Applying a Standardization Process to Innovation

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Agenda

Goal-based Standards

Alternate Arrangements & Novel Concepts

Approvals in Principle

New Technology Qualification

Goal Based Standards

Prescriptive Based Requirements

- Traditionally, Class developed Rules and Requirements for standard fuel system designs.
- The Rules and Requirements written would give point by point guidance to multiple parties on a variety of aspects.
- These could be fuel, structure, design, and many more topics.
- Because almost every vessel used fuel oils, there was no need to account for derivations in designs.
- This structure would be found in Class societies worldwide for most of their history.

Goal-Based Requirements

- The increase in urgency involving the climate crisis demanded action from the maritime sector.
- As a result, the International Maritime Organization (IMO) released generic guidelines for goal-based standards.
- The point of these guidelines was to enable innovation in marine design that would allow for the adaptation of electrification and the adaptation of alternative fuels.

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MSC.1/Circ.1394/Rev.2
8 July 2019

GENERIC GUIDELINES FOR DEVELOPING IMO GOAL-BASED STANDARDS

1 The Maritime Safety Committee, at its eighty-ninth session (11 to 20 May 2011), with a view to providing the process for the development, verification, implementation and monitoring of goal-based standards (GBS) to support regulatory development within IMO, approved the *Generic guidelines for developing IMO goal-based standards* (MSC.1/Circ.1394).

2 Taking into account the application of the Generic Guidelines during the development of IMO goal-based regulations, the Maritime Safety Committee, at its ninety-fifth session (3 to 12 June 2015) approved the revised Generic Guidelines (MSC.1/Circ.1394/Rev.1). Subsequently, the Committee approved further revisions to the Generic Guidelines at its 101st session (5 to 14 June 2019). The text of the revised Generic Guidelines is set out in the annex.

3 Member Governments are invited to use the annexed Generic Guidelines and to bring them to the attention of all parties concerned.

4 The present circular supersedes MSC.1/Circ.1394/Rev.1.

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Credit: IMO

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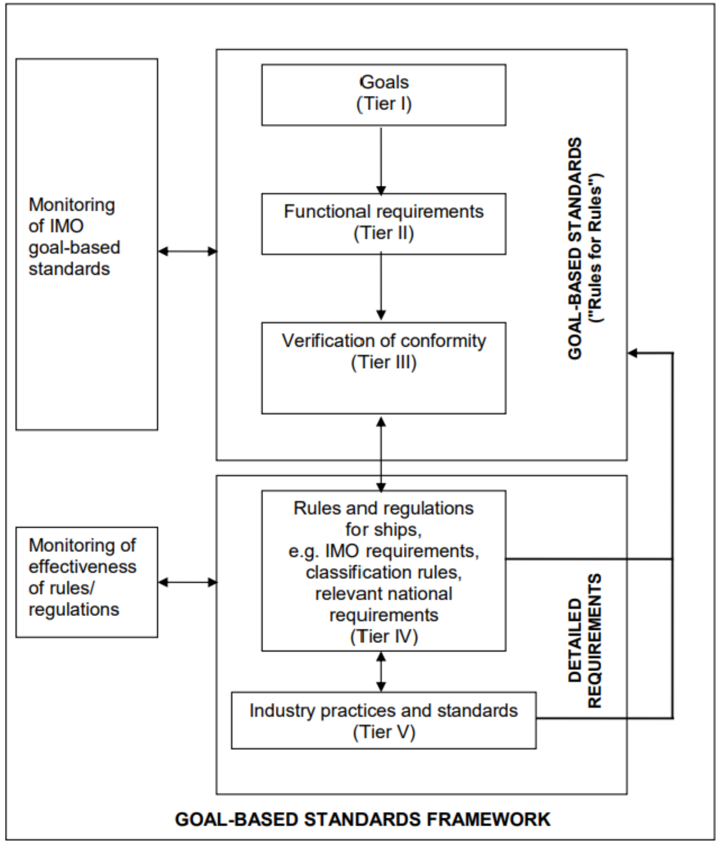
Goal-Based Requirements

- Alternative general arrangements were likely to differ significantly from oil-based vessels.
- These guidelines allow for broad standards that vessels are required to meet.
- The standards are still required to be verifiable and achievable regardless of technology.
- That said, the standards are still required to be specific enough so they're not open to interpretation.
- In service of this, the IMO released a 5-tier framework to inform the new Class structures.



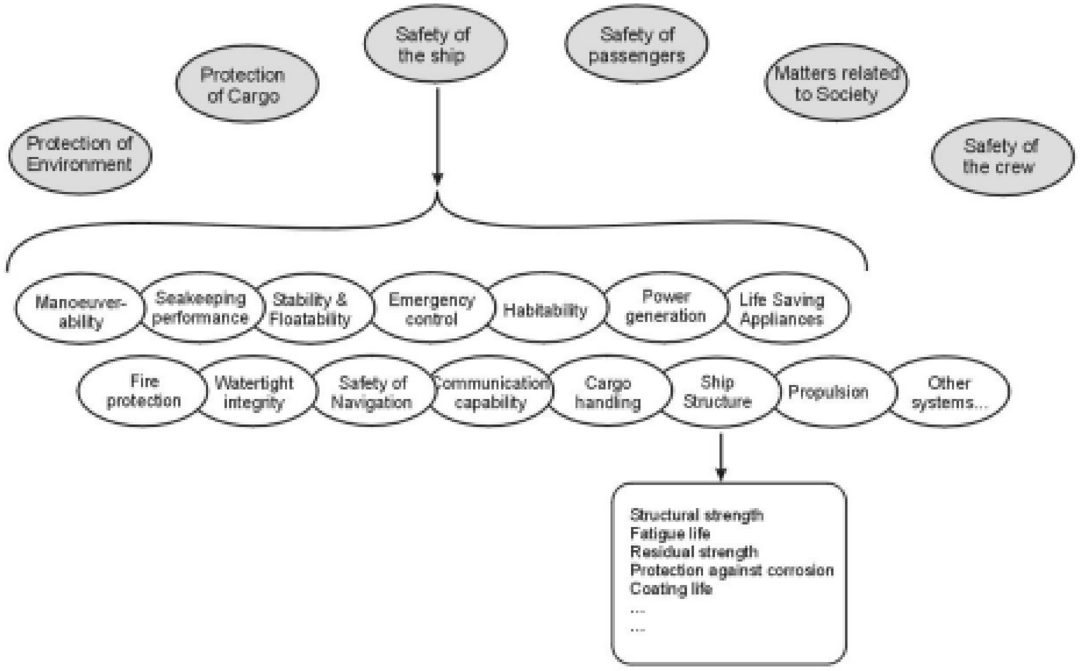
Credit: IMO

Goal-based standards framework

Goal-Based Requirements

- In service of this, the IMO release a 5-tier framework to inform the new Class structures.
- Tier I defines what goals are as high-level objectives to be met.
- Tier II covers the functional requirements for stakeholders to conform to.
- Requirements should have a description, a rationale, and an expected performance from the required function.
- Requirements should also comply with the following:
  - Cover all areas needed to meet goal
  - Address all relevant hazards
  - Criteria for compliance
  - Allow for further technological developments
  - A description of a function to be achieved

15 Figure illustrates a simplified example of how goal-based functional requirements for ship structure could be derived.



Simplified example of how goal-based functional requirements for ship structure could be derived

Credit: ABS

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Goal-Based Requirements

- Tier III deals with the verification of conformity for the established functional requirements
  - This is the process that the ships follow to verify compliance with the functional requirements.
  - These should consider things like commentary, documentation, and mechanisms/methodology of verification.
  - The level spells out the baseline requirements that should be provided for proper client verification.
- Tier IV integrates the IMO Rules and Requirements into the goal-based framework.
- Tier V allows for industry codes and standards to be referenced.
- Tier V also covers the rules for evaluating the effectiveness of Tier I established goals.

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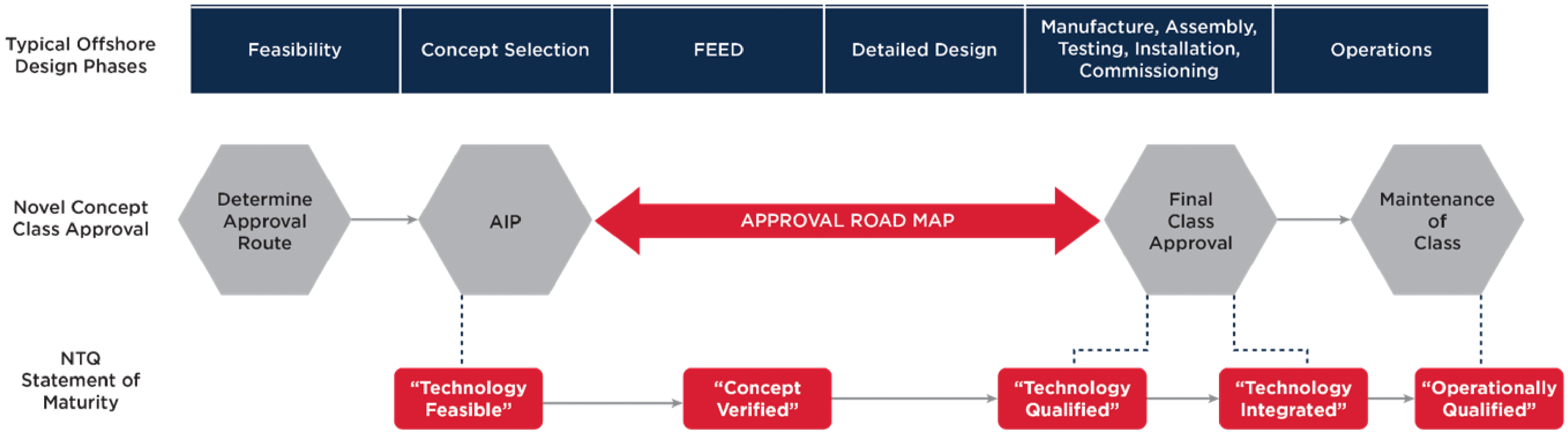
Goal Based Requirements in Class

- Following the IMO directive, Class societies have developed frameworks for conformity by the industry.
- ABS does this through the application of approvals based on the design state of an alternate arrangement vessel



Credit: ABS

Alternative Arrangements & Novel Concepts

Alternative Arrangements

- The ABS guidelines introduced definitions to accommodate for innovative designs.
- These guidelines define traditional arrangements as such:
  - *Conventional Technologies* - Technologies that can be qualified by existing Rules and standards
  - *Conventional Designs* - Designs for which ABS has detailed prescriptive requirements. Known applications of proven technologies
- However, allowing for new technologies requires designs that have not yet been addressed by the existing Rules.
- For the purposes of Class, these new designs are referred to as alternative arrangements.

Alternative Arrangements

- Traditional designs have been standardized for most vessel types.
- The issue is that traditional designs are made for carbon-polluting engine types.
- To introduce decarbonized solutions, vessel designs must be rethought
  - Fuels with lower energy densities will require arrangements for larger fuel storage
  - Fuels with lower flashpoints will require increased and adapted safety systems
  - Electrification will require engine rooms to be re-designed for battery storage
- As more technologies are integrated into marine systems, more alternative arrangements will need to be considered.
- The innovation structure allows for industry to introduce these arrangements more freely while working within the structure of a Class Society.

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Alternative Arrangements Example

- An example of an alternative arrangement is the shown container vessel.
- This design incorporates wind power into a container ship.
- This type of container ship does not have Rules designated for this power source.
- As such, the organization that developed it contacted ABS for temporary approval through the goal-based standard framework.

Credit: Veer Corporation

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Alternative Arrangements Example

- Another example of an alternative arrangement is this tugboat.
- This design incorporates ammonia as its fuel type.
- This fuel type requires a new arrangement to account for energy density and fuel toxicity.
- This arrangement has earned approval from ABS, and later verification processes will continue through the goal-based system.

Credit: COSCO Shipping Heavy Industry

Novel Concepts

- Another drawback of traditional designs is that they rely on proven technology and don't allow for new technology incorporation.
  - Proven technology is defined as a technology with proven experience in the proposed environment
- Meeting decarbonization goals will require incorporating mitigating technology at a much quicker rate.
- ABS has incorporated processes for novel concepts.
- These processes allow for industry to develop and get approval for new technologies that may not yet meet the proven technology definitions.

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Novel Concepts

- The addition of novel concept processes has allowed the industry to really explore technology to meet short term and long-term goals.
- There are technologies being integrated that allow for immediate carbon reductions and challenge the growing industry.
- For example, carbon capture and storage technology has seen heavier investment as an immediate solution that can be integrated to lower traditional oil emissions.
- On the other hand, general new technologies are also being pushed to adapt for the maritime needs.
- An example of this are the design challenges being posed to the hydrogen industry to create larger tanks capable of completing comparable shipping routes.

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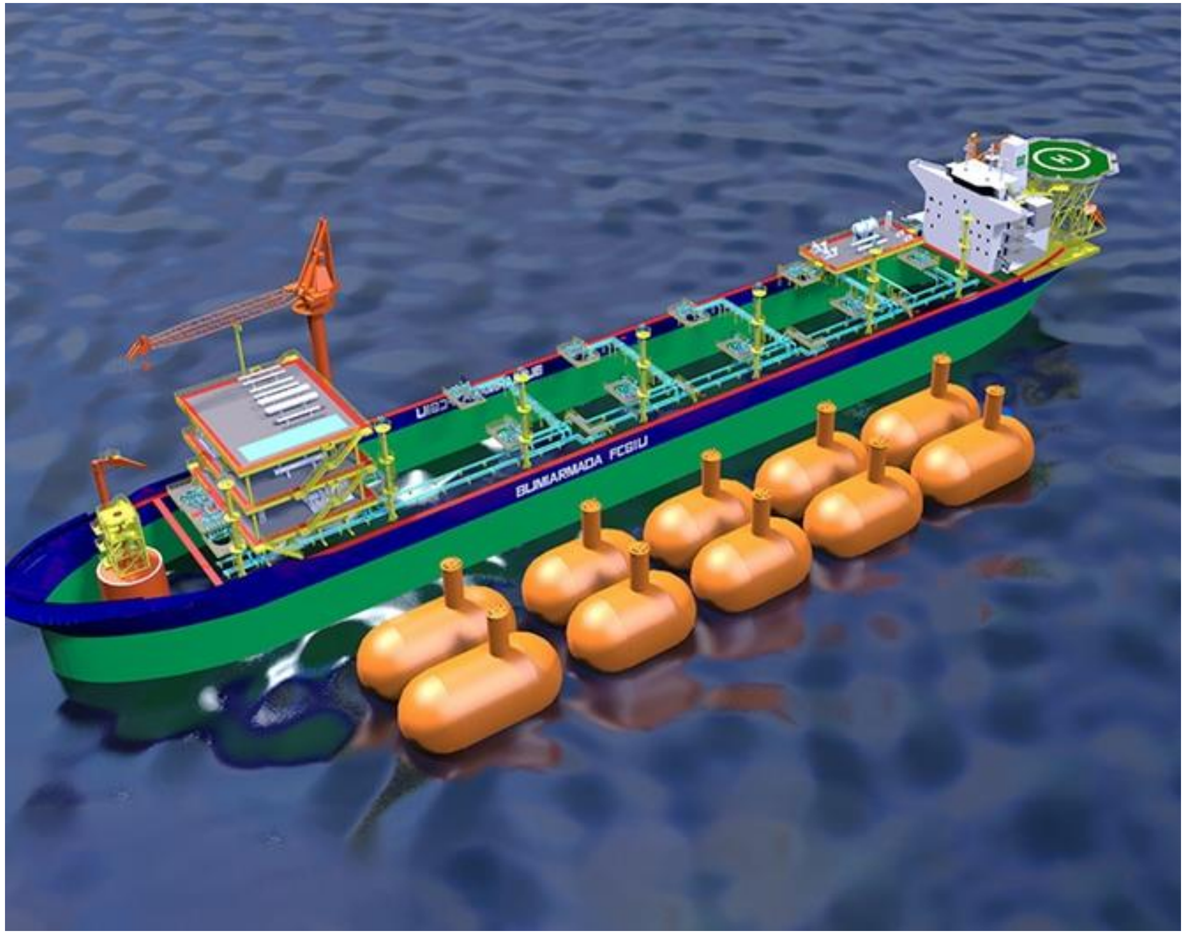
Novel Concept Example

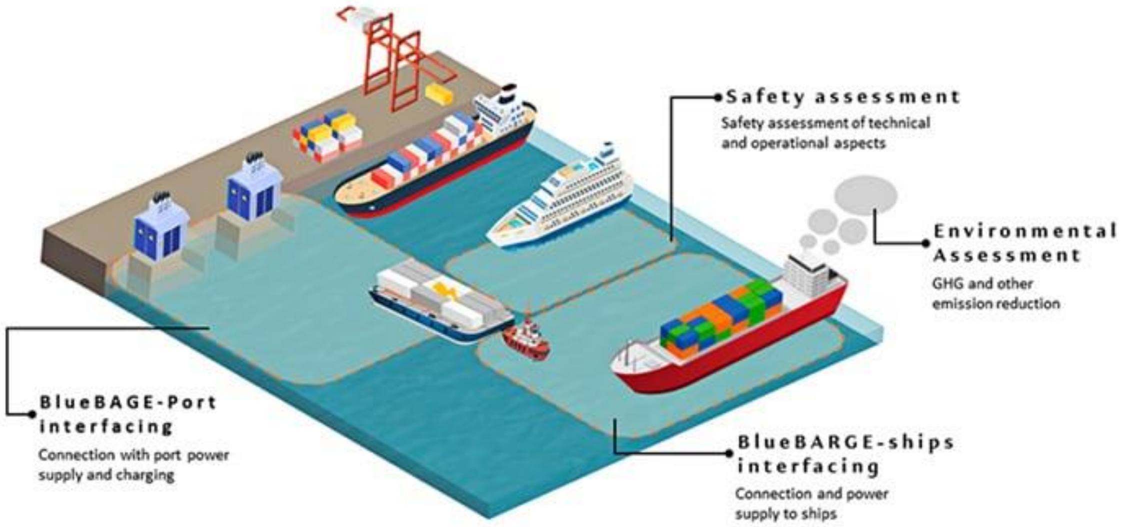
- An example of a novel concept is the shown carbon capture technology.
- Proposed is technology that allows for the storing and injection of liquid CO_2 back into depleted oil and gas fields.
- Current Rules do not allow for this type of process to occur.
- This is also an experimental technology so traditional requirements would not allow for its approval.
- The novel concept processes allows this organization to test this system with approval from ABS.



Credit: Bumi Armada

Novel Concept Example

- Another example of a novel concept is cold ironing technology.
- Proposed is a technology that allows for docked ships to plug into electrical power at port.
- Current Rules only allow for the use of onboard generators.
- This is also an experimental concept so traditional requirements would not allow for its approval.
- The novel concept processes allows this organization to test this system with approval from ABS.



Credit: *Fundación Valenciaport*

Approvals in Principal

Approvals in Principle

- Clients who are just beginning to explore the possibilities of a new technology or concept often seek Class input and expert opinion on its perception of the concept in terms of Class approval.
- Thus, clients will seek a preliminary approval on the novel feature or concept.
- This preliminary milestone in the class process is called Approval in Principle (AIP).
- Often, many concepts that are granted an AIP are simply napkin ideas or preliminarily designs.
- The idea is the encouragement of innovation without the handcuffs of prescriptive requirements.

Approvals in Principle

- Engineering within the AIP phase is to be progressed to the point of demonstrating that likely failure modes and consequences have been identified and at least considered in the concept design.
- The need for proof or model testing and data gathering will have been identified.
- Further need for refined risk assessment and engineering analysis will have been identified as well.
- Additional resources provided to the Class will also aid in the granting of an AIP.
- Completed HAZIDS/HAZOPS, FMEAs, design analysis, etc. are some examples of what an organization may submit in consideration for their AIP.

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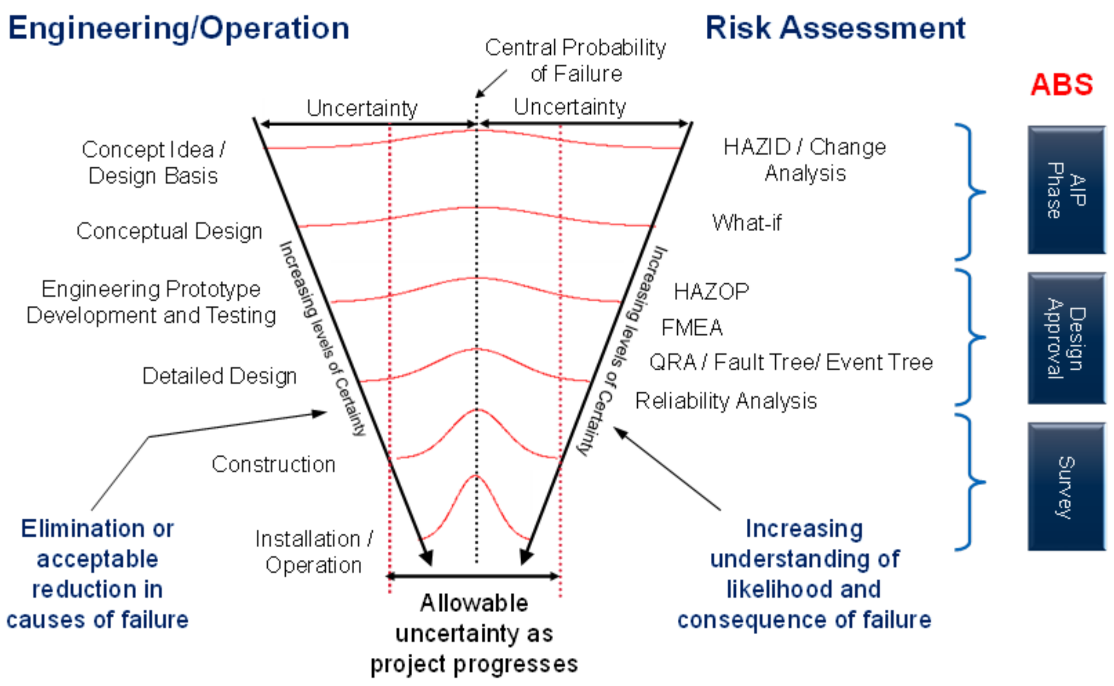
Requirements

- In order for ABS to grant Approval in Principle to the novel concept, the following conditions must be satisfied:
  - Both the Concept Engineering Evaluation and the concept-level Risk Assessment must not have identified any “showstoppers”.
  - The concept must be deemed suitable for use within a marine or offshore environment without the need for excessive or onerous monitoring during operation or maintenance/ inspection considered atypical for such applications.



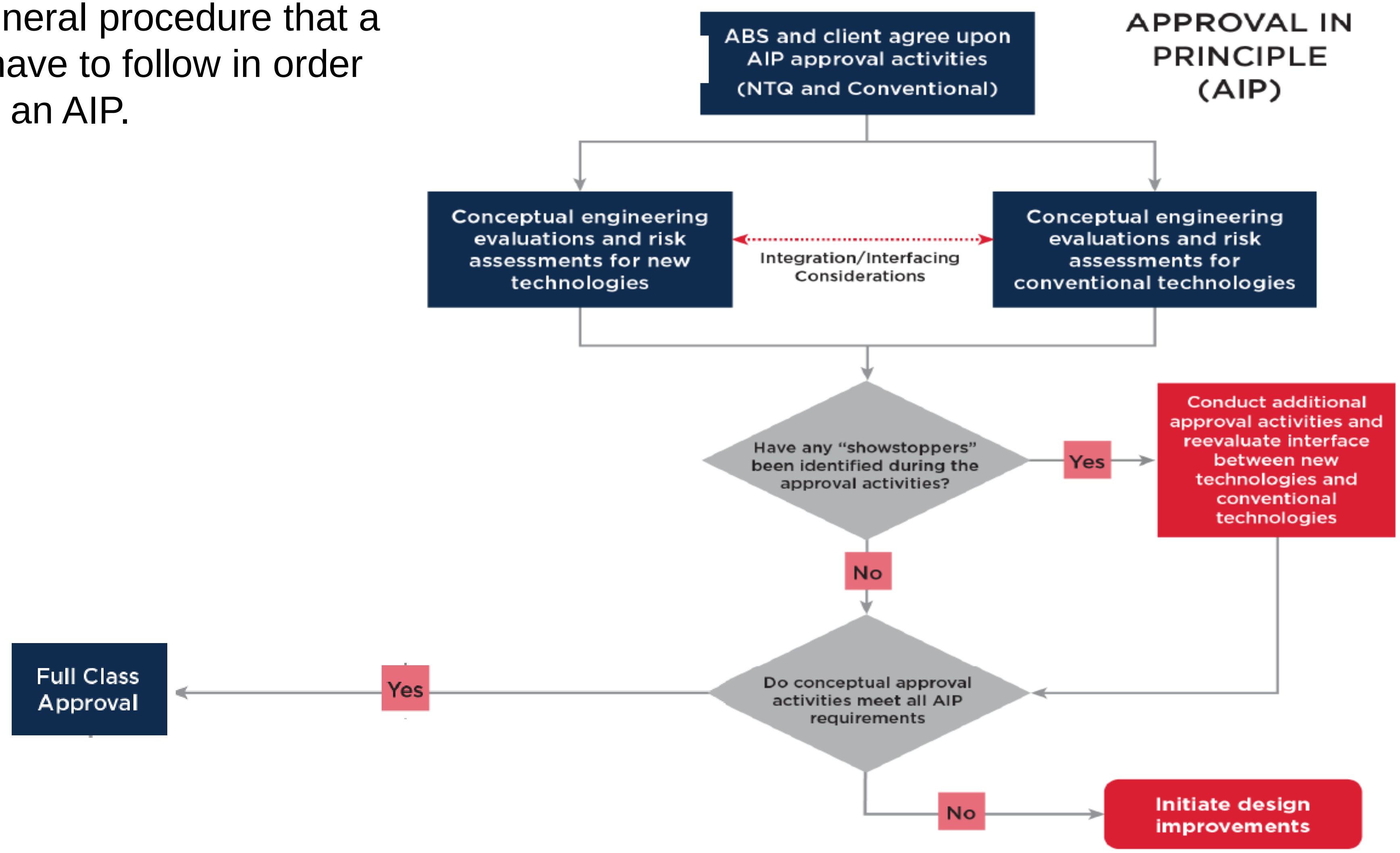
Credit: ABS

Benefits

- The benefit of an AIP is that the client now has a document issued by a knowledgeable independent marine and offshore society attesting to the acceptability of the concept for classification.
- Risk is assessed at a high level early in the concept stage through well-established qualitative techniques, such as HAZID/ HAZOP, Structured What-if Analysis, FMEA, etc.
- On-going designs can be reviewed as the manufacturing is developed to ensure Class compliance.
- The client can secure early insurance and funding with the Class issued document.
- The Class has a window into developing technology that can later be implemented in developing Rules and Requirements.

Procedure

- This is the general procedure that a client would have to follow in order to be granted an AIP.



Credit: ABS

New Technology Qualifications

What Constitutes a New Technology?

- Any new design (materials, components, equipment or systems), new process or procedures with no prior in-service experience or any classification rules, statutory regulations or industry standards directly applicable to them as a new technology.
- It is possible to categorize the type of “novelty” in one of four categories:
  - Existing design/process/procedures challenging the present boundaries or envelope of current offshore or marine applications
  - Existing design/process/procedures in new or novel applications
  - New or novel design/process/procedures in existing applications
  - New or novel design/process/procedures in new or novel applications.

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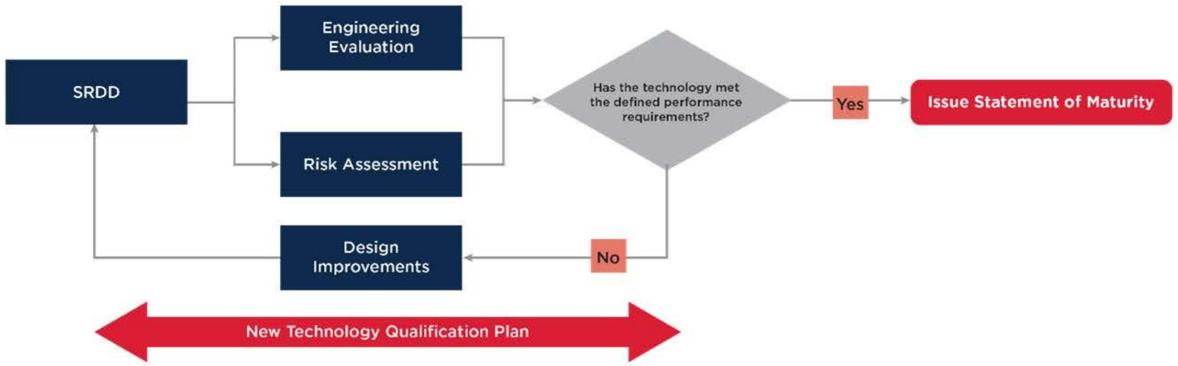
Getting Started

A System Requirements and Description Document (SRDD) should be developed to properly define a new technology and maintained throughout the NTQ process.

Engineering evaluations are used to verify and validate that the new technology is capable of performing acceptably with respect to intent and overall safety according to the requirements of each stage.

A risk assessment is to be performed/updated at each stage as applicable. The risk assessment within the NTQ process will vary from qualitative to quantitative depending on the maturity level and information available at that stage.

Based on the results of the engineering evaluation and risk assessment activities, design improvements may be necessary to enhance reliability and safety of the design.

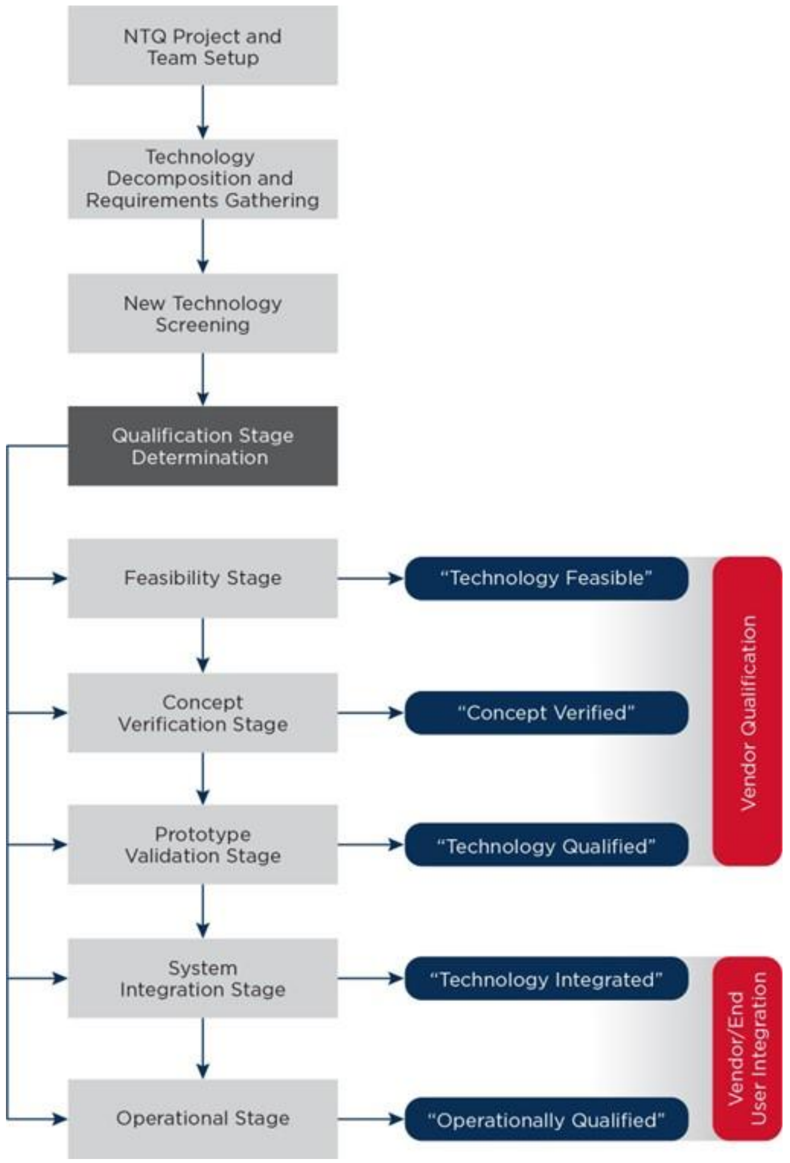


Credit: ABS

Systems Engineering Approach

A five-stage process is followed that aligns with the typical product development phases of a new technology:

1. Feasibility Stage
2. Concept Verification Stage
3. Prototype Validation Stage
4. System Integration Stage
5. Operational Stage



Credit: ABS

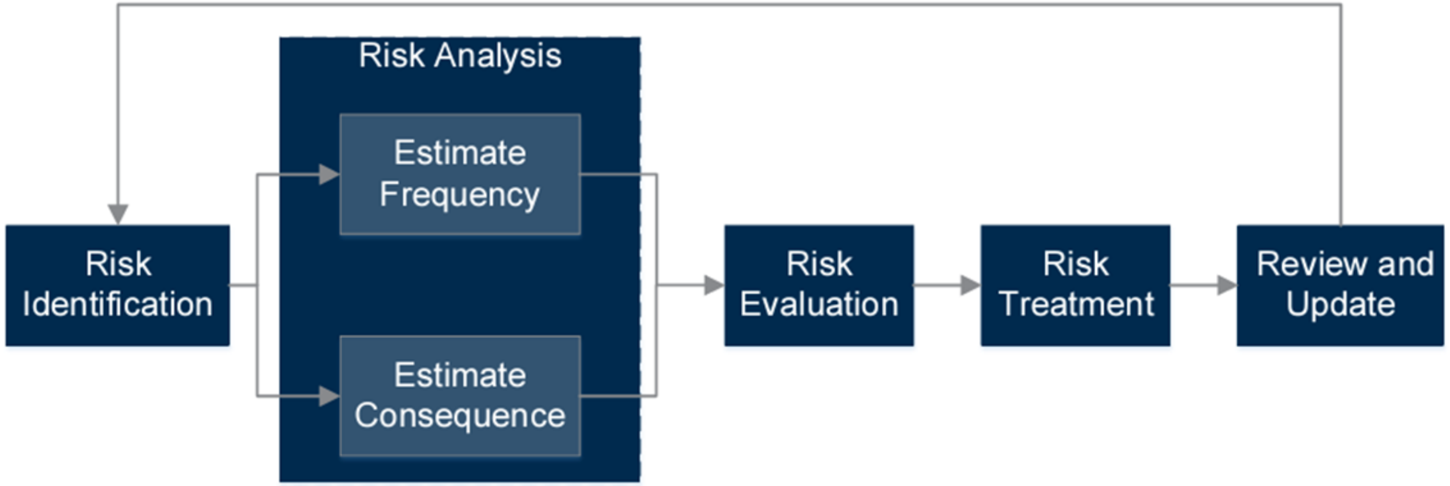
Feasibility Stage

Engineering Evaluation

- All goals, functional requirements, and performance requirements submitted as part of the SRDD in 1D-A2-3/3.3 are reviewed along with any available high-level engineering design analysis to verify that the proposed concept is feasible.

Risk Assessment

- A high-level risk assessment should be carried out during this stage to identify any preliminary technical risks and uncertainties associated with the proposed concept.



Credit: ABS

Concept Verification Stage

Engineering Evaluation

- Engineering Design Review
  - The concept is confirmed, and the engineering design is performed to verify that the functionality and performance of the new technology can be satisfied.
- Functional and Model Testing
  - The objective is to verify that the system meets the performance and reliability requirements, as well as to verify the results obtained from the analytical models.

Risk Assessment

- Any design modifications from the Feasibility Stage should be addressed
- Updated functional and performance requirements
- Updated configurations
- Possible interfaces and integrations
- All potential failure modes, failure causes and failure mechanisms in all expected operational modes and life cycle stages
- The effectiveness of existing risk control measures and the need for any additional or more reliable measures

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Prototype Validation Stage

Engineering Design Review

- The engineering design is to confirm that the overall system, down to the lowest component level, has satisfied all system requirements.
- The performance requirements a technology should meet should be finalized and measurable.

Prototype Testing

- Prototype Testing is intended to prove that the interactions between the systems/subsystems/ components under relevant loading and environmental operating conditions can perform reliably as intended.

Manufacturing and Survey

- A manufacturing plan should be finalized that includes the manufacturing methods and processes, the facilities, the production schedule, and quality assurance requirements.
- Survey during the manufacturing process and prototype testing may be required.

Risk Assessment

- Risk assessments performed in the Prototype Validation Stage is to validate the final design of the new technology.
- All previous risk assessments should be reviewed against any newly identified failure modes or hazards.

System Integration Stage

Engineering Evaluation

- System Interface and Integration Requirements are to be finalized.
- Interface analysis should be conducted to ensure the addition or incorporation of the new technology does not negatively affect the integrity of the surrounding systems and components.
- Full interface and function test programs are performed in the intended (or closely simulated) environment with Survey witness.

Risk Assessment

- Evaluate any technical risks resulting from system integration and operations that have not been previously evaluated as part of the design risk assessment, process risk assessments or other risk assessments in the previous stages.

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Operational Stage

- Such requirements, defined in previous stages, have to be translated into specific and quantifiable performance requirements to be attained during operations.
- Any critical assumptions made in the risk assessment and engineering evaluations during the four previous qualification stages should be monitored to confirm that operational experience does not disprove them.

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Statements of Maturity and Type Approval

- Through Statements of Maturity, issued at each stage in the qualification process, vendors can demonstrate feasibility and maturity levels to gain a competitive advantage with customers, partners and potential investors.
- Upon completion of the Prototype Validation Stage, eligible products can be “Type Approved” under the ABS Type Approval Program to limit repeated evaluation of identical designs.

STATEMENT OF MATURITY ABS

Client Name: XXXXXXXXXXXXXXXXXXXInc. **Certificate Number:** T2369XXX
Date Issued: XXXXX, 2023

CONCEPT VERIFIED

This is to certify that

XXXXXXXXX OFFSHORE
XXXXXXXXX SYSTEM

has been reviewed in accordance with the ABS *Guidance Notes on Qualifying New Technologies* [1]. The proposed technology concept is verified as being capable of performing its intended functions in accordance with the defined performance requirements as outlined in "TVO NGL System Requirements" submitted by TVO and referenced in the ABS Technology Qualification Review Letter "TVO NGL NTQ Review Letter T2369XXX". The technology may proceed to the *Prototype Validation Stage.*

Description and Application: XXXXXXXX Offshore (XXX) has developed the XXXXXXXXX(XXX) system to XXXXXXXXXXXXXXXXXXXby XXXXXXXXXXXX a XXXXXXXXX. The XXXX system uses the XXXXXX assemblies with standard interfaces connected to XXXXXXXXXXXXXXX and then connected by the XXXXXXXXXXXXthrough the XXXXXXXXXXXXX to the XXXXXXinterface welded to the hatch cover. A detailed description of the XXXX system is provided in the documents submitted by XXXXX and referenced in the ABS Technology Qualification Review Letter.

Boundaries: This concept verification is limited to the XXXXXsystem that is supplemental to the existing XXXXXXXXXXX system in compliance with applicable requirements.

Scope of Review: This review is limited to the XXXX system and its components (XXXXX, XXXXX, XXXX xxxxx, and XXXXXXX interface structures).

Comments/Notes: Refer to the ABS Technology Qualification Review Letter "TVO NGL NTQ Review Letter T2369XXXX" for the comments and notes.

Reference Documents:
[1] ABS *Guidance Notes on Qualifying New Technologies*

ABS shall in no event be held liable for any identified/unidentified hazardous scenarios or qualification activities associated with this technology.

Approved By:

Qing Yu
Director, Technology

Credit: ABS

New Technology Stage Determination

These questions serve as general guidance to understand the design maturity of the technology based on completed qualification activities and thus determine the corresponding qualification stage.

Qualification Stage	*Item #*	*Question*	*Yes/No/NA*	*Evidence to support?*
Feasibility Stage	1	Has what is specifically new and/or unique about the concept been clearly identified?		
	2	Has what specifically needs qualification been defined?		
	3	Have potential applications been identified?		
	4	Have goals, functional requirements, and fundamental objectives (e.g., RAM) for the identified application been identified?		
	5	Have basic functionality and durability of the technology been analyzed?		
	6	Have basic principles been observed and reported?		
	7	Have lessons learned from similar technology been reviewed and documented?		
	8	Have basic design calculations been performed?		
	9	Have conceptual research and development been completed?		
	10	Has a preliminary list of reliability drivers been prepared?		
	11	Has a preliminary fitness assessment (physical interfaces, human etc.) been performed?		
	12	Can engineering drawings(basic configurations, interfaces, and/or PFD's or flow charts) and calculations be submitted for review?		
	13	Have any early stage risk assessment and mitigation studies been performed and documented?		
Concept Verification Stage	14	Has the concept functionality been demonstrated by physical models or "mock-ups"?		
	15	Have laboratory scale material testing and degradation mechanisms been performed?		
	16	Have all conceptual design engineering studies been completed?		
	17	Have preliminary function/performance/reliability engineering studies been completed?		
	18	Have reliability drivers been confirmed?		
	19	Is there documentation that RAM requirements can likely be met?		
	20	Has durability been confirmed by testing or calculation?		
	21	Has a viable manufacturing or fabrication scheme been documented?		
	22	Has preliminary qualitative design risk analysis(e.g., FMECA) been documented?		
	23	Have the initial risk assessments been reviewed/updated to identify any additional technical risks?		

Credit: ABS

Thank You

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