Safety Assurance Challenges for New & In-service Submarines.

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Lloyd's Register

Introduction

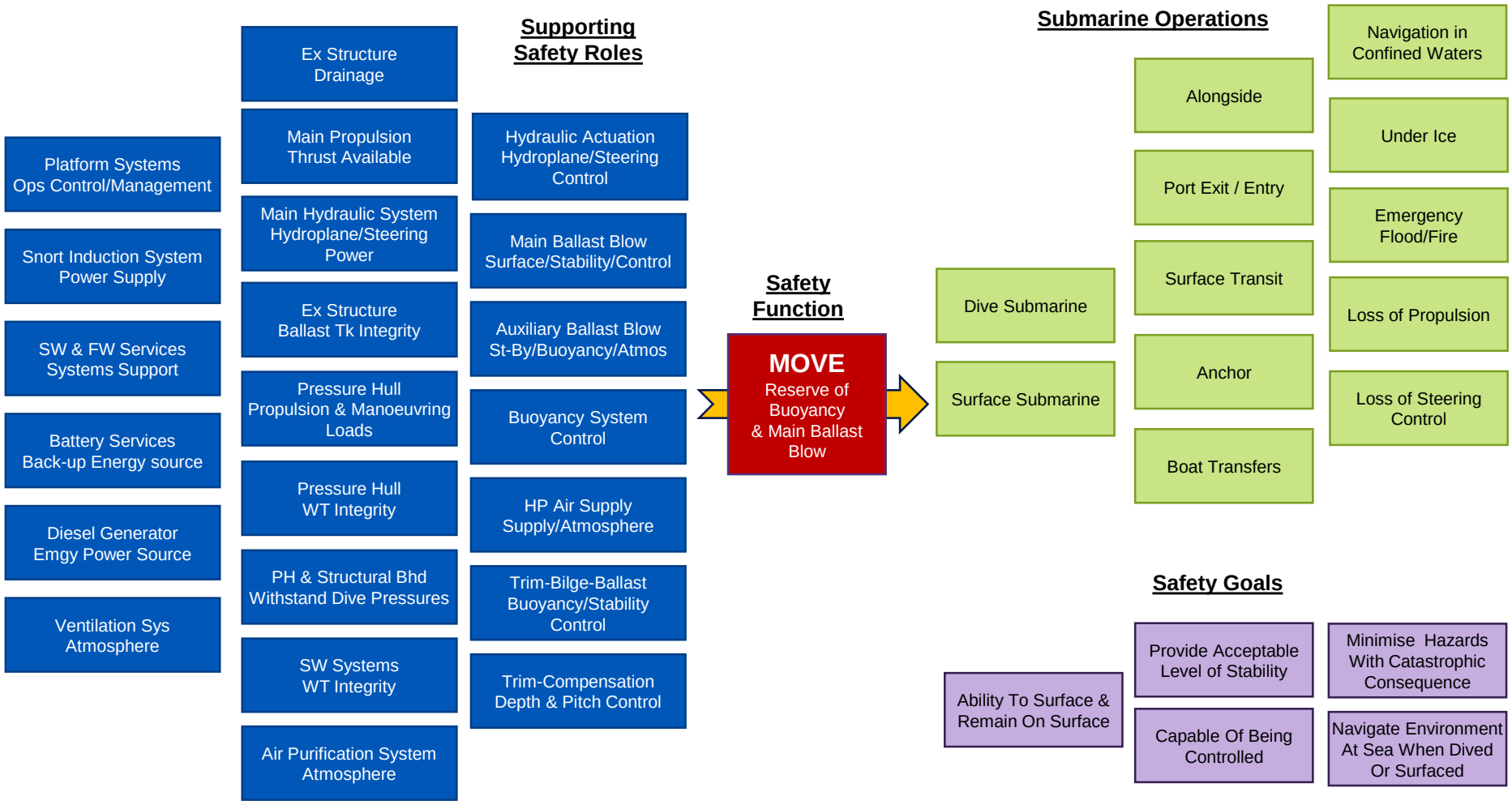
- High value assets in a hostile environments
- Acceptable Risk Level
- Design Build In-Service Assurance
- Owners Responsibility
- Assurance and Compliance
- Rule Based Assurance
- Goal Based Assurance

Basic Differences

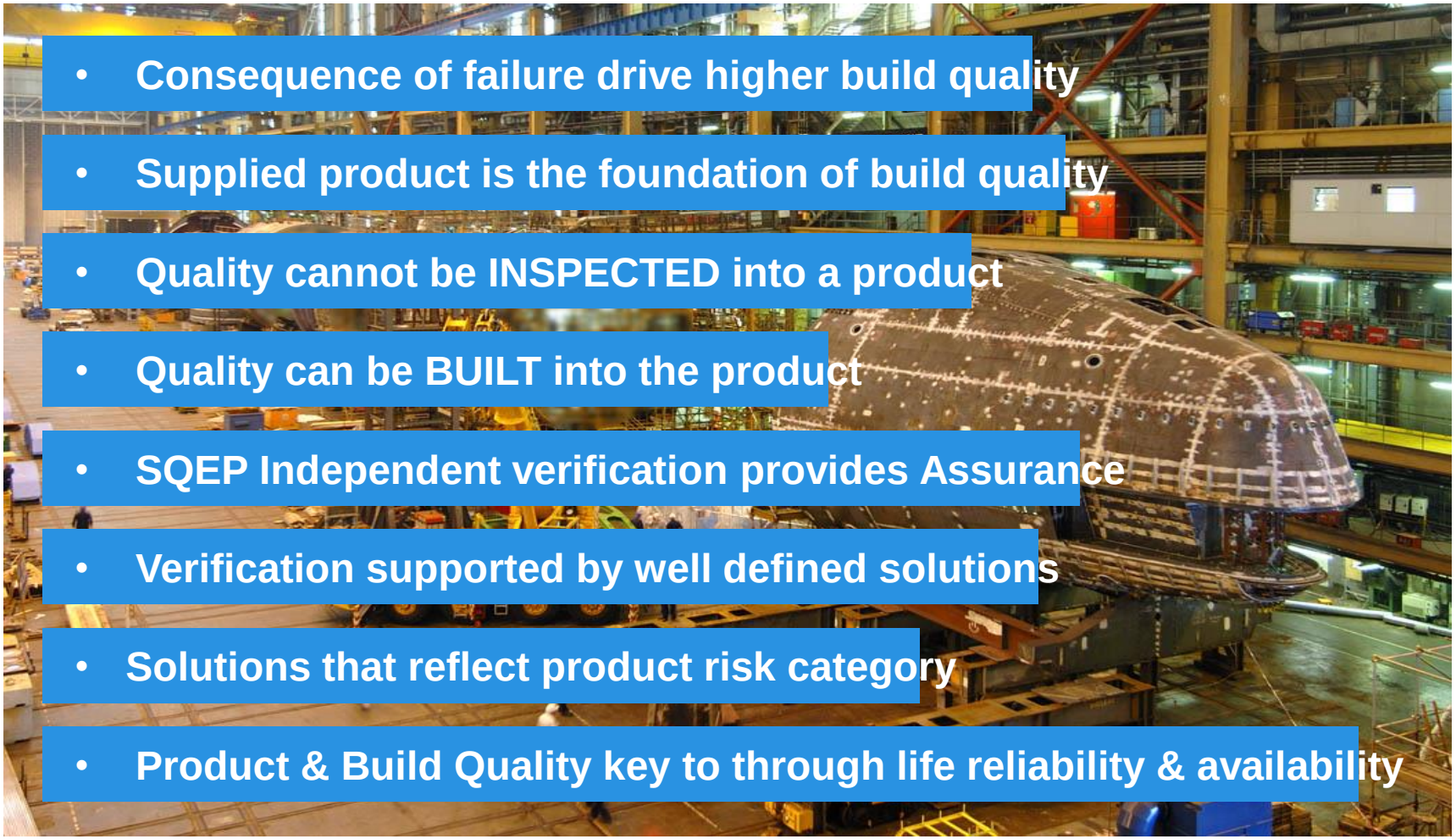
- Stealth Power
- Submarines Stability
- Closed Atmosphere
- Defect Tolerance
- Weight Watchers
- System Integration

The Inter Connection and Dependency

Operations - Goals - Functions– Roles - Systems



Build Quality



Ship Rule Base Assurance

- Developed over many years
- Ship Rules demanded by industry to protect assets
- Built on a vast knowledge & experience base
- Provide a well established & robust compliance framework
- Ship Rules work across the shipping industry
- Readily adopted by naval ships
  - Share common features & compliance demands
  - Exist in large numbers so good knowledge & experience base
  - Resource pressure on standards

Submarine Rule Base Assurance?

- Submarines a small sector
- Submarines value as a weapon is its unknown capability
- Secrecy dilemma:

  Absence of shared knowledge to support regulation but sharing knowledge undermines secrecy & security

- Submarine differ from ships
  - Ship Rules tend to ‘catch all’ minimum safety levels
  - Ship Rule would require clarifications & modifications to be effective
  - Prescriptive rules only address known risks
  - Prescriptive rules restrict innovative design, materials and methods

resource

Can we use Ship Standards

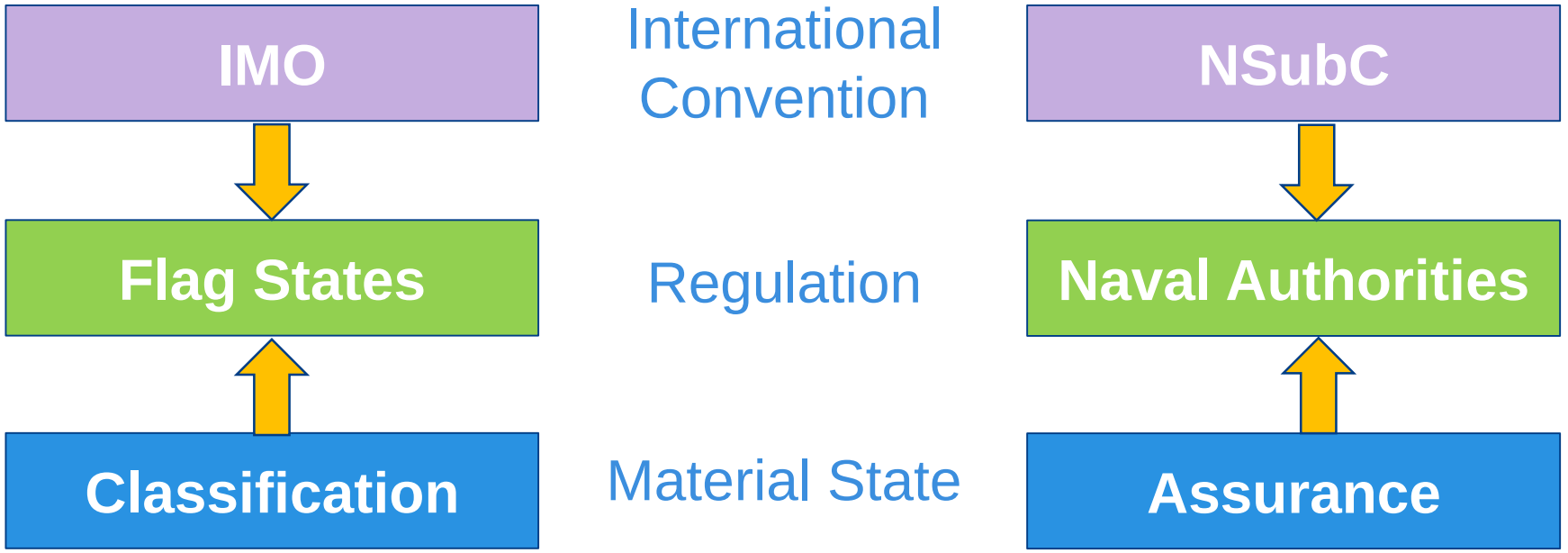
- Compliance with prescriptive standards doesn’t address every safety risk
- Ship standards set minimum safety requirements
- Whole boat transverse issues apply to every design level
- Higher quality requirements driven by higher risk
- Components and System Design Level considerations
- Modifications or additions is an acknowledgement a rule does not address the requirements
- Suitable if fully comply with design, transverse issues and quality requirements
- A cost effective solutions for the designer & builder

Regulation for a Goal Based Approach

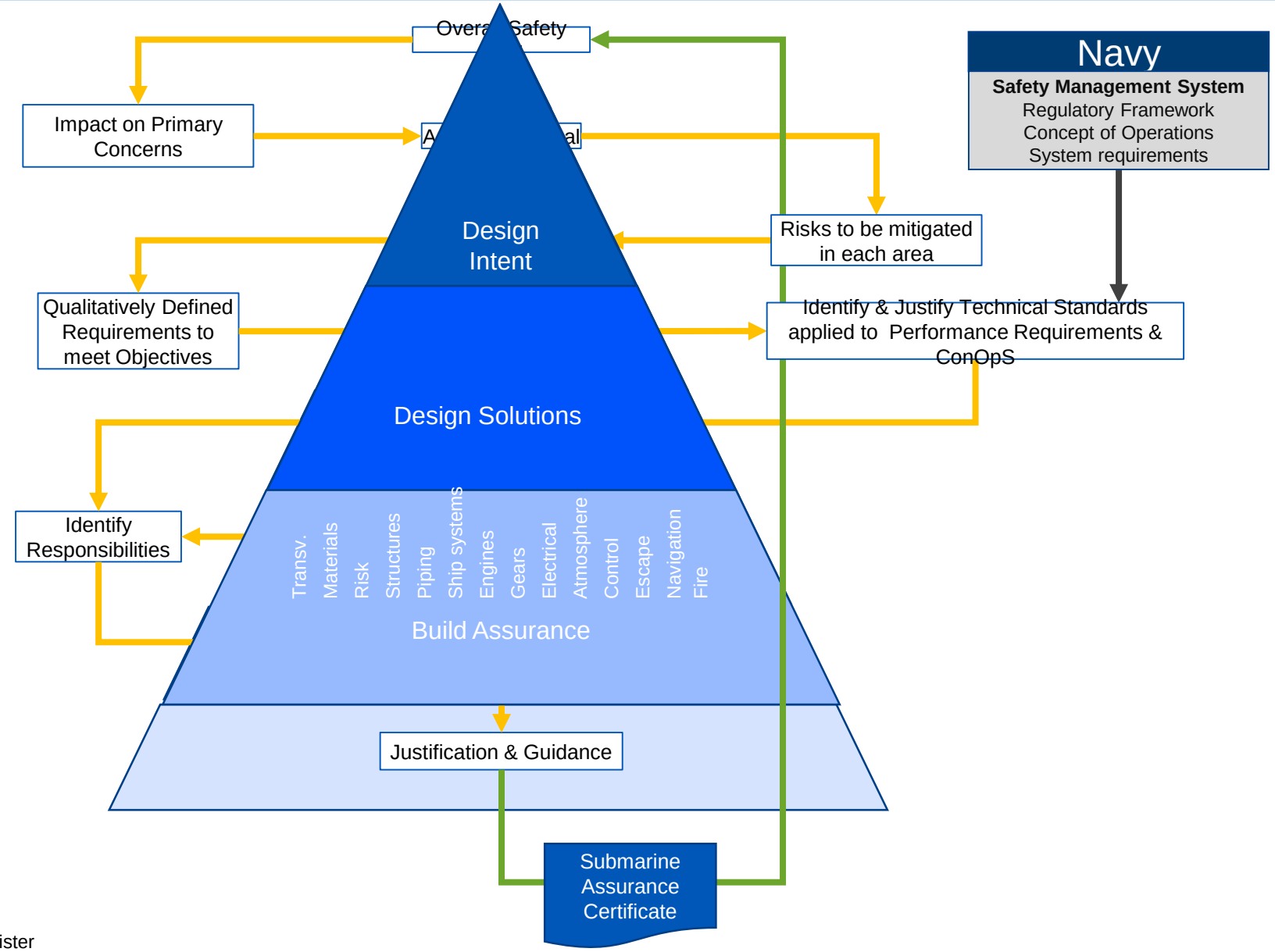
Why do we need the Naval Submarine Code (NSubC)?

Designed to provided an equivalence to commercial regulation by providing over arching safety framework.

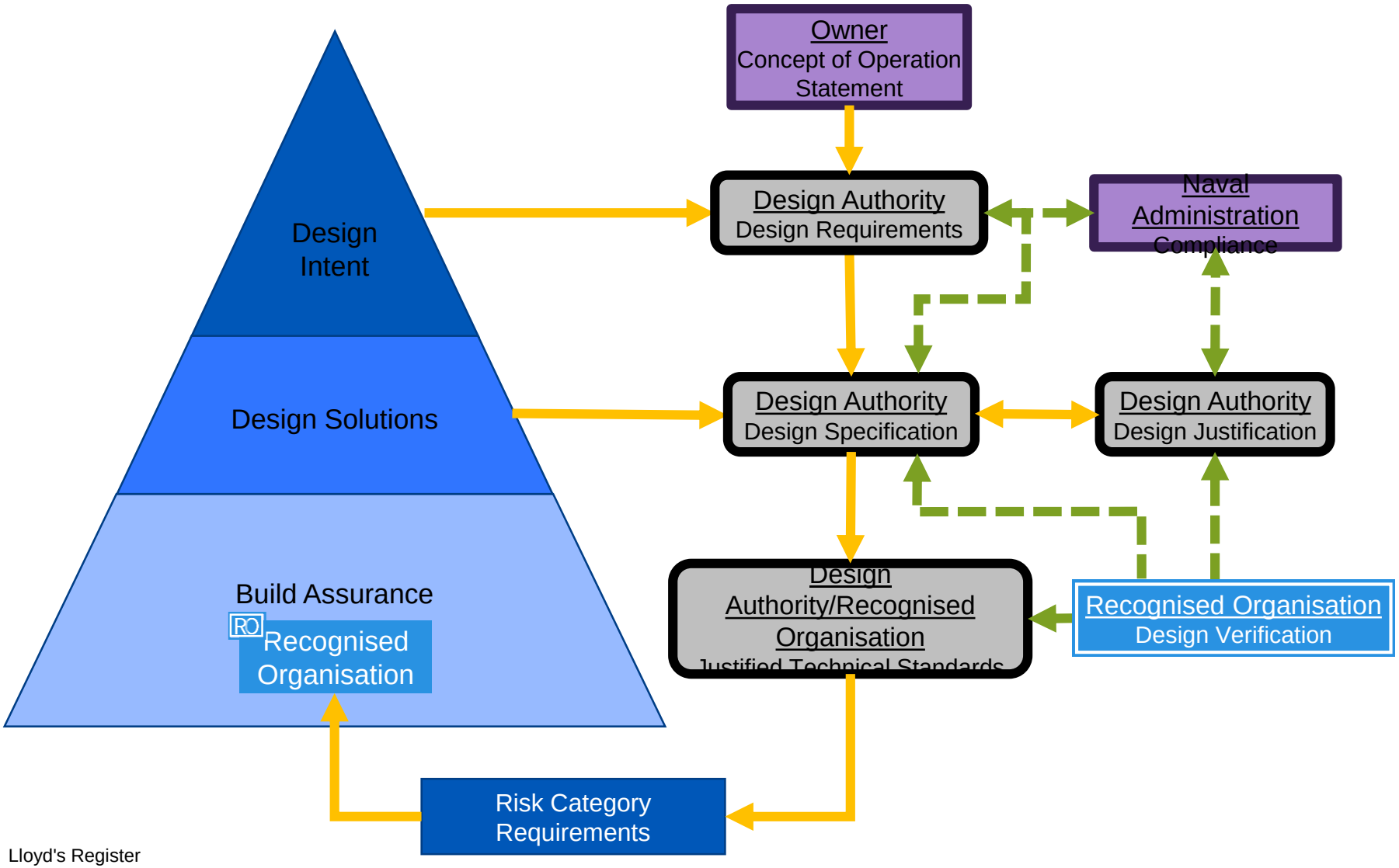
INSA
INTERNATIONAL NAVAL SAFETY ASSOCIATION



Goal Based Assurance Model



Goal Based Design to Build Assurance Model



Assurance Framework Mapped to Components

System Pump Compressor

Materials

Rules for Materials

- General
- Testing Procedures
- Copper Alloys

Component

Pressure and Piping System Components

- Performance Requirements
- Assessment
- Materials
- Copper and copper alloy piping and components
- Pumps

System

Pressure and Piping Systems

- Performance Requirements
- Construction and Installation
- Sea water cooling systems
- Control supervision and monitoring
- System Testing, Integration and Trials

Regulations

Whole Boat

- Transverse
- Survivability
- Product Verification
- Categorisation

Functions

Propulsion and Manoeuvring

- Propulsion

Summary

The iterative nature of a goal based approach when applied in a common industry manner will:

- Provide risk categories for components & systems
- Identify available standards and regulation that consistently provide solutions
- Provide common and consistent solution that could be developed and shared as submarine standards
- Allow a common risk assessment & safety case approaches to be adopted and reduce variation across the industry.
- Allow Naval Administration legislation and statutory requirements to be addressed
- Build a submarine assurance approach that uses standards were appropriate and goals where necessary

Owners perspective

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Owner’s perspective - 1

- Safe to operate depends on
  - Design
  - Condition
  - Operation
  - Changes
- Assessment at any stage depends on knowledge
- Knowledge depends on documentation to provide corporate memory

Owner’s perspective - 2

- Much data disappears if it is not recognised, recorded and collated as it is produced
- Data capture needs to start at the start of design right through to disposal
- You don’t know you needed it until it is the vital last piece in the jigsaw
- Documentation/data management must be defined and managed from the start
- The owner needs an experienced friend to ensure that all this is done

What am I being given? –The Design Process

- Safety Case
- Tests
- Trials
- Demonstrations
- Operability
- Survey
- Documentation

What have I got? - Validation

- Safety case
- Supplied Product Verification
- New Build Verification
- Tests
- Trials
- Periodic Survey
- Maintenance
- Refit
- Maintain Documentation

Safety Case

- Traditional
  - Inflexable
  - Assumes everything works as new
  - Is difficult to run ‘what iffs’
- Goal Based
  - Can be flexible
  - Allows for manipulation at lowest level
  - Can be extended if circumstances change
  - Copes with multiple degradation of systems
  - More easily updated
  - INSA provides authority for the approach

Do I allow this boat to continue running? – Through life management

- Performance assessment
  - Survey
  - Defects
  - Tests
  - Trials
  - Accumulation
- Update Safety Case
- Material state – records/documentation
- Professional judgement – Owner’s responsibility, cannot be delegated or diluted

The role of the Owner’s friend

The story so far

- Identify gaps within Naval Administrations regulatory structures and can be a powerful tool for Regulators, allowing robust risk management processes to be implemented.
- Incorporate different elements such as risk, product verification and existing standards.
- Reduce the burden of maintaining large standards portfolios.
- Allows the right questions to be asked.
- Be a key tool for builders, maintainers and Naval operators today to provide effective support for submarines.

Conclusions

- The ship rules culture does not map to Submarines
- Goal based suits the needs of a Submarine
- Goal Based has many benefits
  - Addresses risks and hazards
  - Provide technical solutions to satisfy safety objectives
  - Allows for innovation
  - Verifies Procurement Build & Maintenance activities through-life
  - Provide a compliance route
  - Provide certification and record maintenance
- Owner is always ultimately responsible for safety
- Class Societies are able to provide help to advise, maintain, verify, certify through a goal based framework
- The designer becomes an active owner of the design specifications and safety requirements

Thank you

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