ENHANCED EVACUATION SCENARIOS - BACKGROUND AND RECOMMENDATIONS

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SUMMARY

Within the last years at IMO/FP, the agenda item for enhancing the scenarios of advanced evacuation analysis has been put forward together with the inclusion of the obligation for cruise ships to pass such an analysis. Recent events also highlighted the importance to check the orderly evacuation capability of all passenger ships. Well before that, SAFEGUARD had adopted a proactive approach based on safety assessment looking back into the past events, quantitatively using databases and statistics, and qualitatively using accident reports and expertise. Within this approach we stressed important parameters that were not taken into account in the current IMO MSC/Circ.1238 and that will improve safety if included in a new guideline. A set of possible improvements in the current scenarios have been investigated and implemented in software. Final recommendations to IMO are being submitted by the SAFEGUARD group to the next IMO/FP session.

NOMENCLATURE

MVZ Main Vertical Zone
Ro-pax Ro-ro passenger vessels
SAR Search And Rescue
LSA Life Safety Appliance

1. INTRODUCTION

The current regulation, IMO MSC/Circ. 1238 Annex 2, has many areas where improvement is possible. The potential enhancement of scenarios used in the approval process is addressed in this paper.

The work presented here involved a detailed look at all available historical data, from databases and accident reports. This is a fairly typical process, however where the work differs is that the partners also took an in-depth look at the procedures on-board the vessels, including large cruise ships, and interviewed crews who have been involved in evacuation incidents. Getting feedback from professional mariners is very important because it brings realism and credibility to the scenarios being enhanced.

Previously the software and hardware limitations of simulations have been a major hindrance to the possible complexity of scenarios used in the approval process. However, with developments in the latest evacuation analysis software and vast increases in computation performance these scenarios can now be more realistic and still feasible.

2. SAFETY ASSESSMENT

As its part in the project, Bureau Veritas has been analysing past accidents. The research included the quantitative study of accident databases and the qualitative assessment of accident reports and professional mariners’ feedback. This was done in 2009. For the quantitative study, 135 relevant accidents on passenger ships from 1999 to 2009 were studied.

Factors to emerge included that 20% of evacuations happened in listing conditions and 12% with smoke having spread in the ship super-structure.

It was also noted that 45% of abandonments were at sea, the other 55% took place in port (of origin, destination or transit). One third of these disembarkations at berth probably happened in hazardous conditions.

<table>
<thead>
<tr>
<th>Casualty Type</th>
<th>Abandon at sea (by any means)</th>
<th>Disembark at berth</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collision</td>
<td>1%</td>
<td>10%</td>
<td>11%</td>
</tr>
<tr>
<td>Contact</td>
<td>2%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>Fire/ Explosion</td>
<td>12%</td>
<td>13%</td>
<td>25%</td>
</tr>
<tr>
<td>Founndered</td>
<td>4%</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Hull/Machinery damage</td>
<td>2%</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td>Wrecked/Stranded</td>
<td>21%</td>
<td>8%</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td>45%</td>
<td>55%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 3: Observed ways of abandoning the ship per casualty type. 135 relevant accidents from 1999 to 2009

The table above also shows that the majority of stranding and wrecking accidents lead to an abandonment of the ship at sea, whereas the majority of collisions and contacts are followed by disembarkation at berth, as would be expected. Finally this table shows that 50% of fires lead to evacuation of passengers at berth and 50% at sea. In many cases the casualty leads to a serious situation but the SAR manage to tow the ship to a port or the ship itself manages to reach a port.
3. ENHANCED SCENARIOS

Accident reports and testimonies also provided excellent details on past incidents. They revealed, for example that in addition to accidents, passenger assembly occurs for ‘man overboard’ or security alerts as well.

From a procedural point of view it was highlighted that the evacuation process on Ro-pax and cruise ships differs and the impact was shown on the different phases of an evacuation process. Another factor to emerge was that the evacuation procedures on cruise ships can vary considerably from one ship to another.

All this information was gathered to identify areas for improvement and then expert judgement was applied to recommend enhancements to test. Recommendations were also made for other risk assessment methods. We discussed whether our proposals should take into account that IMO MSC/Circ. 1238 is used for purposes other than standard evacuation, such as alternative design for fire safety and alternative design for life saving appliances.

We have listed current evacuation scenarios but added other possible alternatives to be considered. Our initial study looked at the enhancement of existing cases, which are recommended to the next IMO MSC/FP56 in [1]:

- Adding congestion as a performance criterion, and applying this as a fixed criterion value, i.e. fixed threshold of density of persons (4p/m2) not to be exceeded longer than 10% of the maximum allowed assembly time

- Realigning existing secondary cases 3 and 4 so that they take into account smoke effects in the scenario and also aim to be consistent with the Safe Return to Port concept where the casualty threshold is exceeded in some critical main vertical zones (MVZ). These critical zones would be the longest to evacuate and the most populated. Our view is that only these worst case degradations should be evaluated. These would be evacuated using first horizontal secondary routes, then main routes to the assembly stations.

As a first attempt in SAFEGUARD, the original idea was to block the access back in the degraded MVZ, therefore potentially to assembly station(s) in it, but many re-allocation issues were encountered by the developers. Indeed, there is a problem with the software (how to define the arriving passengers being redirected to a new AS?), but also (and mainly) with the operations: how people are assigned a new AS? Finally, the unavailability of the assembly stations in the degraded zone has been left aside.

Examples of results are given below:

- When the alternative assembly stations are chosen in remaining public spaces over the ship, the evacuation dynamics totally changes from the original and effects on the evacuation are very dependent on the assumptions made.

- When the alternative assembly stations are the existing ones, with an increase of the capacity thereof, the assembly time (on a specific ship) increases by 10-15%.

- When access is still admitted to assembly stations in the degraded zone, the increase of assembly time is of the magnitude of 30%-35%.

What is noteworthy is that the dynamics of the evacuation is totally different because of the change in the procedure. This was reflected by the congestion criteria analysis with different congestion spots and durations. This also highlighted the role of the procedure and questioned what is addressed by the IMO MSC/Circ.1238 guideline: is it the design or the procedures? Both are legitimate.

4. OTHER SCENARIOS RELEVANT TO THE OPERATION OF THE SHIP

Within the project we also tested interesting additional cases which are relevant mostly to the operation of the ship:

- Locating some passengers on public open decks for day cases – this had an effect only when loading the sun deck with a significant amount of people. This was concluded to be recommended and done with a maximum load. Additionally this gave rise to the idea to investigate the day case with specific public spaces filled at 100%, according to the actual commercial attraction of the public spaces of the ship.

- Setting up a hybrid of night and day cases where 50% of the passengers are in cabins and 50% in public areas. This has been tested to see how it compares to the current day and night case. We identified different congestion spots and longer evacuation times compared to the day case but not longer than the night case. However, in our test the night response time (delayed by 400s) has been applied to people starting in cabins, whereas the response time for cabin day ought to be closer to the one measured in [2]. As the two sets of populations would start at the same time, more cross flow would then be observed.
Finally, four areas have been identified which need further research as data is not yet available to make recommendations to modify the Circular.

These are:

- Establishing a disembarkation to shore case where people start from the assembly station and evacuate through gangways/footbridge. But no sufficient data to model flows on gangways or footbridges are available.
- Simulating life vest recovery in the day case for cruise ships. Models for life vest recovery procedures are presented below (see figure 1).
  - Procedure A: Passenger go to assembly stations and are given their life vests in the vicinity.
  - Procedure B: Passengers collect life vests from their cabins and then proceed to the assembly station with their life vest
  - Procedure C: Crew members collect life vests from passenger cabins and bring them to the assembly station. The life vests are then distributed to the passengers at the assembly stations.

- Establishing a complete evacuation performance standard including abandonment. This case has been developed in SAFEGUARD. Our proposals would keep the methodology for analysing only the assembly phase within a timescale of 30 minutes, as set out in the current circular, abandonment overlapping on the assembly phase or not depending on the case. Additional features have been identified for designers when calculating abandonment times. This is especially true when group locations and the embarkation time in the life-crafts. This will require defining new time variables for individuals (grouping, travelling to embarkation, embarking and launching) so that the whole procedure on board can be modelled.

Figure 1: Three different lifejacket procedures on board cruise ships

While they cover all the known procedures on board, not enough information is available about the time taken to find and put on lifejackets, their effect on the speed of people during evacuation and the way people behave carrying or wearing lifejackets.

Figure 2: Example time line of survival craft groups assembling and abandoning after Captain’s signal (at t=860 s)

Figure 3: Example time line of survival craft groups assembling and abandoning immediately. Same segments as in Figure 2, i.e. no interaction with assembly phase, e.g. if routes are independent.

In this way different evacuation strategies can be selected by the designer and the owner (in Figure 2 the procedure includes awaiting the
captain’s signal before sending groups to embarkation, in Figure 3 the procedure allows the survival craft groups to go to embarkations immediately after having been formed). The methodology needs several ‘allocation’ tables to map where people or groups of people ought to go during the different phases of evacuation. The global performance standard for the current circular is 60 or 80 minutes (assembly plus abandonment). However, more data is necessary to model the group behaviour over all phases of evacuation and to model the flow of persons at the LSA entrances.

5. CONCLUSIONS: RECOMMENDATIONS TO IMO MSC / FP

Most of these enhanced scenarios and additional scenarios have been developed and tested in an implementation work phase of SAFEGUARD. Final recommendations are currently made in the IMO information paper [1].

6. ACKNOWLEDGEMENTS

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7. DISCLAIMER

The opinions expressed are solely those of the author.

8. REFERENCES

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9. AUTHOR'S BIOGRAPHY

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