MONALISA 2.0 – Activity 3

Launching and Recovery System Design

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<td>Italian Ministry of Transport, with the technical assistance of RINA</td>
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1. Objective of the document

The objective of this deliverable is to make a compendium of all technical documentation such as drawings, specifications and additional explanations associated with the design of the SES launch and recovery system.

This document corresponds to the deliverable D3.4.2 and it reports the conclusions of the “Launching and Recovery System Design”.

2. Introduction

As it has been already mentioned in D3.4.1., SES (Safe Evacuation System), is a safe, effective, efficient and reliable system, intended to perform evacuation operations on board passenger ships in extreme sea, weather and stability conditions (specially high wind speed and high heel values).

Such system, is capable to work in situations where conventional ones cannot work properly and it is conceived to be compatible with existing launch appliances for lifeboats and to be easily installed on different sorts of vessels.

Fig 1. Example of Costa Concordia Evacuation
According with all this, the design of the SES has been defined and adjusted as it is discussed in later sections of this document.

3. Rules

The SES system, which essentially consists in all extra elements and adaptations which must be made to conventional launching and recovery systems of lifeboats in order to achieve those mentioned special capabilities (to work at extreme heel conditions), complies with the following rules and regulations as well as the davit, hook and lifeboat.

- IMO Resolution MSC 81(70), Recommendation on Testing of Life-Saving Appliances (adopted on 11 December 1998).
- IMO Resolution MSC CIRC.811
- IMO Resolution MSC CIRC.1006
- IMO Resolution MSC.320(89)
- IMO Resolution MSC.321(89)
- IMO Resolution MSC.1/Circ.1206

4. Problem Analysis

4.1. CONCERNING TO THE DAVITS
As it has been mentioned before, the existing launching appliances for lifeboats which are onboard passenger vessels are limited for its use up to the values demanded by SOLAS & LSA Code.

This especially means a limitation on the possible evacuation, limited to 20º heel to the opposite side.

This kind of vessels are mostly designed “over” the mandatory limitations of stability (similar to reflected in LSA Code, Chapter VI, Part B, 6.1.1.2) and the evacuation time that is necessary quite long (up to 30min mandatory from the time when the abandon ship signal is given). During this time the heel of the vessel will normally become higher but evacuation is not finished. Considering those issues and having analyzed some real recent accidents, the SES system provides a solution to increase the capability of the existing equipment in order to allow evacuation of lifeboats up to 30º of heel to the opposite side. The increase between 20º and 30º is not small, as it is close to the 50% more that which is the maximum normally demand on the capability of the system. Bigger heel angles have been considered but in such situation, even if the equipment could perform the operation, nonprofessional people wouldn't be able to achieve and embark into the lifeboats.

They should be also considering geometry limitations on existing/commercial davits, boats and vessel’s embarking/stowing deck.

As a part of all the requirements for the modification to existing davits should be to ensure that the boat in these heel conditions does not fall on/over deck, but to the shipside; so the system must guarantee that the lifeboats can be positioned along the shipside in order to launch them to the sea, in this mentioned conditions.

4.2.- CONCERNING TO THE LIFEBOAT AND RELEASE HOOKS

The SES system, focus on the big problem that appears when the heel of the damaged vessel is higher than 20º, which is the maximum heel angle considered in the IMO rules, but that could be significant higher for most of the modern passenger vessels before final sinking. High heel angles involve not only problems for the launching operation itself, but also for the equipment used: boat, release mechanism and davit.

During the launching operation when the heel to the opposite side is higher than 20º (requested by SOLAS), once the personnel has embarked into the lifeboat
and it is under the deck level/edge, might appear secondary effects on the lifeboat itself that could dangerously damage the equipment. The main ones are:

- To exceed the superficial force (pressure) against the hull of the vessel.
- To exceed the lateral pulling angle between the release hook of the boat and the fall wire from the davit.

For a better understanding, go to paragraph 7 “SES General Arrangement” (drawings No. 46583 & 46584).

In addition to all the modifications we are proposing in this document for davits and lifeboats, the embarkation station as well as evacuation procedures, should also be adapted for this new operation conditions. Could also be necessary to increase the hook throw and so the winch drum capacity.

5. Technical Issues and design proposal

The specific technical features that the SES system must meet in order to avoid those mentioned risks are:

- SES must guarantee that lifeboats can be positioned along the shipside in order to launch them to the sea.
- The friction between the hull of the lifeboat and the passenger vessel side during the evacuation should be reduced as much as possible, in order to maintain the angle between the hook and the davit throw at small values (a critical factor which is usually guilty of preventing the release systems from working with heel angles above 20º).
- Due to commercial issues, the system should be compatible, with small adaptations, with existing launch appliances for lifeboats and should be installed on different sorts of vessels.
- SES must be capable of operating at heel conditions, either way but mostly to the opposite side, much higher than conventional ones (> 20º).
- SES should be able to work also with empty lifeboats.
- SES should be compatible with both telescopic and tilting launching devices.
The hull of the lifeboat will be supported on the ship’s hull with a force 45% higher than what the law requires, due to the increased angle of heel at which the SES will work.

5.2. TECHNICAL ISSUES CONCERNING TO THE DAVITS

The system should be compatible with both telescopic and tilting launching devices, and also be able to work with empty lifeboats.

It includes fittings for its connection up to the lower part of the davit arm, and to connect down to the edge of the boarding deck to the hull side (this is an special critical point, to ensure the sliding of the boat down to the shipside).

According to commercial issues, the system should be compatible, with small adaptations, with commercial existing launching appliances for lifeboats, and should be installed at different sort of vessels.

The proposed system has been adapted for two options, as follows (see drawings No. 46583 & 46584 for a better understanding):

1.- A system based on straps

- This system essentially consists of 2 or 3 straps that tighten at the time that the davit arms tilts or telescopes out of deck (it depends on the sort of davit), in order to put out the lifeboat directly of the shipside and prevent it from falling on the deck of the passenger vessel.
- Those 2-3 straps (it depends on the lifeboat) must have their ends anchored to the edge of the deck before starting the launch operations. On the deck of the vessels they will be already placed special clamped devices for an easy clamped operation when an evacuation is needed.

- The maximum tension that the straps will support will be equal to half the weight of the boat, and divide by the number of straps (depending on the boat).

**Main components**

- **STRAPS:** they are made of a textile material, mainly for reasons of weight reduction and ease of manipulation, and additionally to avoid damages on the lifeboat hull. They are in “flat type”, which reduce the contact stress with the boat, and facilitate the distribution of forces along the lifeboat hull structure.

  At one end, the straps have a hook, for a quick connection to the hooking system on deck. And at the other end, the straps are connected to the tensioning system.

- **HOOKING SYSTEM ON DECK** (for each strap). The main components are:
  1. One pad-eye to be weld on deck
  2. One shackle, bolted to the pad-eye, where the hook of the straps will be connected.
  3. The protection system for the pad-eye, shackle and hook, for a better sliding of the boat when the boat is close to the corner between the deck and the shipside.

- **TENSIONING SYSTEM.** In order to achieve the displacement of the boat from the vertical line to the shipside, the straps must be tensioned. Depending on the kind of davit, there are proposed three different options:
  1. To tension the straps with an auxiliary winch. An auxiliary winch (electric or hydraulic) should be installed at the embarkation area. The winch must have the necessary pull capacity to tension the straps and displace the boat. This is the solution that it is propose in drawing 46583 and 46584.
2. To tension the straps with an auxiliary hydraulic cylinder. An auxiliary hydraulic cylinder should be installed at the embarkation area. The winch must have the necessary pull capacity to tension the straps and displace the boat.

3. To tension the straps, at the same time that the davit tilts or telescopes out. It must be taken advantage of the geometry of the davit, by using wire forwarding and pulling.

The connection between the straps and the tensioning system, as it will never contact the boat, will be by means of a steel galvanized wire, for a better forwarding on the sheaves.

- **FORWARDING SYSTEM.** On the davit and embarkation area must be installed several sheaves for forwarding wires of the tensioning system. The structural capacity of the davit and the ship structure are considered for arrangement definition.

### 2.- A system based on telescopic vertical booms

- This system essentially consists of 2 telescopic arms that make a telescopic movement downward in order to work as pads to put out the lifeboat directly on the shipside and prevent it from falling on the deck of passenger vessel but .
- The maximum tension that the booms will support will be equal to one quarter of the weight of the boat.

### Main components

- **FIXED ARMS.** These arms are fixed to the davit structure, and they allow the telescoping movement of the mobile part. There are made of steel, and in "box type". In the inner side, sliding synthetic plates are installed, for a better telescoping displacement of the mobile arm.

- **MOBILE ARMS.** In stowed position, they are kept in the fixed arms. By means of hydraulic cylinders, the mobile arms slide in the fixed arms the necessary length to reach the shipside. They are made of steel, and the end which contacts with the shipside has been designed to obtain the best stress distribution on the hull structure. The structural capacity of lifeboat structure might be considered for the best arrangement definition.
HYDRAULIC CYLINDERS, double effect hydraulic cylinders, for telescoping in and out the secondary arm.

5.2 TECHNICAL ISSUES CONCERNING TO THE LIFEBOAT

Once the lifeboat is below the deck level and against the shipside, it starts to slide down. To seriously reduce those risks that could appear during this operation, it is proposed a solution by adding to the lifeboat hull several sliding pads with the following main design characteristics (see drawing PU-47501):

- The external surface of the pad should resist the huge pressure that appears during the operation, and also reduce both, the friction coefficient against the vessel hull and against the straps that are proposed as a complementary solution when the lifeboat is above deck. With this reduction of the friction coefficient, when the lifeboat is lowering against the hull of the vessel it will stay more in “parallel” to the vessel, and so the angle between the fall wire and the hook it will be significantly lower. If this angle exceeds from the angle of design of the hook, both, the release mechanism and its connection to the hull of the lifeboat, could be broken. Safety and comfort of the passengers of the lifeboat has been considered. In fact, during the last few months, Industrias Ferri has been able to confirm that the seats are able to hold passengers in such high heel of the boat. In order to obtain the sliding benefits which have been mentioned before, and after several tests in factory, it has been selected the material “P.U. MARINO 75SHD”, which has the following main characteristics:

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value</th>
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<tbody>
<tr>
<td>Hardness at 20ºC</td>
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<td>Shore 75D</td>
</tr>
<tr>
<td>10 % Modulus</td>
<td>DIN 53504</td>
<td>MPa 39</td>
</tr>
<tr>
<td>100% Modulus</td>
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<tr>
<td>200% Modulus</td>
<td>DIN 53504</td>
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<td>Tear Strength (without nick)</td>
<td>ISO 34-1</td>
<td>KN/m 239</td>
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<td>Tear Strength (without nick)</td>
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<tr>
<td>Resilience</td>
<td>DIN 53512</td>
<td>% 52</td>
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The intermediate part of the pad should be thicker and softer (quite less hard) than the surface so to reduce the surface pressure: the increase of heel from 20° to 30° would mean that the force which the lifeboat makes on the vessel's hull is a 45% higher, and it can become half of the full lifeboat weight. Further this, the part of the shape of the lifeboat’s hull that now would be in contact, wouldn't be the reinforced part with fenders prepare for "lateral" contacts, but it would be a part originally designed just to sail. Therefore it is essential to disperse/distribute into a bigger surface such force that appears on the hull of the lifeboat, in order to avoid the boat’s hull to be broken. In order to obtain all benefits which have been mentioned before, and after several tests in factory, it has been selected the material “P.U. MARINO 60SHA”, which has the following main characteristics:

- The internal part of the pad should include the glue to fix it to the lifeboat’s hull with its normal painting/coating protections. It should resist the effort coming from the friction of the external surface of the pad, and ensure a better/higher friction coefficient with the surface of the hull’s boat paint/coating. This fixing solution of the sliding pads is proposed also, to ensure the quickest installation as possible on the existing boats.
- The sliding pads with their three layers, should be also flexible enough to adjust to the curved part of the lifeboat hull shape and properly fixed to it: the “points” of contact between the hull of lifeboat and vessel in such position, are in most of the studied boats, in a part of its hull designed for sailing, and because of this, with a curved form/shape. Further this, in many lifeboats, there are also holding bars intended to allow shipwreck people (castaway) to grab them when the lifeboat is turned around.

- Proposed materials should resist especial atmosphere conditions: wetting, high/low temperatures, saline corrosion, sun radiation, etc. Both selected materials have a very good resistance to hydrolysis (water, acid and base), to micro-organisms and many other factors.

- The sliding pads should also resist its effort during the sailing of the lifeboat, with a minimum reduction of the hull hydrodynamic characteristics. Under no circumstances the boat certification or main characteristics should be compromised.

- Less important, but an issue to be considered especially in this kind of passenger vessels, is the aspect and easily cleaning of the components. Therefore the option we have selected, especially for the external surface, is an anti-bacteria material. Concerning the color, it might be all white to affect the minimum to the existing aspect of lifeboats, or orange & black to emphasize as an especial safety component (as existing defenses).
6. SES General Arrangement

TWIN TELESCOPIC DAVIT

ANTI-HEELING SYSTEM BASED ON WINCH AND STRAPS

SLIDING RUBBER

ANCHOR POINTS FOR REMOVABLE STRAPS

REMOVABLE STRAPS FOR LAUNCHING WITH 30° HEEP

CONTROL PANELS

CORRECT

RISK

CORRECT

RISK

CHARACTERISTICS

TWIN TELESCOPIC DAVIT

SLIDING RUBBER

TWIN TELESCOPIC ANTI-HEELING ARMS
7. Prototyping and testing

In order to verify the main features of SES system in a real test, Industrias Ferri, S.A. is currently defining, together with Jovellanos Center and Compass (Ferri’s subcontractor), the objectives and resources which will be available/needed for the testing phase of this sub-activity.

Therefore, although the SES system has to satisfy all the above mentioned requirements, the prototype to be developed, will be target into a real test at Jovellanos Center, and such prototype/s will be designed in order to minimize the time of inoperability of Jovellanos Center.

8. Bibliography

- IMO Resolution MSC 81(70), Recommendation on Testing of Life-Saving Appliances ((adopted on 11 December 1998).
- IMO Resolution MSC CIRC.811
- IMO Resolution MSC CIRC.1006
- IMO Resolution MSC.320(89)
- IMO Resolution MSC.321(89)
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