Risk-Based Ship System Approval Process

by R. Hamann, Germanischer Lloyd

Germanischer Lloyd

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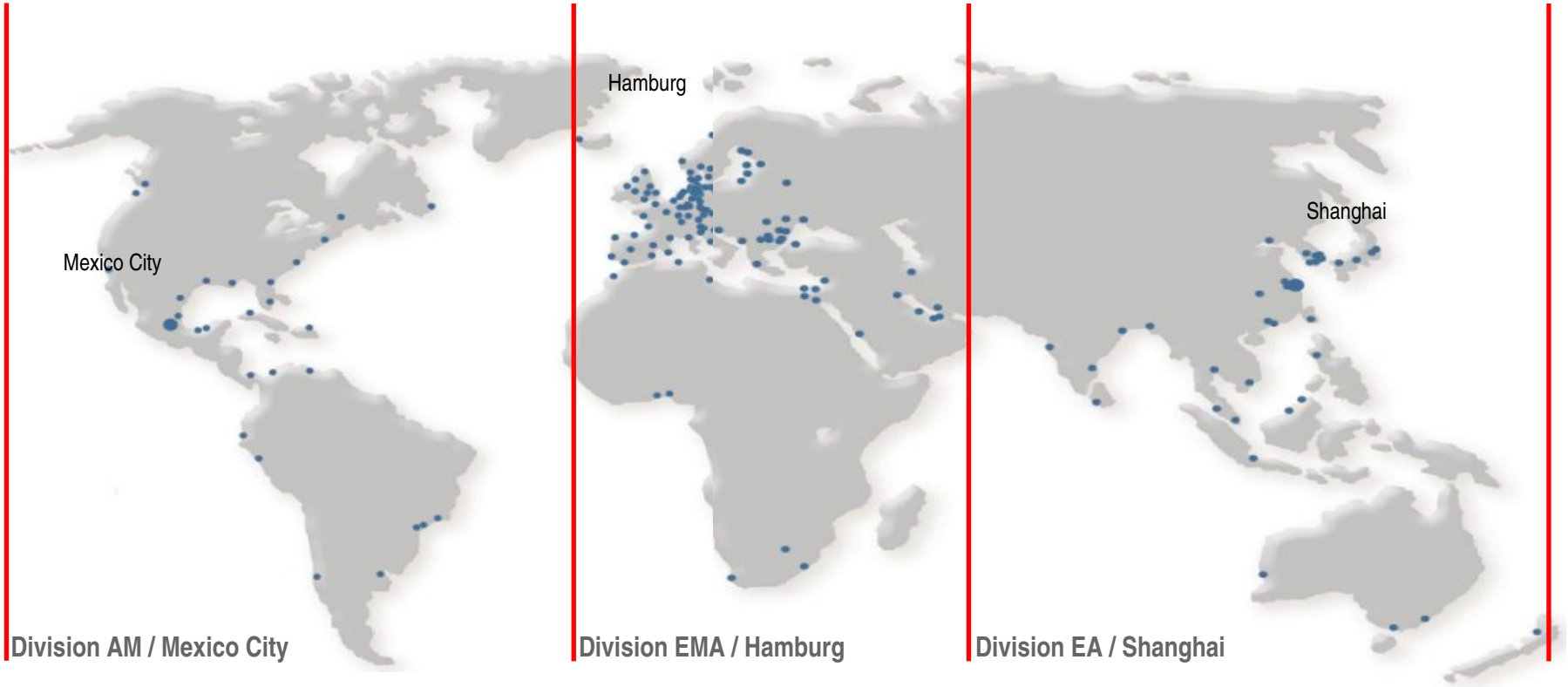
GL: Worldwide service on site

Over 3,200 employees, of which 1,900 are engineers, are working for you in over 176 offices in more than 76 countries.



Over 100 years of GL – over 100 years of service

- **Monitoring of ship newbuildings**
  Outstanding know-how in design, construction and approval of technically demanding vessels
- **Supervision of the GL classified fleet**
  Regularly monitoring of the operating condition of vessels and assistance in ensuring the smooth and reliable sailing of ships
- **Research and development**
  Ship newbuilding is becoming increasingly challenging, GL is the leader with regard to hydromechanics, acoustics, oscillation behaviour and stability
- **Engineering services**

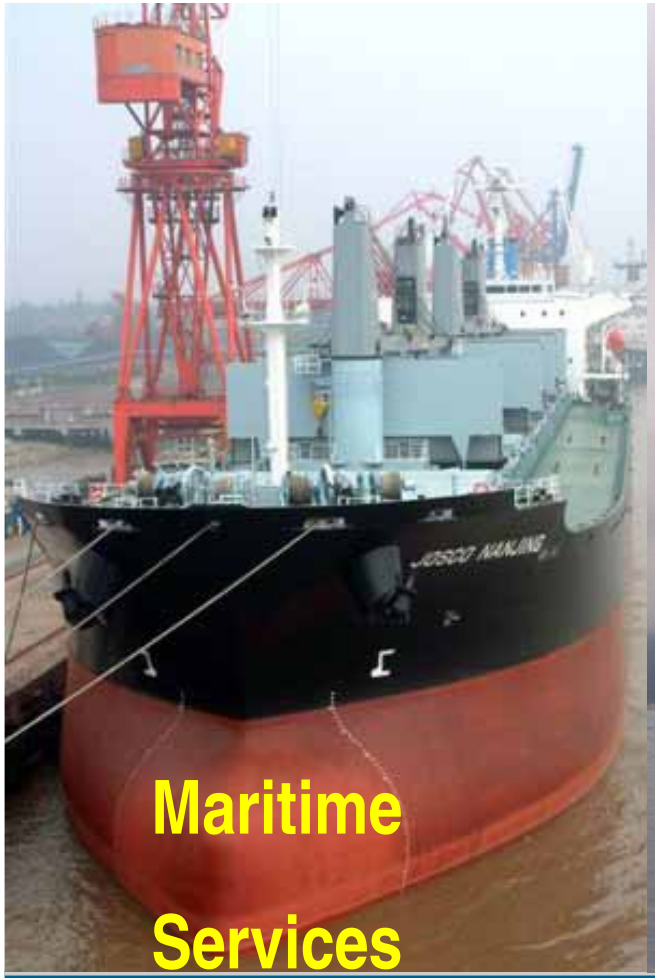
GL classification: The foundation for safe operations

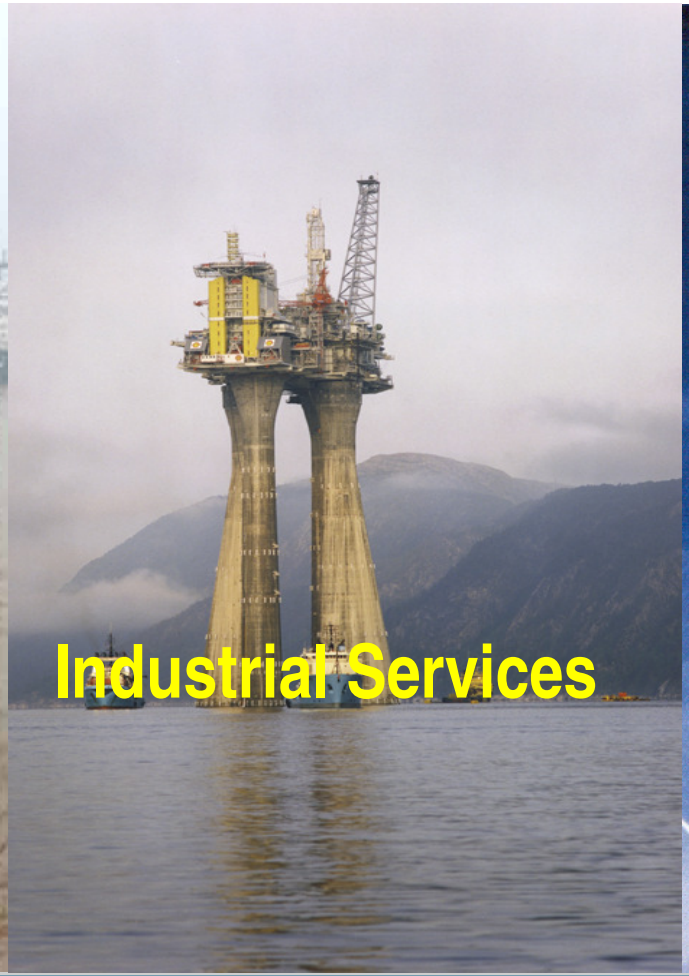
Classification is important for:

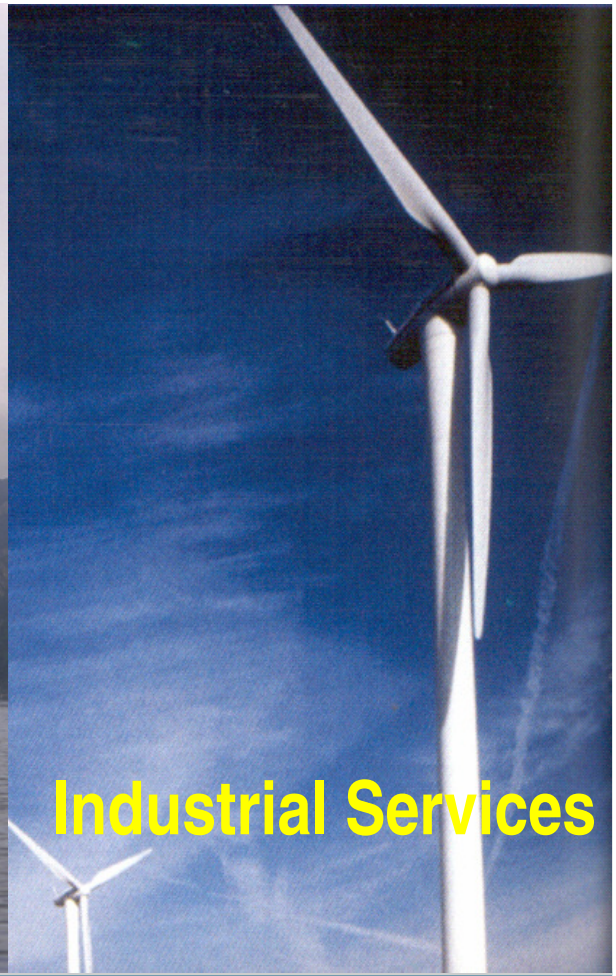
- Shipowners and charterers
- Shipyards and sub-contractors
- Banks
- Maritime insurance companies
- National maritime safety authorities which issue so-called ‘trading certificates’ as a prerequisite for the operation of a ship

Germanischer Lloyd – Ship Classification since 1867

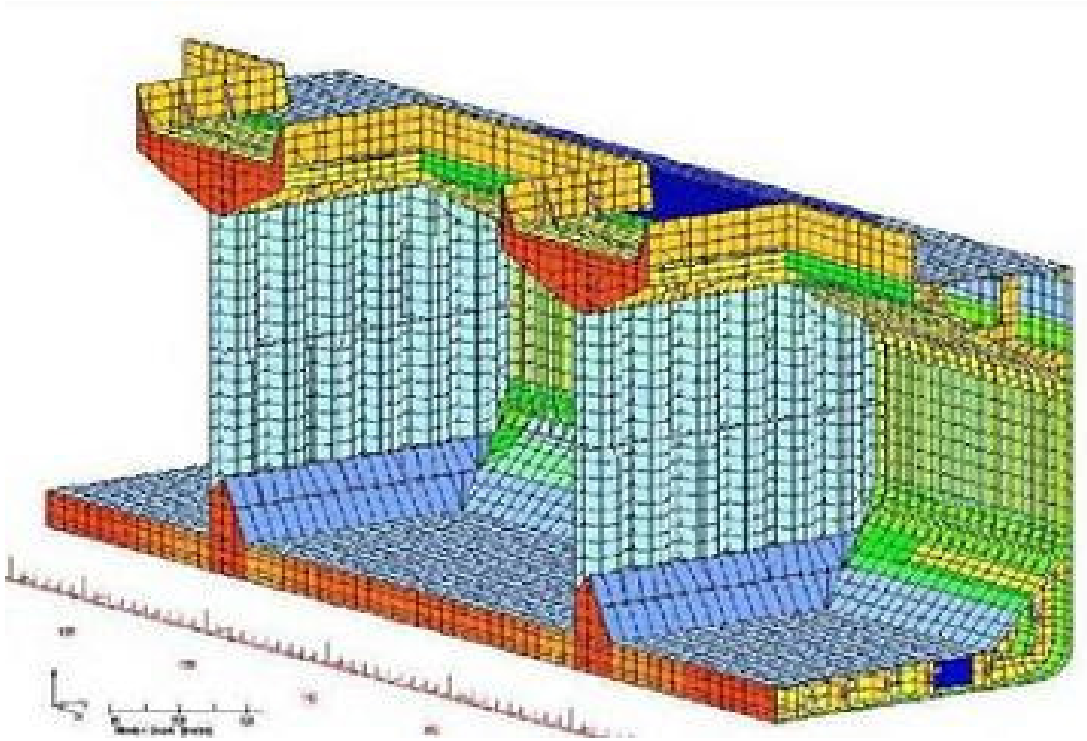
Germanischer Lloyd







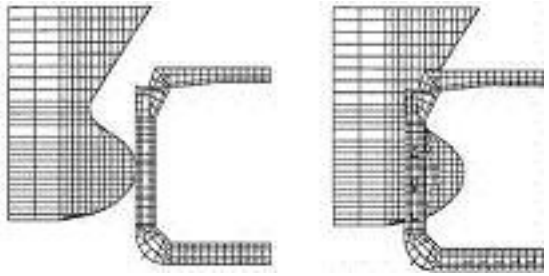
Advanced engineering and strategic research

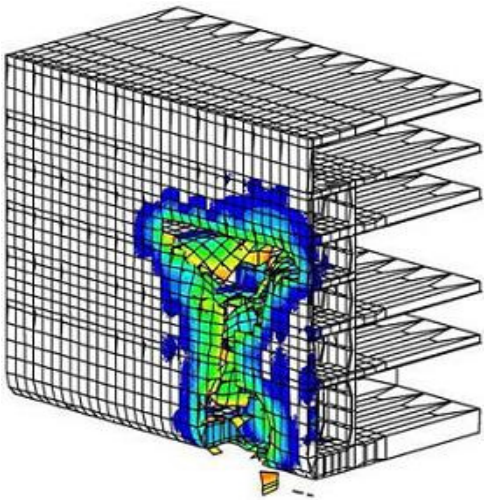


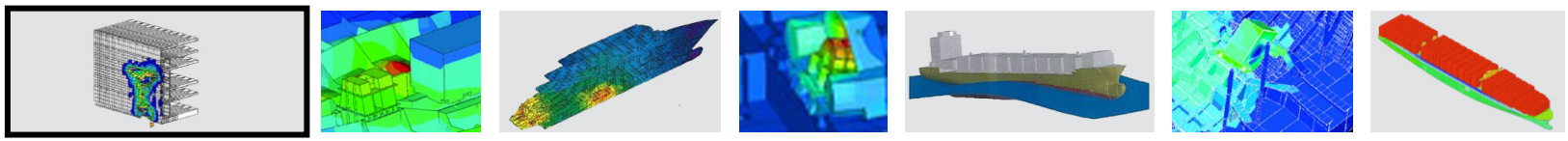
Development engineering and strategic research

Collision investigations using modern calculation methods

- Optimisation of the construction
- Resistance to penetration and distortion



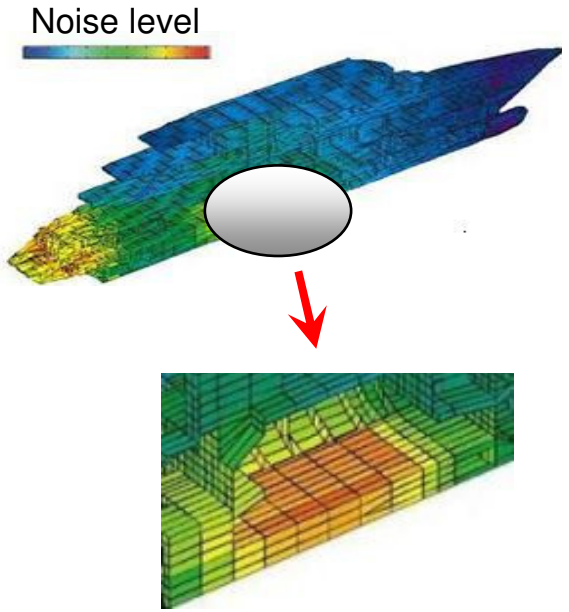


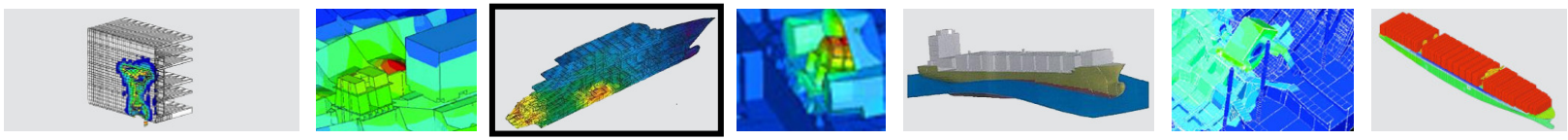


Development engineering and strategic research

Sound gauge prediction using NoiseFEM

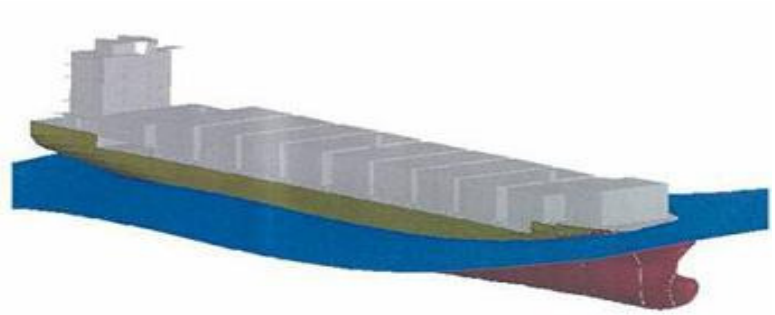
- Prediction of structure-borne noise propagation
- Use of existing FE models
- Identification of main structure-borne noise path
- Prediction of noise level in work and accommodation areas





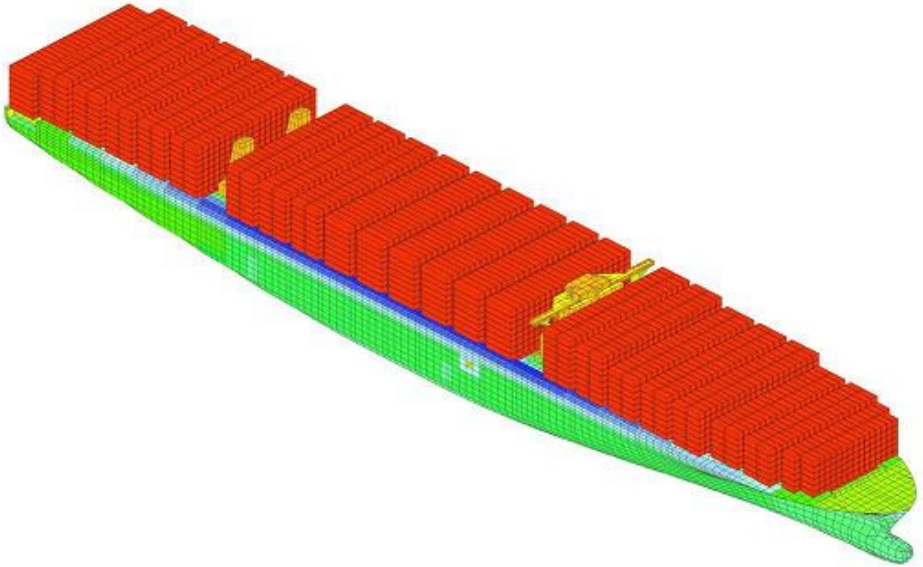
Development engineering and strategic research

- Ship – sea interaction



Development engineering and strategic research

The 13,440 TEU container ship – design study



Hyundai Ship No. 3045, 12770 TEU Class Container Carrier

Length: 382.0 m

Breadth: 54.2 m

Draught: 13.5 m

Speed: 25.5 knots

Engine power: two 45,000 kW engines

Risk-Based Design in Shipping Industries $_1$

- **Ships are designed in accordance with prescriptive Rules of Classification societies**
- **These Rules are based on SOLAS and MARPOL regulations**
- **Usually, these Rules are empirical based**

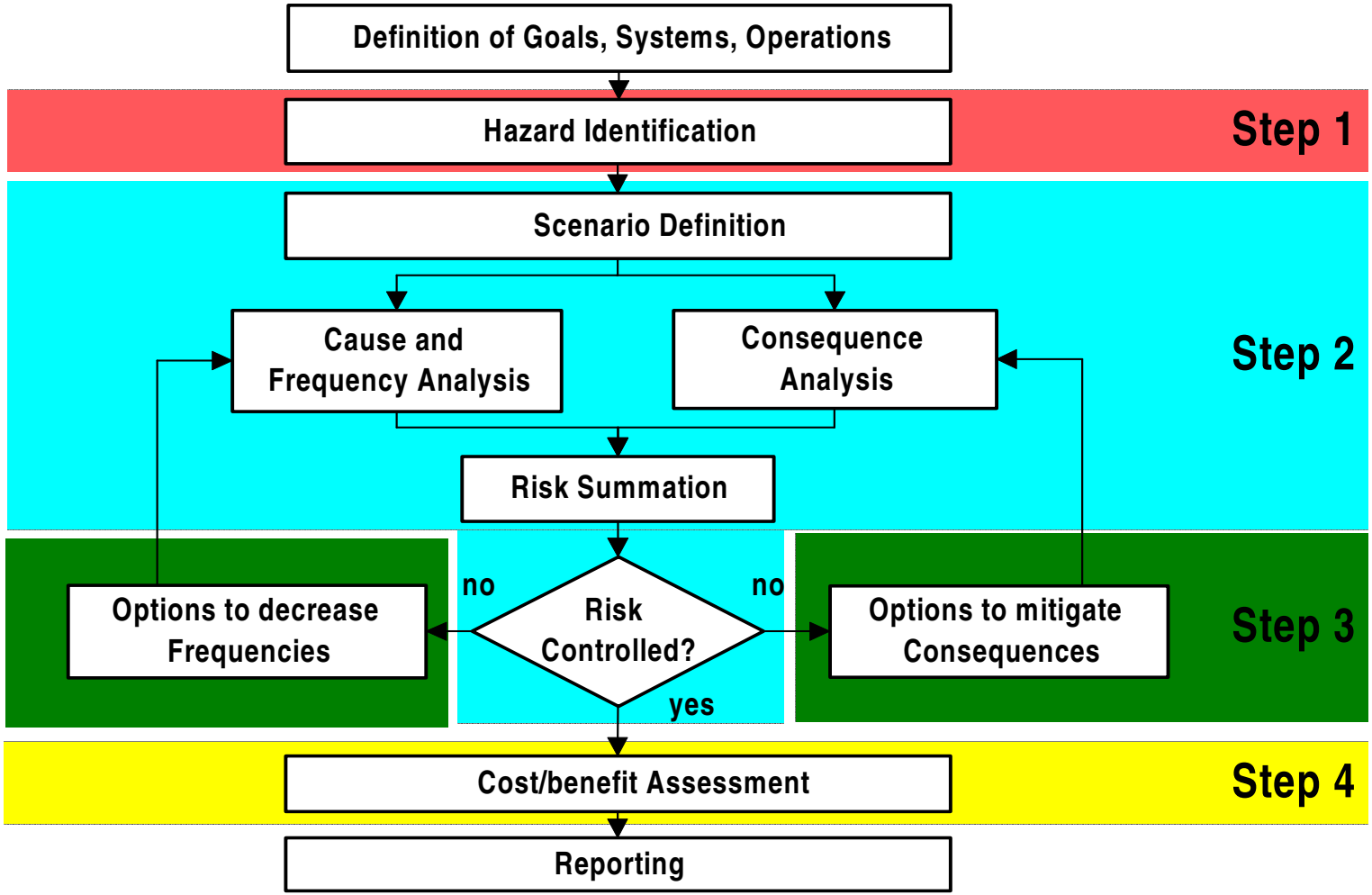
Risk-Based Design in Shipping Industries$_2$

- **Like in other industries risk-based methods are increasingly regarded as an alternative**
- **Examples:**
  - High Speed Crafts
  - Demonstration of equivalence
  - IMO Rule making process
  - GBS

Demonstration of Equivalence

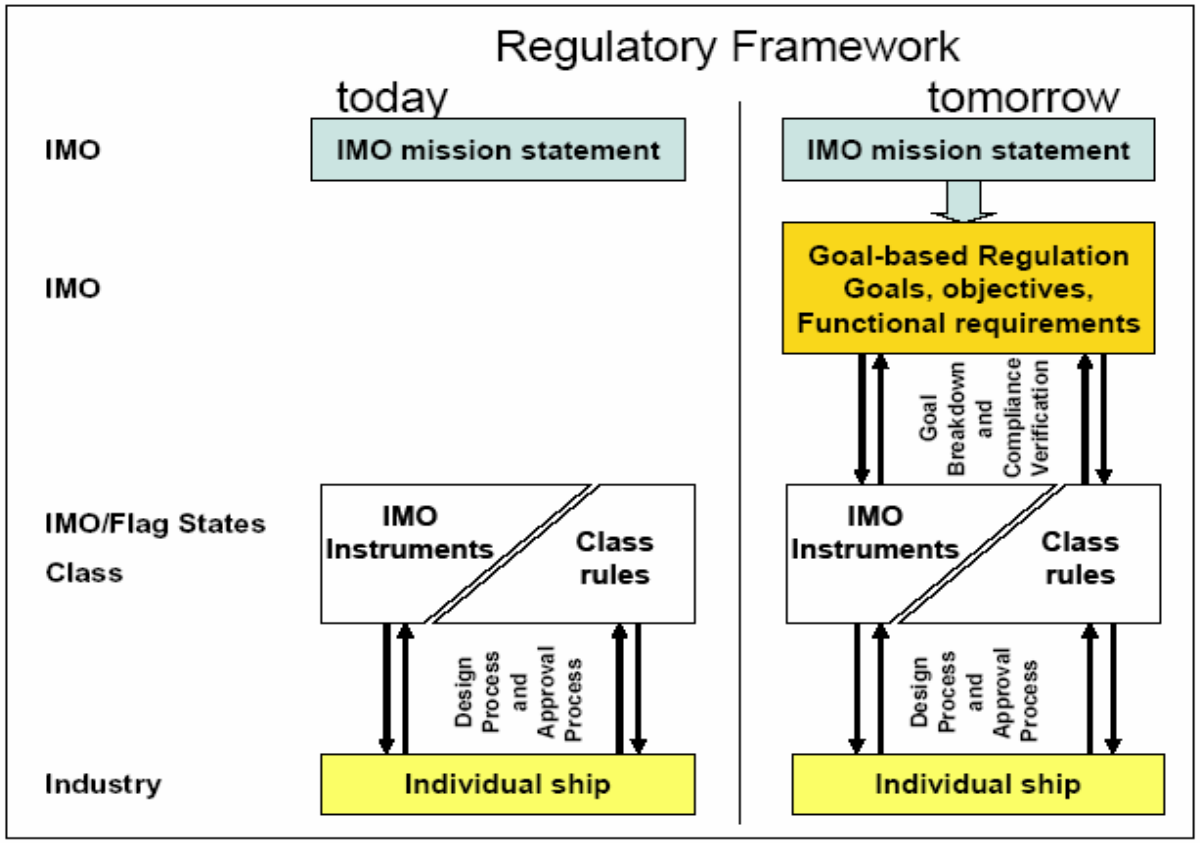
- **Design challenging prescriptive Rules**
- **Compliance with the intention of existing Rules is demonstrated**
- **Process defined in MSC/Circ 1002**
- **Presently, only for selected chapters of SOLAS**

FSA – Formal Safety Assessment



[IACS]

Goal-Based New Ship Construction Standards (GBS)

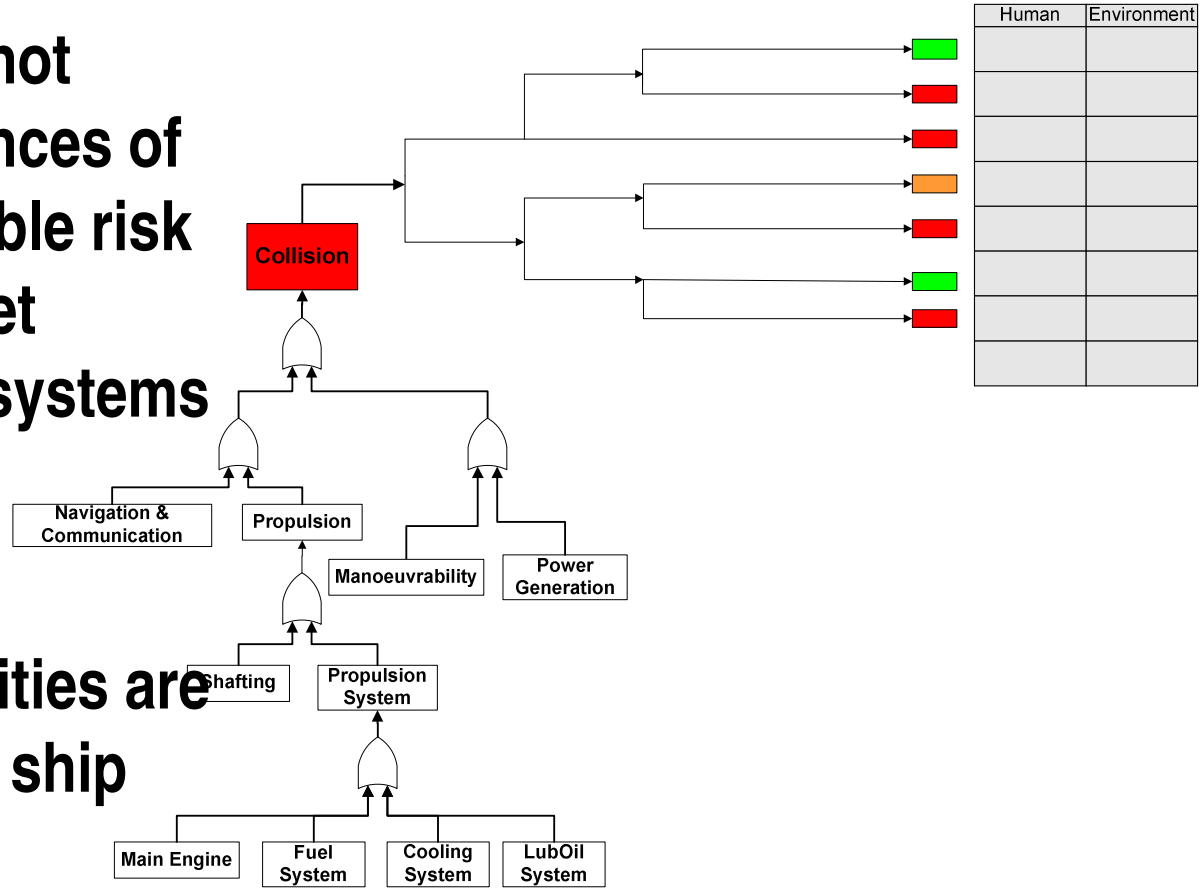


Risk-Based Design$_1$

- **Risk-based design challenges Rules of administration and classification**
- **Administrative Rules are focused on safety and environment**
- **Risk-based design is supported by risk analysis and risk evaluation**
- **Evaluation is performed by using defined acceptable risk for specific system**
- **Risk-based design requires acceptance criteria defined either explicitly by the administration or by existing Rules (equivalency)**

Risk-Based Design$_2$

- If a new design does not influence the consequences of an accident the acceptable risk can be replaced by target failure probabilities for systems



- Target failure probabilities are linked to overall risk via ship functions

Motivation

- Risk-based design requires additional analysis and thus increases the engineering effort for design
- Although this: the number of risk-based designs appears to be increasing
  - SOLAS II-2/17: alternative design and arrangements for fire safety
  - In the future (2010): SOLAS II-1 (C, D, E) and SOLAS III
- Reasons:
  - Economic motivation (lower costs for fabrication, operation, maintenance)

➡ Benefit: higher flexibility to develop solutions because prescriptive regulation are replaced by target values in terms of safety and environmental protection

Risk-Based Regulatory Framework

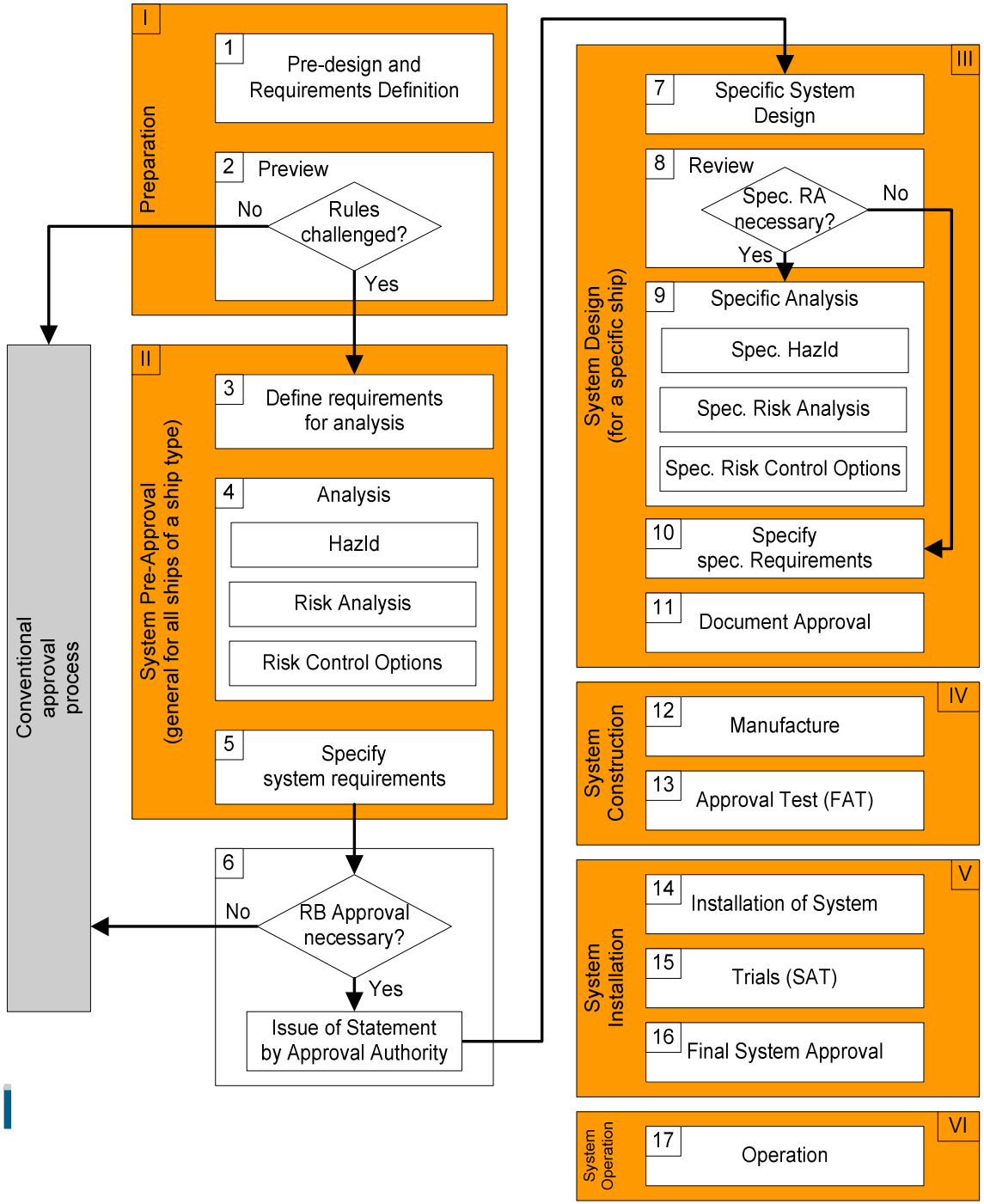
- **Requirements:**

  The risk-based evaluation of designs must be traceable, transparent and objective

- **Guidelines, laws, rules provide the regulations to comply with the requirements**

- **Regulatory Framework**

- **Risk-based approval process for ship system design is part of framework**



Risk-Based System Approval Process

I. Preparation

II. System Pre-Approval

III. System Design

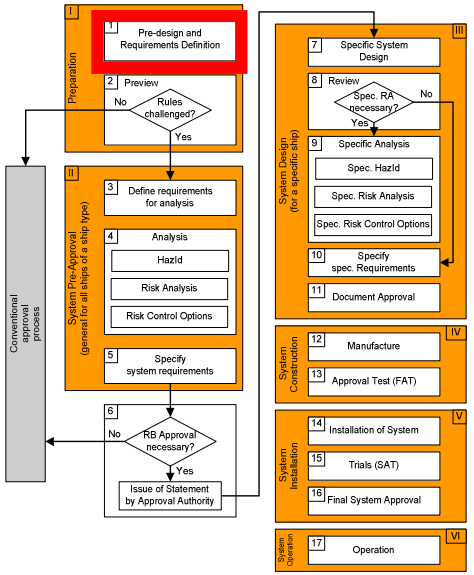
IV. System Construction

V. System Installation

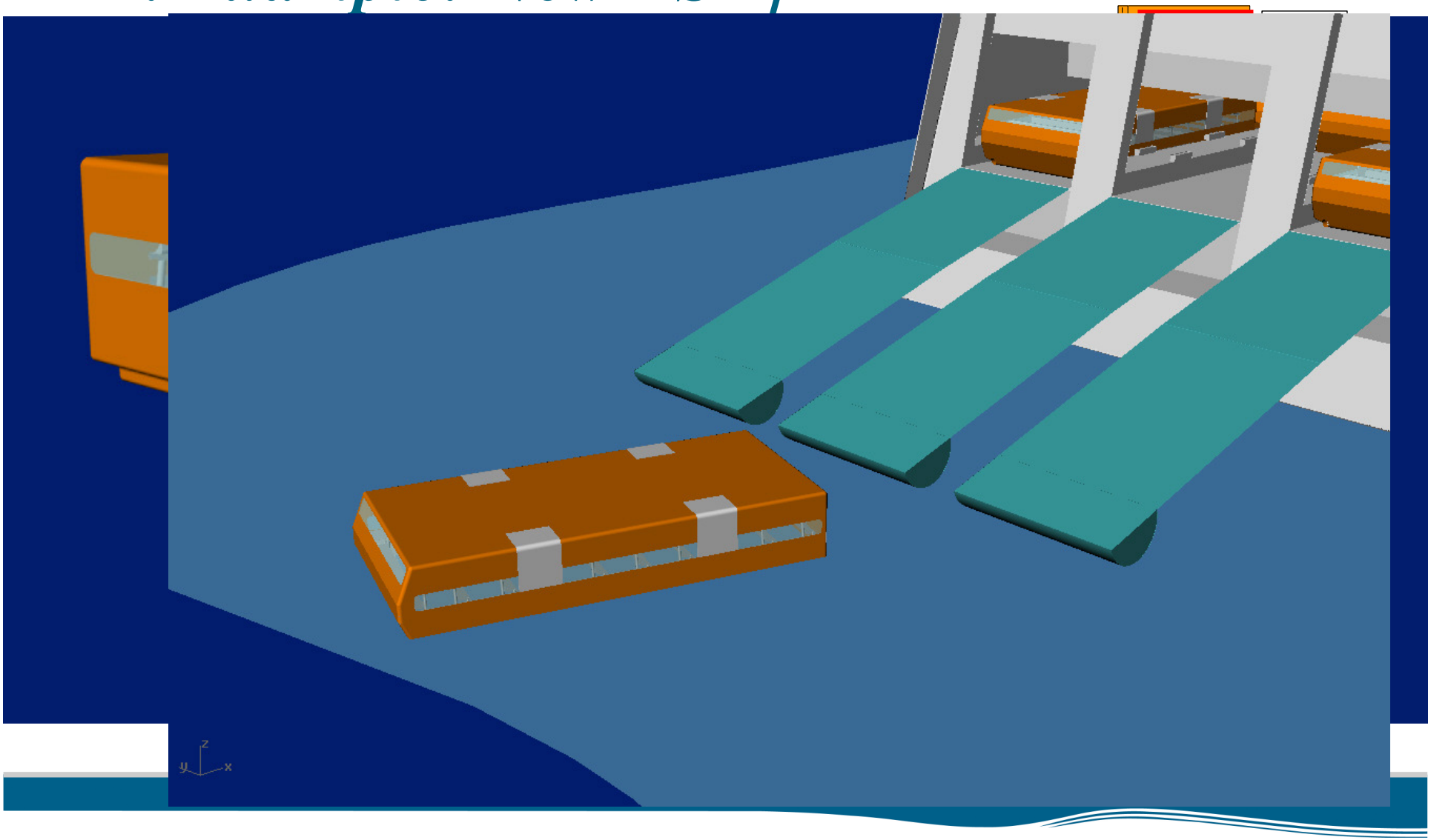
VI. System Operation

1. Pre-Design and Requirements Definition

- *Parties: Supplier*
- Pre-design by supplier
- This pre-design is used to:
  - Describe the system (function, arrangement, spaces, major components)
  - Define the system boundaries
  - Define a list of applicable rules and regulations
  - Specify a list of rules and regulations that are likely to be challenged
  - Define system requirements:
    - Safety
    - Environment
    - Operation (boundary condition such as thermal and mechanical loads)
- Terminology

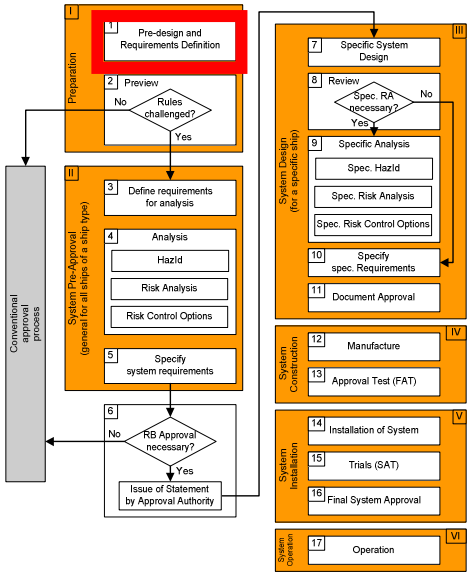


1. Example: New LSA$_1$



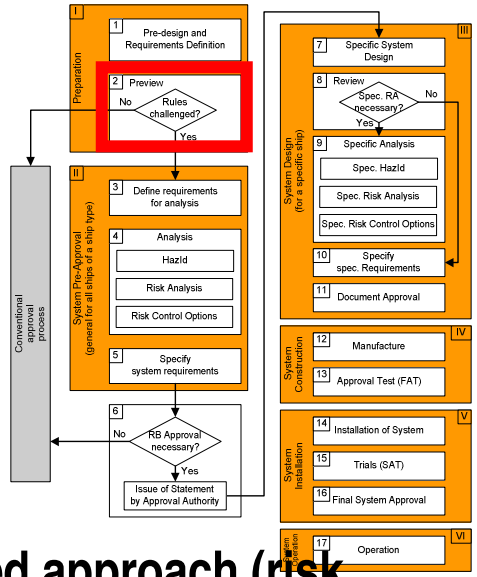
1. Example: New LSA_2

- **System boundaries:**
  - Lifeboat, launching system
  - Evacuation process, maintenance, training
- **Applicable rules and regulations: LSA Code**
- **Specify a list of rules and regulations that are likely to be challenged**
  - Maximum capacity (300) > 150 persons
  - Regulation 13: interference between lifeboats
  - Regulation 21: storing on each side
  - …
- **Define system requirements:**
  - Safety: safe evacuation of crew and passengers
  - Operational: 6 knots speed fully loaded
- **Terminology: FSA glossary**



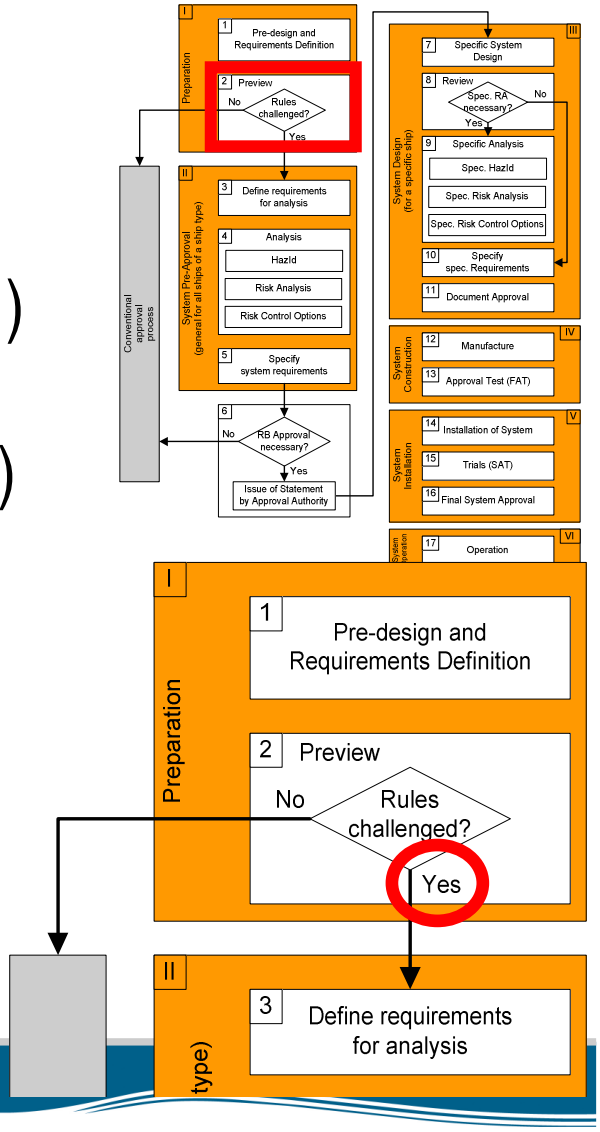
2. Preview

- *Parties:* *Supplier, Approval Authority*
- **Documents of step1 are submitted to Approval Authority (and/or recognised organisation)**
- **Preview of pre-design by AA**
- **Objective: decide whether implementation needs risk-based approach (risk evaluation)**
- ***Presently: flag state is prescribed by ship owner. For a generic ship a flag state is not defined. Thus, supplier requires a possibility to contact a flag state!***

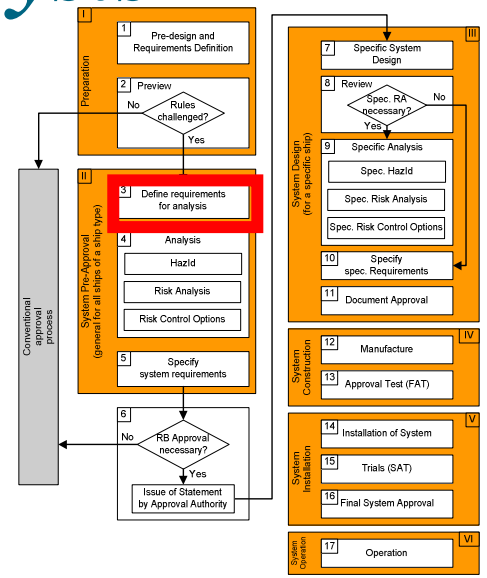


2. Example: New LSA

- **New design challenges different SOLAS/LSA regulations**
  - capacity > 150 (LSA Code Ch. IV-4.4.2.1)
  - Reg. 13: interference between lifeboats
  - (Reg. 13: protected from fire & explosion)
  - Reg. 21: storing on each side



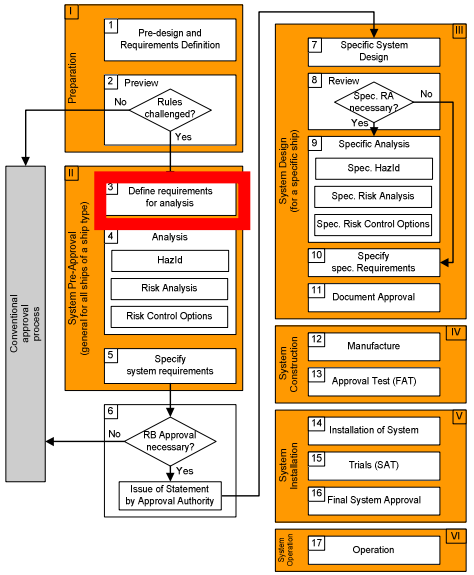
3. Define Requirements for Analysis



- ***Parties:*** ***Supplier, AA***
- **Requirements for the analysis (agreed with AA)**
  - Definition of risk acceptance criteria
  - Definition of the risk evaluation criteria
  - Definition of risk modelling approach
  - Identification of the relation between new design and ship functions
  - (required expertise)
- **Accuracy of the analysis in *system pre-approval* depends also on requirements of the supplier (required level of confidence for the results of this phase)**

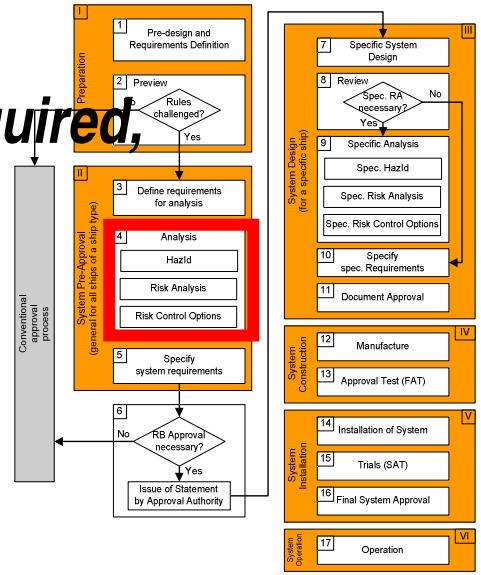
3. Example: New LSA

- Requirements for analysis:
  - Qualitative and quantitative analysis for lifeboat, launching system in a generic vessel and processes (evacuation, training, maintenance).
  - Because of lifeboats storage position: consideration of evacuation routes from mustering to embarkation.
  - Atmosphere in the lifeboats during “waiting for rescue”
  - No consideration of life-rafts
  - Risk evaluation criteria: individual and societal risk
  - Risk acceptance criteria: derived from Rules conform design
  - Risk modelling: ET and FT
  - Ship function: Emergency control
  - Expertise: structural (lifeboat, vessel), machinery, operation/training, human behaviour



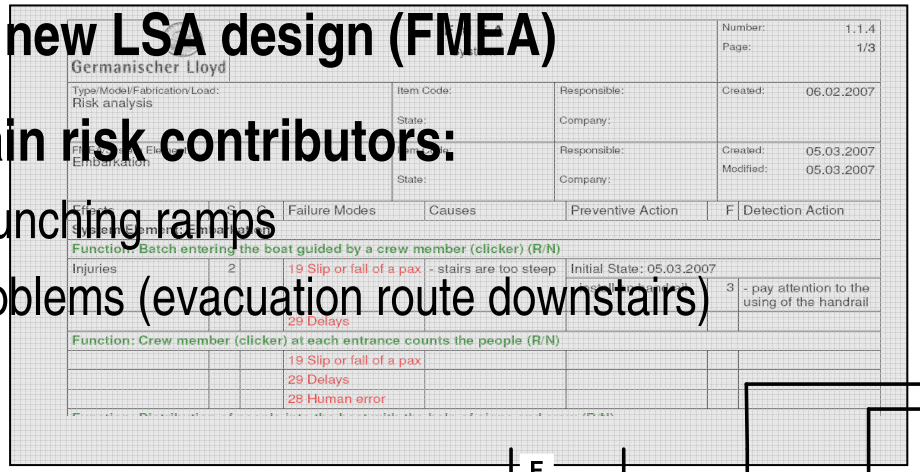
4. Analysis

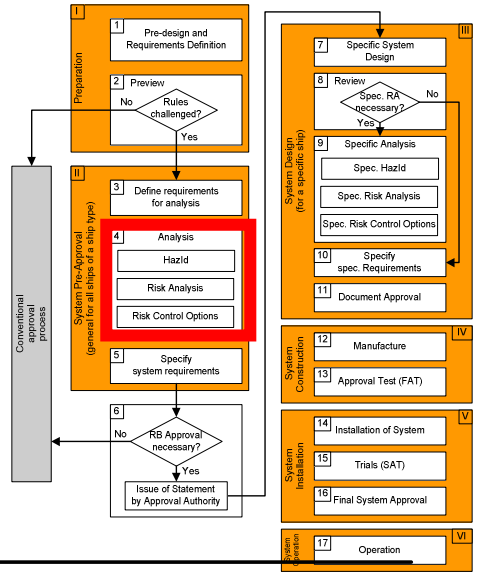
- ***Parties:*** ***Supplier, and additional Experts required, Approval Authority***
- **Analysis consists of:**
  - Hazard identification
  - Risk analysis
  - Risk control option
- **Usually, a step-by-step process with intermediate review/agreement by AA**

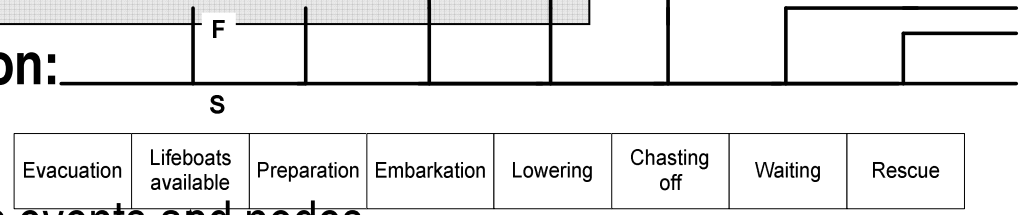


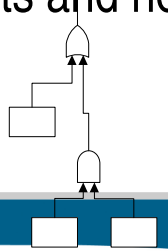
4. Example: New LSA_1

- **Hazard identification for a generic passenger ship and the new LSA design (FMEA)**
- **Example: main risk contributors:**
  - blocked launching ramps
  - Human problems (evacuation route downstairs)
-
- **Risk analysis and evaluation:**
  - Develop risk model
  - Simulation to quantify basic events and nodes
  - Expert judgement



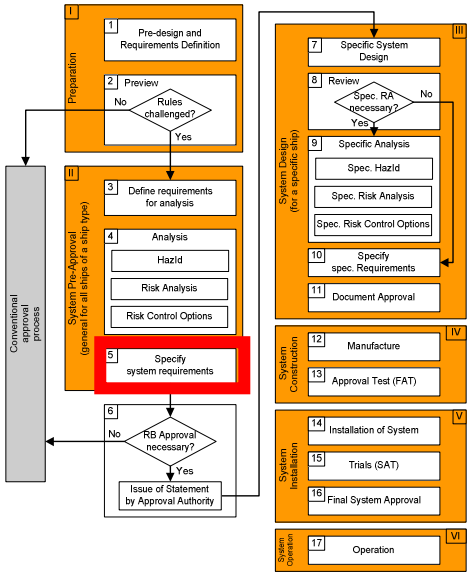






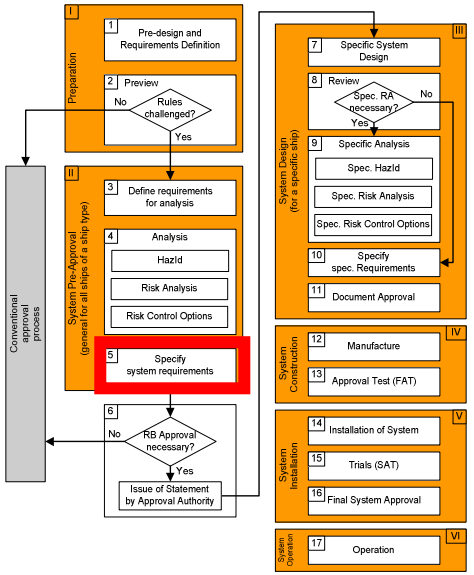
5. System Requirements

- ***Parties:*** ***Supplier, AA***
- **Objectives: specification of requirements for the risk analysis of the specific design as well as construction and installation**
- **Safety: define the functions the system must provide to meet safety requirements**
- **Operation requirements: operational boundary conditions, environment, maintenance etc.**
- **Performance requirements: measurable quantities for trial designs**



5. Example: New LSA

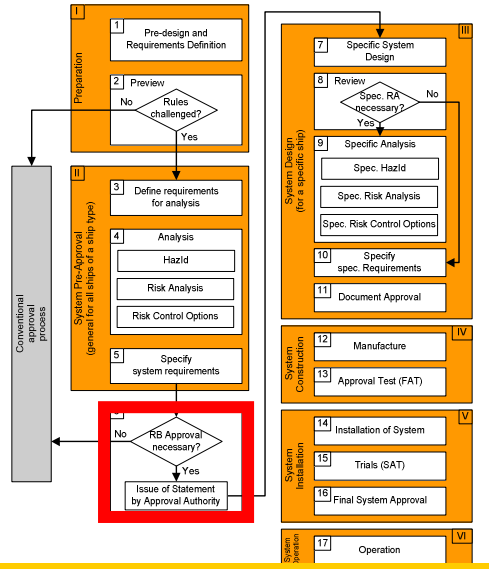
- **Specification for RA:**
  - influence of (specific) parent vessel
- **Operation requirements:**
  - operational radius
  - velocity of X up to a wave height of Y
- **Safety requirements:**
  - safe shelter for specified number of passengers up to X days



6. Issue of Statement by Approval Authority

- ***Parties: Approval Authority***
- ***Approval Authority:***
  - Reviews / assesses the results of previous steps
  - Statement of by AA concerning the acceptability of the results and specifying the requirements for the design phase
  - Statement valid for a generic design
  - No guarantee that design will get final approval!
- **Decision if new design deviations from conventional design is marginal**

  → no further analysis for detailed design required?
  → conventional approval process can be followed?

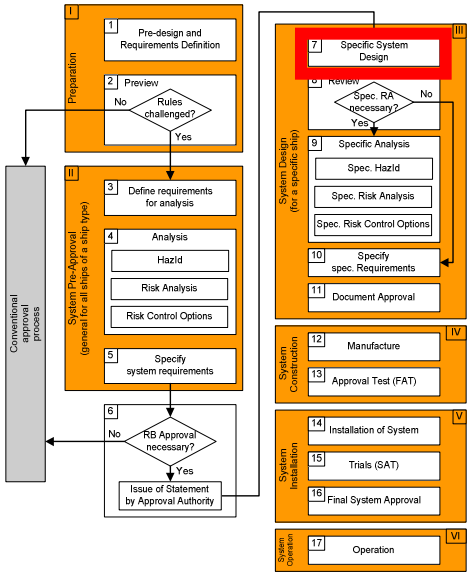


Example: New LSA

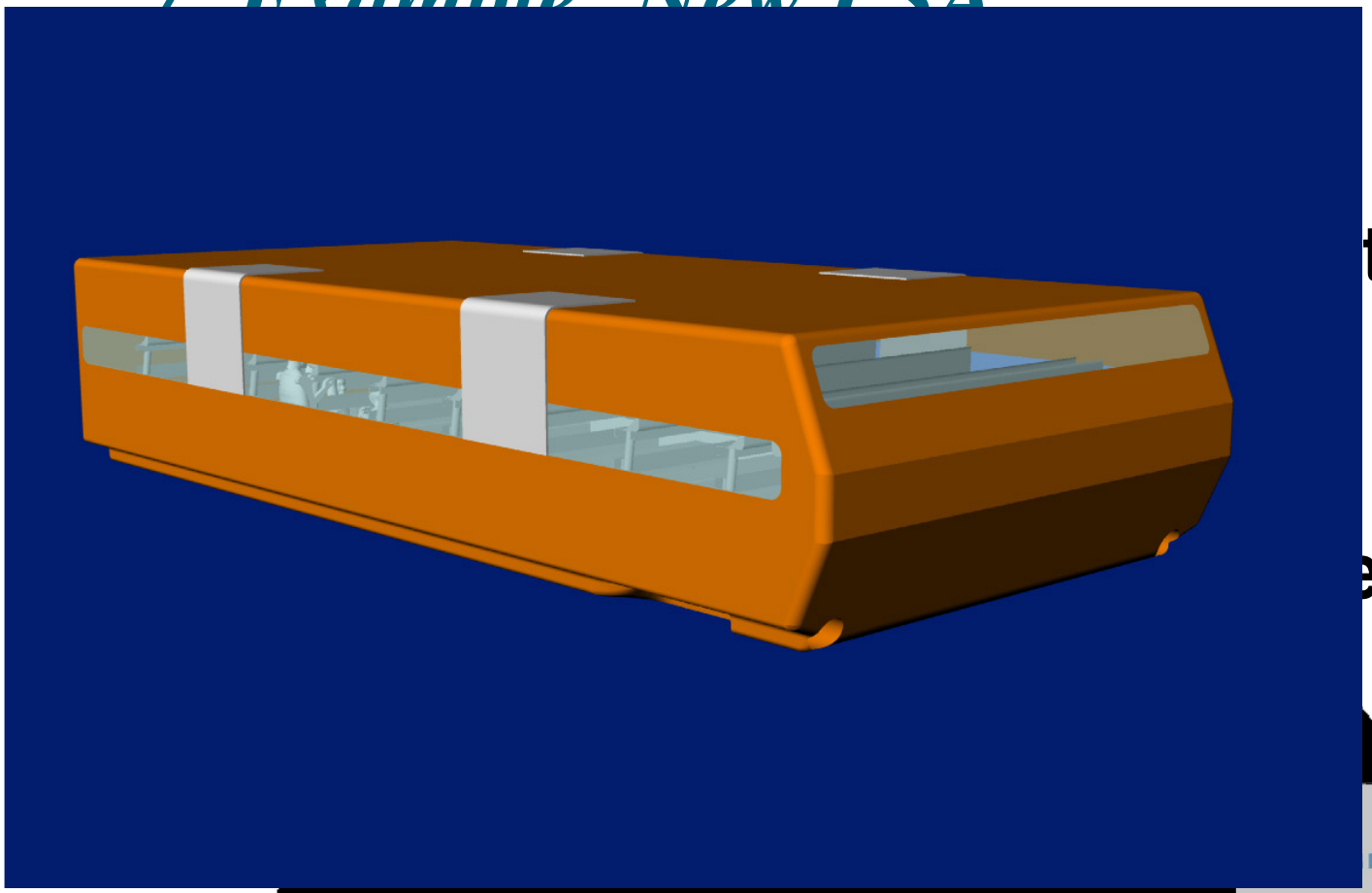
Statement by AA received

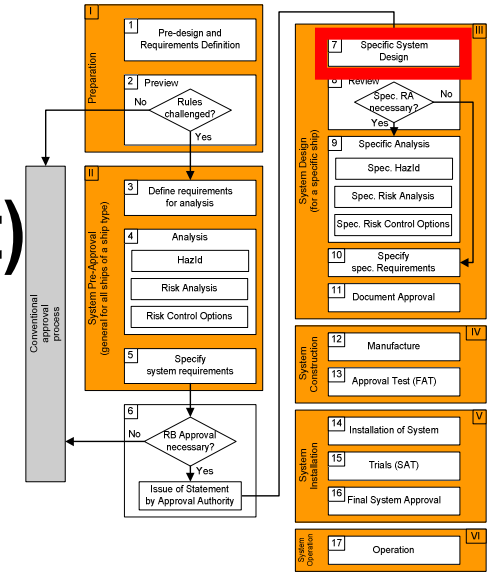
7. Specific System Design

- ***Parties: Supplier***
- **Design the specific system conforming with requirements (step 5) on basis of the statement of the AA**



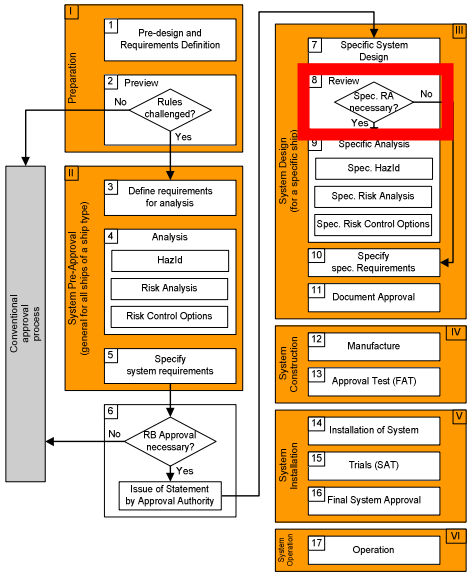
7 Example: New LSA





8. Review

- *Parties: Supplier, Yard, Owner, AA*
- **Review of specific design to determine the range of specific risk analysis (difference between specific and generic system design)**
- **If no specific risk analysis need continued with step 10 “Specifi**
- **Needed for each detailed desig**



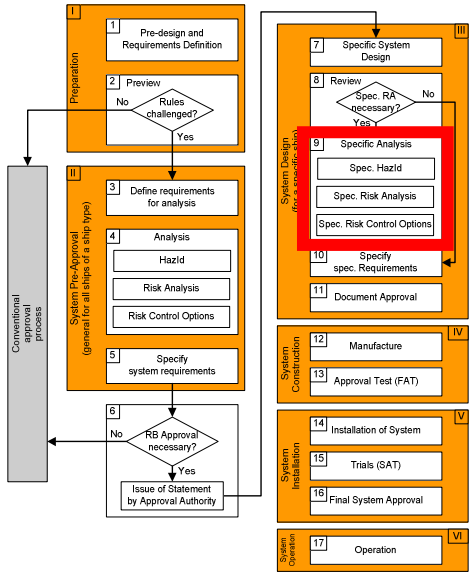
Example: New LSA

Differences require a review of HazId.

Quantitative risk analysis required with special attention to evacuation process and launching of lifeboats

9. Specific Analysis

- ***Parties:*** ***Supplier, Yard, Owner, AA***
- **Objective: Demonstration that specific design is in conformance with the require-ments of step 5 “System requirements”**
- **Similar to step 4 “Analysis” in the Pre-Approval phase of the process**
  - Check if new hazards exist -> modification of risk model
  - Qualitative/quantitative risk assessment considering data of specific design
  - Evaluation of specific design with agreed risk acceptance criteria
  - If necessary, identify/evaluate RCOs

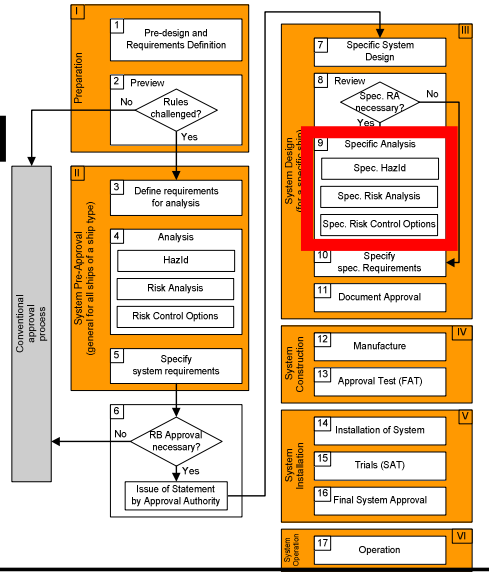


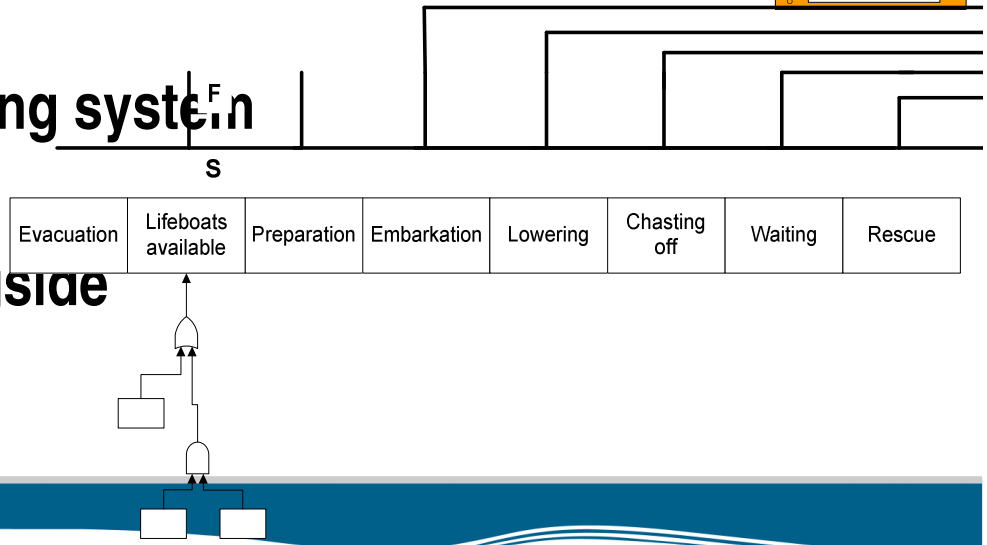
9. Example: New LSA

- A new FMEA for the specific design is performed

  ➡ No new hazards

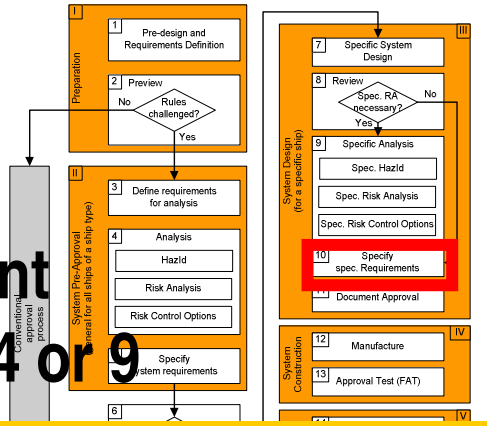
- Revision of the risk model using the data of the specific design
- Evaluation
- RCO: special fire extinguishing system for evacuation routes
- RCO: launching ramps alongside





10. Specific System Requirements

- ***Parties:*** ***Supplier, Yard, Owner, AA***
- **Requirements for system and each component on basis of quantitative risk analysis in step 4 or 9 ("Analysis" or "S**
  - Installation and co
  - Testing, quality co
  - Safety (functional)
  - Operation and mai procedures
  - Data acquisition and assessment during operation
  - Performance (by manufacturer/purchaser)

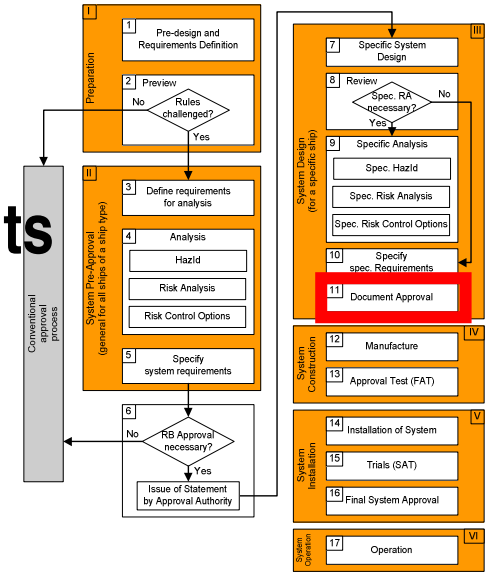


Example: New LSA

- **Safety: embarkation time**
- **Operation/Maintenance/Inspection: testing of electrical equipment and record of failures**
- **Data acquisition: determination of corrosion rate (launching system)**

11. Document Approval

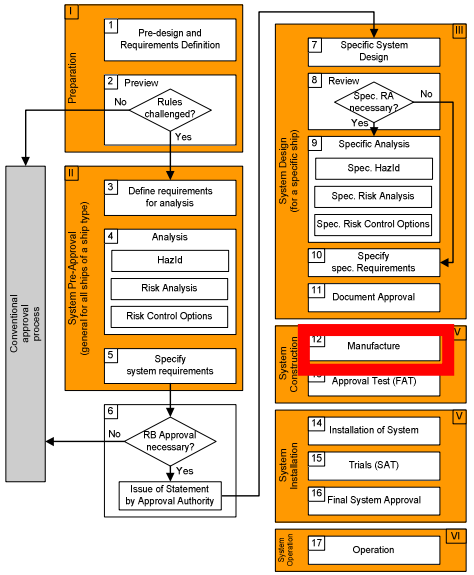
- ***Parties:*** ***Approval Authority***
- **After completion of previous steps documents exist for**
  - Pre-design and Requirements
  - Requirements of analysis
  - HazId of generic and real system
  - Quantitative risk analysis of generic and real system
  - System and specific requirements
  - Drawings, etc
  - Specifications for operation and maintenance
- **Additionally, documentation of verification by AA**
- **AA approves the specific risk-based system design**



Example: New LSA approval by AA received

12. Manufacture

- ***Parties: Supplier***
- **Components and eventually sub-systems are assembled**
- **Quality control as specified in specific requirements must be considered**



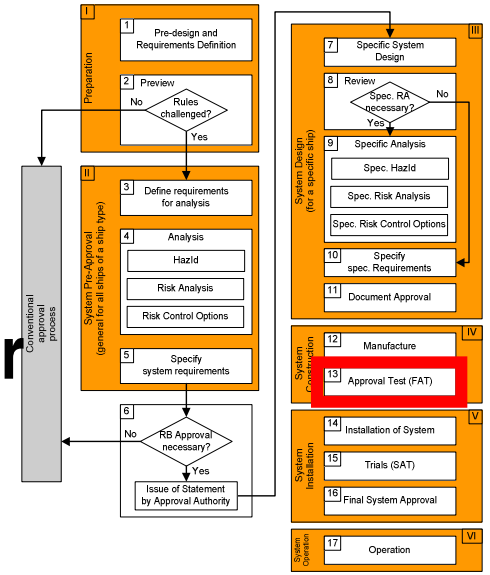
Example: New LSA

Construction and assembly of new lifeboat.

Construction of the launching system for the specific ship.

13 Approval Test (FAT)

- ***Parties: Supplier, AA***
- **Testing of the Manufacturer's work similar to factory acceptance test (FAT)**
- **Based on system requirements (step 5 "system requirements" and step 10 "specific requirements")**



Example: New LSA

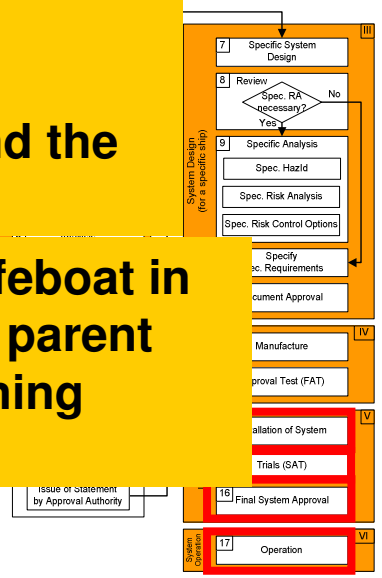
New lifeboat exists: Embarkation tests (verify specified embarkation time)

Further steps

Example: New LSA

Installation of the launching system and the lifeboats.

sea trials of the lifeboat in combination with parent vessel and launching system.



- **14 Installation of System**
  - *Parties: Supplier and Yard*
- **15 Trials (SAT)**
  - *Parties: Supplier, Yard, AA*
  - Validation of the system, similar to sea acceptance test (SAT)
- **16 Final System Approval**
  - *Parties: AA*
  - The acceptance of the system by AA is attested by a certificate if applicable
- **17 Operation and Maintenance**
  - *Parties: Purchaser/Operator, AA*

Summary 1

- **Risk based design for ships and ship systems offers a higher flexibility to develop optimal solutions tailored for a specific task**
- **Risk-based design is fundamentally different to traditional design and requires an approval process taking into account the special issues of risk-based design**
- **Such an approval process for risk-based ship system design was developed in SAFEDOR**
- **The approval is focused on safety and environmental requirements**
- **The approval process contains two risk analysis phases**
  - risk analysis concerning the pre-design (for a generic system)
  - risk analysis concerning the specific design

Summary 2

- To provide a sound basis for the statement by AA a quantitative risk analysis is part of the first risk analysis
- Often, the risk based analysis and the approval started in a later project phase. Higher costs for necessary modifications.
- To increase the benefit of the phase *system pre-approval* suppliers should have the possibility to perform the *system pre-approval* without a specific ship (before order)
- This implies that all flag states mutually accept the *statement by AA*
- RBA process definition provides an increased reliance for suppliers "by the assignment of responsibilities the supplier has the assurance to receive a statement from the approval authority after defined process steps"

Vielen Dank für Ihre Aufmerksamkeit!