipated loads to be handled and transferred.

11.6 Submarines shall have sufficient working space for the crew involved in RAS operations to fulfil their duties.

11.7 Submarines engaged in the transfer of liquids that are controlled by international convention shall have means to contain accidental spillage during transfer and prevent any loss into the sea.

11.8 The requirements of Chapter II are applicable for local structural loads.

11.9 The requirements of Chapter III are applicable for seakeeping, stability and manoeuvrability.

11.10 The requirements of Chapter IV are applicable for propulsion and machinery redundancy.

11.11 The requirements of Chapter X are applicable for the transfer of dangerous goods.

11.12 The requirements of Regulation 15 Lifting and Hoisting Appliances are applicable for the lifting appliances associated with RAS operations.

11.13 Means are to be provided to rapidly stop RAS operations and disconnect.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 12 Boat Operations

Functional Objective

12.1 Where required submarines shall be capable of boat operations.

Performance Requirements

12.2 Submarines shall be capable, where required by the Concept of Operations Statement, of launching and recovering boats while alongside or underway (including while making way).

12.3

12.4 The person controlling the launch and recovery of the boat shall be able to visually observe both the boat and any associated appliance operator at all times.

12.5 Means of communications, complying with the requirements of Chapter VIII, are to be provided between:

12.5.1 the launch/recovery control position and the conning position;

12.5.2 the launch/recovery control position and the boat;

12.5.3 the boat and the conning position.

12.6 Means of transferring personnel and equipment into and out of boats shall be provided.

12.7 The requirements of Chapter II are applicable for local structural loads.

12.8 The requirements of Chapter III are applicable for seakeeping, stability and manoeuvrability.

12.9 The requirements of Chapter VI, Regulation 14 Carriage of Low Flash Point Fuels shall be complied with.

12.10 The requirements of Regulation 15 Lifting and Hoisting Appliances are applicable for the lifting appliances associated with boat operations.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 13 Helicopter Transfers

Functional Objective

13.1 Submarines shall be capable, where required by the Concept of Operations Statement, of transferring stores, munitions or personnel by helicopter.

Performance Requirements

13.2 Arrangements for replenishment by helicopter shall be suitable for transfer/evacuation operations where defined by the Concept of Operations Statement, using internal and/or under slung loads. Where applicable, the following conditions shall be met:

13.2.1 The replenishing area shall be safe and accessible.

13.2.2 The replenishing area shall be clear of obstructions which may impede the transfer operation.

13.2.3 A suitable means for the earthing of persons and cargo shall be available.

13.2.4 The replenishing area shall be clearly indicated and visible from the air.

13.2.5 The replenishing area shall be equipped to prevent personnel falling overboard.

13.3 Where transfer by helicopter is envisaged for the submarine shall be provided with operating limits for those activities.

13.4 Effective means of communications, complying with the requirements of Chapter VIII, are to be provided between the conning position, the replenishment area and the helicopter.

13.5 The requirements of Chapter II are applicable for local structural loads.

13.6 The requirements of Chapter III are applicable for seakeeping, stability and manoeuvrability.

13.7 The requirements of Chapter VII are applicable for casualty evacuation operations.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 14 Diving Operations

Functional Objective

14.1 Submarines shall be capable of supporting diving operations that are consistent with the areas of operation and environmental conditions defined in the Concept of Operations Statement.

Performance Requirements

14.2 Where required by the Concept of Operations Statement, the submarine shall provide means of ingress, egress and recovery of divers to and from the water.

14.3 Where required by the Concept of Operations Statement, submarines shall carry the means to recharge breathing apparatus. In such instances the following apply:

14.3.1 The submarine shall be provided with means to ensure the quality of air provided for diving purposes, meets defined standard.

14.4 The submarine shall be provided with means to inhibit the movement and/or transmission of underwater fittings, sensors and machinery which may present a hazard to diving operations.

14.5 The Naval Administration may require that the hull be provided with a system to assist diver orientation.

14.6 Dedicated first-aid capability shall be provided for diving operations.

14.7 The diving system shall conform to a recognised naval, national or international standard.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 15 Lifting and Hoisting Appliances

Functional Objective

15.1 The submarine shall be provided with means to raise, lower and traverse loads as required by the Concept of Operations Statement.

Performance Requirements

15.2 Lifting appliances and equipment must satisfy an applicable naval, national or international standard and be subject to a regime of periodic inspection and certification. The Naval Administration may require additional standards and define the inspection regime.

15.3 Lifting appliances shall be equipped with the requisite safety devices.

Note: For this chapter, lifting and hoisting are synonymous.

15.4 The operational use of each item of lifting equipment shall be defined.

15.5 The lifting appliance shall remain under control during all modes of operation.

15.6 Lifting appliances shall minimise the risk to embarked persons, the lifting equipment and the platform during lifting operations.

15.7 Necessary instructions for assembly, use and maintenance shall be present. The safe working load and the maximum test load shall be displayed on or adjacent to the equipment.

Note: The Naval Administration shall specify which organisation/personnel are authorised to carry out testing and periodical inspections. Along with the periodicity and method of testing and inspection which shall mandate that records of all testing and inspection are maintained and readily available.

15.8 As far as reasonably practicable, the location of the lifting appliance shall be such that the load can be viewed directly by the operator. In the event that the load cannot be viewed directly by the operator, an effective means of communication, complying with the requirements of Chapter VIII, shall be provided between the load area and the operating position.

15.9 The lifting appliance shall not be able to be controlled from more than one operating position at the same time.

15.10 The Naval Administration may require additional requirements for lifting appliances used for personnel or munitions.

15.11 Lifting equipment required for life-saving functions shall be in accordance with the requirements of Regulation 12 Boat Operations and Chapter VII.

15.12 Upon motive power failure the load shall remain in position.

15.13 After motive power failure, means shall be provided to safely move the load to a pre-determined location.

15.14 The requirements of Chapter II are applicable for local structural loads.

15.15 The requirements of Chapter III are applicable for stability.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

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PART 1 CHAPTER VI FIRE SAFETY

Contents

Regulation 0 Goal

0.1 For effective fire safety, the submarine and its arrangements are to be designed, constructed, maintained and operated in such a way that, as far as it is practicable, fire can be prevented, detected, contained and extinguished while maintaining essential safety functions during and after the outbreak of a fire.

Note: Essential safety functions are defined in the Concept of Operations Statement. Essential safety functions to support fire safety are: power supplies to provide lighting; fire detection; functional awareness; communcations; the availability of firefighting systems; and other functions identified by the Naval Adminstration.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter VI Fire Safety and its application.

Scope

1.2 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter VI goal, the requirements of both this chapter and Chapter I shall be met.

1.3 There is an interface with Chapter X Dangerous Goods. Chapter VI contains the requirements for fire safety which apply to the carriage and use of dangerous goods (Class 1–9). Chapter X supplements Chapter VI by providing additional requirements applicable to Class 1 dangerous goods (explosives).

1.4 The Naval Submarine Code excludes training requirements. Chapter VI assumes all embarked persons have an appropriate level of competence for the operation of the installed systems. Part 3 contains some guidance on typical training requirements.

Application

1.5 Alternatives to the requirements will be accepted provided that they have been demonstrated to be equivalent to meet the fire safety goal and functional objectives of this chapter to the satisfaction of the Naval Administration.

1.6 The function of the submarine as defined in the Concept of Operations Statement will determine the applicability of the Tier 4 Solutions.

General Performance Requirements

1.7 The fire safety policies are to be defined which reflect the Concept of Operations Statement for the ship and address the functional objectives of this chapter.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 2 Structural Integrity during Fire

Functional Objective

2.1 Structural integrity of the submarine shall be maintained to prevent partial or whole collapse of submarine structures due to strength-deterioration by heat.

Performance Requirements

2.2 The structure, including the pressure hull, conning tower, structurally effective bulkheads, decks and pillars, shall be constructed of approved non-combustible materials that have adequate structural properties or suitable protection from fire.

2.3 Fire-resistant boundaries shall be designed to withstand the instantaneous pressure differences that may result from a fire and any pressure effects from extinguishing it.

2.4 Fire-resistant boundaries shall be designed with pressure relief if required to enable safe evacuation through the boundary.

2.5 The structure of the submarine, when subjected to a design fire for a defined period of time and after a fire, shall not:

2.5.1 deform such that it prevents access for submarine escape, rescue, abandonment and survival (SMERAS) facilities, maintenance of essential services and firefighting activities;

2.5.2 threaten the structural integrity of the submarine through loss of a structural member, e.g. bulkhead strut or pillar, in or adjacent to a compartment which has a fire;

2.5.3 threaten or degrade the structure supporting A- and B-class divisions;

2.5.4 threaten or degrade the structure supporting components of columns, stanchions and other structural members required to support SMERAS arrangements such that they are unable to operate;

2.5.5 threaten or degrade the structure supporting naval systems or specific compartments as defined by the Naval Administration.

2.6 Fittings that preserve external watertight integrity shall remain effective during and after a fire.

2.7 Minor structures that are essential for SMERAS facilities, maintenance of essential services or firefighting activities shall remain effective during and after a fire.

Note: Examples of minor structure are raised floor plating in machinery spaces and access ladders.

2.8 Every construction shall be designed with the consideration that it may be exposed to a fire.

2.9 The Naval Administration may require a significant structural loading from an extreme load event or damage event to be considered coincident with a fire.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 3 Risk of Ignition

Functional Objective

3.1 The ignition of combustible materials or flammable liquids, gases and vapours shall be prevented.

Performance Requirements

3.2 The following performance requirements shall be satisfied for all operational activities:

3.2.1 means shall be provided to control leaks of flammable liquids and gases;

3.2.2 means shall be provided to limit the accumulation of flammable gases and vapours;

3.2.3 the ignitability of combustible materials shall be restricted;

3.2.4 ignition sources shall be restricted;

3.2.5 ignition sources shall be separated from combustible materials and flammable liquids and gases;

3.2.6 flammable liquids and gases shall be stored in dedicated spaces or tanks.

Note: Additional requirements for machinery and electrical installations that present a risk of ignition are identified in Chapter IV Regulation 21 Hazardous Areas.

3.3 Flammable gas concentrations shall be limited to a level below their explosion limit, e.g. hydrogen from batteries; see also Chapter XII, Regulation 4 Removal of Hydrogen, Carbon Monoxide and Other Contaminants.

3.4 The submarine's atmosphere shall be monitored continuously in terms of the content of oxygen and the alarm for high oxygen level shall be set by the Naval Administration in accordance with requirements in Chapter XII.

3.5 Except as otherwise agreed, flammable liquids of a low flashpoint shall not be used.

3.6 A margin shall be maintained between the maximum ambient temperature of a space, consistent with the Concept of Operations Statement, and the minimum flashpoint of flammable liquids contained in piping.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Fire Growth Potential

Functional Objective

4.1 The fire growth potential shall be limited in every space of the submarine.

Performance Requirements

4.2 The following performance requirements shall be met:

4.2.1 The means of control for the air supply to a space or group of spaces shall be readily accessible from outside the spaces concerned.

4.2.2 The means of control for flammable liquids in a space or group of spaces shall be readily accessible from outside the spaces concerned.

4.2.3 The use of combustible materials shall be restricted. Exposed surfaces in normally occupied locations and access routes shall have low flame-spread characteristics.

4.2.4 Storage of flammable liquids within high risk spaces shall be restricted to the minimum.

4.2.5 Storage of flammable gases shall be appropriately located and restricted to the minimum.

4.2.6 Pressure systems for flammable liquids and gases shall be designed to minimise any potential effect from fire.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 5 Smoke Generation and Toxicity

Functional Objective

5.1 The hazard to life from smoke and toxic products generated during a fire, from spaces that contain the fire or adjacent to the fire, shall be reduced in spaces where persons work, live or may have regular access.

Performance Requirements

5.2 Smoke and toxic products released from materials exposed to the effects of elevated temperatures and/or fire shall be limited and demonstrated to be in accordance with Naval Administration requirements. This requirement shall include:

5.2.1 paints, varnishes and other surface finishes, excluding surfaces of voids, tanks and exterior surfaces;

5.2.2 primary deck coverings and floor finishes;

5.2.3 combustible insulation materials;

5.2.4 electric and fibre optic cabling;

5.2.5 other materials identified by the Naval Administration which may include:

5.2.5.1 non-combustible insulation materials;

5.2.5.2 soft furnishings, textiles and mattresses;

5.2.5.3 non-metallic piping;

5.2.5.4 non-mettalic armour.

Note: The above does not include pressure hull construction materials.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 6 Control of Smoke Spread

Functional Objective

6.1 The spread of smoke in and the removal of smoke out of the submarine shall be controlled in order to minimise the hazards from smoke.

Performance Requirements

6.2 The submarine shall be capable of expelling smoke from within the pressure hull, in both surfaced and snorkelling conditions.

6.3 Smoke clearance shall be provided for all compartments.

6.4 The atmosphere on the clear side of a smoke boundary shall be monitored in terms of toxic combustion products see Chapter XII Regulation 8 Monitor the Internal Atmosphere.

6.5 A means for controlling the spread of smoke is to be provided within:

6.5.1 fire zones, ventilation zones and smoke containment zones;

6.5.2 decks and compartments;

6.5.3 machinery spaces;

6.5.4 special category spaces of high fire risk;

6.5.5 control stations manned in an emergency;

6.5.6 concealed spaces behind ceilings, panels or linings.

6.6 Where possible, a submarine's ventilation system shall be designed such that smoke clearance after a fire is extinguished will be possible from every fire zone and or compartment without contaminating other areas of the submarine.

6.7 The risk of smoke spread by the ventilation system and battery ventilation system shall be as low as reasonably practicable.

6.8 Control stations shall have arrangements to ensure that, in the event of fire, ventilation, visibility, freedom from smoke and the functions of the control station can be maintained, unless these functions can be accomplished at an alternative location, suitable for occupation for the duration of the incident.

6.9 The effectiveness of smoke control and clearance provisions shall be demonstrated against design intent and periodically tested.

6.10 For alternative breathing air, there shall be access to an emergency breathing system.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 7 Detection and Alarm

Functional Objective

7.1 A fire shall be detected in its space of origin and an alarm shall be provided for safe evacuation and firefighting activity.

Performance Requirements

7.2 An effective means of detecting and locating fires and alerting the continuously manned control station and fire teams is to be provided.

7.3 The fire detection and fire alarm system shall be functional for both a manned submarine and an unmanned submarine in harbour.

7.4 Silent fire alarms shall give a clear visual signal of the detection of a fire.

7.5 Fixed fire-detection and fire-alarm-system installations shall be suitable for the nature of the space, fire growth potential and potential generation of smoke and gases.

7.6 If required, manually operated call points shall be placed effectively to ensure a readily accessible means of notification.

7.7 If required, the fire alarm is to activate the general alarm if it is not responded to within a defined timescale.

Fixed fire-detection and fire-alarm-system installations are to be approved in accordance with a recognised standard and tested after installation and periodically, in accordance with a recognised procedure. Software shall be approved and tested in accordance with Chapter I, Regulation 6 Software Systems.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Containment of Fire

Functional Objective

8.1 A fire shall be contained in its space of origin.

Performance Requirements

8.2 The submarine shall be subdivided by thermal and structural boundaries or equivalent:

8.2.1 Fire containment at boundaries shall have due regard to the fire risk of the space, the function of the space and the function of adjacent spaces.

8.2.2 The fire integrity of the boundary shall be maintained at openings and penetrations.

8.2.3 Active or passive containment arrangements shall be provided.

8.3 Fire boundaries, openings and penetrations shall be demonstrated in accordance with a recognised standard.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 Firefighting

Functional Objective

9.1 Suppression, containment and quick extinction of fires shall be effective within the space of origin.

Performance Requirements

9.2 For all foreseeable fire hazards there shall be defined, effective and proportionate means of extinguishing each such fire.

9.3 Fixed fire-extinguishing systems shall be installed, having due regard to the risk of ignition, fire growth potential, casualty potential and operational importance of the protected spaces.

9.4 Firefighting systems and appliances are to be readily available throughout the submarine.

Note: Passages shall be of a sufficient size to allow crew wearing firefighting outfits and breathing apparatus to pass through.

9.5 Fire-extinguishing systems are to be suitable for application at the initiation of a fire and for all stages through to the maximum potential escalation.

9.6 Automatic activation of firefighting systems shall have due regard for the function of the space, manning and/or equipment protected.

9.7 Controls for firefighting systems shall be operable from a safe location.

9.8 Firefighting media shall have due regard for the fire risk and the function of the space and or equipment protected.

Note: The submarine shall be designed so that water from firefighting efforts can be drained without unnecessarily contaminating equipment.

Drainage installations shall exist in areas with electrical equipment for the purpose of reducing damage caused by firefighting water.

The location of any power source shall take into account the risk of fire and other damage.

Where electrical equipment is supported by an uninterrupted power supply (UPS), fire safety measures shall be able to disconnect the UPS or manage the incident without disconnection.

9.9 Selection of firefighting media shall have due regard to potential environmental impact, toxicity of the agent and its fire breakdown products, and potential short- and long-term effects on space recovery and atmosphere control.

9.10 Means of purging spaces with a gaseous firefighting system shall be provided, operable outside the space.

9.11 Reversionary means of firefighting are to be provided to mitigate the failure of fixed systems.

9.12 Fire-extinguishing systems and appliances are to be demonstrated in accordance with a recognised standard and shall be tested periodically.

9.13 Firefighting shall not result in a loss of depth control or trim instability.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 10 Maintain Capability

Functional Objective

10.1 In case of fire, the capability of essential safety functions and other defined services shall be maintained and/or recovered to a defined level.

Performance Requirements

10.2 The submarine shall be able to safely return to surface and to port under its own propulsion after an incident that does not exceed the casualty threshold.

10.3 The submarine shall be provided with safe areas that maintain basic services to ensure that the health and effectiveness of embarked persons is maintained after a casualty that does not exceed the casualty threshold.

10.4 The systems required to remain operational to support orderly SMERAS shall remain operational if the casualty threshold is exceeded.

10.5 The Naval Administration may define other submarine functions that need to be maintained after a casualty that does not exceed the casualty threshold.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 11 Provision of Operational Information

Functional Objective

11.1 Information shall be provided to address the operational effectiveness of installed fire safety arrangements.

Performance Requirements

11.2 To operate, maintain and monitor the effectiveness of the fire safety arrangements, the following information and instructions shall be provided:

11.2.1 information for operation including: operating locations, performance capability, limitations and restrictions of all fire-protection systems, firefighting systems and appliances;

11.2.2 information for the maintenance of all fire-protection systems, firefighting systems and appliances incorporated into the submarine's maintenance plan;

11.2.3 information for the safe testing of fire-protection systems, firefighting systems and portable appliances, including recommended test schedules, which are to be incorporated in the submarine's maintenance plan;

11.2.4 information and instructions for proper submarine operations and handling operations for the carriage of dangerous goods in relation to fire safety.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 12 Special Requirements

Functional Objective

12.1 Any special features of the submarine shall be consistent with the fire safety goal and other functional objectives of this chapter.

Note: Examples include carriage of vehicles, dangerous goods, bulk liquids and materials.

Performance Requirements

12.2 For submarines carrying dangerous goods, as defined in the Concept of Operations Statement, the following performance requirements shall be met in addition to other requirements in this Code:

12.2.1 Fire-protection systems shall be provided to protect the submarine from the additional fire hazards associated with carriage of these dangerous goods.

12.2.2 Dangerous goods posing a fire or explosion hazard shall be separated from ignition sources and other areas of high fire risk as far as reasonably practical.

12.2.3 Appropriate personal protective equipment (PPE) shall be provided against the hazards associated with the carriage of dangerous goods. Operation manuals and training shall be provided.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 13 Carriage of Low-Flashpoint Fuels

Functional Objective

13.1 Safe storage of low-flashpoint fuel shall be provided where this is required by the Concept of Operations Statement.

Performance Requirements

13.2 Low-flashpoint fuel shall be avoided if possible.

13.3 The Naval Administration may permit low-flashpoint fuel to be used in an air-independent propulsion system, in accordance with Chapter IV Regulation 12.

13.4 If low-flashpoint fuel has to be transported, this shall to be done under the following conditions:

13.4.1 The storage shall be only in single, independent containers.

13.4.2 The single, independent containers with diving pressure, as determined by Concept of Operations Statement.

13.4.3 The containers shall be stored adequately within special space(s) in the exostructure.

13.4.4 The special space(s), including their closing devices, shall be protected against sun radiation by the exostructure.

13.4.5 The fixing arrangement of the containers shall allow jettisoning of containers overboard in surfaced conditions of the submarine; jettisoning arrangements are to be demonstrated against design intent and periodically tested, when acquired by the Naval Administration.

13.4.6 Safety precautions shall be considered if the submarine is in port.

13.5 Means to allow for safe fuelling, refuelling and defuelling of equipment shall be provided, consistent with the Concept of Operations Statement and in accordance with Naval Administration requirements.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

PART 1 CHAPTER VII SUBMARINE ESCAPE, RESCUE, ABANDONMENT and SURVIVAL

Contents

Regulation 0 Goal

0.1 The arrangements for the submarine escape, rescue, abandonment and survival (SMERAS) of embarked persons shall be designed, constructed and maintained to provide:

0.1.1 effective evacuation for all embarked persons from all manned spaces to a place of safety in the event of foreseeable accidents and emergencies at least until the threat has receded;

0.1.2 an effective means of escape, rescue and abandonment from the submarine;

0.1.3 an effective means of survivability for embarked persons;

0.1.4 an effective means of communication with external facilities.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter VII Submarine Escape, Rescue, Abandonment and Survival and its application.

Purpose

1.2 Naval submarines shall be adequately designed, constructed, equipped, maintained and provided with procedures for the evacuation, escape, rescue, abandonment and survival of all embarked persons following all foreseeable emergency situations and damage conditions of a submarine on the surface and submerged.

1.3 SMERAS measures shall be in place to ensure that the submarine is as safe as reasonably practicable for all embarked persons to conduct escape, rescue, abandonment and survival by:

1.3.1 supporting the life of embarked persons awaiting rescue or escape;

1.3.2 allowing embarked persons to abandon from the distressed submarine (DISSUB) into life raft(s), for rescue by a submarine rescue system (SRS) or to escape using submarine escape and surface survival personnel equipment (SESSPE);

1.3.3 supporting the life of persons, who may be in a life raft, as long as reasonably practicable and commensurate with the anticipated time for rescue;

1.3.4 permitting the recovery of persons from the submarine, life rafts or the sea.

Scope

1.4 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter VII goal, the requirements of both this chapter and Chapter I shall be met.

1.5 The Naval Submarine Code excludes training requirements. Chapter VII Submarine Escape, Rescue, Abandonment and Survival assumes all embarked persons have an appropriate level of competence for the operation of the installed systems. Part 3 contains some guidance on typical training requirements.

General Performance Requirements

1.6 SMERAS measures shall meet the requirements of Chapter I and additionally:

1.6.1 be robust and have a minimum susceptibility to damage;

1.6.2 not be affected by the submarine’s weapon systems;

1.6.3 not have a detrimental impact on other SMERAS measures on board;

1.6.4 be designed for the maritime environment and the intended area of operation.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 2 Internal Communications Equipment

Functional Objective

2.1 Internal communications equipment shall enable the notification of all embarked persons in a timely manner that an emergency situation exists.

Performance Requirements

2.2 Internal communications shall:

2.2.1 be clearly noticeable by all embarked persons;

2.2.2 be easily distinguishable and recognisable;

2.2.3 be continuously available;

2.2.4 be protected from hazards;

2.2.5 have more than one means of providing information that an emergency situation exists;

2.2.6 be operable from strategic positions as agreed by the Naval Administration.

2.3 The requirements of Chapter VIII Communications shall be complied with as well.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 3 Escape Compartment(s)

Functional Objective

3.1 The submarine shall provide escape compartment(s) capable of supporting the embarked persons for the duration of SMERAS scenarios.

Performance Requirements

3.2 The escape compartment(s) shall enable the conduct of SMERAS activities from within that compartment.

3.3 The escape compartment(s) shall contain, but not be limited to:

3.3.1 internal and external communications;

3.3.2 emergency life support stores (ELSS);

3.3.3 an escape system(s);

3.3.4 interoperability with an SRS;

3.3.5 capable of receiving external support and supplies;

3.3.6 SESSPEs;

3.3.7 atmosphere control and monitoring arrangements;

3.3.8 personal hygiene and sanitary facilities.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Access Hatches

Functional Objective

4.1 Each hatch on the casing or in the conning tower shall allow safe entry into and safe exit from the submarine.

Performance Requirements

4.2 Hatches shall be situated in watertight compartments of the pressure hull to allow safe evacuation of the embarked persons.

4.3 Each hatch on the casing or in the conning tower shall allow safe entry into and safe exit from the submarine.

4.4 Hatches shall be able to be secured in an open and a closed position.

4.5 Hatches shall be suitable for the transport of injured persons in and out of the submarine.

4.6 Access hatches are to be operable from both sides.

4.7 The requirements of Chapter III Regulation 2 (Watertight Integrity) shall be complied with.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 5 Evacuation Routes

Functional Objective

5.1 Evacuation routes shall enable the movement of embarked persons from any compartment within the submarine to another compartment (e.g. muster stations and/or escape compartments) as quickly and as safely as possible.

Performance Requirements

5.2 Fixtures and fittings on evacuation routes shall facilitate the movement of embarked persons from any compartment and/or space within the submarine to the muster station and/or escape compartment(s) as quickly and as safely as possible.

5.3 Evacuation routes shall: allow for safe, quick and easy movement of embarked persons, taking into account that they shall:

5.3.1 be as redundant as reasonably practicable to provide for the possibility that certain evacuation routes may not be available as a result of fire, flooding or other damage;

5.3.2 remain functional as long as reasonably practicable during fire, flooding, heel and trim;

5.3.3 be arranged such that they do not contribute to the spread of fire, flood, smoke or other gases to any compartment;

5.3.4 be as direct as reasonably practicable and readily identified;

5.3.5 be functional in case of normal operations, electrical power failure and anticipated levels of heel or trim for damaged conditions;

5.3.6 allow for safe and easy movement of embarked persons, taking into account:

5.3.6.1 that there shall be sufficient space for the evacuated persons on the casing in an area which minimises the risk of being washed overboard;

5.3.6.2 the anticipated number, physical characteristics and distribution of embarked persons, including the possibility that some incapacitated persons may be transported by casualty evacuation (CASEVAC) equipment;

5.3.6.3 the size, location, function and risks of individual compartments and/or spaces on board the submarine;

5.3.6.4 the clothing and personal protective equipment (PPE) that may be worn and/or carried.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 6 Wayfinding System

Functional Objective

6.1 A wayfinding system shall allow embarked persons to safely and effectively locate muster stations, escape compartment(s) and as far as reasonably practicable take into account hazards caused by fire, smoke and flood water.

Performance Requirements

6.2 Wayfinding systems shall:

6.2.1 enable embarked persons to locate evacuation routes, exits, muster stations and escape compartment(s);

6.2.2 be unambiguous and readily found;

6.2.3 be operational in case of unavailability of electrical power;

6.2.4 be provided taking into account:

6.2.4.1 the anticipated distribution of embarked persons;

6.2.4.2 the anticipated familiarity of embarked persons with the submarine;

6.2.5 lead from all compartments to the muster stations and escape compartment(s).

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 7 Incapacitated Persons

Functional Objective

7.1 Embarked persons shall be able to move an injured/incapacitated person to a place of safety.

Performance Requirements

7.2 CASEVAC equipment shall:

7.2.1 enable crew members to transport any incapacitated persons horizontally or vertically throughout the submarine;

7.2.2 be compatible for helicopter pick-up;

7.2.3 be provided and located considering:

7.2.3.1 the number, distribution and physical characteristics of embarked persons;

7.2.3.2 the evacuation routes of the submarine.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Emergency Breathing Air

Functional Objective

8.1 Embarked persons shall have access to breathable air if the atmosphere in the submarine is outside permitted criteria as agreed by the Naval Administration.

Performance Requirements

8.2 A system to provide breathable air in an emergency shall be fitted and shall be operated separately from the general atmosphere control system.

8.3 Access to emergency breathing air is to be situated throughout the submarine as agreed by the Naval Administration.

8.4 The embarked persons shall be able to move around to execute their duties and be able to sit or lie down.

8.5 The requirements in Chapter XII Atmosphere Control Regulation 14 (Provide Emergency Breathing Air) shall be complied with.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 SMERAS Lighting

Functional Objective

9.1 SMERAS lighting systems shall provide sufficient illumination to conduct any SMERAS activity during an emergency and shall be independent of the submarine's own power.

Performance Requirements

9.2 SMERAS lighting systems shall:

9.2.1 provide sufficient illumination to any location essential for any SMERAS scenarios;

9.2.2 operate for a period as necessary to complete all SMERAS scenarios;

9.2.3 be provided such that any incident which may cause lighting failure shall be guarded against by system or equipment redundancy;

9.2.4 have minimised susceptibility to damage.

9.3 The requirements of Chapter IV Engineering Systems, Regulation 14 (Lighting) shall be complied with.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 10 Power Supply for SMERAS Scenarios

Functional Objective

10.1 There shall be power for all SMERAS scenarios as stated in the Concept of Operations Statement.

Performance Requirements

10.2 The power supply for shall:

10.2.1 have capacity to operate all equipment in a SMERAS scenario;

10.2.2 operate for a period as necessary to complete all SMERAS scenarios.

10.3 The requirements of Chapter IV Regulation 1 (General) shall be complied with.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 11 Provide Breathable Atmosphere

Functional Objective

11.1 The atmosphere in a DISSUB shall be suitable for breathing until the defined first intervention or rescue time as agreed by the Naval Administration.

Performance Requirements

11.2 The atmosphere in the enclosed volume of the submarine shall comply with the requirements as agreed by the Naval Administration.

Note: Also see Chapter XII Atmosphere Control.

11.3 The atmosphere shall be monitored and maintained independent from the submarine's own power.

11.4 The requirements of Chapter XII shall be complied with.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 12 SMERAS Emergency Life Support Stores

Functional Objective

12.1 For the embarked persons in a DISSUB, ELSS shall be maintained for the time to first intervention or the time to first rescue as agreed by the Naval Administration.

Performance Requirements

12.2 Food and water rations shall be available for the number of embarked persons.

12.3 If applicable, SMERAS storages shall protect the stored equipment from but not limited to:

12.3.1 outside environmental conditions such as diving-depth pressure, wash, green water, sea state, temperature, icing and wind;

12.3.2 the submarine's weapon systems and helicopter downwash;

12.3.3 temperature, humidity, fire, smoke, internal atmospheric presssure and hazardous gases.

12.4 SMERAS storages shall:

12.4.1 be robust and have minimum susceptibility to damage;

12.4.2 enable stored equipment to be accessible and readily deployed;

12.4.3 be readily found and unambiguously recognised;

12.4.4 allow regular inspection of the stored equipment;

12.4.5 not have a detrimental effect on the stored equipment;

12.4.6 not have a detrimental impact on the ready deployment of any other stored equipment in case of an emergency;

12.4.7 be free from undue hazards, such as protrusions or obstructions which could cause injury or ensnare clothing, life jackets or PPE;

12.4.8 be able to withstand the seakeeping accelerations of the submarine;

12.4.9 if applicable, be appropriately distributed over the escape compartment(s) of the submarine.

12.5 The stowage of life rafts, emergency and/or indicator buoys, and other outside-stored float-free equipment shall float free when released.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 13 Maintain Personal Hygiene and Clean Sanitary Conditions

Functional Objective

13.1 For the embarked persons in a DISSUB, minimum personal hygiene and sanitary facilities shall be provided.

Performance Requirements

13.2 There shall be hygiene and sanitary facilities in all compartments, either fixed or temporary, for use in a SMERAS scenario.

13.3 Waste shall not endanger the health of embarked persons.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 14 External Communication Equipment

Functional Objective

14.1 External communication equipment shall enable communication to other ships, submarines or aircraft or to shore during SMERAS scenarios.

Performance Requirements

14.2 A submarine shall be able to send out a distress signal stating their position and identity.

14.3 Communication shall be available between the DISSUB and submarine search and rescue assets.

14.4 External communications equipment shall have more than one means of providing information to external facilities.

14.5 External communication equipment shall be robust and have minimum susceptibility to damage.

14.6 The requirements of Chapter VIII shall be complied with.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 15 Life Jackets

Functional Objective

15.1 Life jackets shall provide effective flotation assistance for persons overboard.

Performance Requirements

15.2 Sufficient quantity of life jackets shall be provided for embarked persons as defined by the Naval Administration.

15.3 A life jacket shall:

15.3.1 protect unconscious persons from drowning;

15.3.2 be provided to accommodate the full range of physical characteristics of embarked persons;

15.3.3 be compatible with the PPE, not including SESSPEs, that embarked persons may be wearing during surface abandonment or operations on deck;

15.3.4 allow the person overboard to be readily located under different environmental conditions (e.g. weather, sea state and at all times of day or night).

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 16 Submarine Escape and Surface Survival Personnel Equipment

Functional Objective

16.1 SESSPEs shall protect persons in a SMERAS scenario.

Performance Requirements

16.2 Sufficient quantity of SESSPEs shall be provided for all embarked persons as defined by the Naval Administration.

16.3 A SESSPE shall:

16.3.1 protect against the effect of environmental conditions for the expected rescue times;

16.3.2 accommodate the full range of physical characteristics of embarked persons;

16.3.3 be unpacked and donned easily, swiftly and without assistance;

16.3.4 not hinder the person wearing it from conducting SMERAS activities;

16.3.5 remain functional during SMERAS scenarios;

16.3.6 provide effective buoyancy;

16.3.7 protect unconscious persons from drowning;

16.3.8 not hinder the person wearing it from swimming and boarding a life raft;

16.3.9 allow the person to be readily located under different environmental conditions.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 17 Escape System(s)

Functional Objective

17.1 A means of escape, from a DISSUB down to a depth as agreed by the Naval Administration, shall be provided.

Performance Requirements

17.2 The submarine shall be fitted with at least one escape system as agreed by the Naval Administration.

17.3 All aspects of the escape system shall be capable of being operated by one person.

17.4 All aspects of the escape system shall be capable of being operated from within the submarine.

17.5 The escape system shall accommodate the full range of physical characteristics of embarked persons while in a SESSPE.

17.6 There shall be sufficient air for all embarked persons to escape from the submarine as agreed by the Naval Administration.

17.7 The submarine shall be able to receive SMERAS supplies from external facilities.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 18 Interoperability with Submarine Rescue Systems

Functional Objective

18.1 There shall be a means for a dry transfer rescue from a DISSUB and into an SRS.

Performance Requirements

18.2 The submarine shall be fitted with at least one rescue seat interoperable with an SRS, as agreed by the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 19 Safe Embarkation into Life Raft(s)

Functional Objective

19.1 A safe method of transfer of embarked persons from the submarine into life raft(s) shall be available.

Performance Requirements

19.2 A safe means of launching life raft(s) shall be provided.

19.3 A safe means of embarking personnel into life raft(s) shall be provided.

19.4 It shall be possible to transfer incapacitated persons with CASEVAC equipment into a life raft.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 20 Survival until Recovery from Sea

Functional Objective

20.1 The survival of embarked persons who have abandoned the submarine shall be achieved without external support while awaiting recovery.

Performance Requirements

20.2 Survival arrangements shall protect evacuated persons for a length of time as agreed by the Naval Administration.

20.3 Signal equipment shall identify the rescue datum area and comply with the requirements in Chapter VIII Regulation 9.

20.4 A means of preventing the dispersion of survivors shall be provided to facilitate rapid recovery.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 21 Inspection and Maintenance

Functional Objective

21.1 Inspection and maintenance procedures shall ensure that any SMERAS arrangement or equipment has an availability which is as high as reasonably practicable.

Performance Requirements

21.2 SMERAS measures which are supplied in accordance with recognised standards shall be inspected and maintained as specified by those standards.

21.3 Maintenance and inspection activities shall be undertaken by suitably qualified personnel in accordance with approved procedures and the activities shall be recorded.

21.4 The periodicity of maintenance and inspection activities shall optimise the operational availability of SMERAS measures.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 22 Provision of Operational Information

Functional Objective

22.1 On-board documentation shall provide information, plans and procedures for the conduct of effective SMERAS activities.

Performance Requirements

22.2 On-board information shall:

22.2.1 cover information necessary for embarked persons to conduct SMERAS-related activities;

22.2.2 be ergonomically presented and correct, clear and understandable;

22.2.3 be readily found and available at locations where it might be needed.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 23 SMERAS Analysis and Demonstration

Functional Objective

23.1 A SMERAS analysis and demonstration shall ensure that the effectiveness of SMERAS measures is optimised.

Performance Requirements

23.2 A SMERAS analysis shall:

23.2.1 optimise the effectiveness of SMERAS measures, considering:

23.2.1.1 normal seagoing conditions for a surfaced and a submerged submarine;

23.2.1.2 DISSUB conditions, defined in the Concept of Operations Statement, for the surfaced and the submerged submarine.

23.2.2 represent flows of persons during SMERAS that are as factually accurate as possible.

23.3 A SMERAS demonstration shall:

23.3.1 verify the accuracy of the SMERAS analysis;

23.3.2 enable the Naval Administration to identify unforeseen shortcomings of the SMERAS measures;

23.3.3 represent flows of persons during SMERAS as realistically as possible;

23.3.4 not impose unacceptable risks to persons involved in the demonstration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

PART 1 CHAPTER VIII COMMUNICATIONS

Contents

Regulation 0 Goal

0.1 The communications equipment shall be designed, installed and maintained so that the submarine, while at sea and where practicable depending on the operating condition (surfaced, submerged or at periscope depth), is capable of:

0.1.1 transmitting ship-to-shore distress alerts by at least two separate and independent means, each using a different radio-communication service;

0.1.2 transmitting ship-to-air distress alerts;

0.1.3 receiving shore-to-ship distress alerts;

0.1.4 transmitting and receiving ship-to-ship distress alerts;

0.1.5 transmitting and receiving search-and-rescue coordinating communications;

0.1.6 transmitting and receiving on-scene communications;

0.1.7 transmitting and receiving signals for locating ships, aircraft, units or persons in distress, including persons lost overboard;

0.1.8 transmitting and receiving maritime safety information;

0.1.9 transmitting and receiving general radio communications to and from shore-based radio systems or networks;

0.1.10 transmitting and receiving bridge-to-bridge communications from the position where the submarine is normally navigated;

0.1.11 transmitting and receiving internal communications.

0.2 The communications equipment shall:

0.2.1 provide high reliability and minimise the risk of mal operation in all foreseeable operating conditions, accidents and emergencies;

0.2.2 maintain essential safety functions after a minimum of one single operational error and/or system/equipment fault.

0.3 The communications systems shall provide the capability to facilitate all submarine safety communications, including but not limited to SUBLOOK, SUBMISS and SUBSUNK procedures through the Global Maritime Distress and Safety System (GMDSS) and/or the military internal and external communications fit.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter VIII Communications and its application.

Purpose

1.2 The ability to be deployed to any area of interest to the navy, as defined in the Concept of Operations Statement, shall be maintained and the communications fit and on-board personnel shall provide:

1.2.1 the capability to receive and transmit all information as required by the Global Maritime Distress and safety System (GMDSS) in all sea states and weather conditions; this shall include an emergency submerged capability, including communications to facilitate safe submarine escape and rescue;

1.2.2 on-board safety communications including internal communications, main broadcast, portable and survival craft equipment;

1.2.3 qualified personnel that are certified to operate and, if required, maintain the GMDSS equipment to International Telecommunication Union (ITU) Radio Regulations.

Scope

1.3 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter VIII goal, the requirements of both this chapter and Chapter I shall be met.

1.4 The Naval Submarine Code excludes training requirements. Chapter VIII Communications assumes all embarked persons have an appropriate level of competence for the operation of the installed systems. Part 3 contains some guidance on typical training requirements.

General Performance Requirements

1.5 The Concept of Operations Statement is the owner's vision of how the communications systems of the submarine are to be operated and maintained throughout the life of the submarine and is to be shared by the Naval Administration and, where appointed, its recognised organisation.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 2 GMDSS and Other Safety Communications Equipment

Functional Objective

2.1 The submarine shall be fitted with GMDSS and other safety communications equipment to enable communication with shore-based communication and rescue authorities, in addition to vessels in the immediate vicinity, in the event of marine distress.

Performance Requirements

2.2 The submarine shall be fitted with:

2.2.1 GMDSS equipment to:

2.2.1.1 transmit ship-to-shore distress alerts by at least two separate and independent means, each using a different radiocommunication service; one of these means shall be portable;

2.2.1.2 receive shore-to-ship distress alerts;

2.2.1.3 transmit and receive ship-to-ship distress alerts;

2.2.1.4 transmit and receive search and rescue coordinating communications;

2.2.1.5 transmit and receive on-scene communications;

2.2.1.6 transmit and receive signals for locating ships, aircraft or units in distress;

2.2.1.7 transmit and receive maritime safety information;

2.2.1.8 transmit and receive general radiocommunications to and from shore-based radio systems or networks;

2.2.1.9 transmit and receive bridge-bridge communications from the navigation area of the submarine;

2.2.2 a satellite emergency-position-indicating radio beacon (SEPIRB) which shall be:

2.2.2.1 capable of transmitting a distress alert through global covering satellite service;

2.2.2.2 installed in an easily accessible position;

2.2.2.3 ready to be manually released and capable of being carried by one person into a survival craft (see Regulation 9 Survival-Craft Radio Equipment);

2.2.2.4 capable of being activated manually;

2.2.3 a marine survivor-locating system (MSLS) which shall:

2.2.3.1 provide an audible alert that a person has fallen overboard;

2.2.3.2 provide in-water tracking of the casualty.

2.3 The GMDSS equipment to be fitted shall be determined by the submarine's sea area of operations with reference to the Concept of Operations Statement.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 3 Availability of GMDSS and Other Safety Communications Equipment

Functional Objective

3.1 GMDSS and other safety communications equipment shall be continuously available at sea.

Performance Requirements

3.2 The continuous availability of the GMDSS and other safety communications equipment functions defined at Part 1, Regulation 2 shall be ensured by using such methods as duplication of equipment or provision of maintenance facilities.

3.3 The number and diversity of methods used to ensure continuous availability of the GMDSS and other safety communications equipment functions shall be determined by the submarine's area of operation with reference to the Concept of Operations Statement.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Communications Sources of Energy

Functional Objective

4.1 A suitable source of power shall be available for all critical internal and external communication systems.

Performance Requirements

4.2 A redundant supply of electrical energy sufficient to operate the critical communication systems shall be immediately available in the event of loss of the primary energy supply, for a time specified by the Naval Administration, while the submarine is at sea. Any dedicated batteries used for the critical communication systems shall be maintained and inspected regularly.

4.3 The source of energy to supply GMDSS radio installations shall be provided in accordance with Chapter IV Regulation 10 Electrical Generation and Power Supplies and Regulation 11 Battery System and Battery Charging for the purpose of conducting distress and safety radio communications. The source or sources of energy shall be capable of simultaneously supporting all provided GMDSS equipment.

4.4 If an input of information from the submarine's navigational or other equipment is needed to ensure the critical communication system's proper performance, that equipment shall be equally supported.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 5 Position Updates

Functional Objective

5.1 Electronic position information shall be available to both the GMDSS equipment and any fitted supplementary submarine emergency communications and location equipment.

Performance Requirements

5.2 All communication equipment carried on board a submarine which is capable of automatically including the submarine's position in the distress alert shall be automatically provided with this information from an internal or external navigation source, if either is installed.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 6 Internal Communications

Functional Objective

6.1 Internal communications equipment shall be provided to:

6.1.1 enable safe operation of the submarine;

6.1.2 alert embarked persons of emergency or hazardous situations;

6.1.3 facilitate appropriate emergency response and recovery.

Performance Requirements

6.2 Internal communications shall provide effective two-way verbal communication between crew members and it shall:

6.2.1 be operable from all positions used for submarine escape, rescue, abandonment and survival (SMERAS), damage control, and command and control.

6.3 Backup internal communications shall also be available in the event that the primary means of communication is unavailable. The backup communications shall:

6.3.1 be effective and continuously available;

6.3.2 be protected from hazards such as fire, vibration, electrical interference and flooding;

Note: The Naval Administration may also require that the equipment be protected from hazards associated with extreme events, e.g. shock, blast and EM radiation.

6.3.3 be independent of the submarine's main power supply;

6.3.4 be operable from positions used for SMERAS, damage control and command and control.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 7 Main Broadcast

Functional Objective

7.1 A main broadcast system shall enable verbal and audio communication to all embarked persons of an emergency incident and the actions to be taken.

Performance Requirements

7.2 The main broadcast system shall:

7.2.1 allow one-way verbal communication to all embarked persons, including the transmission of live speech;

7.2.2 be clearly audible by all embarked persons;

7.2.3 be easily distinguishable and recognisable;

7.2.4 be continuously available;

7.2.5 be protected from hazards such as fire, vibration, electrical interference and flooding;

Note: The Naval Administration may also require the equipment be protected from hazards associated with extreme events such as e.g. shock, blast, and EM radiation.

7.2.6 be operable from positions used for SMERAS damage control and command and control.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Portable Communications

Functional Objective

8.1 Portable communication systems shall be available to enable effective two-way communication between crew members in situations not covered by the main broadcast nor the internal communication systems.

Performance Requirements

8.2 Portable communications systems shall:

8.2.1 allow clear and distinguishable two-way communication;

8.2.2 have adequate system coverage for the intended area of use;

8.2.3 have sufficient system redundancy, as agreed by the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 Survival-Craft Radio Equipment

Functional Objective

9.1 External communication equipment shall be available to be used in survival craft to enable communication to other vessels, aircraft or shore during emergencies.

Performance Requirements

9.2 External communication equipment that is to be used in survival craft shall:

9.2.1 be easy to operate, including by those wearing firefighting or other individual protective equipment;

9.2.2 incorporate redundancy;

9.2.3 be located at strategic SMERAS positions as agreed with the Naval Administration;

9.2.4 be installed in such a way as to avoid harmful electromagnetic interference arising from or being given to other equipment on board;

9.2.5 work safely with other survival equipment.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 10 Sea–Air Radio Communications

Functional Objective

10.1 A sea-to-air, two-way radio communications system shall be fitted to enable communication with overflying aircraft during emergencies.

Performance Requirements

10.2 Every submarine shall be provided with means for two-way, on-scene radio communications for search and rescue purposes using civil aeronautical very high frequencies (VHF).

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 11 Installation, Testing, Maintenance and Repairs

Functional Objective

11.1 The location and submarine installation of all safety communications equipment shall enable its operation, maintenance, testing and repair.

Performance Requirements

11.2 All safety communications systems shall:

11.2.1 be located so that no harmful interference of mechanical, electrical or other origin affects its proper use, and so as to ensure electromagnetic compatibility and avoidance of harmful interaction with other equipment and systems;

11.2.2 be located so as to ensure a sufficient degree of safety and operational availability;

11.2.3 be protected against harmful effects of water, extremes of temperature and other adverse environmental conditions;

11.2.4 be provided with reliable, permanently arranged electrical lighting, independent of the main and emergency sources of electrical power, for the adequate illumination of the controls for operating the safety communication installation;

11.2.5 be clearly marked with the call sign, ship-station identity and other codes as applicable for the use of the safety communication installation.

11.3 Control of the VHF radiotelephone channels, required for navigational safety, shall be immediately available at the point of navigation, convenient to the conning position.

11.4 Where applicable, equipment shall be so constructed and installed that it is readily accessible for inspection and on-board maintenance purposes.

11.5 Where required by the Naval Administration, all communications equipment shall be provided with facilities to guarantee the inhibition transmissions.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 12 Operational Audit and Compliance Validation

Functional Objective

12.1 Safety communications equipment shall be surveyed at regular intervals.

Performance Requirements

12.2 The safety communications equipment shall be surveyed at intervals determined by the Naval Adminstration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3

PART 1 CHAPTER IX NAVIGATION

Contents

Regulation 0 Goal

0.1 The submarine shall be designed, constructed, installed and maintained so that, while at sea, whether surfaced, dived or at periscope depth it can:

0.1.1 be independently navigated;

0.1.2 provide alerts of all navigation hazards, fixed or mobile;

0.1.3 measure and interpret environmental data;

0.1.4 where practicable, assist other ships, aircraft, units or persons in distress;

0.1.5 where practicable, make other vessels aware of the submarine's position, course, speed and manoeuvring limitations.

0.2 The submarine shall be able to manoeuvre to minimise risk of grounding, collision and negative environmental impact.

0.3 The navigation systems shall be designed, constructed, operated and maintained to:

0.3.1 provide high reliability and minimise the risk of mal operation in all foreseeable operating conditions, accidents and emergencies;

0.3.2 maintain uninterrupted essential safety functions after a minimum of one single operational error and/or system/equipment fault;

0.3.3 maintain uninterrupted essential navigation safety functions, regardless of the operational tasking of the submarine.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter IX Navigation and its application.

Purpose

1.2 The ability to be deployed to any area of interest to the navy, as defined in the Concept of Operations Statement, shall be maintained and the navigation equipment and sensors that are fitted and the embarked persons shall provide:

1.2.1 the capability to conduct safe navigation as required by SOLAS and the Regulations for the Prevention of Collision at Sea, 1972 (COLREGs);

Note: The requirements of Chapter III, IV and VI which relate to navigation equipment shall be met.

1.2.2 communications capabilities as defined in Chapter VIII;

1.2.3 qualified personnel who are certified to operate and, if required, maintain navigation equipment and systems.

Scope

1.3 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter IX goal, the requirements of both this chapter and Chapter I shall be met.

1.4 The Naval Submarine Code excludes training requirements. Chapter IX Navigation assumes all embarked persons have an appropriate level of competence for the operation of the installed systems. Part 3 contains some guidance on typical training requirements.

General Performance Requirements

1.5 The submarine's Concept of Operations Statement defines how the navigation systems of the submarine are to be operated and maintained throughout its life and is to be shared by the Naval Administration and, where appointed, its recognised organisation.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 2 Navigation Areas Working Environment

Functional Objective

2.1 The navigation areas shall provide a working environment which facilitates the sustained maintenance of an effective lookout and the conduct of safe navigation.

Performance Requirements

2.2 It shall be possible to manoeuvre the submarine from the navigation area.

Note: The requirements of Chapter III and IV which relate to navigation equipment and manoeuvrability shall be met.

2.3 External conning positions shall be provided with protection from harsh and unfavourable weather conditions.

2.4 The navigation area shall be arranged such that the Officer of the Watch (OOW) or other appropriate person has immediate access to all necessary navigational aids to maintain safe navigation of the submarine.

2.5 The navigation area shall be arranged such that the OOW or other appropriate person has immediate access to the submarine's internal and external safety communications network.

2.6 The elements of the navigation area that are within the pressure hull shall be provided with a heating, ventilation and air conditioning (HVAC) system, or equivalent, that maintains the ventilation, temperature and humidity of the navigation area within a comfortable range.

Note: The HVAC system shall also comply with Chapter IV.

2.7 The navigation area and the systems installed shall be provided with lighting and illumination systems that enable personnel to perform all navigation tasks, including maintenance, by day and night. Lighting systems external to the pressure hull shall be designed such that they do not impair safe navigation.

2.8 The effects of direct and indirect glare are to be reduced to a minimum.

2.9 Where multiple consoles or workstations are to be installed in the navigation area they shall be of a common design.

2.10 Noise levels within the external navigation areas during good weather are to be sufficiently low as to enable operators carrying out navigation duties to concentrate for long periods of time and comfortably hold conversations with other personnel for the sustained conduct of safe navigation. Noise levels within the internal navigation areas are to be suffienctly low at all times.

2.11 Within the navigation area any alarm, whether audible or visible, must be capable of being immediately acted upon by the appropriate personnel.

2.12 There shall be a means available to monitor navigation area activity and detect operator disability which could lead to marine accidents.

2.13 The navigation area shall be arranged such that access to equipment, movement around the area and escape from the area is, so far as practicable, unobstructed and hazard-free.

Note: Access shall also comply with Chapter VII.

2.14 Safety equipment stored in the navigation area shall be readily accessible.

2.15 Facilities to promote the efficiency and alertness of the navigation area operators are to be provided in or adjacent to the navigation area.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 3 Navigation Area Workstations

Functional Objective

3.1 The design and arrangement of the workstations shall ensure that the operators are enabled to perform expeditious, continuous and effective information processing and decision making for maintaining a proper lookout and the conduct of safe navigation.

Performance Requirements

3.2 The design and arrangement of the navigation area and the navigational systems and equipment shall:

3.2.1 facilitate the tasks to be performed by the navigation team in making a full appraisal of the situation and in navigating the submarine safely under all operational conditions by enabling expeditious, continuous and effective information processing and decision making;

3.2.2 enable the navigation team to have convenient and continuous access to essential information which is presented in a clear, unambiguous manner, using standard symbols and coding systems for controls and displays;

3.2.3 indicate the operational status of automated functions and integrated components, systems and/or sub-systems;

3.2.4 prevent, or minimise, excessive or unnecessary work and any conditions or distractions in the navigation areas which may cause fatigue or interfere with the vigilance of the navigation team and the pilot;

3.2.5 minimise the risk of human error and detect such error, if it occurs, through monitoring and alarm systems, in time for the navigation team and pilot to take appropriate action.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Navigation Safety – Geospatial, Temporal and Environmental Awareness

Functional Objective

4.1 The submarine shall be provided with a means to continuously and accurately determine, display and record its present time, position, orientation and movement in relation to the Earth in order to ensure safe independent navigation.

Performance Requirements

4.2 The Concept of Operations Statement shall determine the levels of accuracy to which means are required to operate in all three operating conditions.

4.3 The submarine shall be provided with sufficient sensors and systems to:

4.3.1 ensure continuous monitoring of position, velocity and time;

4.3.2 generate a precise time reference continuously for intended voyage;

4.3.3 determine and input heading information and rates of turn;

4.3.4 determine heel (roll) and trim (pitch) angles at all times;

4.3.5 correct heading and bearings to true at all times;

4.3.6 determine and input speed and distance travelled over ground;

4.3.7 determine and input submarine's depth below the surface of the water;

4.3.8 determine and input depth of water below the submarine;

4.3.9 establish and update the submarine's position; the submarine shall be able to detect false position updates to avoid such data entering the navigation process;

4.3.10 identify weather and sea conditions;

4.3.11 measure, display, record and analyse, in real time, the submarine's behaviour in the prevailing conditions of wind and sea.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 5 Operation and Control Systems

Functional Objective

5.1 A submarine shall be provided with appropriate means to control propulsion and manoeuvring systems from the navigation areas for the conduct of safe navigation and collision avoidance.

Performance Requirements

5.2 When conning the submarine, the Commanding Officer or authorised delegate (OOW) shall:

5.2.1 have means to control the heading, speed, depth, heel (roll) and trim (pitch) of the submarine in a timely manner;

5.2.2 control the means by which manoeuvring intentions are passed to the appropriate control station;

5.2.3 be aware at all times of the submarine's manoeuvring and propulsion limitations.

5.3 The OOW shall control the means by which the submarine displays its illuminated appearance.

5.4 The submarine shall have means to communicate with other ships or aircraft by day and night.

5.5 The submarine shall have means to alert others that the submarine is in distress.

5.6 There shall be a means for the OOW to communicate with those in charge of essential safety functions and with all embarked persons in the event of an emergency.

5.7 The OOW shall have means to communicate with control station operators.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 6 Resilience and Continuous Availability

Functional Objective

6.1 The submarine shall be provided with sufficient equipment to assure that there is resilience and continuous availability in navigation-related systems and equipment.

Performance Requirements

6.2 The submarine's spaces, systems and equipment essential to the maintenance of a proper lookout and the conduct of safe navigation shall be so arranged as to ensure high reliability and minimise the risk of mal operation.

6.3 Machinery, equipment and systems that are essential to safe navigation shall be so arranged that they will continue to function correctly and/or be easy to restore in the event of a minimum of a single operational error and/or system/equipment fault.

Note: Refer to Chapter III and IV for resilance of controllability and electrical supplies.

6.4 Equipment that is necessary for the safety of navigation shall be capable of being accessed for the purpose of routine maintenance to keep it in efficient working order.

6.5 There shall be reversionary methods of controlling propulsion, manoeuvring compensating and deballasting systems from the navigation area, machinery control position and other places determined by the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 7 Integrated Systems

Functional Objective

7.1 Where required by the Naval Administration, an integrated bridge system (IBS), an integrated navigation system (INS) or both (an integrated navigation bridge system – INBS) shall present all relevant information

necessary for the conduct of safe navigation, manoeuvring and collision avoidance to ensure that additional hazards are not introduced as a result of installing or operating the system.

Note: Unless otherwise noted, or clear from the context of the requirement, the term 'INBS' in the following paragraphs of this regulation refers to both an IBS and INS.

Performance Requirements

7.2 The INBS shall be designed, constructed and able to be maintained so as to support the proper and safe integration of navigational functions and information required to maintain a proper lookout, sustain safe conduct of navigation and manoeuvre as required, in particular:

7.2.1 to allow the installation and use of an INBS instead of stand-alone navigational equipment on board submarines;

7.2.2 to promote safe procedures for the integration process;

7.2.3 to ensure its performance is at least equivalent to the performance required of the individual components and subsystems by this chapter;

7.2.4 to alert operators of any degraded condition relevant for the conduct of safe navigation, such that the OOW and pilot can understand the nature of the failure and its consequences.

Note: The system shall also comply with all other regulations of this chapter.

7.3 Navigation systems shall not be rationalised by sharing functions or by inter-switching.

7.4 INBS equipment utilising programmable electronic systems shall be robust, resilient to operator errors and able to continue functioning in extremis. The Naval Administration shall identify the degree of functionality that should remain in extreme circumstances.

Note: The system shall also comply with Chapter IV and XI.

7.5 The INBS shall be so arranged that it is not dependent upon the submarine's combat systems being available and it will allow rapid removal of tactical data for the purposes of safe navigation. If a higher level of integration of the INBS and the combat management system (CMS) is considered, due measures to support safe integration shall be taken.

Note: The system shall also comply with Chapter XI.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Data Communication

Functional Objective

8.1 The submarine shall be fitted with equipment and systems in order to receive, transmit, record and analyse data, in recognised formats, that is relevant to safe navigation.

Performance Requirements

8.2 The submarine shall be fitted with a means for recording all navigation-related data for a period as determined by the Naval Administration such that the sensor presentations, internal and external voice communications, navigation staff decision-making processes and the submarine's movements might be adequately reconstructed if necessary.

Note: The system shall also comply with Chapter VIII.

8.3 The submarine shall be provided with systems/equipment to support the regular reporting of its position and movement to the appropriate Command.

8.4 The submarine shall be capable of the automatic transmission and reception of specified navigation and safety-related information to and from appropriately equipped ships, aircraft and shore stations, when surfaced or at periscope depth. The system shall:

8.4.1 be controlled from the navigation area and its extensions and may be interfaced with, or an integral element of, the combat system, provided that independent operation is possible;

8.4.2 be capable of providing (at the Commanding Officer's discretion) to similarly fitted ships, aircraft and shore stations the submarine's identity, position, course, speed, navigational status and other safety-related information;

8.4.3 automatically receive such information from automatic identification system (AIS) fitted vessels;

8.4.4 monitor and track ships;

8.4.5 exchange data with shore-based facilities.

8.5 When surfaced or at periscope depth, the submarine shall be able to automatically receive maritime safety information.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 9 Collision Avoidance

Functional Objective

9.1 The submarine shall be provided with sensors, systems and equipment to enable the crew to determine the risk of collision, signal the submarine’s condition and intentions, and manoeuvre to avoid collisions in the prevailing circumstances and conditions.

Performance Requirements

9.2 When surfaced the submarine shall be able to exhibit, by day and night and in all weathers, appropriate lights and shapes in order to indicate its size, orientation, activity and limitations so as to facilitate the determination of risk of collision by other mariners.

9.3 When surfaced the submarine shall be able to generate, by day and night and in all weathers, sound signals, in order to indicate its size, orientation, activity and limitations so as to facilitate the determination of risk of collision by other mariners.

9.4 When surfaced, if the submarine is equipped with external operational lighting for military purposes, it shall be possible to revert to ordinary navigation lights in a time sufficient to avoid a collision.

9.5 In all operating states the submarine, by day and night and in all weathers, shall be able to detect the presence of nearby vessels, understand their intentions and take measures as required to avoid a collision.

9.6 In all operating states, the submarine shall be able to track other vessels to determine the risk of collision.

9.7 In all operating states, the submarine shall always have sufficient power and a means of manoeuvring available, to ensure proper control.

Note: The system shall also comply with Chapter IV.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

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PART 1 CHAPTER X DANGEROUS GOODS

Contents

Regulation 0 Goal

Note: This chapter primarily regulates the carriage and use of Class 1 articles and substances. The chapter scope (Regulation 1) also details how Class 2–9 articles and substances shall be addressed.

0.1 The submarine arrangements for the carriage and use of dangerous goods shall:

0.1.1 minimise the risk of an incident associated with the carriage of dangerous goods;

0.1.2 manage the risk to people, property and the environment, including essential safety functions, arising from incidents associated with the carriage and use of dangerous goods to an acceptable level;

Note: National and International regulations regarding Health and Safety shall apply to personnel involved with the carriage and use of dangerous goods in addition to the requirements of this Chapter.

0.1.3 enable the safe movement, maintenance and preparation for use of dangerous goods.

Note: This chapter seeks to control the risk of an incident arising from the carriage and use of dangerous goods and could be considered a component of an environmental protection policy.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter X that shall be met if the role of the submarine requires the carriage or use of dangerous goods.

Scope

1.2 Chapter X Dangerous Goods is written in a goal-based format which specifies high-level objectives to achieve a minimum level of safety. It also provides some solutions which form the foundation for the selection of standards and development of practices and procedures.

1.3 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter X goal, the requirements of both this chapter and Chapter I shall be met.

1.4 Submarine arrangements associated with dangerous goods shall be in accordance with the requirements of the IMO Convention on the Safety of Life at Sea (SOLAS) and the International Maritime Dangerous Goods (IMDG) Code.

1.5 For Class 1 items where compliance with paragraph 1.4, in whole or part, is not compatible with the Concept of Operations Statement, the owner shall comply with this chapter by the implementation of either (or both):

1.5.1 equivalent arrangements for aspects within the scope of SOLAS or the IMDG Code;

1.5.2 additional arrangements for aspects outside the scope of SOLAS or the IMDG Code.

1.6 For Class 2–9 items where compliance with paragraph 1.3, in whole or part, is not compatible with the Concept of Operations Statement, the owner shall address the issues of stowage, personal protection and emergency procedures when dangerous goods are in use, and the subsequent stowage of opened dangerous goods, through a risk assessment.

1.7 The requirements of this chapter apply directly to all spaces and systems in which dangerous goods are stowed, maintained, handled or used and to those adjacent spaces containing items that might produce an unacceptable risk of incident. The list of affected spaces and equipment shall be agreed with the Naval Administration.

1.8 Chapter IV contains the overarching requirements for engineering systems which apply to the carriage and use of dangerous goods (Class 1–9). Chapter X supplements Chapter IV by providing additional requirements applicable to Class 1 dangerous goods (explosives).

1.9 Chapter VI contains the overarching requirements for fire safety which apply to the carriage and use of dangerous goods (Class 1–9). Chapter X supplements Chapter VI by providing additional requirements applicable to Class 1 dangerous goods (explosives).

1.10 Chapter X does not apply to dangerous goods which are a permanent component of a submarine system, except for Class 1 items stored within their launching mechanisms.

1.11 Once equipment containing dangerous goods is removed from its host system it is subject to the regulations of this chapter.

1.12 Where a submarine loads and unloads dangerous goods to vehicles, the submarine arrangements shall manage the safety of the dangerous goods until the loaded vehicle no longer places the submarine at risk.

1.13 The Naval Submarine Code excludes training requirements. Chapter X Dangerous Goods assumes all embarked persons have an appropriate level of competence for the operation of the installed systems. Part 3 contains some guidance on typical training requirements.

Application

1.14 This chapter shall apply from the point at which dangerous goods directly contact or place at risk the receiving submarine (e.g. on the casing) to the point at which they no longer put the submarine at risk (e.g. after consumption or transfer to another vehicle or to shore).

1.15 This chapter applies to the carriage and use of dangerous goods during foreseeable operating conditions. For extreme threat conditions, the owner shall define the requirements in the Concept of Operations Statement and set the performance requirements for the safety of dangerous goods.

Note: Foreseeable operating conditions and extreme threat conditions are defined in Part 1 Definitions and Abbreviations.

1.16 Where the submarine arrangements do not meet the requirements of the other chapters, the implications for dangerous goods shall be identified and submarine arrangements provided that are specific to the risk management of dangerous goods.

General Performance Requirements

1.17 The submarine's safety management system shall include a section specific to dangerous goods, whose scope at a minimum addresses all the elements of this chapter and shall be independently assured. Design standards, acceptance criteria and verification of effective submarine arrangements throughout the submarine's life shall be derived from the safety management system.

1.18 Submarine arrangements supporting the safe carriage and use of dangerous goods shall be clearly identified, operated and maintained commensurate with the importance of the risk they manage.

1.19 Dangerous goods shall be designated in accordance with the UN Recommendations on the Transport of Dangerous Goods – Model Regulations.

1.20 Dangerous goods shall not be embarked without appropriate documentation that identifies the dangerous goods' inherent safety and associated safety parameters.

1.21 Where, for extraordinary, immediate operational reasons the requirements of Chapter X are unable to be met, approval for the safe carriage and use of dangerous goods and potentially dangerous goods shall meet the requirements of Chapter I Regulation 6.Safety Certification

Note: Potentially dangerous goods are items whose safety is not fully understood that may reasonably be suspected of being either (a) hazardous in accordance with the UN Recommendations on the Transport of Dangerous Goods – Model Regulations; or (b) may endanger embarked dangerous goods.

1.22 The submarine, systems and equipment shall be approved in accordance with the agreed standards by the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 2 Layout and Services

Functional Objective

2.1 Submarine arrangements for the location within the submarine, layout of spaces and the provision of supporting services shall maintain the inherent safety of the dangerous goods and manage incidents.

Performance Requirements

2.2 The size, shape and location of the dangerous goods stowage areas, maintenance facilities, embarkation and disembarkation routes, and emergency procedures shall be designed taking into account the Concept of Operations Statement, the use of the dangerous goods and the risks associated with the dangerous goods as derived from the safety management system.

2.3 Spaces adjacent to dangerous goods stores and submarine equipment (for both normal and fault conditions) shall be designed to manage the hazards they present to the dangerous goods.

2.4 Submarine arrangements for temporary holding areas for dangerous goods shall manage the risk from and to the dangerous goods commensurate with the time at risk.

2.5 The ergonomics of the spaces in which dangerous goods are stored, prepared, maintained or used shall provide for the safe carriage and use, maintenance, and inspection of dangerous goods and the dangerous goods stowage areas.

2.6 Submarine arrangements shall mitigate the risk of a reaction occurring between dangerous goods.

2.7 Systems or equipment passing through or resident in spaces in which dangerous goods are stored or used shall not present an unacceptable risk to the dangerous goods or vice versa during normal operation or fault conditions.

2.8 Dangerous goods stowage areas shall be designed to collect any leakage of hazardous liquids and detect gases or vapours that might emanate from dangerous goods, or other items, so that they can be safely managed.

2.9 Submarine arrangements shall be such that an incident associated with dangerous goods does not degrade essential submarine escape, rescue, abandonment and survival systems below an acceptable level.

2.10 Incident control systems, such as pressure relief systems and containment control, shall not endanger the crew or third parties when operated.

2.11 Dangerous goods stowage areas shall have emergency evacuation arrangements for personnel. The scope of such arrangements shall be commensurate with the size of the submarine and the type of hazard presented by the dangerous goods.

2.12 The submarine arrangements shall control the environment to be as required by the dangerous goods embarked.

2.13 Submarine arrangements shall be demonstrated at build and through life to control the environment in accordance with the dangerous goods requirements.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 3 Structural Protection

Functional Objective

3.1 Submarine arrangements shall provide appropriate structural integrity to support dangerous goods and their associated safety systems.

Performance Requirements

3.2 Structure which is a component of the submarine's safety management system shall be designed, constructed and maintained to protect the submarine from incidents occurring with dangerous goods.

Note: For foreseeable damage conditions, structural requirements relating to fire incidents are contained in Chapter VI, Regulation 2 and structural requirements relating to damage are contained in Chapter II, Regulation 3 Loads and Load Cases.

3.3 Submarine structure shall support safety and consequence management systems.

3.4 Safety factors of structures associated with handling and operating equipment shall be appropriate for the hazard classification of the dangerous goods being used and the operation under consideration.

3.5 Temporary or portable submarine structures or fittings associated with the carriage and use of dangerous goods shall be designed, built, assembled and tested commensurate with the risk associated with the dangerous goods.

3.6 Structural fixing of items within dangerous goods stowage areas shall ensure the items remain fixed in all foreseeable operating conditions and extreme conditions where required by the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Fire Protection

Functional Objective

4.1 Submarine arrangements shall manage, to an acceptable level, the risk of fire incidents that are initiated by dangerous goods or that threaten dangerous goods.

Note: This regulation applies whenever and wherever dangerous goods are present and are additional to the requirements of Chapter VI – which shall be read in conjunction with Chapter X.

Performance Requirements

4.2 The fire management policy for dangerous goods for the submarine, including prevention, detection, containment, control and extinguishing of fires, shall be defined in the Concept of Operations Statement.

Note: This will include a definition of the number and severity of fire incidents the submarine shall be expected to manage and verified for operation in the extreme threat conditions as defined in Chapter I.

4.3 The fire detection, alarm and response system shall be appropriate to the submarine's Concept of Operations Statement (e.g. fully automated or requiring manual activation).

4.4 Materials shall be selected to minimise the fire risk they present.

4.5 Drainage, flooding and fixed firefighting systems for dangerous goods stowage areas shall be controllable from outside the space.

4.6 To prevent fire escalation, the fire protection system design, coverage, reaction times and rates of deployment shall be commensurate with the type of hazard presented by the dangerous goods.

4.7 Systems that pass through dangerous goods stores shall be avoided where failure of the system presents a fire risk to the goods stored. Where this is not possible, appropriate mitigation such as shielding or enhanced fire protection systems shall be provided.

Note: Systems refers to pipes, cables, vents, etc.

4.8 The integrity and operational efficiency of fire protection systems for dangerous goods shall not be compromised by failure or maintenance of the submarine systems or equipment that support the fire protection system.

4.9 Ventilation control shall ensure the effectiveness of the fire protection system provided for the protection of dangerous goods.

4.10 The operation of the fire protection system shall be monitored at all times while dangerous goods are embarked and reported to the crew when activated.

4.11 Reporting from the fire protection system of the dangerous goods stowage shall be to a continually manned space.

4.12 Arrangements for dangerous goods stowage areas shall limit transfer of heat from fires, machinery systems or other equipment or systems outside of the stowage areas to within safe levels.

4.13 Submarine arrangements shall provide the rapid and direct distribution of appropriate fire suppressant or cooling media.

4.14 Dangerous goods shall not be embarked until the fire protection system is operable and verified.

4.15 Control points for firefighting systems shall be provided and separated to reduce the probability of loss of system control.

4.16 Positions where dangerous goods are temporarily stowed, prepared or maintained shall be provided with fire detection, prevention and suppressant systems commensurate with the time at risk and the magnitude of the risk presented by the dangerous goods.

4.17 Submarine arrangements shall facilitate the testing of fire systems to ensure their availability and reliability is maintained while the dangerous goods are present.

4.18 Submarine arrangements for fire protection of dangerous goods shall consider failure modes and provide suitable mitigation measures.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 5 Electrical Fittings

Functional Objective

5.1 The submarine arrangements shall protect dangerous goods from electrical conditions that could lead to an incident.

Performance Requirements

5.2 Electrical items shall be approved and certified safe for operation in dangerous goods stowage areas or in the vicinity of dangerous goods or their associated safety systems.

5.3 The design and operation of electrical items under normal, overload and fault conditions shall maintain the safety arrangements associated with the protection of dangerous goods.

5.4 Submarine arrangements shall maintain the electromagnetic conditions within safe limits wherever and whenever dangerous goods are present.

Note: Authorised electrical items are recognised by the Naval Administration to be safe for operation through meeting or exceeding applicable standards associated with the dangerous goods embarked.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 6 Stowage and Handling

Functional Objective

6.1 The submarine arrangements shall provide safe and secure stowage, handling, movement, relocation and transfer of dangerous goods.

Performance Requirements

6.2 Submarine arrangements shall have secure restraint systems that maintain the integrity and safety of the dangerous goods.

6.3 All other items stored within dangerous goods stowage areas shall be assessed for compatibility with the dangerous goods and restrained such that they do not endanger the dangerous goods.

6.4 Where versatile stowage of dangerous goods is used, submarine arrangements shall provide appropriate segregation, restraint and partitioning.

6.5 Dangerous goods located external to the pressure hull shall be provided with adequate protection from environmental conditions.

6.6 Stowage layouts shall be commensurate with the protection systems (e.g. adequate clearance to bulkheads and decks for boundary cooling from firefighting systems).

6.7 The temperature of surfaces in the vicinity of dangerous goods shall be maintained at safe levels during normal and fault conditions.

6.8 Where the safety of dangerous goods is at risk from exposure to seawater, flood alarms shall be fitted and reported in a continually manned space, at sea and in harbour.

6.9 The interface between safety arrangements for the submarine and any system delivering dangerous goods to and from the submarine shall be properly managed and controlled commensurate with the risk posed.

6.10 Restraint systems and layout shall allow access to and removal of dangerous goods without detriment to the safety of other dangerous goods.

6.11 Movement, relocation or transfer shall be undertaken in accordance with a procedure to efficiently, with the minimum delay or pause in the process, to limit the exposure of the submarine to increased safety risk.

6.12 All dangerous goods transfer routes shall be defined and approved.

6.13 All handling equipment is to comply with approved standards and regulations for the areas in which they are to be used commensurate with the risks appropriate to the dangerous goods stored.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 7 Security

Functional Objective

7.1 Submarine arrangements shall prevent malicious or unintended interference with the dangerous goods or their safety management system.

Performance Requirements

7.2 The permission of the Commanding Officer or a delegated responsible representative is required for the embarkation of any dangerous goods.

7.3 Submarine arrangements shall prevent access to dangerous goods or associated safety management systems by unauthorised persons and shall be approved by the Naval Administration.

Note: Authorised persons are those approved by the Naval Administration to have access to dangerous goods and have been assessed as competent or are appropriately supervised.

Note: Access includes physical presence, control of procedures or freedom to affect the safe carriage and use of dangerous goods. This may apply when dangerous goods are not present.

7.4 The location, condition and quantity of all dangerous goods shall be known, logged and monitored at all times by the Commanding Officer or a delegated responsible representative and a system in place for reporting discrepancies.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Incident Reporting

Functional Objective

8.1 Incidents involving dangerous goods or associated safety systems shall be reported, investigated and, where appropriate, submarine arrangements amended to maintain or improve safety levels.

Performance Requirements

8.2 A management system shall exist to ensure that dangerous goods incidents are recognised and reported.

8.3 The Naval Administration shall make adequate and proportional arrangements for the investigation or review of each dangerous goods incident.

8.4 Appropriate measures shall be taken such that the intended acceptable safety levels are maintained or improved following a dangerous goods incident.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 Use of Dangerous Goods

Functional Objective

9.1 Submarine arrangements shall control the safety risk associated with the use of dangerous goods.

Performance Requirements

9.2 All planned activities involving the use of dangerous goods shall be identified, with a safe system of work defined for each activity.

9.3 Submarine arrangements shall provide for the safe disassembly and assembly of packaging.

9.4 Submarine arrangements shall manage the safe preparation of dangerous goods.

9.5 Submarine arrangements shall manage the safe activation of dangerous goods.

9.6 Submarine arrangements shall manage the risk due to the carriage of dangerous goods by off-board systems operating to and from the submarine.

9.7 Submarine arrangements shall manage the risk due to carriage and use of dangerous goods by embarked persons.

9.8 Submarine arrangements shall manage the safety of tests, trials and experiments involving dangerous goods.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are conatined in Part 3.

Regulation 10 Emergency Procedures

Functional Objective

10.1 Submarine arrangements shall control the consequences associated with dangerous goods that arise from foreseeable emergency situations.

Performance Requirements

10.2 Emergency planning shall be conducted to identify and prioritise all foreseeable emergency situations.

10.3 Arrangements to control the consequences of emergency situations shall be put in place.

10.4 Emergency arrangements shall be implemented effectively.

10.5 Appropriate measures shall be taken to return all dangerous goods to a safe condition following an emergency.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

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PART 1 CHAPTER XI INTEGRATION OF PLATFORM, COMBAT AND NAVIGATION SYSTEMS

Note: INSA recognises the importance of addressing integration issues and this chapter is currently under development.

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PART 1 CHAPTER XII ATMOSPHERE CONTROL

Contents

Regulation 0 Goal

0.1 To preserve life and promote well-being and long-term health by providing and maintaining a safe breathable atmosphere within the pressure hull which does no harm to embarked persons or the fabric of the submarine.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 1 General

Functional Objective

1.1 The purpose of this regulation is to outline the principles and framework of Chapter XII Atmosphere Control and its application.

Application

1.2 Any changes to the submarine during design, construction or through life that impact on compliance with this chapter shall be approved by the Naval Administration.

1.3 Chapter I General Safety Requirements applies to all chapters of the Code and therefore in order to meet the Chapter X goal, the requirements of both this chapter and Chapter I shall be met.

1.3.1

General Performance Requirements

1.4 Maximum and minimum levels of life gases within the enclosed volume of the submarine shall be established. The limits established shall support the full range of activity by all embarked personnel in support of the Concept of Operations Statement for the submarine.

1.5 Maximum levels of atmospheric contaminants within the enclosed volume of the submarine shall be established. The limits established shall ensure that no person within the enclosed volume of the submarine is exposed to harmful levels of any atmospheric contaminant.

1.6 Limits shall be established for temperature, humidity and pressure within the enclosed volume of the submarine to ensure crew effectiveness and limit fatigue, in support of the Concept of Operations Statement for the submarine.

1.7 Limits shall be established for life gases and for contaminants in the submarine's atmosphere within the framework of national legislation and the operating patterns of the submarine.

1.8 Limits shall be established for temperature, humidity and pressure within the submarine's atmosphere within the framework of national legislation and the operating patterns of the submarine.

1.9 There shall be a means to maintain records of the submarine's atmosphere and subsequent crew exposure to this environment.

1.10 A process shall be established for the assessment and classification of the toxicological hazard of materials which are proposed to be:

1.10.1 incorporated within the enclosed volume of the submarine;

1.10.2 carried within the enclosed volume of the submarine.

1.11 The process shall also establish a record of the classification of materials that have been assessed for introduction to the enclosed volume of the submarine. This record shall be made readily available to design authorities and Naval Administrations for them to use.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 2 Provision of Oxygen

Functional Objective

2.1 Oxygen shall be provided in sufficient quantity to support the full range of activities undertaken by all embarked persons while the submarine is at sea, alongside or undergoing maintenance.

Performance Requirements

2.2 Oxygen shall be provided to all parts of the enclosed volume of the submarine in sufficient quantity to support the activities of the embarked persons at all times and in support of the Concept of Operations Statement. A higher limit based on the determined fire risk associated with raised oxygen levels shall be determined by the Naval Administration.

2.3 Oxygen may be provided in any way as agreed with the Naval Administration.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 3 Removal of Carbon Dioxide

Functional Objective

3.1 A means of maintaining carbon dioxide at a safe level shall be provided while the submarine is at sea, alongside or undergoing maintenance.

Performance Requirements

3.2 Carbon dioxide shall be maintained throughout the enclosed volume of the submarine at a level which does not affect the capacity of crew members and special personnel to perform their tasks in support of the Concept of Operations Statement.

3.3 The means of maintaining carbon dioxide at an acceptable level shall be agreed with the Naval Administration so that the design solution meets the Concept of Operations Statement.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 4 Removal of Hydrogen, Carbon Monoxide and Other Contaminants

Functional Objective

4.1 A means of removing hydrogen, carbon monoxide and other contaminants from the submarine's atmosphere while the submarine is at sea, alongside or undergoing maintenance shall be provided to ensure that they remain within the limits as determined by this chapter.

Performance Requirements

4.2 Means shall be provided for the removal of all identified types of gaseous and vaporous contaminants from the submarine's atmosphere.

4.3 Hydrogen shall not exceed a level which leads to the creation of an explosive atmosphere at any point in the enclosed volume of the submarine.

4.4 The Naval Administration shall establish the design limit for the amount of carbon monoxide in the atmosphere of the enclosed volume of the submarine.

4.5 Systems containing refrigerant gases shall be monitored individually for leakage of gas into the submarine's atmosphere.

4.6 The Naval Administration shall define limits for the quantity of particulates and aerosols present in the submarine's atmosphere.

4.7 There shall be a means of removing particulates and aerosols from the submarine's atmosphere.

4.8 The means of maintaining hydrogen, carbon monoxide and other contaminants at an acceptable level shall be agreed with the Naval Administration so that the design solution meets the Concept of Operations Statement.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 5 Preserve Nitrogen Balance

Functional Objective

5.1 The nitrogen balance in the atmosphere of the submarine shall be preserved.

Performance Requirements

5.2 The Naval Administration shall provide the crew with guidance on the management of nitrogen in the submarine's atmosphere.

5.3 Where nitrogen is carried in large quantities, means of directly measuring and recording the partial pressure of nitrogen in the submarine's atmosphere shall be provided.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 6 Maintenance of Temperature, Humidity and Pressure

Functional Objective

6.1 A means of maintaining temperature and humidity, and regulating internal pressure within the enclosed volume of the submarine within the operating patterns of the submarine shall be provided.

Performance Requirements

6.2 The Naval Administration shall define the acceptable range of internal temperature and humidity of the submarine.

6.3 The means of maintaining temperature and humidity within the acceptable range shall be effective in the operational areas and support the operational profile established in the Concept of Operations Statement.

6.4 Humidity within the enclosed volume of the submarine shall be maintained within the defined limits at all times when the submarine is at sea.

6.5 The designer shall ensure that systems for maintaining humidity can be properly drained and cleaned so that they do not present a hazard to the health and well-being of all embarked persons at any time.

6.6 The Naval Administration shall specify the normal operating limits of internal pressure for the submarine when operating within the Concept of Operations Statement.

6.7 The internal pressure of the submarine shall be maintained at a pressure that does not affect crew health or restrict the ability of the crew members to safely operate the submarine.

6.8 The upper limit of internal pressure shall not be set at a level such that the probability of successful escape by all capable survivors in the event of a distressed submarine (DISSUB) is significantly reduced.

6.9 The lower limit of internal pressure shall not be set so low that the partial pressure of oxygen falls below the level set by the process established under Regulation 2.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 7 Circulation of Air

Functional Objective

7.1 A means shall be provided of circulating air to all compartments and spaces within the enclosed volume of the submarine at a rate which ensures effective functioning of the crew members and other embarked persons during the full range of activities which they may undertake.

Performance Requirements

7.2 The Naval Administration shall define the minimum air flow through compartments, spaces and workstations.

7.3 The Naval Administration shall consider all the operational profiles which can be derived from the Concept of Operations Statement to ensure that the needs of each embarked person for provision of oxygen and removal of carbon dioxide are adequately met.

7.4 Air shall be circulated throughout the compartments and spaces of the submarine to distribute oxygen and to encourage mixing of the air to ensure that the atmosphere does not present a hazard to the embarked

persons. The air-circulation system shall direct return air to the contaminant-removal systems so that the contaminants may be removed.

7.5 Air shall be circulated through the submarine so that the temperature and humidity of the enclosed volume of the submarine remains within the prescribed limits.

7.6 The air-circulation system shall not make a significant contribution to the noise in any part of the submarine.

7.7 The Naval Administration shall set limits for noise levels within each compartment or group of compartments.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 8 Monitor the Internal Atmosphere

Functional Objective

8.1 A means of monitoring the constituents of the internal atmosphere of the submarine at all times shall be provided.

Performance Requirements

8.2 Monitoring of the atmosphere within the enclosed volume of the submarine shall be conducted to ensure that the life gases and contaminants are maintained within the limits established by the Naval Administration.

8.3 The Naval Administration shall agree the most appropriate atmosphere-monitoring methods to be used on the submarine.

8.4 There shall be at least two methods for determining the state of the life gases in the atmosphere.

8.5 For each submarine-powered method of real-time sampling there shall be a non-submarine-powered second method available to the submarine's crew members.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 9 Continuous Monitoring and Recording of Specified Gases

Functional Objective

9.1 A means of continuously monitoring and recording of specified gases in the submarine's atmosphere shall be provided.

Performance Requirements

9.2 There shall be a means of continuously monitoring and recording the atmosphere inside the enclosed volume of the submarine. The system shall:

9.2.1 provide embarked persons with real-time information about the state of the atmosphere to allow prompt and effective remedial action to correct challenges to the atmosphere;

9.2.2 provide a record of the quality and challenges to the atmosphere in the event of an accident which may result in either or both acute illnesses or chronic conditions affecting the crew or other embarked persons.

9.3 The Naval Administration shall ensure that the continuous atmosphere-monitoring system supports the requirements of the Concept of Operations Statement.

9.4 The design of the system shall ensure that the fully representative samples of the atmosphere are taken throughout the submarine and are analysed and recorded.

9.5 Areas of high or continuous occupancy shall be continuously monitored.

9.6 Records of the atmosphere quality of each submarine shall be kept for the period specified for health-related records in national legislation.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 10 Recording and Reporting the Condition of the Submarine's Atmosphere

Functional Objective

10.1 Additional means of recording and reporting the condition of the submarine's atmosphere at regular intervals shall be provided.

Performance Requirements

10.2 There shall be a system for the continual recording of the condition of the atmosphere within the enclosed volume of the submarine.

10.3 The method used shall be independent of any continuous recording system which may be fitted to the submarine.

10.4 The means of recording shall be appropriate to the size of the submarine and the number of submariners in the scheme of complement.

10.5 The record shall, in addition to the atmospheric constituents, as a minimum requirement, record the number of souls on board, the atmosphere-control systems operating at the time each entry is made, any events which have challenged the atmosphere, any corrective action taken and the results of any periodic surveys conducted.

10.6 Records of the atmosphere quality of each submarine shall be kept for the period specified for health-related records in national legislation.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 11 Assessment and Feedback of the Records

Functional Objective

11.1 Assessment of, and feedback on, the records of the control of the submarine's atmosphere, by suitably qualified and experienced personnel (SQEP) ashore, shall be provided.

Performance Requirements

11.2 The Naval Administration shall ensure that a system for the timely assessment of the records of atmosphere control on submarines under the charge of the Naval Administration is established and maintained.

11.3 The system for the assessment of records established by the Naval Administration shall include SQEP to ensure that all aspects of atmosphere control within the submarine can be fully and fairly assessed.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 12 Assessment of Materials

Functional Objective

12.1 A means of assessment shall be provided for materials contained within or introduced to the enclosed volume of the submarine for their effect on the submarine's atmosphere, crew members or other equipment in normal and abnormal conditions.

Performance Requirements

12.2 The Naval Administration shall ensure that the Naval Administration establishes a list of materials and compounds which:

12.2.1 shall not be introduced into the submarine's atmosphere;

12.2.2 shall have limits placed on the quantity which is introduced into the submarine's atmosphere;

12.2.3 are permitted to be present in the submarine atmosphere;

12.2.4 may be permitted to be used provided sufficient time is allowed for any off gassing to complete prior to closing down the atmosphere of the submarine.

12.3 The list shall be kept under continual review.

12.4 The Naval Administration shall have a means to gather information on the composition of materials and equipment proposed for introduction into the submarine so that the materials or equipment can be classified and a risk assessment made as to their use on a submarine.

12.5 In establishing the list, the Naval Administration shall also consider the breakdown products and products of combustion of the materials and compounds under scrutiny.

12.6 The designer, shipbuilder, ship repairer and equipment suppliers shall be required to consult the list when considering items to be fitted to submarines to ensure that hazardous materials are not introduced into the submarine without the hazards and risks associated with such materials being first reduced, by the adoption of suitable monitoring and control measures, to as low as reasonably practicable (ALARP).

12.6.1 The designer, shipbuilder, ship repairer and equipment suppliers shall be required to make a full disclosure to the Naval Administration of the materials used in the products intended for the submarine service.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 13 Infrastructure

Functional Objective

13.1 The infrastructure to assess, select, support and dispose of atmosphere-control equipment and consumables shall be provided.

Performance Requirements

13.2 The Naval Administration shall have a means to assess and select items of atmosphere-monitoring equipment to demonstrate that the items introduced to the submarine will function correctly through the full range of normal operational conditions experienced inside the submarine.

13.3 The monitoring system and/or sensors shall not be subject to cross-sensitivity from atmospheric constituents of the submarine's air other than the target species.

13.4 The monitoring system shall not interfere with the safe operation of the submarine.

13.5 The disposal of consumables and equipment shall be considered during the design and operation of the submarine and shall comply with national and international legislation and regulations.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

Regulation 14 Provide Emergency Breathing Air

Functional Objective

14.1 A safe and breathable supply of air shall be provided and distributed throughout the submarine for use by the crew when the submarine's internal atmosphere is out of the specified limits.

Performance Requirements

14.2 The submarine shall have a means of supplying breathable air, for use when the atmosphere is outside the specified limits, to all parts of the submarine to enable the crew and embarked persons to bring the submarine's atmosphere back to a safe condition without breathing contaminated air.

14.3 The submarine shall provide a means to supply breathable air to all parts and all users, having regard to:

14.3.1 the number of occupants in any space or compartment and their activity;

14.3.2 the need to ensure safe navigation of the submarine;

14.3.3 Carry out the tasks necessary to ensure continued operation of the submarine, in line with the Concept of Operations Statement;

14.3.4 the need for embarked persons to move about the submarine to deal with the emergency, to reach a place of safety or to evacuate the enclosed volume of the submarine.

14.4 The endurance of the system shall be agreed by the Naval Administration with due regard to the contents of the Concept of Operations Statement.

14.5 There shall be a means of assuring the quality of the emergency breathing air.

Solutions for this regulation are contained in Part 2.

Justification and Guidance for this regulation are contained in Part 3.

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