




## Approval process for risk-based ship systems

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## Introduction

Risk-based ship design promises economic benefits through enabling novel solutions beyond current rules.

Ship systems are vital to the safety-performance of a ship, e.g.

- power generation and distribution
- navigation and control
- life saving


Novel systems promise new functionality and superior performance – also under accidental conditions.

An approval process for risk-based ship systems is needed to provide a transparent procedure incl. assignment of responsibilities and a reliable schedule.

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## Risk-Based Regulatory Framework

**Key elements are**

- high-level approval process (presented at SAFEDOR first open seminar in 2006, London)
- system-level approval process (to be presented today)
- high-level risk evaluation criteria (public SAFEDOR report, available at [www.safedor.org](http://www.safedor.org))
- risk evaluation criteria at function and system level (available only as SAFEDOR internal report)
- requirements for documentation and qualification (currently being addressed within SAFEDOR)

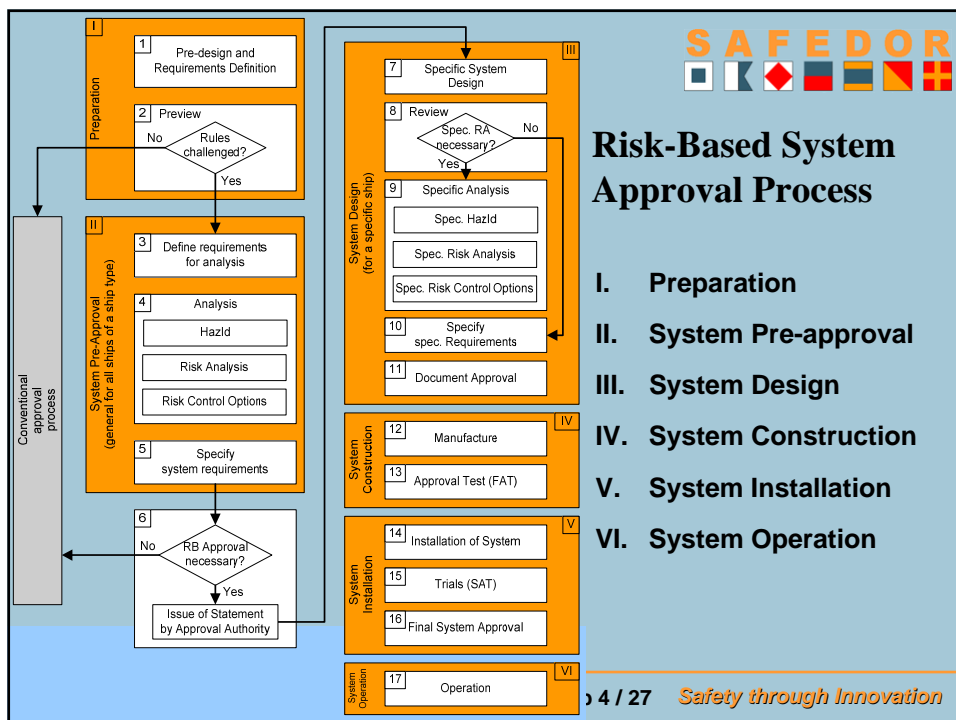
**A link to the existing regulatory framework is needed, too.**

**Key requirement / guiding principle**


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

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## 1. Pre-Design and Requirements Definition

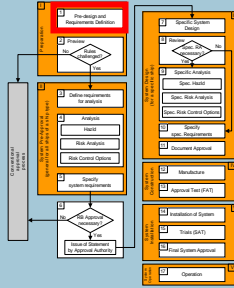


**Parties:** Supplier and/or yard

**Pre-design by supplier (yard)**

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 (such as thermal and mechanical loads)



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## 1. Example: New LSA<sub>1</sub>

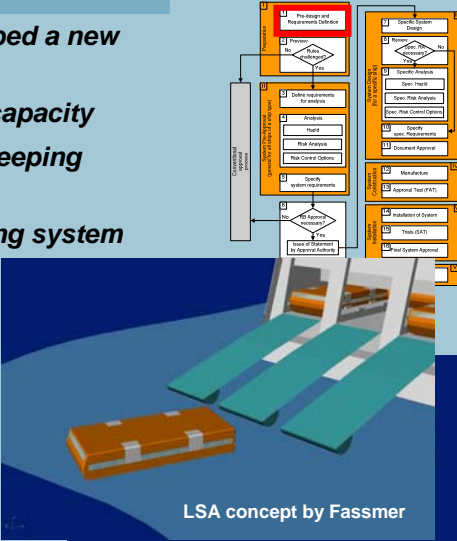


**A lifeboat manufacturer has developed a new lifesaving appliance concept, e.g.**

- a lifeboat with an increased capacity
- a lifeboat with a higher sea-keeping performance
- a lifeboat with a new launching system

The system description comprises

- the lifeboat's equipment
- the launching system



LSA concept by Fassmer

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### 1. Example: New LSA<sub>2</sub>


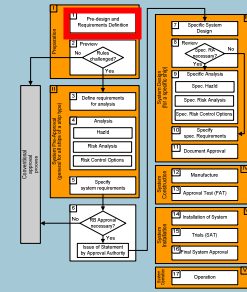
**System boundaries:**

- Lifeboat, launching system
- Evacuation process, maintenance, training

**Applicable rules and regulations and those likely to be challenged**

**System requirements:**

- Safety: safe evacuation of crew and passengers
- Operational: 6 knots speed fully loaded

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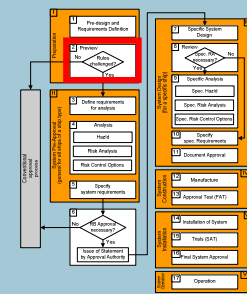
### 2: Preview

**Parties: Supplier and/or yard, Approval Authority (AA)**

**Documents of step 1 – pre-design - are submitted to Approval Authority for preview to decide whether implementation needs risk-based approach (risk evaluation)**

**Note:**

- The flag state is chosen by ship owner. For a generic ship a flag state is not defined.
- A supplier may contact a flag state before system is installed a specific vessel.

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### 2. Example: New LSA

**New design challenges different SOLAS 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

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### 3: Define requirements for analysis

**Parties: Supplier and/or Yard, AA**

**Requirements for the analysis, to be 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 of involved experts

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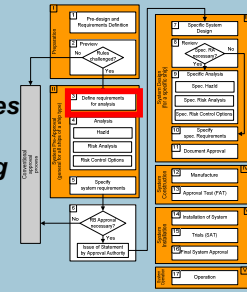
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### 3. Example: New LSA

**Requirements for analysis:**

- Qualitative and quantitative analysis for lifeboat, launching system in a generic vessel and processes (evacuation, training, maintenance).
- Consideration of evacuation routes from mustering to embarkation (due to new storing location)
- Atmosphere in the lifeboats during "rescue"
- Life-rafts are not considered
- Risk evaluation criteria: individual and societal risk
- Risk acceptance criteria: equivalence
- Risk modelling: fault and event trees
- Ship function: Emergency control
- Expertise of involved experts: structural (lifeboat, vessel), machinery, operation/training, human behaviour

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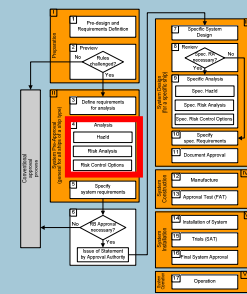
### 4: Analysis

**Parties:** Supplier and/or Yard, AA, additional experts may be required,

**Analysis for pre-design consists of:**

- hazard identification
- risk analysis
- evaluation of risk control options

**Usually, a step-by-step process with intermediate review by AA**

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### 4. Example: New LSA


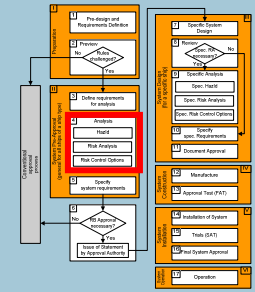
**Hazard identification for a generic passenger ship and the new LSA design (FMEA)**

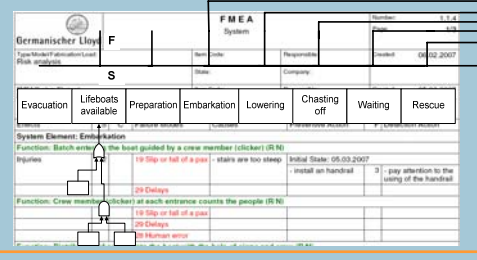
**Main risk contributors**

- blocked launching ramps
- evacuation route downstairs

**Risk analysis and evaluation:**

- Develop risk model
- Simulation to quantify basic events and nodes
- Expert judgement



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### 5: System requirements


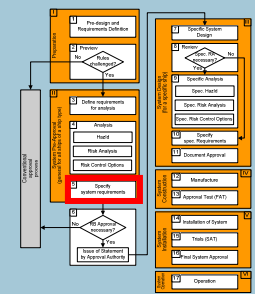
**Parties: Supplier, Yard, AA, Owner**

**Specify requirements for the risk analysis of the specific design**

**Specify performance requirements for trial designs**

**Specify operation requirements (operational limits, environment, maintenance etc.)**

**Specify functions the system has to provide to meet safety requirements**

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### 5. Example: New LSA

**Specification for risk analysis**


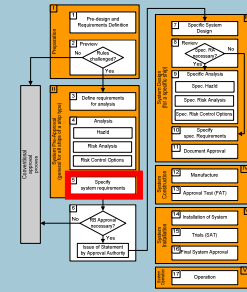
- influence of (specific) parent vessel

**Operation requirements:**

- operational radius
- speed  $X$  in waves of height  $Y$

**Safety requirements:**

- safe shelter for specified number of passengers up to  $N$  days

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### 6: Issue of statement by Approval Authority


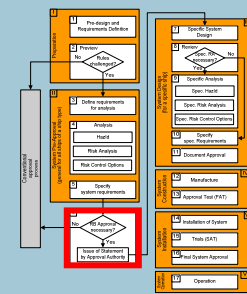
**Parties:** Approval Authority

**Reviews / assesses the results of analysis**

**Statement of AA specifying the requirements for the next phase**

- Statement valid for a generic design
- No guarantee that design will receive final approval!

**Check if new design only marginally deviates from conventional design and normal approval process can be followed**

Example: New LSA  
Statement by AA received

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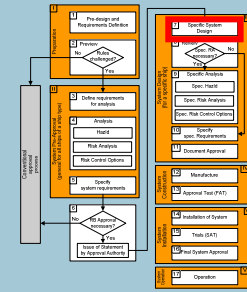
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## 7: Specific system design

**Parties: Supplier**

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





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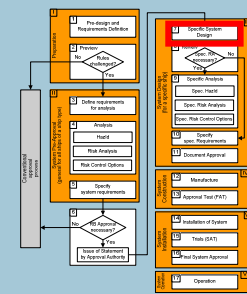
## *7. Example: New LSA*

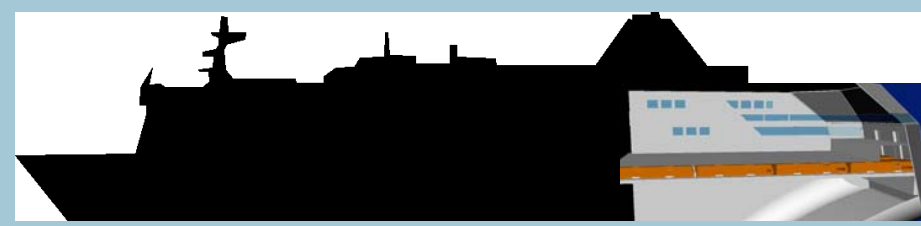
***Supplier develops lifeboat according to purchaser requirements (e.g. tender-boat)***

***Selection of lifeboat components***

***Supplier adjusts launching system to the parent vessel***







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### 8: Review

**Parties: Supplier and/or Yard, AA**

Review is needed for each detailed design which is based on the generic design

Review of specific design to determine the range of specific risk analysis (difference to generic design)

If no specific risk analysis needed, the approval process continues with step 10

*Example: New LSA*

*Risk analysis required special attention to evacuation process and launching of lifeboats*

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### 9: Specific analysis

**Parties: Supplier and/or Yard, AA**

Demonstrate that specific design is in compliance with the requirements of step 5

- Check if new hazards exist and, if yes, modify risk model
- Qualitative / quantitative risk assessment considering the specific design
- If necessary, identify and evaluate specific RCOs

Similar to step 4 "Analysis" in Pre-Approval phase

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### 9. Example: New LSA


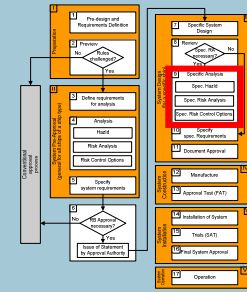
**A new FMEA is performed for the specific design**

**No new hazards are identified**

**The risk model is updated using the data of the specific design**

**New RCOs are evaluated**

- special fire extinguishing system for evacuation routes
- launching ramps alongside

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Evacuation	Lifecoats available	Preparation	Embarkation	Lowering	Chasting off	Waiting	Rescue
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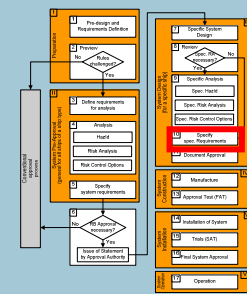
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### 10: Specific system requirements

**Parties: Supplier and/or Yard, AA**

**Specify requirements for system based on quantitative risk analysis in step 4 or 9 (“Analysis” or “Specific Analysis”) relating to**

- Installation and commissioning
- Testing and quality control
- Safety performance
- Operational performance
- Operation and maintenance procedures
- Data acquisition and assessment during operation

**Example: New LSA**

*Safety: embarkation procedure*

*Operation/Maintenance/Inspection: testing of electrical equipment and record of failures*

*Data acquisition: determination of corrosion rate (launching system)*

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## SAFEDOR

### 11: Document approval

**Parties: Approval Authority**

AA approves the specific risk-based system design based on the following documents

- Hazld of generic and specific system
- Quantitative risk analysis of generic and specific system
- System and specific requirements
- Drawings, etc
- Specifications for operation and maintenance

*Example: New LSA  
 approval by AA received*

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## SAFEDOR

### 12. Manufacture


**Parties: Supplier**

Components and sub-systems are assembled

Quality control as specified is considered

*Example: New LSA  
 Construction and assembly of new lifeboat.  
 Construction of the launching system for the specific ship.*

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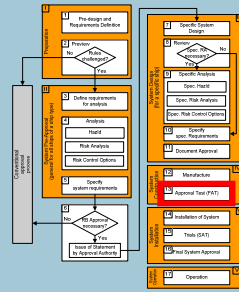


## 13 Approval test (FAT)

**Parties: Supplier, AA**

**Testing of the system similar to factory acceptance test (FAT)**

**Testing is based on system requirements (step 5 and step 10)**




*Example: New LSA*

*New lifeboat tested: embarkation tests (verify specified embarkation time)*

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## Concluding steps

### 14 Installation of System

- Parties: Supplier and Yard

### 15 Trials (SAT)

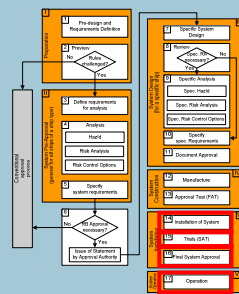
- Parties: Supplier, Yard, AA
- Validation of the system, similar to sea acceptance test (SAT)

### 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 for survey



*Example: New LSA*

*Installation of the launching system and the lifeboats.*

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

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## Summary



**A new approval process for risk-based ship system design was developed in SAFEDOR. It comprises two risk assessment phases**

- risk assessment for a generic system (pre-design), eventually leading to a statement of the AA
- risk assessment for the specific system design

**Suppliers need to perform the phase “system pre-approval” without a specific vessel (before order).**

**The proposed risk-based approval process will provide a reliable schedule for ship system suppliers to receive a statement from the approval authority.**

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