

9. TOTAL SHIP SAFETY

Formal Safety Assessment (FSA) is acknowledged as an overall future approach for design of safe ships but the methodology has not yet been available for designers and operators to run the safety design and assessment easily with practical results for existing ships and newbuildings.

We have and are placing a lot of effort in developing practical tools for safety design, simulations and assessments. Basis of our work is the experience of comprehensive R&D, design and engineering work for different kinds of vessels, machineries, etc. However, the valuable input from our customers and partners guarantees the quality of our product.

We are continuously building up our safety products intended for covering the Total Ship Safety as a lifecycle issue.

Total Safety Assessment and Passenger Evacuations Simulations are described in the following pages.

9.1 Total Safety Assessment

Total Safety Assessment (TSA) has been developed by Deltamarin to fulfil the principles of the Formal Safety Assessment. The developed method systematically covers the ship geographically and all the installed systems including propulsion and electric power production, energy production, emergency power, bridge systems, safety systems as well as passenger comfort related systems.

The TSA methodology consists of four stages:

1. Generic Ship Model
2. Topographical Reliability Block Diagram
3. Ship Audit aboard
4. Action Tables

Generic Ship Model describes how all the ship functions are built up from subsystems and systems, i.e. what is the impact of a subsystem in a certain compartment on passenger comfort or emergency power, etc. Importance of each component is clearly defined. Generic Ship Database is developed by utilising the model and collected data.

Reliability Block Diagram is a well-known method of reliability technology. Deltamarin has developed the system for practical use in ship environment. These diagrams in topographical format give a firm basis for the assessment/design showing lack of system redundancies and effect of fire and flooding situations aboard on top of the actual ship arrangement.

The TSA methodology is systematic in evaluating the overall safety and service reliability of a ship, its functions, spaces and systems. Generic Ship Model is further utilised as a basis for comprehensive Ship Audit. Specific evaluation criteria is developed together with the crew/operational people to enable efficient ship checks and to have the crew commitment. An onboard data collecting and reporting system is developed for collecting reliable and specific failure and operational data, which is fed directly into the Generic Database.

The end product of TSA is Action Tables including recommended actions for improving safety and service reliability of the ship. A priority index is developed to evaluate cost-efficiency. This novel method enables the owner to make immediate decisions about necessary actions. Continuous follow-up of the proposed improvements is also possible by the same reporting database.

Selected References:

- ✓ 'Voyager of the Seas' (RCI)
- ✓ 'Prinsesse Ragnhild' (Color Line)
- ✓ Millennium and Radiance class; COGES reliability analysis (RCI)
- ✓ Machinery reliability comparison (A.P. Møller)
- ✓ 'Radiance of the Seas' (RCI)

9.2 Safety Simulations

The principle of a safety simulation is close to the ship function simulations. The main difference is that often in safety related simulation the human behaviour is the key issue and in many cases that cannot be measured “on-site”.

The efforts at this moment are aimed at developing reliable evacuation simulation for passenger vessels and a simulation tool for safety simulations (fires, damages, collisions, groundings).

Passenger comfort is an essential area in safety design, simulations and assessments.

In addition there are several other safety-related simulation possibilities, for example:

- The use of life saving appliances (lifeboats, life rafts, evacuation chutes and slides) in heavy seas.
- Fire propagation and fire fighting simulations.
- Simulation of flooding and other damages. A simulation differs from a stability calculation as the complete process is simulated instead of just some intermediate cases.

In safety simulations Deltamarin has cooperation with well-known partners: e.g. passenger evacuation simulation is developed together with the University of Strathclyde.

Selected References:

- ✓ Evacuation Analysis of 'Voyager of the Seas' (RCI)
- ✓ Evacuation Analysis of 'Trollfjord' (Troms Fylkes Dampskipsselskap)
- ✓ Evacuation Analysis of Fast Ferry (Blue Star Ferries/Strintzis Lines)
- ✓ Evacuation Analysis of 'Prinsesse Ragnhild', partial (Color Line)
- ✓ Evacuation Analysis of 'Normandie II' (Brittany Ferries)

9.3 Passenger Evacuation Analysis

The SOLAS regulation II-2/28-1.3 requires that the escape routes of ro-ro passenger ships constructed in or after July 1999 should be evaluated by an evacuation analysis early in the design process. Deltamarin has an effective simulation tool, which allows evacuation analysis according to the SOLAS requirements and also extended analysis including human behaviour and various evacuation conditions. A training tool is also provided.

The main idea of an evacuation analysis is to replace current awkward calculations with a more realistic and reliable evacuation simulation model. This kind of a simulation will answer the following questions:

- What is the total evacuation time in different conditions?
- Which are the most critical design, environmental and behavioural parameters?
- What and where are the bottlenecks and other problem areas?

The human behaviour is a key issue in an evacuation analysis. Deltamarin has developed an evacuation simulation tool in co-operation with the University of Strathclyde. Among other things the following human behaviour elements are included in the simulation:

- Effect of ship motions and heeling
- Blackout and 'smoke in corridors' situations
- Panicking passengers
- Passengers returning to cabin to collect their belongings
- Passengers carrying their luggage
- Simulating passenger profile (age, sex, intoxication, mobility impairment)

Several cases can be simulated in a very short time, such as:

- Special cases: all passengers gathered to one area, e.g. sundeck, etc.
- "What-if" situations: corridors blocked with luggage, locked doors, etc.
- Different design/arrangement configurations

Different evacuation situations can easily be simulated by the Client. For this purpose a runtime version of the simulation can be provided, with easy means of input parameters. The results of the simulation can be also viewed on a PC; this is a good way to show the crew the areas requiring most attention in an evacuation situation.

