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Update on the Atmosphere Control Chapter of the Naval Submarine Code

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Den Helder

Naval Submarine Code Update

A brief history of Maritime Regulation

The Naval Submarine Code, NSubC

Developing the NSubC

Goal based regulation

The Atmosphere Control chapter

Next Steps

History of Regulation - Maritime

Late 18th century Increasing losses of ships and cargoes

- Ships in varying condition from build
- Insurers needed to establish risk to set premiums

1760 - the Register Society formed in Lloyds coffee house in London

Inspection regime established to classify hull and equipment

- “A1 condition” - hull and equipment in best condition
- Improved condition and reliability of ships
- But could still be overloaded

1876 - Plimsoll line on UK ships

1906 - on all ships in UK waters

History of Regulation - Maritime

1912 - Titanic built with too few lifeboats for all on board
- 1500+ lost

International Convention for the Safety of Life at Sea (SOLAS) published 1914 and in force 1915
- covers life saving, construction, fire prevention and fighting, navigation, wireless telegraphy

Revised over time most recently 1974 with minor revisions since

Classification Societies have rule books on how to implement SOLAS and other regulations

Enforcement by national maritime administrations – USGC, MCA, Transport Canada

Naval vessels not covered

Regulation - Naval

Safety and design guided by national defence related standards

- Defence Standards, Mil Specs
- Built on national experience

Post Cold War approach to defence procurement

- Faster, Cheaper, Better
- Use national and international standards to save money

Naval Ship Code developed from SOLAS for surface ships only as Classification Societies had the experience to advise, guide and certify

Submarines seen as “too difficult for now”

2010 - work starts on NSubC with chapter working groups established in 2012

The Naval Submarine Code – What is it?

- A logical description of the essential design features which, if followed, will lead to the development of safe and capable submarine.
- It is NOT an Instruction Manual
  - Or a set of requirements
- Intended to aid the setting of detailed Statement of Technical Requirements and the ensuring the necessary support and disposal facilities are considered
- May be used by Classification Societies to provide essential oversight of the design, build and support aspects of the Submarine's life

Approach

- Understand the baseline
  - Recognise NATO developments, notably ANEP 77 Naval Ship Code - used as reference
  - Recognise IMO Conventions and Codes, notably SOLAS
  - Recognise submarine best practice

- Understand differences between civil and military practice
  - Make use of Class Society knowledge and expertise
    - GL LR BV DNV

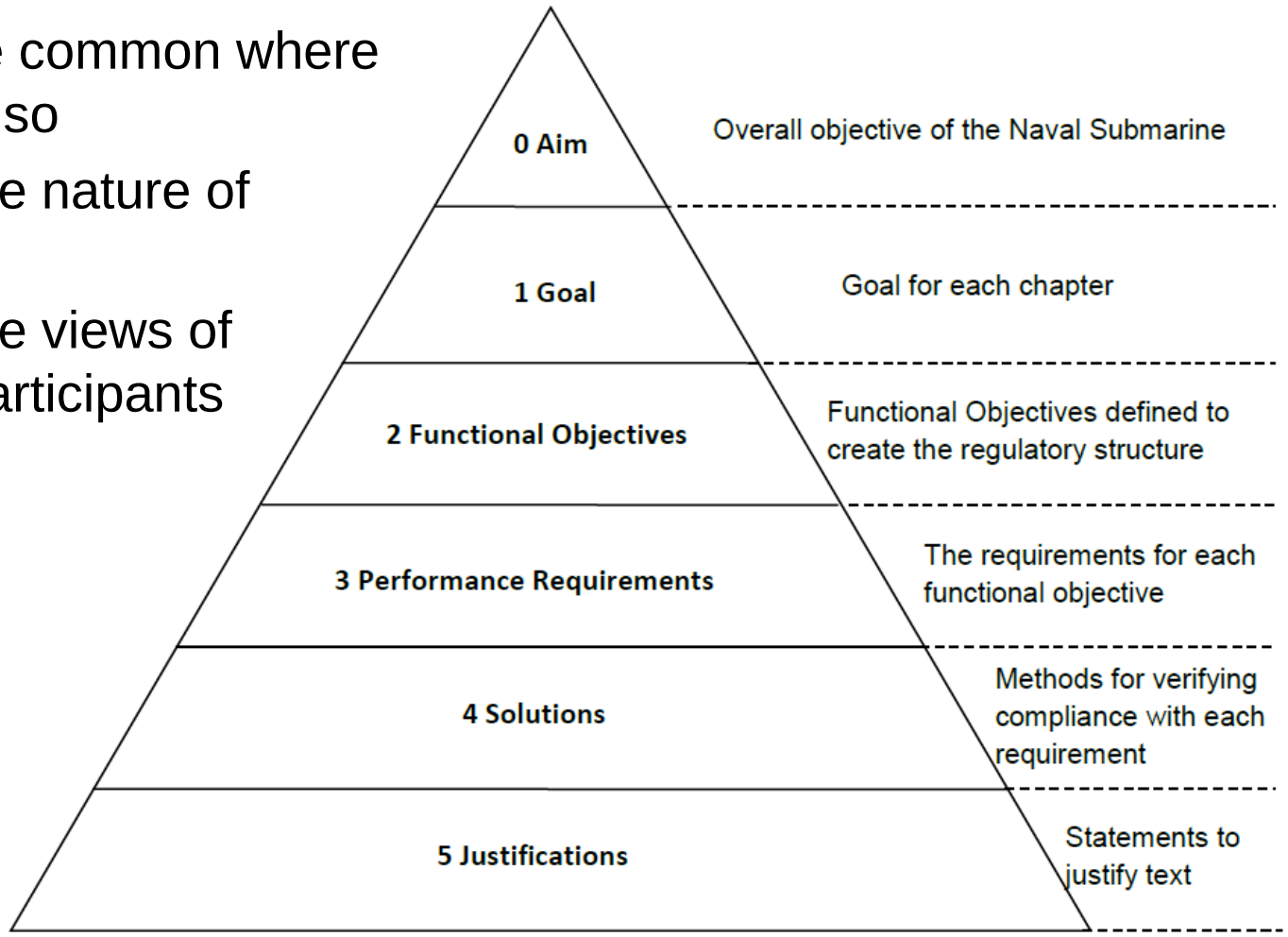
- Capture common international submarine safety requirements
  - Start with ANEP 77, The Naval Ship Code
  - Where possible, adopt/adapt civil practice for submarine design & build
  - Where not possible, define naval submarine requirements

Aim

The overall aim of the Naval Submarine Code (NSubC) is to provide a standard for submarine safety based on and benchmarked against IMO conventions and resolutions that embraces the majority of submarines operated by Navies.

Against the NSC, the NSubC…

- Is Goal Based
- Is similarly structured
- Has same objective
- Attempts to be common where sensible to do so
- Reflects unique nature of Submarines
- Reflects unique views of NSubC WG participants



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Goal Based Regulations

High level standards and procedures to be met through regulations and rules for submarines

Comprised of

- at least one goal,
- the functional requirements associated with that goal
- measures of the verification of compliance

Sufficient detail to allow the development of rules for the construction and use of safe submarines

Rules developed from regulations and applied by Classification Societies

Goal Based Regulations

Consider these statements:

An electrolyser will be used to provide oxygen for life support on the vessel

Oxygen shall be provided in sufficient quantity to support the full range of activities undertaken by the occupants of the vessel

The Atmosphere Control Chapter

Goal

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 the crew members, special personnel and other embarked persons

or the fabric of the submarine.

The Atmosphere Control Chapter

Follows the pyramid format having:

A single unifying Goal

Remains unchanged

14 Regulations each with a Functional Objective (level 2)

Iterative revision after comments from INSA contributors

and Performance Requirements (level 3)

Iterative revision after comments from INSA contributors

Part 2

Classification society rules - a standard statement in each regulation pending development of the rules of the society

The Atmosphere Control Chapter

Part 3 Justification of the individual regulations

- Each regulation has a justification.

Guidance for Tier 3: Performance Requirements

- Each individual performance requirement has sources and guidance added.

Review, Revise and Expand

2013

First draft of NSubC accepted by steering group noting that the state of completion of each chapter was not consistent

Presented to International Naval Safety Association in April

Draft accepted at INSA Annual General Meeting in October

Goal of publication as an ANEP accepted but needed all chapters brought to same state

2014

Parts 3 and 5 of each chapter drafted in working groups

INSA AGM accepted the draft as acceptable for presentation as an ANEP

2015

Part 5 of most chapters developed in working groups

INSA AGM will forward for publication as an ANEP

4. Removal of Hydrogen, Carbon Monoxide and Other Contaminants
•A means of removing hydrogen, carbon monoxide and other contaminants from the submarine's atmosphere whilst the submarine is at sea or alongside or undergoing maintenance shall be provided to ensure that they remain within the limits as determined by this Chapter.
•Performance Requirements
4.1 Means shall be provided for the removal of all identified types of gaseous and vaporous contaminants from the submarine's atmosphere.
4.2 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.
4.3 The Duty Holder shall establish the design limit for the amount of carbon monoxide in the atmosphere of the enclosed volume of the submarine.
4.4 Systems containing refrigerant gases shall be monitored individually for leakage of gas into the submarine's atmosphere
4.5 The Duty Holder shall define limits for the quantity of particulates and aerosols present in the submarine's atmosphere.
4.6 There shall be a means of removing particulates and aerosols from the submarine's atmosphere.
4.7 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.4.7
Solutions for this Regulation are contained in Part 2.
Justification & Guidance for this Regulation are contained in Part 3

4. Removal of Hydrogen, Carbon Monoxide and Other Contaminants

Functional Objective and Performance Requirements for this Regulation are contained in Part 1.

Perf Reqt Ref (Pt1, ChXII, Reg4, Para)	Source	Guidance
4.2		The means of removal of any contaminant shall not create another hazardous product which may harm the embarked persons or the fabric of the submarine. When new materials are introduced to the submarine due account must be taken of the potential for the material to affect or be affected by the submarine's atmosphere and the contaminant removal system. Safe products such as water and carbon dioxide can be managed by other equipment in the atmosphere management system.
4.3	National legislation EH40 (UK)	The lower explosive limit, LEL, for hydrogen in air is 4%. This is significantly lower than the proportion of hydrogen required to affect human health or wellbeing. Therefore the risk posed by hydrogen is that of explosion. It is common practice for the whole boat limit for hydrogen to be set at 50% of the LEL; that is at 2% hydrogen in air. The Duty Holder may choose to set a different level for the main hydrogen removal system from the battery compartment(s).
4.4	FPA	Carbon monoxide sources include diesel exhaust products, cooking, smoking, and the thermal breakdown of lubricants. Fires will also generate copious quantities of the gas. It has been noted that in navies where smoking within the enclosed volume of the submarine has been banned significant reduction in the levels of carbon monoxide has been achieved at times when the diesel engines are not running. The Duty Holder shall consider whether the means of eliminating carbon monoxide shall run continuously.
4.5	Montreal Protocol 1987 Kyoto Protocol 1997	Monitoring of plants containing refrigerant gases is required for signatories of the Montreal Protocol on Substances that Deplete the Ozone Layer. Refrigerant gases are heavier than air and will collect in the lowest parts of the submarine. They will displace air from places where they collect. When a release has occurred great care must be exercised to ensure that there is sufficient oxygen in the lower reaches of the compartment. The pooling of refrigerant gases in the lower levels makes them difficult to disperse and procedures for the removal of large quantities of the gas from the lower levels of a submarine should be considered as part of the design process for the submarine.

Next Steps

Classification societies have been developing their own rules based on the code

Some references back to chapter chairs for clarification or review

Has aided editing of the code

Apply rules to a real or existing design for goodness of fit

After first publication as an ANEP the normal cycle of review revise and reissue will commence

Achievement

- We have defined a minimum set of requirements to produce a safe & capable submarine
  - Leaves designer to develop solutions to the principles in the code inline with CONOPS for the vessel and national legislation
- Allows classification society to develop their own approach to certification by writing their own set of rules.

Thanks

- Isaac Barendrekt NL DMO
- Cdr Trond Juvik RNoN
- South African submarine service
- Supporters and Reviewers
- Lloyds of London for providing meeting spaces
- Chapter Leads
- Classification Societies


A thought for you as
you extend your
time under water.
Photo: HDW

Questions

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Content - Technical Chapters

	II	STRUCTURE
	III	BUOYANCY, STABILITY AND CONTROLLABILITY
	IV	ENGINEERING SYSTEMS
	V	SEAMANSHIP
	VI	FIRE SAFETY
	VII	EVACUATION, RESCUE, ABANDONMENT, SURVIVAL AND ESCAPE
	VIII	COMMUNICATIONS
	IX	NAVIGATION
	X	DANGEROUS MATERIEL
	XI	SENSORS, WEAPONS & COMBAT & WEAPON CONTROL SYSTEMS (CWCS)
	XII	ATMOSPHERE CONTROL
	XIII	NUCLEAR POWER GENERATION (Blank)

Naval Submarine Certification Programmes

- Certification of submarines before going to sea (Subsafe programs)
  - UK: MoD requires independent assurance of MoD shipping benchmarked with national/international best practice and includes Submarine Atmosphere Control
  - No: Navy has to be equivalent to civil shipping
  - NL : Seaworthiness Program bottom-up approach, no high level written guidelines
  - Sw: Test their Standards