RoPax & Naval vessels composite experiences

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Conversions two Ro-Pax Vessels

2009 TKMS AB worked with two project on conversion of two Ro-Pax Vessel with composite superstructures on the top level

STENA BRITANNICA

STENA HOLLANDICA

Conversions two Ro-Pax Vessels

- For a long time the prescriptive rules for safety at sea in SOLAS have excluded other construction material than “steel or equivalent material”, which means that composite materials not could be used in, superstructures, structural bulkheads, decks and deckhouses since they are combustible.

- Since 2002 a new rule 17 in SOLAS allow construction of other material than steel provided that they can give same safety level as the ship should have had if it had been constructed according to the prescriptive rules for steel ships

Conversions two Ro-Pax Vessels

The aim of the conversion was to design and build the superstructure on the upper decks in GRP sandwich on both vessels:

- The new parts of the superstructure should be converted to a light weight design solution made of composite materials with a sill of steel, which shall be possible to weld to the steel hull with traditional welding methods by the dedicated yard for the final installation of the superstructure on board the actual ship.
- The design should meet the structural requirements in accordance with the Lloyds Registers Rules
- The structure shall fulfill SOLAS convention and the structure will be based on tested and approved solutions according to Rule 17 in SOLAS

Design work

- The conversion and steel design was done by two well known consultants companies:

www.knudehansen.com

KNUD E. HANSEN A/S

NAVAL ARCHITECTS • DESIGNERS • MARINE ENGINEERS

DELTAMARIN

The composite design was made by Kockums

The conversions should be approved by

Lloyd's Register

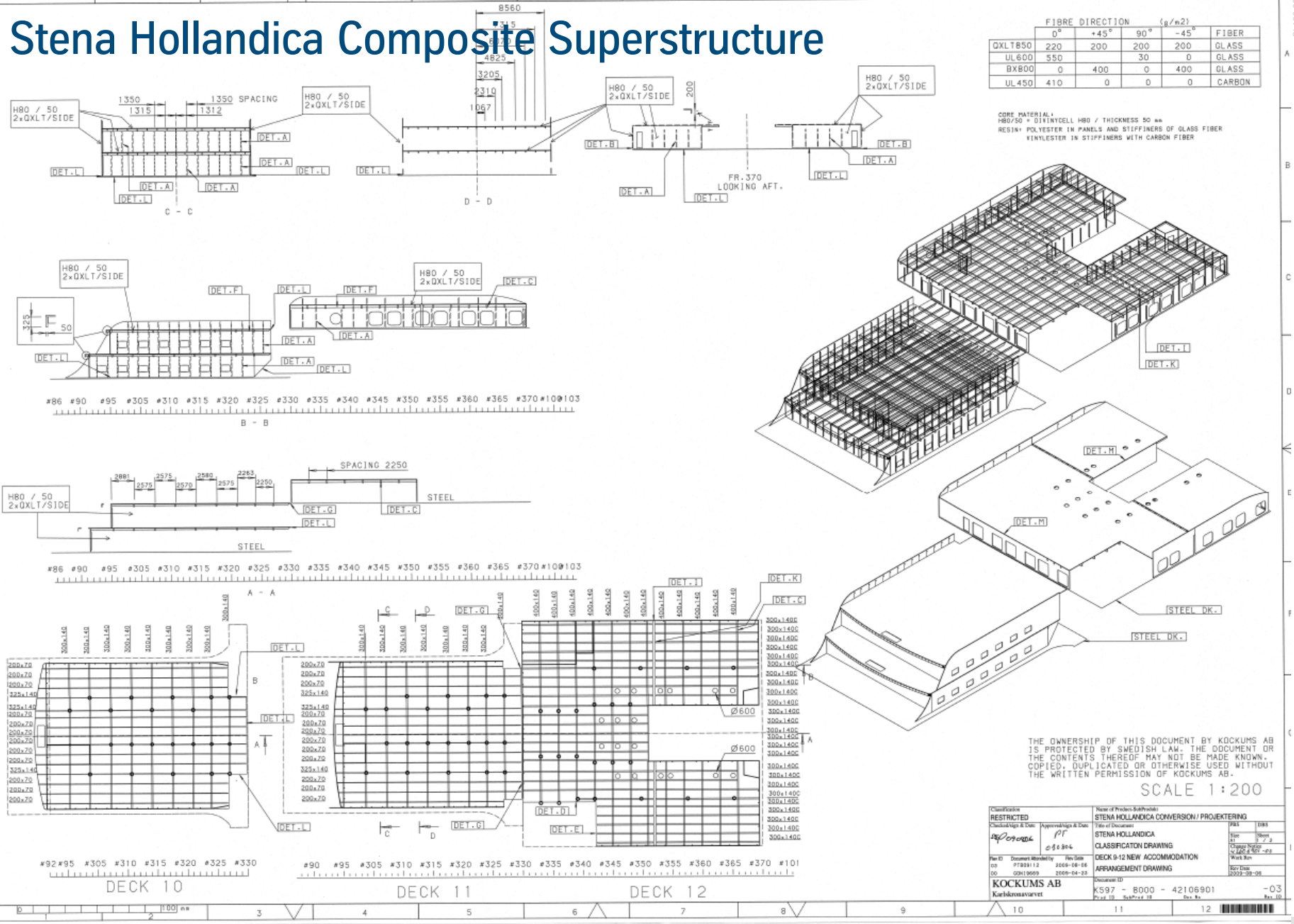
Conversions two Ro-Pax Vessels

Total Composite weight Stena Brittanncia ~90 ton

Total Composite weight Stena Hollandica ~50 ton

The expected weight saving of using composite instead of steel is ~ 50%, which had a positive impact on stability and on green effects and was the driver for projects

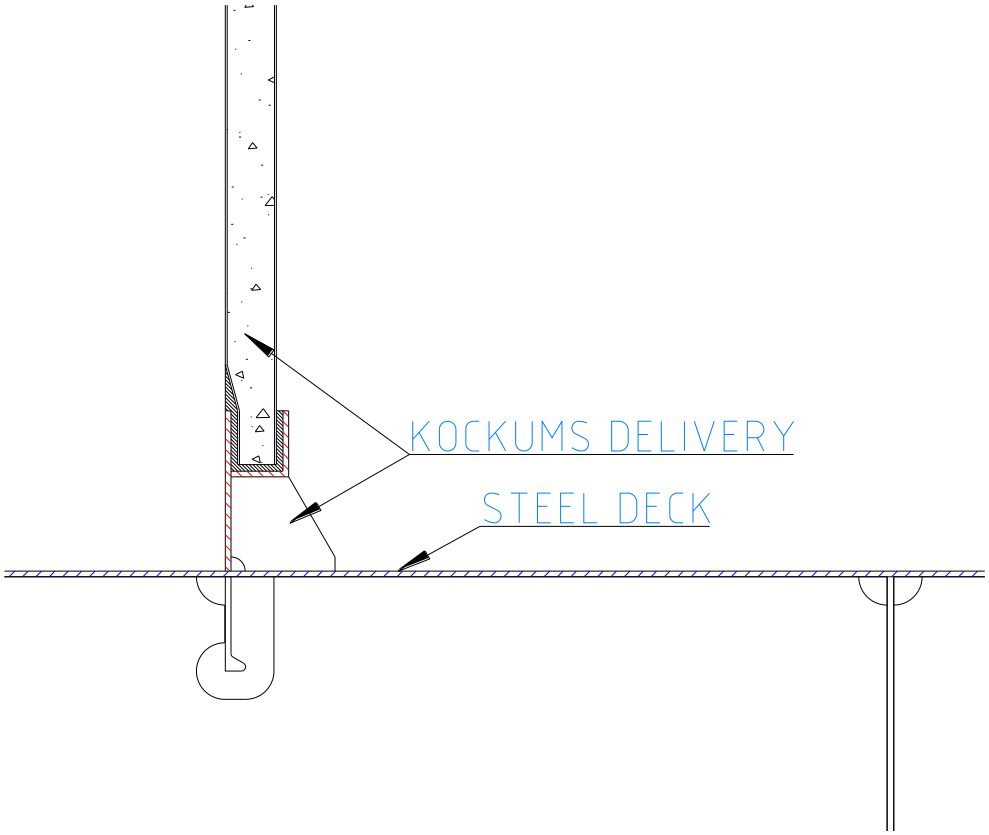
Stena Hollandica Composite Superstructure



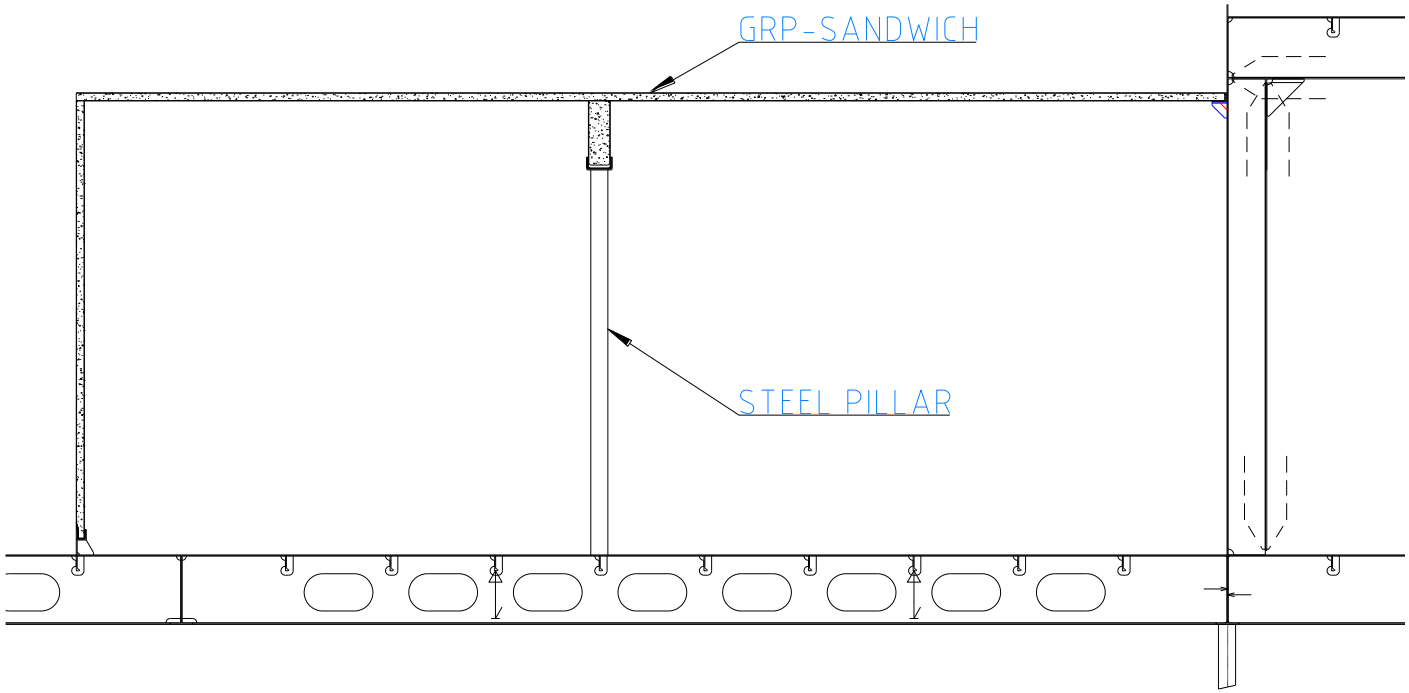
Design solutions

- A number of design solutions for the hybrid Steel/Composite solution were developed and sent to Client for visualization and for information to Yards that might give a quotation for the scope of installation work of the composite superstructure

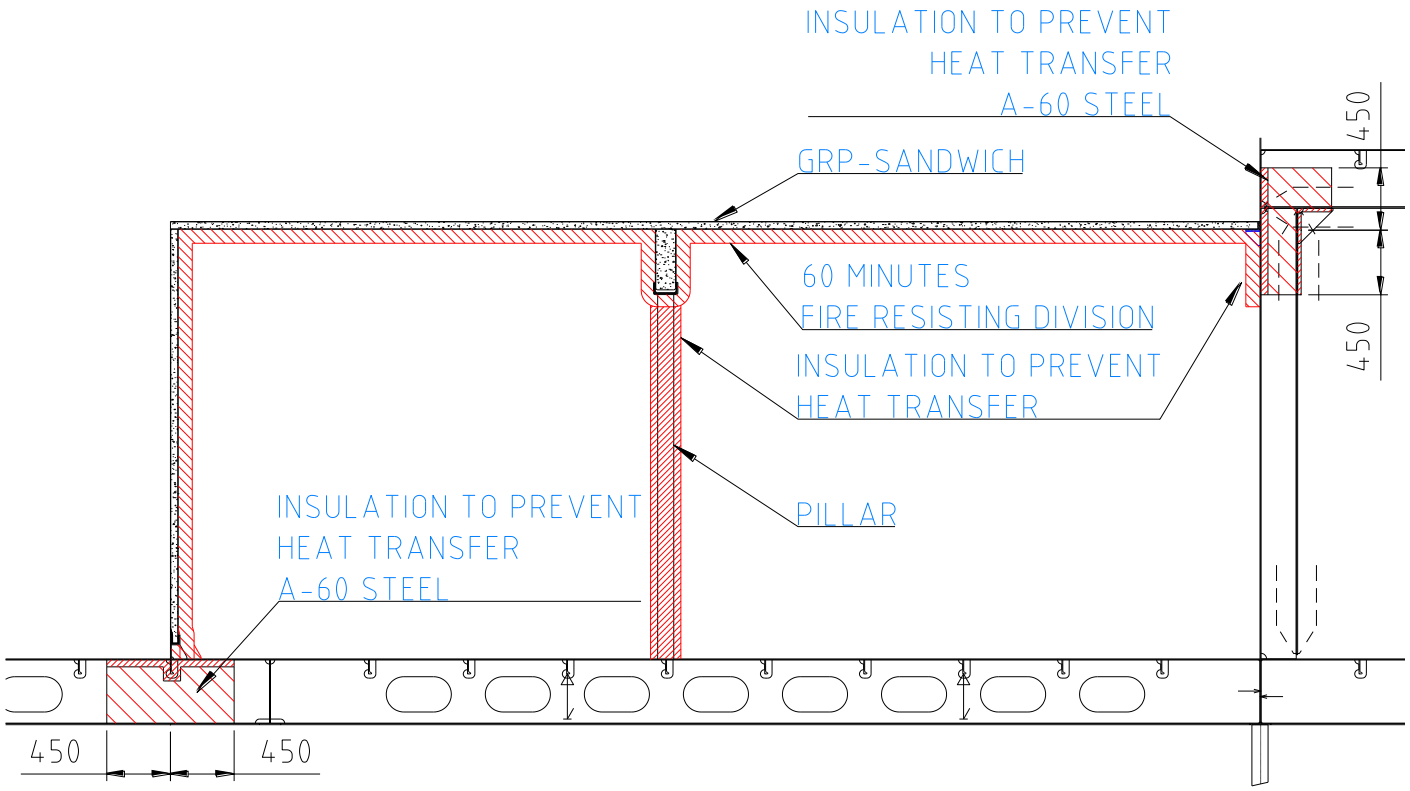
Composite to Steel



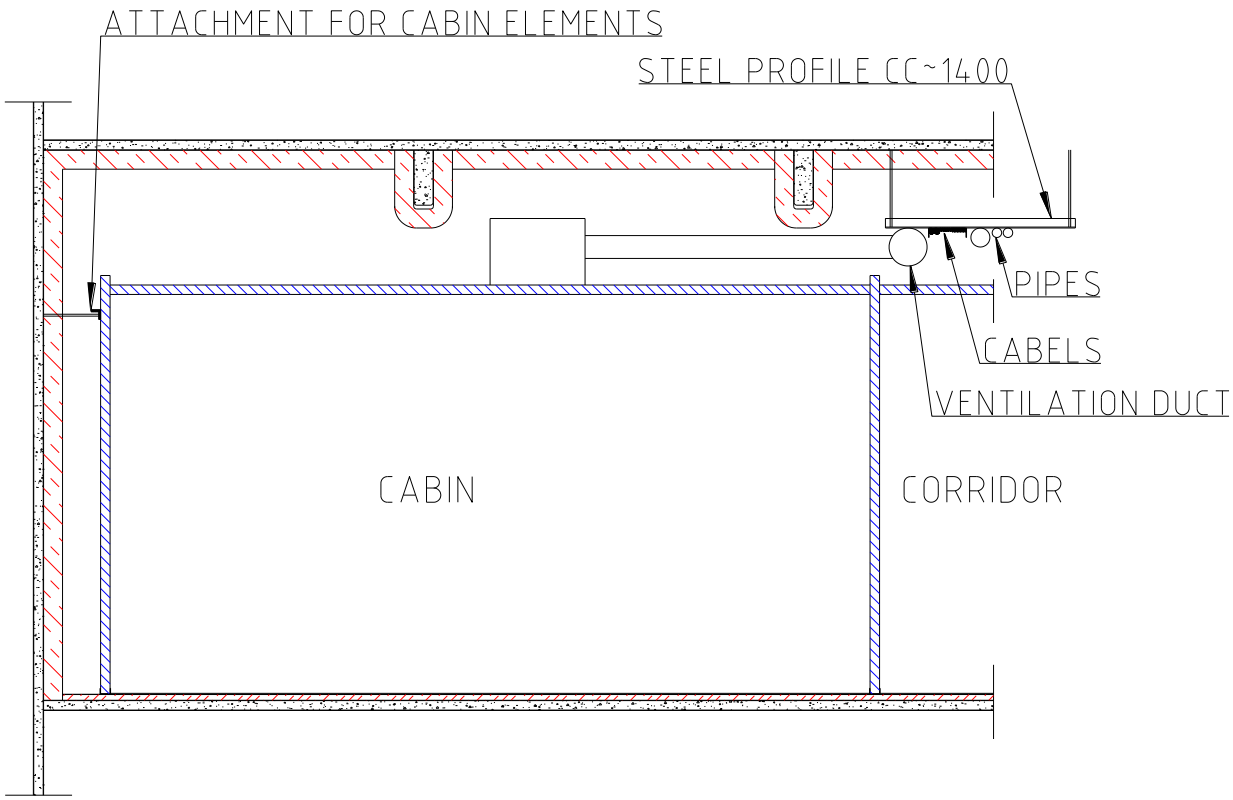
Composite to Steel



Composite to Steel



Outfitting


ATTACHMENT FOR CABIN ELEMENTS
STEEL PROFILE CC~1400
PIPES
CABELS
VENTILATION DUCT
CABIN
CORRIDOR

Risk based analysis

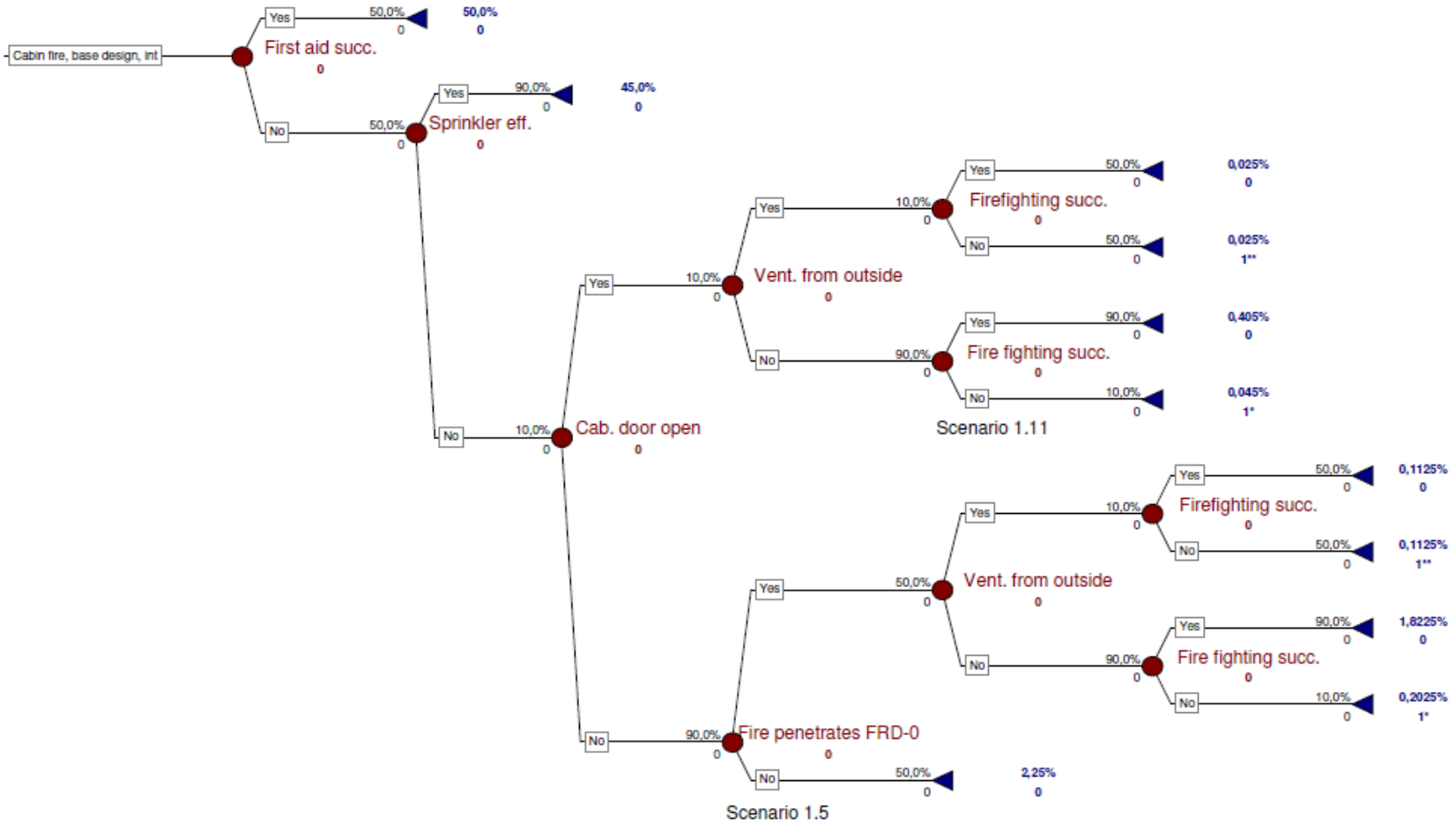
- A risk based analyses have to be carried out showing that the safety is better or equal compared to a traditional steel design

- The Risk based analysis is quite time consuming and thereby expensive and must start early

- Expertise from users and yard participates and must be done with experts on the subject for Risk Based Analysis

Risk based analysis

Cabin fire, internal, base design.



*If no ventilation from outside (only internal doors open) can fire continue until a structural collapse?
**If ventillated fire can continue until a structural collapse, fire is also spread to outside areas - shown in separate event tree

Example of a preliminary event tree – Cabin fire, internal

Fire tests in the LASS project

- 60 minutes Fire Resisting Division
  - Load-bearing decks
  - Load-bearing bulkheads
  - Deck with pipe and duct penetrations and cable transits
  - Bulkhead with pipe and duct penetrations and cable transits
  - Bulkhead with doors
  - Bulkhead (superstructure side/front) with window
- 30 minutes Fire Resisting Division
  - Load-bearing bulkheads
- Fire Restricting Materials
- Large scale fire test, two cabins with a corridor inside a FRP-sandwich structure

Problematic areas

The different ships had different flag-states:

- Stena Britannica has MCA (UK) Administration
- Stena Hollandica have NSI (Holland) Administration.

- When TKMS AB (former KOCKUMS AB) started this project, it was just Stena Britannica that was actual and therefore the first contact was with Maritime and Coastguard Agency who represented the UK Administration

- Later it was decided that LR was "acting on the behalf of 'NSI' (Dutch equivalent of the Swedish Maritime Administration).

Problematic areas

- Lack of knowledge regarding composite material in general and fire of composite materials particularly at both LR and the Administration

- The experienced person from MCA that have participated in earlier projects like SAFEDOR and had good knowledge of the Risk Based Analysis procedures retired without transfer of knowledge to younger staff in the organization

- The representative from LR was an older and experienced gentleman who was very skeptical of anything that had the composite.

Possible reasons for not choosing the composite solutions

- Too expensive for conversion projects, where the whole benefits not can be integrated in the total design as for a New Building Project and not can be paid back during the rest of the life time of the vessel
- Time frame with Risk Based Analysis created a too high risk for the owner to postpone the conversion, since usage of the vessels after conversion was in detail planned
- Risk that the different flag states have different interpretation of the Risk Based Analysis
- Outcome of the too late started Risk-based Analysis and how this would be judged by the Administration with no of such large Projects (No one would like to be the first in experience this size of a project)
- Selected steel yard for conversion lose work and gave a higher price due to un-known risks

Lessons Learned

- The project was to big for any Administration to take the lead in the development according to Rule 17
- Flag State (Administration) and the Class must be involved at an early stage of the Project
- Class work and evaluation according to Rule 17 must be done with a template or otherwise it will be time critical in future projects

What News on Naval Side and R&D?

Naval Side:

- Two Superstructures in CFRP-sandwich with a length of 78 m and total weight or 120 ton each have been produced in sections and shipped to an Indian Shipyard and is mounted on a steel hull with traditional welding methods used by the steel ship yard on the normal Indian conditions!

- A new project for Singaporean Navy with an 80 m High Speed Patrol Vessel in optimized High Strength Steel with a CFRP-sandwich superstructure according to same principles

What News on Naval Side and R&D

Carbon fibre composite superstructures to the Indian Corvette before shipment

What News on Naval Side and R&D

Launching of the 109 m Indian Steel Corvette with 120 ton composite superstructure

What News on Naval Side and R&D

An extensive work has been carried out within in BESST where one goal for DNV was to establish Classification Rules.

Since some Flag states are very conservative and are not willing to accept Composite solutions and Rule 17, the outcome could only be guidelines and not rules.

Several fire test were performed within BESST and both for interior and exterior fire and increased knowledge of the behavior for SOLAS vessels with higher structural loads are gained.

Methodology for Risk based analysis is developed and throughput time for the risk analysis is supposed to be shorter