Next generation of life Saving appliances and systems for saFE and swift evacuation operations on high capacity PASSenger ships in extreme scenarios and conditions

MG-2-2-2018 Marine Accident Response No. 815146

D3.2 - Report on Emerging Needs and Specification for LSA

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Acronyms and Abbreviations

PSE	Personal Survival Equipment
LSA	Life Saving Appliance
AD&A	Alternative Design Appraisal
OEM	Original Equipment Manufacturer
DL	Davit Launched Liferaft
MES	Marine Evacuation System
SOLAS	Safety of Life at Sea
LSA CODE	Lifesaving Appliances Code
GBS	Boal Based Standard
IMO	International Maritime Organisation
CLIA	Cruise Line International Association
JOS	RCCL Jewel of the Seas
SME	Subject Matter Expert
IMO DE	International Maritime Organisation Deck Equipment Sub Committee
ALARP	As low as reasonably practical
ADA (USA)	Americans with Disability Act

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Executive Summary

The drafting of the SafePASS Requirements for Future LSA and PSE has built on the work, ideas and outputs from the SafePASS WP3 Workshop in Glasgow, the RCCL Jewel of the Seas Questionnaire and the online Future Requirements Questionnaire. It has also drawn on the experience of the LSA OEMs involved in the consortium and the work already undertaken for deliverables D2.1 - *Evacuation Processes: Best practices, tools and gaps* and D2.2 - *SafePASS Mission and Operational KPIs*.

This report also builds on the Design Thinking process that has been adopted for the project, with this being the Define phase.

A number of key issues or themes were noted during the workshop and questionnaires, relating to the wide demographics onboard vessels, equipment reliability and performance, the ability to incorporate SMART technology into or onto them and how training and maintenance are conducted on the equipment when onboard the vessel.

The need to adopt a different approach in developing novel LSA and PSE is highlighted by the review of the current trends in LSA and PSE, where the equipment capacity is increasing, stored space onboard is decreasing and safety levels are increasing slower than the corresponding technology. The current trends are mainly being driven by the current prescriptive regulations that constrain the design of the equipment within certain boundaries. These prescriptive requirements are isolated from the real-world scenarios of fire or flood and the actual performance of the equipment in those situations. Some progressive vessel owners, yards and OEMs are utilising the AD&A (Alternative Design and Appraisal) process to introduce novel equipment onboard. However, this process is unwieldy and involves extensive review by all parties involved in delivering the vessel, as it carried out on a case-by-case basis.

A GBS approach has been adopted in generating the Future Requirements by identifying and quantifying a certain need, additional safety level or through experience of the lack of a particular feature or capability. In parallel, the consolidated list of User Requirements that were defined in D2.3 - *SafePASS Personas and respective scenarios of use* have been taken into account, in order to correlate the functional requirements of the developed system with specific user needs.

During the development of the Requirements, it became evident for the Consortium that they should think out of the box, so as to develop novel Systems that will improve Evacuation. In order to encourage the creative thinking, the Combined LSA Requirements were developed in that way, so as not to constrain the integration of the developments within either a Hardshell (lifeboat style) or Softshell (inflatable) category.

The Requirements for each type of equipment were ranked as capabilities that the equipment Must, Should or Could have. These Functions also had a specific Performance requirement identified, so that the effectiveness could be verified or demonstrated.

As part of the Performance Requirements, the approach of the Offshore Oil and Gas Sector has been adopted into the Combined LSA Requirements. This encourages the assessment of the performance of the equipment when it is installed in a particular location onboard a vessel, to ensure it will perform as expected in different conditions (the sea is agitated for 80% of the time) or real-world scenarios of fire or flooding.

The increased understanding of how the LSA performs with respect to the vessel and the passengers boarding in those different scenarios or locations, as well as the lifeboats leaving the vessel, will allow the equipment to be fully integrated into the overall vessel design and perform better, comparing to the approach that the requirements currently drive.

The Functional and Performance Requirements have been documented in a format so that they can be presented to IMO and encourage their adoption into the current GBS work that is ongoing and will form part of the deliverable D9.7 – *IMO Recommendations*.

The Requirements for Future PSE and LSA will, in turn, allow the development of the concepts and prototypes to be created as part of the deliverables D3.4, D3.5, D3.6 and D3.7. The work that is completed as part of D3.8 – LSA *Model Testing* will further assist in the definition of the performance requirements for different locations onboard the vessel, in different critical scenarios and conditions.

1. Introduction

1.1 Purpose of the Document

Deliverable D3.2 Future Requirements – LSA & PSE is a report that aims to provide an insight of the current trends of LSA and PSE. It will also detail the approach and methodology used to generate the Specifications (Performance and Functional Requirements) for Future LSA and PSE concepts and prototypes that are to be developed in deliverables D3.4, D3.5, D3.6 and D3.7.

The Report will also map out the draft Requirements (Performance and Functional), which can be used to direct future discussions with IMO on life saving appliances.

The Requirements that are generated in this report are built on the work, research and feedback that has been collected during the Glasgow Workshop and Report (D3.1) and from the LSA Questionnaires carried out online and onboard RCCL Jewel of the Seas with key stakeholders.

The report makes recommendations on the Function and Performance of Future LSA, once the vessel has reached the extreme point where it can no longer be its own best lifeboat and beyond a safe return to port.

1.2 Intended Readership

This deliverable is addressed to both interested readers in the consortium and to external interested parties. The report is driven by the OEM's within the consortium with input from all the other relevant members of the consortium – Flag, Class, Yard, Owner and technology developers. It provides a direction on how the Consortium believe LSA and PSE should be developed to meet the needs of the end users, and the wide demographic of population that they interact with.

1.3 Document Structure

The document is structured into 8 key sections.

Section 1 serves as the introduction of this deliverable, describing the purpose of it, the intended readership and its structure.

Section 2 of the report outlines an overview of current LSA and how they are currently being developed by the manufacturers. The section also outlines what are the constraints or limitations on those developments.

Section 3 analyses the methodology used in order to gather information regarding future requirements, as well as the key results that were collected.

Subsequent Sections 4,5,6 & 7 map out the future requirements for LSA and PSE. More specifically, section 4 refers to Personal Survival Equipment, section 5 and 6 analyse the requirements for Softshell and Hardshell Lifesaving Appliances respectively, while section 7 presents the requirements for combined Lifesaving Appliances. The sections detail how the background information has been gathered, reviewed and the requirements for each type of survival equipment identified. For each type of equipment, the requirements were graded as ***Must*** have, ***Should*** have and ***Could*** have. Also, the draft Performance and Functional requirements have been identified and reviewed.

Finally, the conclusions are presented in Section 8, summarizing the analysis and the outcomes of this document.

In order to ensure consistency, each requirement has been given a unique reference number "URXX". This reference number follows on from the User Requirements defined in Deliverable D2.3. for continuity and ease of reference. Table 5 of D2.3 regarding User Requirements has been included in Annex 1 of this deliverable.

The Annexes to this report detail the intended Performance and Functional Requirements, which can be taken forward to IMO. They also include additional supporting documentation.

The report builds on the Design Thinking Process. The process is normally considered to:

- Empathise
- Define
- Ideate
- Prototype
- Test

The deliverable D3.1 empathised with all the key stakeholders, by understanding their needs and requirements for future equipment, while this report attempts to define those needs and requirements to allow for new ideas and prototypes to be developed.

2. LSA & PSE – Current Trends

2.1 Overview

In recent years, the LSA manufacturers have been responding to the changing requirements from Yards and Owners for LSA and PSE.

One of the key drivers has been the increasing capacity of vessels, with the length not significantly increasing and the beam of the vessel increasing. This has meant that LSA manufacturers have increased the density of passengers within their LSA, as an increased number of persons must be evacuated in approximately the same length of vessel as before. It has also meant that equipment has to perform into a higher standard, due to the list and trim of the larger beams and the positioning of the equipment further fore and aft, possibly off the flat side of the vessel, due to the pressure on the available length.

Other factors that have been driving development of LSA and PSE are:

- Size of equipment
- Capacity
- Cost
- Appearance
- Evacuation scenarios (flooding and fire)
- Evacuation regulations for passenger ships

These factors have led the manufacturers to increase the capacity of their systems, while trying to maintain the smallest footprint on the deck as possible.

On large passenger vessels, there are currently 3 main types of LSA installed to evacuate the passengers. They are:

- Lifeboats / Tenderboats
- DL (Davit Launched) Liferafts
- MES (Marine Evacuation Systems)

Within the lifeboat market, the trend has been to regularly go above the statutory maximum capacity of 150 PAX (Figure 1), with boats up to 440PAX (Figure 2) now approved for service. The beam of these boats has increased along with the passengers seated on tiered seating, in order to increase the capacity without significantly increasing the overall length (Figure 3). The increase in passenger numbers has also led to an expansion in davit structure and support to safely lower the number of persons.

Figure 1: 150 Person Partially Enclosed Lifeboat

Figure 2: 150 Person Plus – Oversized Lifeboats

Figure 3: Lifeboat Seating Arrangements

The appearance of lifeboats has also changed significantly (Figure 4), moving from a traditional style to be more futuristic look. This is particularly relevant to the tenderboats that are used on certain vessels.

The tenderboats have also significantly increased their level of comfort onboard for the passengers during their transfer ashore (Figure 5).

Figure 4: Tender boat Designs

Figure 5: Tender boat Seating

To accept the Over Sized lifeboats for carriage onboard a vessel, they have to go through a process known as an AD&A (Alternative Design and Arrangements approval). This involves a review with the stakeholders for a vessel to ensure that the equipment can provide at least an equivalent level of safety as existing approved equipment. The stakeholders involved are Shipyard, Flag, Class, Owner and LSA OEM. They conduct an engineering and safety analysis of the equipment and subsequently confirm that safety performance and functionality are verified to agreed requirements. The AD&A procedure is becoming more common with the current design of large passenger vessels, due to revised layouts and capacity of LSA required onboard.

The lifeboat OEMs are now starting to develop lifeboats with alternative means of propulsion, by installing electric engines (Figure 6). These have already been approved for use in the Offshore Oil and Gas market sector.

Figure 6: Electric Lifeboat

The davit launched (DL) liferaft (Figure 7) is the original high capacity evacuation system, as it consists of a number of packed liferafts located around a davit for launching the liferafts once boarded. The liferafts are normally 25 or 37-person capacity.

DL Liferafts have not evolved significantly in recent years, with some manufacturers looking at capacity up to 50-person liferafts.

Figure 7: Davit Launched Liferaft

In the early 1980's, MES were introduced to ROPAX vessels, using at that stage slides similar to aircraft evacuation slides to transfer the passengers from the embarkation deck down to platform, where they would transfer into a canopied liferaft (Figure 8).

Figure 8: Slide Based MES

These Systems then evolved into chute-based evacuation systems, which allowed the passengers to enter directly into the liferaft, with a capacity per system in excess of 400 persons (Figure 9). This allowed the Systems to be installed at higher deck heights while also reducing the exposure of the passengers to the elements, as the transfer is totally enclosed.

Current MES have built on this technology, increasing the System capacity so as to now be in excess of 800 persons (Figure 10).

Slide based Systems were evolved (Figure 11) to make them lighter and more compact, so that they would be suitable for use onboard HSC – fast ferries.

MES manufacturers have more recently started to improve the aesthetics of the structures on the deck (Figure 12), so that they are less industrial looking, and more blended to the appearance of the vessels.

Figure 9: Chute Based MES

Figure 10: Slide Based MES for HSC

Figure 11: High Capacity MES

Figure 12: Aesthetically Styled MES Enclosures

The recent EU funded programmes SafeCRAFT and SafeDOR identified that a next generation of inflatable LSA could have increased levels of safety, by providing propulsion power for the inflatable craft. The two main OEMs for MES have been developing inflatable Evacuation Systems that have powered inflatable survival

craft incorporated into them. The Viking Lifecraft System (Figure 13) has completed its testing programme, while the Survitec Seahaven System (Figure 14) is currently undergoing its approval programme.

Both these Systems will undergo a formal AD&A process to have them accepted for carriage onboard a large passenger vessel.

Figure 13: Viking Lifecraft System

Figure 14: Survitec Seahaven System

Lifejackets in recent years have not significantly changed due to the reasonably tight functional requirements in the LSA Code (Figure 15). The changes have all generally related to reduced maintenance and reduced storage space.

Due to the functional requirements, the lifejackets are manufactured using an open cell foam, which in turn makes it bulky. This has led the OEMS to be creative in the profiling of the jacket (Figures 16 & 17), so that when folded they are as compact as practical, avoiding any voids or dead space when folded and stacked.

The other significant trend that is occurring is that regularly the requirements of the Yard and Owner are outside the conventional requirements that are detailed in SOLAS and the LSA Code. This has required the use of the SOLAS Chapter III, Regulation 38 and the AD&A process to be used more frequently for the carriage of novel or modified equipment. For Oversized lifeboats, this has been relatively

easy to conduct, as the boats are an “extension” of the existing designs and not a new category of equipment. However, for the new hybrid type Systems (inflatable & powered) being developed by the MES OEM’s, this has proved to be a more involved process than for lifeboats, as the designs are truly novel and do not fall neatly into any equipment category. This has involved all the stakeholders to adapt new approaches to assessing the equipment, so as to ensure it provides an equivalent level of safety and functionality to the traditional LSA onboard a vessel.

Overall, the LSA OEMs have been continually evolving their approved equipment to meet the demands of the Yard and Owner, with incremental developments of their Systems or equipment. Recently, the MES OEMs have undertaken what should be a step change in equipment design, with the development of the compact high capacity powered inflatable craft systems.

Figure 15: Approved Lifejacket – Voids when stored

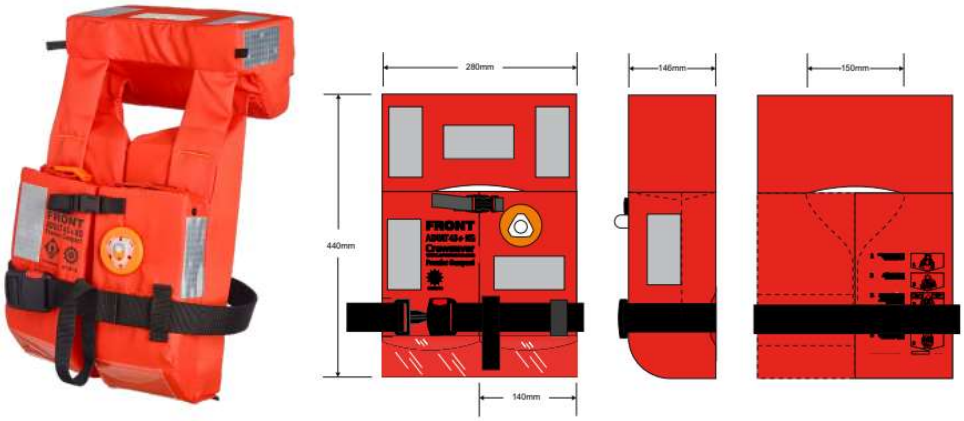


Figure 16: Approved Lifejacket – compact storage arrangements

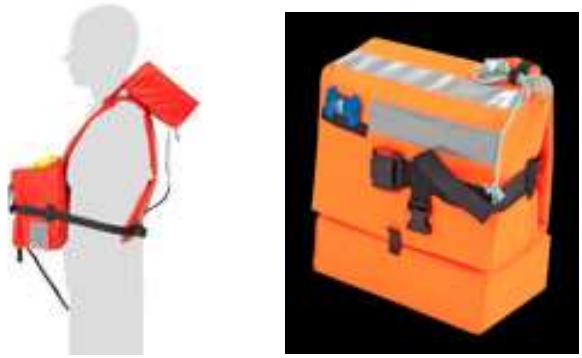


Figure 17: Approved Lifejacket – compact storage arrangements

2.2 Limitations

At present, LSA equipment is designed and approved to the prescriptive requirements detailed in SOLAS Ch. III and the LSA Code. By designing to prescriptive requirements, the equipment developed naturally ends up similar to what has gone before – increased capacity, more compact, lighter, etc.

This prescriptive approach also means that the equipment is developed and approved separately from the vessel. The assumption is that once it is approved in line with the requirements, then there is very little assessment required to install onboard the vessel. However, the equipment may perform very differently in different locations on the vessel, e.g. mid ships could have less motions or accelerations than in a position forward or aft. This not only affects the physical equipment, but will also affect boarding rate for the equipment.

In addition to a limited understanding of the actual performance of the equipment in certain locations, the performance may also vary depending on the driving scenario for the evacuation. The two key scenarios are Fire and Flooding. In the flooding scenario, the vessel response could be significantly different due to the changed freeboards, motion of the vessel, damage of evacuation routes and deck wetness than in a fire situation. The vessel response will in turn affect the performance of the LSAs, the ability of the passengers to access the LSA station and subsequently the boarding to the LSAs.

The positioning of equipment onboard a vessel is driven by requirements in SOLAS and does not offer significant flexibility. The benefits of alternative locations (faster evacuation routes, ease of access evacuation station in different ship scenarios, ease of boarding in different conditions) for the LSA will be developed and reported in deliverable D3.11 – Novel Ship Architectures. In addition, as part of the review on the location of the equipment, the layout of the Muster Areas

and how passengers can move between the Safe Zones, in case that one of them is lost, should be reviewed to identify how these can be improved, further reducing the risk in the overall evacuation scenario.

Within SOLAS, Chapter II, which deals with Fire Safety, has been updated to follow a goal-based standards (GBS) approach. This change in approach was driven by more and more novel equipment being available to deal with Fire Safety, which was not prescriptively covered by the existing legislation, but was clearly providing a higher level of safety. At IMO, Ch. III Lifesaving is currently undergoing a revision to a GBS approach. This is currently in progress and will not be concluded for a number of sessions.

Within Reg. 38 in Ch. III, a “chicken and egg” situation has been identified. OEMs are willing to develop novel systems and they need to be approved. In order to approve the equipment in line with Reg. 38, a stakeholder team (Yard, Owner, OEM, Class and Flag) needs to undertake a detailed review and analysis. However, this process is only viable if it is applied to a specific new build project. This requires the commitment and investment by Yard and Owner, to ensure that the novel equipment will be approved for carriage onboard. There is the associated risk that, during this review and analysis, the equipment may not be accepted, due to delays in testing or not meeting a specific requirement. This would in turn leave the new build project without a viable LSA solution, as the vessel will have been designed around this equipment. In this case, a parallel LSA configuration (traditional boats and MES) can be developed at additional cost for the Owner.

This issue has been acknowledged and there are general discussions ongoing on how to de-risk this for all the stakeholders involved.

Within the testing requirements in the LSA Code, there is a number of anomalies between different types of equipment, which have to perform a similar function. One example is that passenger lifeboats do not conduct any significant launching or evacuation at sea trials, whereas an MES has to undertake what is known as a Heavy Weather Sea Trial (HWST), where the equipment is deployed in a Beaufort 6 sea state, where the equipment is ballasted and tested thoroughly for at least 90 minutes, even though abandonment should be completed within 30 minutes. This is because the average performance within 30 minutes may not be stationary (i.e., the average in each 30 minutes of recording could change from one case to the next).

Passenger LSA installed onboard large passenger vessels is sized around the world side average person. However, the majority of persons onboard a large passenger vessel will be generally of the more affluent population, so will be larger than the worldwide average. Recently the weight per person in passenger LSA has increased from 75 kg to 82.5 kg. However, the physical size of the person was not updated at that stage. Currently, there are discussions at IMO, tabled by CLIA, to revise the size of the seating space per person. One of the key dimensional changes

would be to increase shoulder width from 430mm to 510mm per person (Figures 18 and 19).

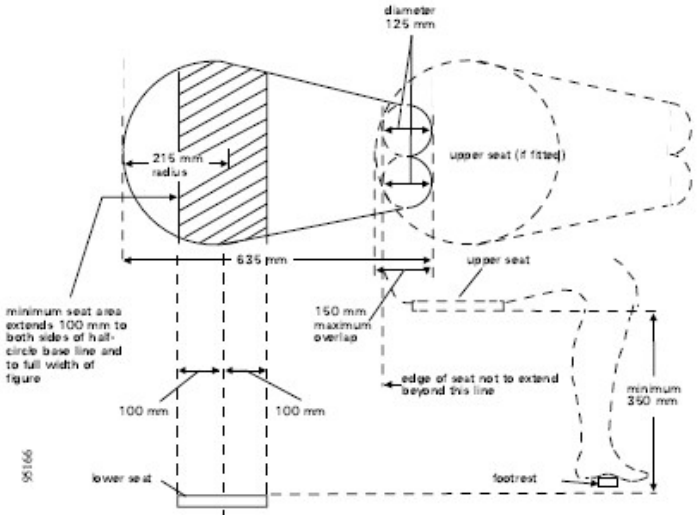


Figure 18: Seating Space – LSA Code

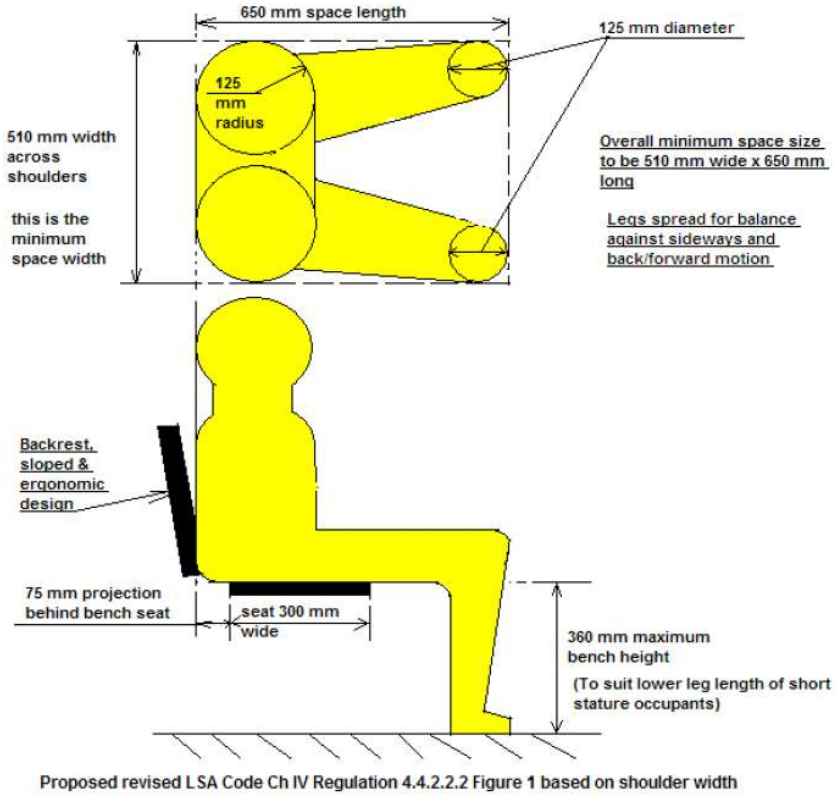


Figure 19: Seating Space – CLIA Proposal

Within the current regulations, there are references to testing with an as wide age group of the population as practical. This tests that the equipment can be used (boarding, seating, operation) by the majority of the population, but excludes any specific requirements relating to persons of reduced mobility or of persons who need assistance or are in a stretcher. New-born children are also not specifically catered for within the requirements.

One other limitation to LSA design has been the balance between cost and safety. All Owners meet the minimum statutory requirements, otherwise they would not be allowed to sail their vessels. However, the equipment design that provides increased functionality or higher levels of safety comes at an additional cost. With only internal policies at Owners to encourage the Yard to purchase higher functionality or safety levels of equipment, cost of equipment is inevitably a critical factor. There is a number of Owners and Yards who do proactively work together to encourage the OEMs to constantly improve safety and functionality.

2.3 WP Integration

The Requirements generated by the outputs from this deliverable link with a number of other deliverables within the SafePASS project, either being driven by them or driving the work in future deliverables.

- *D2.1 – Evacuation Process* – The work in this deliverable highlighted the need to integrate the evacuation process more effectively, as it identified that evacuation is based on the "even keel" scenario, not a real-world situation with either a fire or flooding. These two events will affect the ability of passengers to reach the Muster Station, move to the Evacuation Station and subsequentially board the LSA. Moreover, since evacuation comprises mustering and abandonment, a similar integrated approach needs to be followed concerning the process itself, aimed at gaining considerable time by merging these two elements into one continuous process.
- *D2.2 – Mission and Operational KPIs* – The KPIs that have been identified in this deliverable drive the need for developing new ideas, as they require a step change in performance, which can only be achieved by a step change in design. This is due to that current designs normally are extensions of current designs with incremental changes in performance.
- *D2.3 – SafePASS Personas and scenarios of use* – The user requirements that have been derived from the Description of Action, the best practices, tools and gaps, the mission and operational requirements and the stakeholder workshops and surveys serve as the basis for turning the user needs into functional requirements of the system and the future LSAs &PSEs. The future requirements for LSAs & PSEs are cross-correlated with the user requirements of D2.3.

- *D3.4, D3.5, D3.6, D3.7 – Concept & Prototypes – Future LSA & PSE* – The Requirements from deliverable D3.2 form the foundation of the designs that will be generated in these deliverables. They will capture the step change in design by generating a number of concepts, of which the most appropriate will be developed into prototypes and/or models for testing and evaluation.
- *D3.8 – Model Testing* – The work that is undertaken in this deliverable will give an understanding of how LSA can perform in different locations on the vessel and in different scenarios – Fire and Flooding.
- *D9.7 – IMO Recommendations* – This deliverable will take the Requirements that have been developed in D3.2, along with the experience gained by developing the concepts and prototype LSA and PSE and the tank testing of the models to generate a complete set of Future State requirements, which look at the Function and performance of the Equipment itself and how it integrates (performs) with the vessel I different scenarios.

3. Information Gathering

The sources for the background information that has been used to generate the Future Requirements for LSA & PSE has been compiled from SMEs and the work already completed within the SafePASS. These are:

- On Site Questionnaire - RCCL Jewel of the Seas (JoS)
- WP3 Workshop, MSRC, Glasgow
- Online Questionnaire – Future LSA

The outputs from the JoS Questionnaire and the WP3 Workshop are captured in D3.2 and are summarised in the following section. The outputs from the online Questionnaire have been circulated within the WP3 members and are formally documented in this report.

In order to capture a draft of the Future Requirements, the Design Criteria Prioritisation matrix was used. A copy of the matrix is detailed in Annex 3. It was used initially in a Brainstorming environment by the OEMs to gather requirements for the following types of equipment:

- PSE
- Softshell LSA (inflatable LSA)
- Hardshell LSA (Rigid Hull LSA)

Once a draft set of requirements had been compiled using the outputs from the Questionnaires and Workshop, these were reviewed by the rest of the members of WP3, for comment and any additional requirements.

The draft requirements were expanded to map out the Function that requirements would have to deliver, along with initial specific Performance criteria. This follows the GBS approach of the LSA Code that is currently underway at IMO, by setting a Function that is required and then a benchmark Performance requirement, without being prescriptive as to what the design should ultimately look like. The intent behind the Goal-Based approach is to allow freedom to develop novel solutions, while also demonstrating that the solution is at least equally as safe as the regular lifeboat or MES.

3.1 RCCL JoS Questionnaire

During the Kick of Meeting, KoM in Athens on 10th and 11th September 2019, it was identified that it would be extremely beneficial for the Team to follow an Evacuation Drill onboard an in-service vessel. RCCL offered the Consortium the opportunity to be onboard Jewel of the Seas (JoS, Figure 20), during its routine evacuation drill scheduled for late November whilst in Italy.

Figure 20: RCCL – Jewel of the Seas

The Consortium quickly pulled together a Team who took the opportunity to follow the exercise onboard and question the crew regarding their involvement and thoughts regarding the LSA installed onboard.

The following information details the planned schedule of events.

- RCCL Jewel of the Seas visit
- 22-23rd November 2019
- Naples and Civitavecchia

The Agenda of the on-board drills and meetings are presented in D3.1 Annex 1.

The consortium team members that participated in this activity were representatives from NTUA (Project Management and Naval Architecture and Marine Engineering), Survitec (LSA and PSE expert), Seability (Marine Research), Telesto (ICT and smart technologies), MSRC (Maritime Safety Research Centre), RCCL (cruise line operations and safety management), and Trinity College (Community of Practices, Ethics and Social Behaviour).

22nd November – Civitavecchia, Italy

The first day consisted of a short workshop focusing on the questionnaire. It started with a training from Trinity College Dublin (Ethics Manager), regarding best practices for conducting a survey. This covered ethics, questioning technique and etiquette. The questionnaire was then refined, improving the clarity, reducing the volume of questions and wording of the questions.

The project objectives and the scope of the survey was presented to key RCCL crew staff i.e. the captain, the staff captain, the chief engineer and the hotel director.

RCCL then identified members of the marine crew and hotel staff who could take part in the questionnaire, so that a full range of the emergency crew positions were

covered. The team made a decision to use a facilitated questionnaire approach, due to the Leadtime frame for compiling and disseminating information, along with the windows of opportunity to interview the crew who were still on duty.

The research group were able to attend the "Pre-departure Safety Training" for crew, providing a valuable insight and user perspective on the current situation for basic safety training. The group also witnessed a full vessel muster drill, gaining passenger perspective of the muster process, whilst also being able to question crew during the drill.

23rd November – Naples, Italy

The consortium members observed a Crew drill. This drill is part of the training schedule that RCCL have developed. The scenario begins with a missing item, escalating to a fire, with the lifeboat stations made ready, but not deployed. The research group were able to witness all areas and procedures of the drill, including initiation of alarm signals, emergency control centre, evacuation control room, mobilization of firefighting teams, bridge general command, closing of watertight doors and mobilization of lifeboat teams. During the drill, the consortium members were able to follow the crew personnel, to monitor their actions, the steps followed, the command chain and role assignments and interact with the persons participating in the drill.

The questionnaire, available to view in D3.1 Annex 2, resulted in the raw data (1), which has been collated to produce general trends. The data captured is qualitative, due to the style and delivery of the Questionnaire. This is more accurate and of better quality than a desk top research exercise, even though the results will require additional effort to analyse. Identifying needs and gaps of the market has been possible, as well as special needs that could be applied using smart innovative technologies have been captured.

The representative crew staff participated in the survey. It has to be noted that each of the crew members have also an emergency role.

The direct access to such a wide range of crew members on board of RCCL cruise ship, in real operational conditions during and after an evacuation drill, exercises and crew safety training, was the first activity in the requirements capturing phase. This activity also initiated the establishment of the SafePASS community of practices, which is a crucial step towards understanding the real operational needs, emergency procedures and possible gaps on large passenger ships.

3.2 WP3 Workshop

The Workshop, hosted by MSRC in Glasgow, provided the opportunity for members of the Consortium and additional guests from key stakeholders to provide input into the direction and design of future LSA (Life Saving Appliances) and PSE (Personal Survival Equipment). The direction and design will be driven by the findings of what

the Emerging Needs are perceived to be, what are the potential Future Requirements and how Smart Technology can be integrated, so as to improve the Evacuation process for all participants, reducing the risks involved, while improving the efficiency and effectiveness.

During the two days of the Workshop, a number of interactive exercises, involving all the participants, looked at the Emerging Needs, Smart Technology Application and the possible Future Requirements. In order to encourage Innovation in the way of thinking of the participants, a number of exercises focused on Creative Thinking, rather than the day-to-day Reasoned Thinking. This included an extensive Brainstorming Exercise and then an Exercise in creating a vision of what LSA and PSE would be expected to be like in 10 years' time. In addition, a live Survey was carried out by all attendees, looking at how Smart technology can affect and benefit LSA and PSE.

The members of the Consortium that were present for the workshop provided a wide range of knowledge, ideas and expertise, as they consisted of OEMs, Class Societies, Owners, Naval Architects, Crowd Movement specialists, IoT and Connectivity specialists. In addition, representatives from Flag, EMSA and Owners that were attending the Workshop provided their input.

The results from the survey completed onboard RCCL Jewel of the Seas cruise ship were reviewed, so as to give guidance on possible Emerging Needs. The key findings were that the main concerns or issues noted were regarding PSE - Fitment (comfort, size, ease of donning, bulk). A two-edge sword was also noted from the feedback from the Crew, as Technology was seen as probably providing benefits, but also at the same time providing the opportunity to introduce reliability issues. Regarding LSA, it was noted that Ease of Use and Reliability were seen as the key issues, while also improving the deployment sequence of equipment by reducing crew actions or increasing automation.

During the Workshop, the Brainstorm exercise generated ideas and guidance on the Emerging needs of LSA and PSE. One of the key issues that the exercise highlighted was that one size of LSA and PSE does not fit all. With the wide range of demographics and mobility being onboard large passenger vessels, there was concern that the Safety Equipment may not be as effective as it could be. It was highlighted that increased functionality of the equipment along with reliability would ease those concerns. Training was also noted as a Need that could be improved, as improving the delivery of the Training by means of new methods (e.g. VR, AR etc.) would increase Crew effectiveness.

The feedback regarding the report on Smart Technology clearly pointed out that, by introducing the appropriate technology, the ability to locate, manage and track PAX during an Evacuation would be greatly improved, ensuring that the whole process is carried out as efficiently and effectively as possible. The availability of Real-Time data for those managing the evacuation will also be of benefit. Linking the Smart Technology between the PSE, LSA and vessel in distress allows the real-time tracking

of situation and allows the crew to make informed decisions on the evacuation (evacuations routings, equipment capacity etc.) of the vessel.

In ten-year time, the Workshop participants could see LSA ad PSE that was integrated seamlessly into the vessel design and that the equipment would be efficient to be used by a wide range of demographics onboard and their respective mobility capabilities. The whole evacuation process would be more efficient and reliable, as Technology will have been integrated into the equipment, allowing for real-time management of the process. In addition, the human element and its associated risks will have been introduced as much as practical, as the Equipment will be more Automated to deploy and board.

Overall, the Workshop has provided a clear understanding of the needs and concerns of the LSA and PSE stakeholders and how these issues may be resolved, by providing directions and guidance on what the Safety Equipment needs to be in the future.

3.3 Future LSA & PSE Questionnaire

In order to gather end-user and stakeholder feedback and the direction that they believe future LSA and PSE should move in, an Online Questionnaire was developed. It was circulated amongst the Consortium members for their input, along with a number of knowledgeable external Stakeholders.

The full Questionnaire is detailed in D3.1 WP3 Workshop Report, Annex 5. The questionnaire was designed so as to give prompt feedback, which could be readily analysed, while also providing the participants an opportunity to detail any additional thoughts or comments.

In total, 147 Questionnaires were completed, with the input from a broad spectrum of roles and knowledge. The summary of the results is reviewed below, with the full results detailed in Annex 2.

3.3.1 Future LSA & PSE Questionnaire Results Summary

The SafePASS 2020 stakeholder survey was completed on the 6th March 2020, with over 150 personnel taking part. The survey, in the form of a e-questionnaire, aimed to ascertain the future requirements of the LSA and PSE. Several sections in the questionnaire gave space for additional comments, prompting a clearer insight into the vision for future requirements. The summary below has been split into two sections regarding LSA and PSE, with the results split further into perceived Importance and perceived Performance.

3.3.1.1 Future LSA – Key Results

The summary of the results of the Questionnaire for LSA Important Features & Performance are detailed in table 1 and 2.

Features in order of importance:

Simple to Deploy	Very Important	85.99%
Location Technology	Very Important	71.97%
Simplified entry	Very Important	70.6%

Features in order of Performance

Capacity	Good	55.41%
Provisions/Additional Equipment	Good	49.04%
Function Performance	Good	43.95%

Table 1: Questionnaire Results – LSA Importance

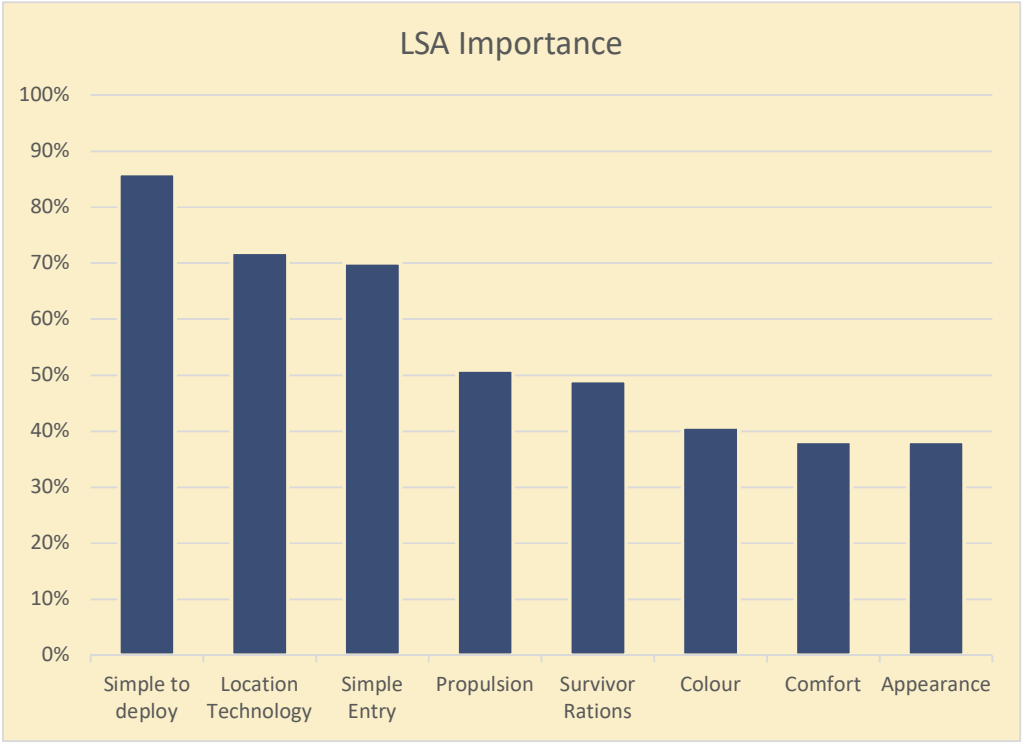
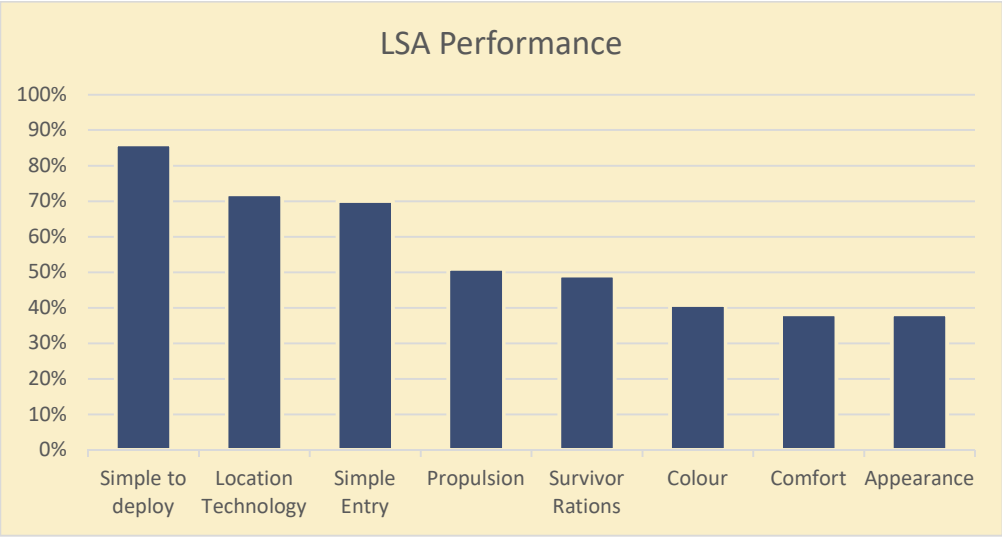


Table 2: Questionnaire Results – LSA Performance



Future LSA design must:

- reduce complexity to a minimum for all aspects of LSA making them more intuitive and user friendly;
- increase reliability of electrical and mechanical equipment;
- reduce incorrect use and human error.

The use of "location technology" as standard would be a big bonus for search and rescue, as well as the potential to "live" track passengers aboard vessels during emergencies, that could be vital for enabling direct location of any passengers that may be lost / injured.

Consideration should be given to improving Lifeboat design, where current seating is inadequate for increasing population weight and there is little consideration for wheelchair or stretcher location. Providing better access into lifeboats and seating and novel design could give better flexibility of use, improve lifeboat mobility and allow crew to move around more freely.

3.3.1.2 Future PSE – Key Results

The summary of the results of the Questionnaire for PSE Important Features & Performance are detailed in table 3 and 4.

Features in order of importance:

Prevention from drowning	Very Important	84.04%
Prevention from hypothermia	Very Important	63.69%

Visibility	Very Important	62.42%
Features in order of Performance		
Location aid	Good	55.41%
Ease of use	Good	52.23%
Function Performance	Good	51.59%

Lifejackets are the last resort as such PSE design must:

- be intuitive in design;
- fit securely;
- perform as intended whatever the conditions.

In addition to the primary function of PSE to prevent drowning, consideration should be given to the prevention of hypothermia, which is most effective during dry shod evacuation. PSE should include provision for electronic or passive devices (such as GPS /AIS) for tracking.

Although issues with PSE do exist, these are considered “very rare”. The questionnaire did not provide details on whether these rare issues affecting function or performance or even if they needed improvement.

In order to further future design and fully address all user group requirements, a complete understanding of current issues, encompassing the full lifecycle i.e. training, retrieval prior to use, muster stations, abandonment, use and entering and habitation in LSA must be captured, so as to ensure that sufficient detail is provided within the statement of requirements.

3.3.1 Future LSA & PSE Questionnaire Discussion

From the feedback, it is clear that regardless of whether it is LSA or PSE equipment, the simplicity is the key. Passenger and Crew obviously do not wish to have to be carrying out a series of operations, to don a lifejacket or to launch, board, evacuate and escape in the LSA in a crisis situation. The lower the quantity of actions and the more intuitive they are, the more confident the users will feel in using that equipment. In addition, the reduced quantity of actions and being intuitive means that training would normally be easier and more effective, as it is more likely to be retained by the trainee.

The other trend from the results is that the end users would want the equipment to be reliable, meaning that it performs exactly as intended when it is needed. This covers the mechanical and electrical components on LSA through to the PSE working

in the event a person is in the water, while also being comfortable to wear for an extended period in the LSA.

If the equipment is to "perform as intended", then there would be an expectation that the equipment will work in the sea state conditions on the day of the emergency. This points to increasing and standardising the performance envelope for large passenger vessels LSA and PSE. An example where a higher performance standard is normally used is for equipment associated with Offshore Oil & Gas Safety equipment.

Other key points highlighted by the Questionnaire are:

- Design equipment to be used by all demographics and mobilities onboard, including casualties in stretchers – whether it is boarding or seating space.
- Revise the design of equipment to accommodate the new "size" of persons onboard large passenger vessels.
- Allow the equipment to incorporate SMART technology.

Table 3: Questionnaire Results – PSE Importance

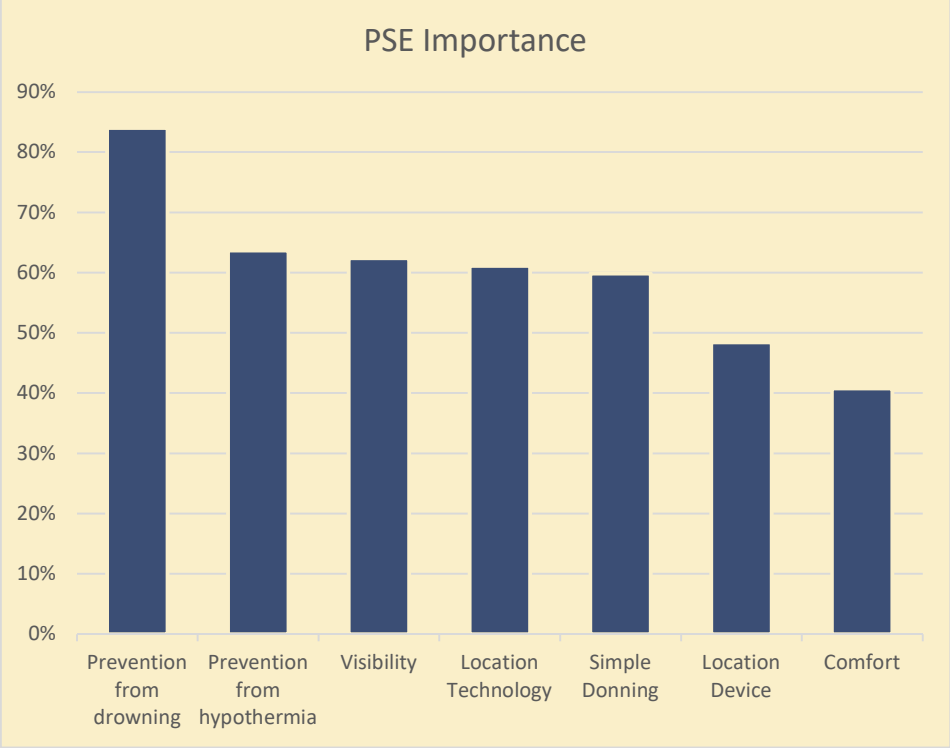
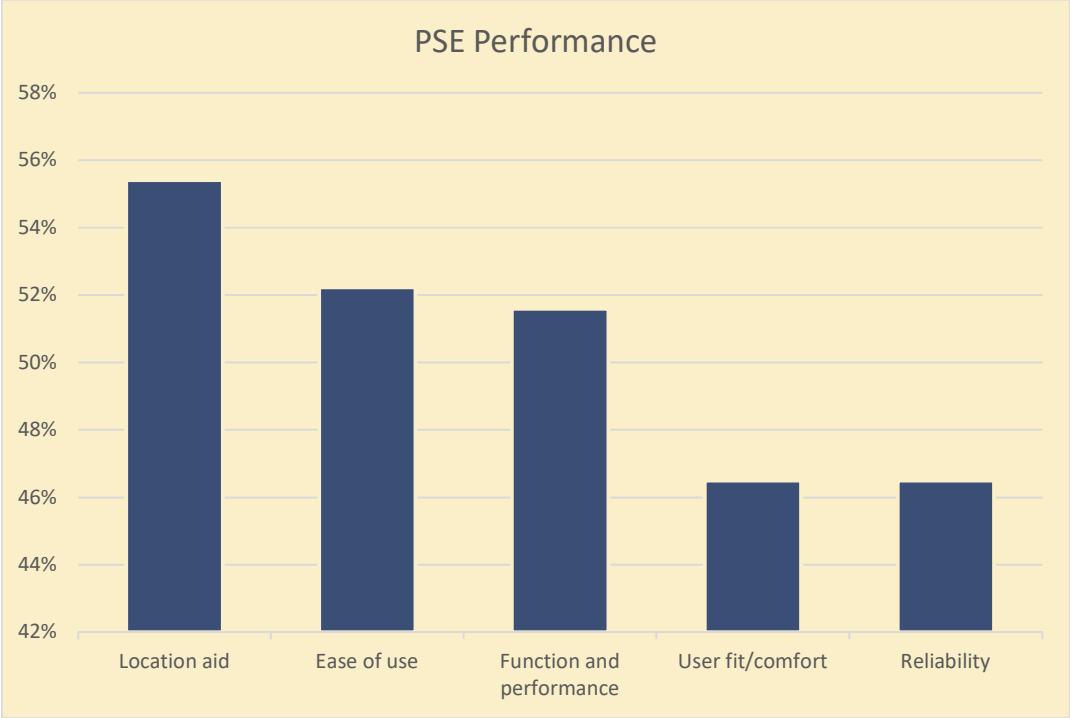


Table 4: Questionnaire Results – PSE Performance



4. PSE – Personal Survival Equipment

4.1 Prioritisation Design Criteria Matrix

The results of the workshop and the questionnaire were summarised in the form of Must, Should, Could, enabling the development of the requirements of PSE for further discussion with stakeholders.

The categories are:

- Must – Minimum performance standards
- Should – provides added value for the customer
- Could – nice to have features

4.1.1 MUST

Provide adequate protection from drowning

- Provide protection to the airways and from wave splash.
- Provide an average freeboard of not less than 130mm, individual no less than 120mm (+/-10mm).
- Provide an average face plane angle of not less than 40^{o} from the horizontal, individual not less than 30^{o}.
- Provide an average torso angle of not less 30^{o} from the vertical, individual not less than 20^{o}.
- Buoyancy >150N (graded to size).

Self-right an unconscious person

- Self-right an unconscious person within 5 seconds when tested in accordance with MSC200(80) as amended.

Provided with means of recovery

- Lifting becket, which must withstand a horizontal load of 3200N for 30mins when wet or 2400N for child when wet.
- Shoulder strength test for 30mins of 900N for Adult or 700N for child. (MSC 81(70) as amended).
- Floating buddy line (to have a breaking strain between 750N and 1500N).

Provide in water performance representative of use

- Tested on a minimum of 12 Adult test subjects or a minimum of 9 child test subjects as outlined in MSC 200(80). Testing must be conducted in both swimwear and clothing deemed suitable for heavy weather.
- Available in three sizes, Infant, Child and Adult:

  - Less than 15Kg, 15 - 43Kg, 43Kg+ (c/w optional - Fit chest girth of 1750mm (MSC200(80) - can be catered for with an accessory).
- Must maintain 95% buoyancy over 24hrs when immersed in fresh water.

Be suitable to be worn with or without heavy weather clothing

- Provide the in-water performance representative of use, tested on a minimum of 12 Adult test subjects or a minimum of 9 child test subjects as outlined in MSC 200(80). Testing must be conducted in both swimwear and clothing deemed suitable for heavy weather.

Enable the user to board rescue or survival crafts

- Be able to board a liferaft or a rigid platform with its surface 300 mm above the water surface.
- Be simple to don and adjust securely.
- Be capable of being donned correctly within 1 minute.
- Be a secure fit – ensure adequate protection from drowning following a 1m jump without holding the device.
- Not dislodge or cause harm during a 4.5m jump during which the device maybe held.
- Maintain sufficient protection from drowning (MFB) following the jump test
- Be marked clearly with instructions for use, applicable warnings, conditions of use in particular providing information on compatibility and advise on limitations for use. No language issues ideally use pictograms only.

Provide means of identification night and day

- Be fitted with 400cm^2 of SOLAS approved reflective tape. IMO Res. A.658(16) Annex 2
- Conspicuous colour within the range detailed in ISO12402-7.
- Fitted with a whistle (ISO12402-8) and Light (SOLAS).
- Provide the facility to integrate smart tech and allow its easy upgrading.

Not cause undue restriction to abandonment

- Ensure that the System has high Reliability.
- Comfortable to wear on deck, during recovery or whilst seated in survival craft for at least 24 hrs.
- Reduce chance of lifejacket becoming caught/snagged.
- Should not interfere with other passengers when sitting back to back or against bulkheads.

Not cause injury or harm to the user

- Ensure that the system has high Reliability.
- Where possible, accommodate all demographics and including bariatric, partially sighted and disabled and if possible “live” tested with manikins or selected representative subjects.

- Withstand drop test of 4.5m when jumping into the water with any accessories attached - (MSC 81(70) as amended.

4.1.2 SHOULD

Passenger Safety

- Reduce snagging hazards, e.g. whistle, oral tube.
- Prevent trip hazards.

Crew visibility

- Colour coded lifejackets for crew and passengers e.g. Yellow = Crew, Orange = Passengers.
- Be self-illuminating Day-Glo and Night-Glo.

Storage

- Require minimal storage space.
- Ease

Self-Rescue

- Location device to interact with other “smart technologies”, such as self-guiding evacuation systems.
- Include “homing” device to bring family members together.
- Provide the facility to communicate with the Vessel, providing status information.
- Passive UHF RFID

Haptic, Optic, Acoustic Integration

- Have audio receiving system incorporated in Lifejacket neck area.
- Have Optical display incorporated in Lifejacket neck area.
- Have Haptic system incorporated in Lifejacket neck area.

4.1.3 COULD

Provide protection from wave splash and wind chill

- Be fitted with a Spray hood.
- Be fitted with a thermal hood.
- Some protection from hypothermia and/or be able to regulate thermal control of body temperature.

Secure fitting of lifejacket

- Some form of automatic tensioning of the belt (Inflatable)
- Automatic fit and self-adjusting

Hygienic protection

- Be fitted with Protective replaceable cover.

Inflatable chambers

- If, to have a “smart” inflator for gas inflation system.
- If Lifejacket is inflatable, to be self-inflating or expanding that requires no compressed gas system.

4.2 Design Requirements Discussion

The main requirement of PSE is to provide protection from drowning, by having the ability self-right an unconscious person and keeping the airway clear of the water. The PSE must allow freedom of movement to enable safe rescue or possess a means of retrieval if help is to hand. The PSE must be intuitive to don and be easily adjusted to a firm comfortable fit, even if wearing heavy weather clothing. The PSE must be reliable in use, highly visible in colour and feature reflective tapes, a light and whistle.

The PSE should be compact, so as not to obstruct movement and ensure confidence in use that it will perform as required. All fastenings should not form a snag or trip hazard or endanger the wearer or delay the wearer in transitioning from Muster to LSA.

Additional features that should be considered as part of the design are protection from wave splash and wind chill, Passenger safety, Adequate storage and smart technologies including haptic, optic and acoustic integration. Smart technologies should be integrated in the Design and be activated only when required automatically, with no intervention from passengers or Crew.

Other features that could be included in the design, such as a method to ensure secure fitting, either as an automatic tensioning or fitting system, are Replaceable Hygienic covers and self-expanding chambers that do not rely on compressed gas.

4.3 Performance & Function Requirements

The Function and Performance Requirements are mapped out in Table 6 for PSE.

Table 5: PSE – Functional and Performance Requirements

ID	Functional Requirements	Expected performance	Applicable Requirements	User Requirement ID (Ref D2.3)
PSE01	Provide adequate protection from drowning	Provide protection to the airways and from wave splash. Prevent channelling of water onto the face. Provide an average freeboard of not less than 130mm, individual no less than 120mm (+/- 10mm). Provide an average face plane angle of not less than 40° from the horizontal, individual not less than 30°. Provide an average torso angle of not less 30° from the vertical, individual not less than 20°. Buoyancy >150N (graded to size).	BS EN ISO 12402-3:2006+A1:2010 5.6.1.6 Performance BS EN ISO 12402-9:2006+A1:2011 5.6. Human subject performance test MSC200(80) as amended 2.8.6 Static balance measurements	UR28, UR29, UR30, UR52
PSE02	**Self-right an unconscious person**	Self-right an unconscious person within 5 seconds when tested in accordance with.	ISO 12402-(3):2006+A1:2010ISO 5.6.3.2 When tested in accordance ISO 12402-9:2006, 5.6	UR28, UR49, UR52
PSE03	**Provided with means of recovery**	Lifting becket which must withstand a horizontal load of 3200N for 30mins when wet or 2400N for child when wet.	BS EN ISO 12402-9:2006+A1:2011 5.5.2.4 Lifting loop test 5.5.2.3.2 Horizontal load test	UR28, UR52

		Shoulder strength test for 30mins of 900N for Adult or 700N for child. Floating buddy line (to have a breaking strain between 750N and 1500N).	5.5.2.33 Vertical load test BS EN ISO 12402-8:+A1:2011 5.4 Buddy Line	
PSE04	**Provide in water performance representative of use,**	Tested on a minimum of 12 Adult test subjects or a minimum of 9 child test subjects as outlined in. Testing must be conducted in both swimwear and clothing deemed suitable for heavy weather. Available in three sizes, Infant, Child and Adult: Less than 15Kg, 15 - 43Kg, 43Kg+ Fit chest girth of 1750mm - can be catered for with an accessory. Must maintain 95% buoyancy over 24hrs when immersed in fresh water.	MSC 200(80) 2.7.2 Test subjects 2.9.1 Infant and Child test subjects MSC 207(81) 2.2.1.2 Lifejacket sizes MSC 207(81) 2.2.1.3 Persons of 140K MSC 81(70) as amended 2.2 Buoyancy test	UR28, UR49, UR50, UR52
PSE05	**Be suitable to be worn with or without heavy weather clothing**	Provide the in-water performance representative of use, tested on a minimum of 12 Adult test subjects or a minimum of 9 child test subjects.	MSC 200(80) 2.7.2 Test subjects 2.9.1 Infant and Child test subjects	UR28, UR29, UR30, UR52

PSE06	**Testing must be conducted in both swimwear and clothing deemed suitable for heavy weather**	Provide the in-water performance representative of use.	Clothing defined as: Underwear T-shirt Jumper Jeans Socks Training shoes Offshore Jacket Offshore trousers	UR52, UR53
PSE07	**Enable the user to board rescue or survival crafts**	Be able to board a Liferaft or a rigid platform with its surface 300 mm above the water surface.	MSC 81(70) 2.9.9 Swimming and water emergence test	UR52
PSE08	**Be simple to don and adjust securely**	Be capable of being donned correctly within 1 minute. Be a secure fit – ensure adequate protection from drowning, following a 1m jump without holding the device. Not dislodge or cause harm during a 4.5m jump during which the device maybe held. Maintain sufficient protection from drowning (MFB) following the jump test.	MSC 200(80) 2.7.4.1 Test without instruction 2.7.4.2 Test after instruction MSC 200(80) 2.8.8 Jump and drop test BS EN ISO 12402-3:2006+A1:2010 6 Marking	UR06, UR07, UR49, UR50

		Be marked clearly with instructions for use, applicable warnings, conditions of use, in particular, providing information on compatibility and advise on limitations for use. No language issues ideally use pictograms only.		
PSE09	**Provide means of identification night and day**	Be fitted with 400cm2 of SOLAS approved reflective tape. Conspicuous colour within the range detailed in. Fitted with a whistle (ISO12402-8) Light Provide the facility to integrate smart tech & allow its easy upgrading.	IMO Res. A.658(16) Annex 2 BS EN ISO12402-7:2007+A1:2011 4.3.3 Colour BS EN ISO12402-8:2006+A1:2011 5.2 Whistle MSC 81(70), MSC 200(80) MSC226(82) MSC200(80) 2.8.8 Jump and drop test BS EN ISO12402-9:2006+A1:2011 5.5.3 Rotating shock bin test	UR52, UR54
PSE10	**Not cause undue restriction to abandonment**	Ensure that the System has high Reliability.	BS EN ISO 12402-3:2006+A1:2010 5.6.1.3 Performance	UR49, UR50, UR51, UR52, UR53, UR55

		Comfortable to wear on deck, during recovery or whilst seated in survival craft for at least 24 hrs Reduce chance of lifejacket becoming caught/snagged. Should not interfere with other passengers when sitting back to back or against bulkheads.	5.6.1.4 Performance	
PSE11	**Not cause injury or harm to the user**	Where possible, accommodate all demographics and including bariatric, partially sighted and disabled and if possible "live" tested with manikins or selected representative subjects. Withstand drop test of 4.5m when jumping into the water with any accessories attached.	MSC200(80) 2.8.8 Jump and drop test	UR49, UR50, UR51, UR52, UR55
PSE12	**Passenger Safety**	Reduce snagging hazards e.g. whistle, oral tube. Prevent trip hazards.		UR52
PSE13	**Crew visibility**	Colour coded lifejackets for crew and passengers e.g. Yellow = Crew, Orange = Passengers	BS EN ISO12402-7:2007+A1:2011 4.3.3 Colour MSC 81(70),	UR52

		Be self-illuminating Day-Glo and nightglow.	MSC 200(80) MSC226(82)	
PSE14	**Storage**	Require minimal storage space. Ease of access		UR52, UR55
PSE15	**Self-Rescue**	Location device to interact with other "smart technologies", such as self-guiding evacuation systems. Include "homing" device to bring family members together. Provide the facility to communicate with the Vessel, providing status information. Passive UHF RFID	MSC200(80) 2.8.8 Jump and drop test BS EN ISO12402-9:2006+A1:2011 5.5.3 Rotating shock bin test (Only integration testing and proves not to dislodge or cause harm to the wearer.)	UR04, UR09, UR08, UR10, UR11, UR12, UR13, UR14, UR15, UR16, UR17, UR18, UR56, UR57
PSE16	**Haptic, Optic, Acoustic Integration**	Have audio receiving system incorporated in Lifejacket neck area. Have Optical display incorporated in Lifejacket neck area. Have Haptic system incorporated in Lifejacket neck area.	MSC200(80) 2.8.8 Jump and drop test BS EN ISO12402-9:2006+A1:2011 5.5.3 Rotating shock bin test (Only integration testing and proves not to dislodge or cause harm to the wearer)	UR04, UR09, UR08, UR10, UR11, UR12, UR13, UR14, UR15, UR16, UR17, UR18, UR54, UR56, UR57
PSE17	**Provide protection from**	Be fitted with a Spray hood.	BS EN ISO 12402-8:2006+A1:2011 5.5 Spray hood	UR29, UR30, UR52

	wave splash and wind chill	Be fitted with a thermal hood. Some protection from hypothermia and/or be able to regulate thermal control of body temperature	5.5 Spray hood	
PSE18	**Secure fitting of lifejacket**	Some form of automatic tensioning of the belt (Inflatable)] Automatic fit and self-adjusting		UR52
PSE19	**Hygienic protection**	Be fitted with Protective replaceable cover.		UR49, UR50, UR52, UR53
PSE20	**Inflatable chambers**	Comprises of an inflatable chamber that maybe fitted with a "smart" inflator for gas inflation system. Be a Lifejacket that is self-inflating or expanding and requires no compressed gas system.		UR52

4.3.1 Performance & Function Discussion

The PSE would only be used for a small percentage of the time, with a vast majority of persons evacuating dry-shod into the LSA. The lifejacket would only be required if there is a need to jump overboard or in the unlikely event that they fall out of the LSA. Should this situation arise, the PSE must provide adequate protection from drowning

by self-righting an unconscious person within 5 seconds and meet the requirements outlined in table 4.1.3. There should be no channeling of water into the face, which can be formed by lifejackets with a split front design. This can be achieved with a type of deflector or the addition of a spray hood that could also provide some thermal protection.

The minimum buoyancy should be no less than 150N, graded for size and must maintain 95% of the buoyancy over 24 hours. The size range should be: Adult >40Kg, Child 15-40Kg, Infant <15Kg and Baby. The performance of the PSE must be representative of use. Current testing is conducted in swimming costume only, while future testing must also include clothing suitable for extreme weather conditions defined as: Underwear, T-shirt, Jumper, Jeans, Socks, Training shoes, Offshore Jacket and Offshore trousers. Donning should be simple and intuitive, so that the PSE can be worn and adjusted to a secure comfortable fit within 1 minute, even when wearing Heavy weather clothing.

The PSE should be equipped with a light, whistle and approved reflective tape. Additional reflective tape in a contrasting colour would aid visibility in broken surf, where conventional silver tape becomes less visible.

Storage of PSE should be kept to minimum; with the PSE presented in a manner so as not to hinder retrieval from stowage or cause delay in donning. Donning must be intuitive, non-restrictive or cause a danger to the wearer as a trip or snag hazard that would affect the speed of transition from Muster to LSA. Colour coding of the PSE would assist passengers in locating Crew relevant to Muster station and LSA location.

Incorporating smart technology provides “live” updates during evacuation, enable self-guidance and location detection. This would need to be an automated operation, activated as part of the donning process without the intervention of passenger or Crew, which would increase evacuation times.

Additional features that could be added to PSEs are:

- Hygienic protection with replaceable covers or manufactured PSEs, using antibacterial fabrics to reduce odors, staining and resist bacterial growth.
- Some protection from hypothermia and/or be able to regulate thermal control of body temperature. This would be part of a modular system that can be added for vessels operating in colder climates.
- Some form of automatic tensioning of the belt (Inflatable), possibly only becoming active when immersed in water.
- Automatic fit and self-adjusting. Standard procedure for abandonment is to have the belt set to the maximum width. The alternative would be a ratchet system that retracts the belt to a secure fit.
- Self-inflating or expanding lifejacket that requires no compressed gas system.

5. Softshell LSA – Softshell Lifesaving Appliances

5.1 Prioritisation Design Criteria Matrix

Following on from the work completed at the Glasgow WP3 Workshop and the Questionnaires, the initial draft of the Design Criteria for the Softshell (inflatable) LSA were generated by SMEs within Survitec and was reviewed by Viking, prior to it being critiqued by the rest of the members of the WP3 Workstream.

The categories are:

- Must – Minimum performance standards
- Should – provides added value for the customer
- Could – nice to have features

5.1.1 MUST

The product *must* meet the following criteria:

- Deploy by one person from a suitable location using minimum number of actions.
- Location of the system should give easy access to the passengers from the Muster areas.
- Passengers must have direct access to the LSA and be protected from the weather conditions.
- Be able to evacuate disable/elderly/mobility impaired and excess of weight persons/children/infants wearing a lifejacket.
- Craft canopy to be in conspicuous color.
- Provide sufficient space for passenger wearing heavy weather clothing and PSE.
- Must reduce the possibility of human error during install maintenance, training and use.
- Allow the transfer of persons in a stretcher or wheelchair.
- Have a reliability plan to demonstrate the performance, including risk analysis – Ensure that the system has high reliability.
- Escape and make way in sea state associated to Beaufort 7.
- Be able to evacuate the full capacity in less than 30 mins (similar to ISO/CD 16707).
- Evacuation instructions must not be language dependent.
- Must be resistant to the marine environment.
- Be functional with the maximum damage conditions of the ship.
- Easy access for all demographics in the worst-case list and trim condition for the vessel.

- Have a safe and dry boarding passage.
- Be designed for average passenger weight of 82.5 kg.
- Facilities to provide survival for at least 24 hrs. & extended water-making.
- Operable independently of ship's power supplies.
- Provide means of external communication to alert and guide ships/ aircraft.
- Habitable environment for all persons.
- Protection against hypothermia (death from hypothermia).
- Protection against hyperthermia (death from hyperthermia).
- Be designed to prevent injuries.
- Hands on training equipment must be available.
- Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).

5.1.2 SHOULD

The product *should* meet these criteria:

- Deployment sequence to be automated as far as practical.
- Require the minimum of maintenance.
- Include a System Status monitoring system (that can be easily upgraded).
- Should be easy to service.
- Have technology for electronic counting system and monitoring of the evacuation which is interactive with the vessel.
- Require the minimum of crew training.
- Allow for more frequent offline training.
- Should include up-to-date location devices.
- System should be easy to maintain onboard (reducing crew effort).
- Keep life cycle costs to a minimum.
- Give enough comfort to passengers.
- Dedicated space for persons in need of assistance.
- Integrated as far as practical into vessel so as to provide scope for multi-use and flexible vessel layouts.
- When stowed, “advertise” what it does.

5.1.3 COULD

The *product* could meet these criteria:

- Be remotely deployed from the bridge by one person.
- Operate as emergency exit whilst in port.
- Up-to-date Navigation aids.
- Evacuation to minimize stress to the PAX during process as far possible.
- Integrate with the SafePASS smart phone application.

- Passengers to be educated & made aware of the system and how to use.

5.2 Design Requirements Discussion

The requirements were generated collectively by SMEs from the OEMs and drawing on the feedback from the Workshop and Questionnaires.

The specific requirements drawn from WP3 are:

- The LSA must be inclusive of all demographics and mobilities onboard a large passenger vessel and demonstrate their function with that demographic.
- The validation should be more realistic to actual situations or a better understanding of how the System performs by:
  - People wearing heavy weather clothing;
  - Increasing the space in the survival craft to be more appropriate for the wide demographic including space for mobility impaired;
  - Understanding the impact in damage conditions for boarding persons.
- The System should be more interactive with the vessel and the passengers with SMART technology.
- Adopt more up-to-date training techniques to improve confidence and competence.

The other requirements are generated by the knowledge of the product sectors and are a mix of minimum characteristics and the possible short comings in the testing and validation requirements.

5.3 Function & performance Requirements

The Design Criteria that have been captured in the matrix are a statement of the Expected Performance of the equipment.

In order to measure and verify how effective the equipment is, it has to meet the Specific Performance Requirements, which have been developed in Table 7.

Table 6: Softshell LSA – Functional & Performance Requirements

ID	Functional Requirements	Expected Performance	Specific Performance Requirements	User Requirement ID (Ref D2.3)
LSA SOFT01	*Comfort*	Passengers must have direct access to the LSA and be protected from the weather conditions	Demonstrate that: - there are no obstructions on the route to and into the LSA	UR08, UR19, UR23, UR28, UR39, UR40, UR45

		- the route to the LSA is covered as far as practical.	
		- after entering the LSA station, the persons are protected from the external environment.	
LSA SOFT02	Provide sufficient space for all passengers, wearing heavy weather clothing and PSE, and be seated safely and comfortably for the expected time to recovery.	Demonstrate by means of a seating tests, that there is sufficient space in the craft for the specified normal capacity. All persons must be wearing a recognised lifejacket/PSE. All persons should be wearing "heavy weather" clothing, as per PSE requirements. Clothing defined as: - Underwear - T-shirt - Jumper - Jeans - Socks - Training shoes - Offshore Jacket - Offshore trousers	UR23, UR28, UR35, UR39, UR40, UR44, UR45, UR48
		Demonstrate that the seats are sufficiently strong to support persons weighing up to 100 kg.	
LSA SOFT03	Allow the transfer of mobility impaired persons and provide appropriate space in the survival craft.	Confirm the max stretcher capacity of the craft and the impact, if any, on overall normal capacity. Stretcher dimensions to be 2130mm Long by 610mm Max Width.	UR23, UR28, UR39, UR44, UR48
		2130 x 610 max width	
		If there are dedicated seats for mobility impaired persons, demonstrate that they are accessible, and secure with appropriate restraints.	
LSA SOFT04	Be designed for average passenger	All testing and verification are to be carried out using persons of an average weight of 82.5kg and 510mm	UR40, UR48

	weight of 82.5 kg.	shoulder width or ballast equivalents to 82.5kg per person.	
LSA SOFT05	Provide a habitable environment for all persons, providing prevention against hypothermia and hyperthermia.	The Survival craft must insulate the persons onboard from the cooling effects on body temperature of seawater temperature.	UR40, UR47, UR48
		The Survival Craft must provide protection from the actions of wave and rain, and if fitted with access doorways, these must be closed and opened from the inside and outside using a gloved hand. These actions must be able of be completed with a fully occupied craft.	
		The Survival Craft must provide a means to ensure that, in any 60-minute period, the CO_2 level within the craft does not exceed 5000ppm, when fully occupied, all weather side doorways/access arrangements are closed or secured and any propulsion units running.	
LSA SOFT06	Provide facilities to provide survival for at least 24 hrs & extended water-making.	Sufficient Food for Survival for 24 hours for all persons onboard the Survival Craft must be provided. The Food ration should be packaged so that it can easily managed and distributed.	UR40, UR48
		There must be provision of 0.5L of fresh water per person per 24-hour period available. If mechanically generated, then suitable storage must be provided, and a backup arrangement means of	

			generating fresh water must be available.	
LSA SOFT07	*Integrity*	Craft canopy should be in conspicuous colour.	Conspicuous colour within the range detailed in BS EN ISO12402-7:2007+A1:2011 4.3.3 Colour	UR47
LSA SOFT08		Provide high reliability to effect evacuation, escape and survival.	Have a Reliability Plan to demonstrate the performance including risk analysis. The following reports are to be generated: - HAZOPS - HAZID - FTA The FTA should demonstrate that the System has a probability of incomplete evacuation and escape that is ALARP.	UR31, UR32, UR33, UR46
			Demonstrate through an appropriate number of full System Tests that the System can usefully deploy and effect escape within the prescribed timeline.	UR35, UR36, UR37, UR41, UR42, UR43, UR44
LSA SOFT09		Provide Evacuation Instructions which are not language dependent.	All labelling and instructions must be in pictogram format. No text to be used.	UR05, UR06, UR07, UR15, UR45, UR56, UR57
LSA SOFT10		The System must be resistant to the marine environment.	All components must be suitable for use in a marine environment and not deteriorate between services. All metal components to be marine grade or suitably protected. All materials to conform with ISO142, ISO2411, ISO4892-4, ISO4675, ISO7854, ISO6065, ISO5978, ISO3011, Inflation System if fitted to comply with ISO 15738	UR29, UR30, UR46, UR47
LSA SOFT11		The System must be	ALARP study (and demonstration if necessary)	UR05, UR06, UR07, UR15,

		designed so as to reduce ALARP of human error during install, maintenance, training and use.	to be carried out to validate that the System has been designed to reduce the opportunity for human error during install, maintenance training and use.	UR31, UR32, UR33, UR46, UR41, UR35, UR36, UR37, UR42, UR43, UR44
LSA SOFT12		Provide a safe environment when damaged.	Demonstrate separately that with each of the key chambers damaged, there is sufficient freeboard to maintain the safety of the persons onboard.	UR46, UR47
			Demonstrate that if flooded, the craft is stable, and the water can be removed effectively.	
			Demonstrate that if only partially loaded the craft is stable with 50% of persons onboard in one half of the craft.	
LSA SOFT13	*Training*	Training & suitable equipment which is current & appropriate must be available so that crew can train offline without using live equipment.	Training equipment which allows the Crew to simulate frequently the deployment, boarding, craft and escape actions must be available onboard. Training Syllabus's and records must be in place to support the training equipment. Training material to make passengers aware of the equipment must be available.	UR05, UR06, UR07, UR15, UR23, UR28, UR35, UR36, UR37, UR41, UR42, UR43, UR44, UR56, UR57
			Training Syllabus's and records must be in place to support the training equipment.	
			Training material to make passengers aware of the equipment must be available.	
LSA SOFT14	*Function*	Deploy by one person from the bridge or the evacuation station using	Demonstrate by means of deployments - local and remote activation.	UR05, UR06, UR07, UR08, UR35, UR36, UR37, UR42,

	minimum number of actions, automating ALARP the process.		UR43, UR44, UR56, UR57
		Demonstrate the backup actions are effective at deploying the system if necessary.	UR23
		Demonstrate the deployment sequence, if more than one action is unambiguous and cannot be actioned incorrectly.	UR35, UR36, UR37, UR42, UR43, UR44
		Validate that the number of actions to deploy is ALARP.	UR31, UR32, UR33, UR35, UR36, UR37, UR42, UR43, UR44
LSA SOFT15	Have the ability to deploy, board & provide for escape from the vessel in distress in less than 30 mins, independent of the vessels power supply.	Demonstrate by means of a full test - the deployment, evacuation and escape can be achieved with 30 mins.	UR23, UR42, UR43, UR45, UR48
		It should be demonstrated that when persons of reduced mobility are evacuated, it does not adversely affect the evacuation rate. Appropriate timings and rates are to be captured, so that the capacity of the system in 30 mins can be determined if a population of 10% of mobility impaired persons is included in the evacuation and escape.	UR18, UR23, UR45, UR48
LSA SOFT16	Be functional with the maximum damage conditions of	Demonstrate that the equipment can be deployed in a combined list & trim angle (combined inclined angle).	UR23, UR29, UR30, UR42, UR43, UR44, UR47

	the ship, and allow effective boarding of all demographics onboard.		
		Demonstrate that the System can be boarded by all types of persons in the combined inclined angle condition.	UR10, UR29, UR30, UR44, UR45
LSA SOFT17	Have dry boarding passage which ALARP reduces injury to persons.	Demonstrate that the Passage does not generate a significant hazard in its minimum and maximum conditions.	UR23
LSA SOFT18	Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).	Demonstrate that the key components of the System operate effectively at ambient temperature.	UR47
		Verify the operation of the equipment at elevated and low temperature, according to where the vessel is to be in service. The temperature to +/- 10^{o}C pf the vessel's operating temperature.	
		Demonstrate or validate that if appropriate, key components are not adversely affected by humidity and condensation.	UR29, UR30
LSA SOFT19	Provide the possibility to board, escape and make way in sea state associated to Beaufort 7.	Validate the operation of the equipment in a 4.5m Hs and 30 kts (55 km/h) wind. This may be means of modelling/analysis and real-world empirical data.	UR29, UR30, UR42, UR43, UR44, UR45, UR47
LSA SOFT20	Have technology for electronic counting system	The LSA should be fitted with a system to count the number of persons, irrespective of mobility, who enter the passage/board the craft. This	UR02, UR04, UR10, UR13, UR14, UR18, UR41, UR56, UR57

	and monitoring of the evacuation, which is interactive with the vessel, (including SafePASS Smart technology).	System should display this information locally in the LSA station and in the Emergency Control Centre.	
		The operation of the System should be demonstrated during a simulated evacuation.	UR23
LSA SOFT21	Integrated as far as practical into vessel so as to provide scope for multi-use and flexible vessel layouts	The System is to be designed so that it has a configuration which can installed in a position other than an open boat deck.	UR38, UR39, UR34
		The System is to be designed so that it can be installed in a Muster Area, to allow direct entry into the LSA and ensure persons with reduced mobility are not delayed in the evacuation.	UR08, UR38, UR39, UR34
LSA SOFT22	When stowed, "advertise" what it does.	Provide appropriate details of the System when stored onboard by means of markings, pictograms, video screens or suitable media to explain the function, basic operation and capability of the novel LSA.	UR05, UR06, UR07, UR38, UR56, UR57
LSA SOFT23	As far as practical in the event of sinking, provide means of floating free.	Document the sequence of events that will allow the equipment to float free of its storage arrangement in the event of a catastrophic sinking.	UR41, UR47

LSA SOFT24	Be either self-righting or provide means of boarding and protection if inverted.	If craft is self-righting, then this should be demonstrated by inverting the craft on open water and the craft righting itself without assistance (including wind or wave) If craft is not self-righting, then it must be fitted with a means of boarding from the water, be fitted with suitable hand holds and fitted with a means of providing shelter from the weather. The means of protection must be a highly visible colour.	UR47
LSA SOFT25	Include a System Status monitoring system (that can be easily upgraded).	The LSA should be fitted with a monitoring system that captures data on the status of critical components in the System while it is stored e.g. cylinder pressures. Critical components are ones which in the event of not being fully functional/operational could result in a delayed or failed evacuation or escape.	UR04, UR05, UR06, UR07, UR08, UR09, UR13, UR14, UR15, UR18, UR41, UR56, UR57

5.4 Function Performance Discussion

The generation of the Performance requirements has highlighted several key potential requirements not currently covered through existing requirements. These requirements are reviewed below.

The provision of space in the craft for all persons wearing appropriate heavy weather clothing allows for the revised size of persons from the increased physical size and the bulk of wearing suitable clothing to keep warm. The requirement also makes an attempt to define the heavy weather clothing, although this may be argued to be regionalised, i.e. less clothing required in the Mediterranean when compared to Northern Europe. As vessels normally operate worldwide, they will usually consider the worst-case clothing for their agreed areas of operation.

At present, within the LSA requirements, there is no dedicated space for persons in stretchers or to define how the loading of stretchers will affect the overall capacity of the craft. By specifying a particular stretcher size, it would allow modelling of space in a craft and the impact on capacity.

Within the survival craft, there is no requirement to have areas dedicated to mobility impaired persons either with restraints or so they can be assisted. The recommendation going forward is to include some arrangements to support those persons.

Ventilation is currently being debated at length at IMO DE, so ahead of a requirement being agreed, a practical requirement is included for the craft allowing for ventilation using the sheltered side of the craft.

As water is critical for survival, even when compared to food, the introduction of a means of generating fresh water, in addition to or instead of water sachets, ensures that fresh water is available until rescue, no matter how long it takes.

By being more rigorous in the development stage of the LSA analysing the Reliability and Demonstration of the System, this inevitably leads to a more reliable product being introduced to service. This type of thorough analysis is currently carried out in the Aerospace and Oil & Gas sectors, so these more critical appraisals should be incorporated into Large Passenger Vessels.

The Large Passenger Vessel sector can improve the overall level of safety by adopting similar practices to those in daily use in the Offshore sector to ensure that, during training and maintenance, the human error is ALARP.

Regarding training, the provisions of simulators onboard or similar equipment which allows the crew to drill without using the live equipment reduces the risk to them and of the equipment being accidentally damaged. It also allows for more frequent training and for training for failure, increasing crew competency and confidence.

With the wide range of demographics onboard large passenger vessels, understanding the impact on the actual boarding or evacuation rate into the LSA equipment is required to be quantified, as in certain circumstances, this may increase the duration to an unacceptable time.

Understanding how easy it is for that wide demographic of passengers and crew to board the System when the vessel is inclined would also need to be quantified, so that any significant impact of evacuation rates is understood.

With the increasing beam of vessels and location of LSA being moved more fore and aft to accommodate vessel layouts, the operation of the LSA in its maximum and minimum conditions should be quantified, as this may again significantly impact evacuation rates.

At present, LSA is verified in conditions up to a sea state associated with Beaufort 6. The performance should ideally be quantified for conditions above that. This can be done by a combination of real-world testing, modelling and simulation.

The System should be fitted with SMART technology to display locally and in the Emergency Control Room, the current status of the system – deployed, numbers boarded etc. The System would also be fitted with a condition monitoring system, so that preventative maintenance can be completed rather than reactive maintenance.

In order to encourage alternative layouts onboard the vessel, two configurations of the System are to be approved, one configuration which can be positioned on a traditional open boat deck, while the other could be positioned on alternative decks, e.g. behind the sideshell.

The following requirements are as a direct result of outputs from the Workshop and Questionnaires:

- Improved seating space
- Improved training arrangements
- Quantifying the effect of the wide demographic that is onboard a Large Passenger vessel, with the wide age range and mobility
- Introducing SMART Technology at a System level
- Alternative System configurations to encourage alternative layouts

6. Hardshell LSA – Hardshell Life Saving Appliances

6.1 Identifying the Future Requirements

Recalling this deliverable's requirement, this section aims to provide an insight of the current trends of LSA equipment.

For the cruise industry, the main trend is the need and wish for equipment that provide safe means of evacuation for all cruise passengers and crew, with a smaller footprint than currently available.

Furthermore, the trend up to now has shown larger and larger hardshell lifeboat structures to accommodate for the ever increase number of passengers and size of cruise ships. Even though it is reasonable to assume that this stops within given limitations, it has given a primary focus to the LSA providers and industry.

Accommodating and provide evacuation for the total number of POB has been the main focus and driving force behind LSA development over the years, while cruise operators and ship owners have identified the wish for less footprint and space requirement.

Future evacuation to sea-level equipment is assumed to be three-folded:

- Traditional solutions and new builds of large cruise vessels, with traditional hard-shell lifeboats in a variety of sizes;
- Modern focusses solutions on new builds of large cruise vessels, with modern/untraditional (hybrid) lifeboats – Inflatable motor propelled to answer to reduced footprint request;
- Smaller cruise ships for more specialized cruise/expedition experiences. Lifeboats in a smaller number with sizes up to 150 POB and/or other solutions like rafts/RIBS/alternative tenders.

For all three above mentioned areas of future LSA applications, the approach and methodology to generate the Specifications (Performance and Functional Requirements) for Future LSA and PSE concepts and prototypes that are to be developed are discussed in this chapter by addressing safety level as input to guidelines for rules and regulations. By doing this, the Report will map out the draft Requirements (Performance and Functional), which can be used to direct future discussions at IMO on life saving appliances and focus on the known limitations that apply here.

The Requirements that are generated in this report are built on the work, research and feedback that has been collected during the Glasgow Workshop and Report (D3.1) and from the LSA Questionnaires carried out online and onboard RCCL Jewel of the Seas with the key stakeholders, as well as discussions, meetings and work in the reference group working on this work package.

During the working group discussions, it was recalled that the initial EU call was to "radically rethink evacuation from large cruise ships". The working group discussed that the identification Softshell/Hardshell used in the report could limit this way of thinking. For most participants, "hardshell" immediately assumes that there always will be lifeboats onboard a cruise ship and "softshell" indicates the presence of rafts. Especially when one calls for input on features and performance as well as functional requirements, it is noted that all participants think about what there is today and how this can be improved.

Figure 21: Future Lifeboat Design

Even though this works well for the activation of people and receiving feedback the working groups can see, it also limits thinking of something radically new. Especially from an LSA provider point of view, with Viking and Survitec present, main medium-term development focus has been to develop Softshell solutions that can replace hard shell. In this context, one could even argue that focussing on hardshell in this report is taking a step back in evolution.

For the sake of answering the EU call in the best possible way, the working group urges the SAFEPASS project to re-address the radical rethinking in a separate task/brainstorming session. This aims to bring ideas to the table that could provide solutions beyond the medium-term solutions and define work packages for future work.

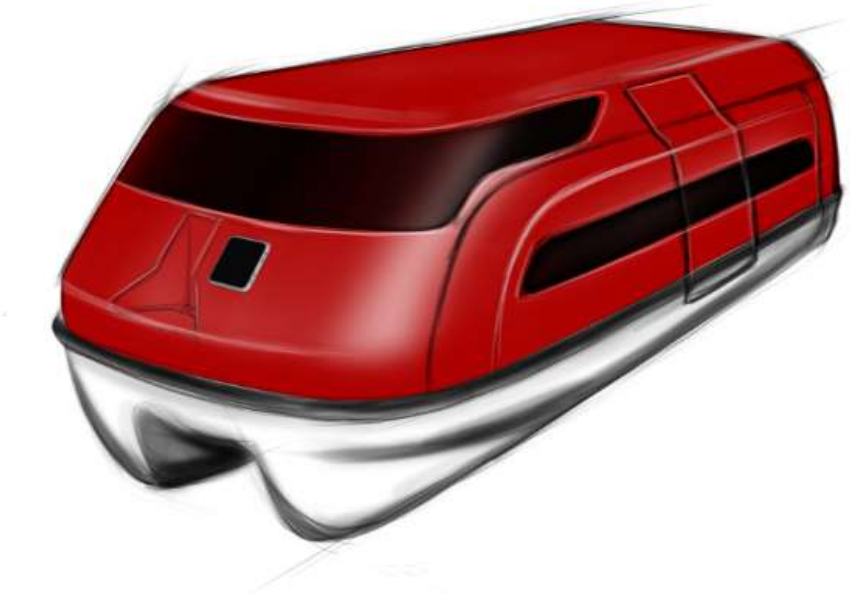


Figure 22: Future Lifeboat Design

6.1.1 Prioritisation Design Criteria Matrix

Based on the input of all participants (app. 60) at the Glasgow workshop in January 2020, all feedback was analysed and categorized.

A Must, Could, Should overview has been provided by the workshop leaders (Survitec) and has been the basis for the work in the working group.

Definitions for hard shell LSA on how to interpret MUST / Could / Should:

Table 7: Must/Should/Could Definitions

MUST = same definition as “Shall” in standards: Indication to strictly follow the requirement in order to conform/comply. Deviation can only be allowed if the alternative is documented by equal/similar safety level.
SHOULD Indication that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.
COULD = same definition as “May” in standards: Indication that a course of action is permissible within the limits of the requirements.

6.1.2 Design Requirements Discussion

The original GLASGOW workshop collected and structured the input in the following result:

Table 8: Must/Should/Could Requirements – Hardshell - Initial Draft

Initial Design Specification Criteria

Fill each box with the requirements for the product. These can be specific or goal based, but beware of scope creep. Undefined or vague criteria often lead to no traction. Or a product that does not fit the user requirements.

MUST

(The product must meet thesecriteria)
Minimum performance standards

Comfort
- Passengers must have direct access to the LSA and be protected from the weather conditions
- Be able to evacuate disable/elderly/mobility impaired and excess of weight persons/children wearing a lifejacket, infants
- Habitable environment for all persons
- Protection against hypothermia (death from hypothermia)
- Provide sufficient space for passenger wearing heavy weather clothing and PSE.

Performance
- Craft canopy should be in conspicuous color
- Allow the transfer of persons in a stretcher or wheelchair
- Must be resistant to the marine environment
- Easy access for all demographics in the worst-case damage condition for the vessel
- Have a safe and dry boarding passage
- Facilities to provide survival for at least 24 hrs & extended water-making
- Operable independently of ship's power supplies
- Include up to date location devices
- Be designed to prevent injuries
- Dedicated space for persons in need of assistance
- Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity)

Functional Requirements
- Deploy by one person from the bridge or the evacuation station using minimum number of actions.
- Deployment sequence to be automated as far as practical
- Location of the system should give easy access to the passengers from the Muster areas in less than 10 mins
- Have a reliability plan to demonstrate the performance including risk analysis – Ensure that the system has high reliability
- Escape and make way in sea state associated to Beaufort 7
- Be able to evacuate the full capacity in less than 30 mins (similar to ISO/CD 16707)
- Instructions must not be language dependent
- Be designed for average passenger weight of 82.5 kg
- System is easy to maintain onboard (reducing crew effort)
- Be easy to service
- Reduce the possibility of human error during install maintenance, training and use
- Hands on training equipment must be available
- Be functional with the maximum damage conditions of the ship
- Provide means of external communication to alert and guide ships/ aircraft

SHOULD

(The product should meet thesecriteria)
Added value for thecustomer
- Require the minimum of maintenance
- Include a System Status monitoring system (that can be easily upgraded)
- Have technology for electronic counting system and monitoring of the evacuation which is interactive with the vessel
- Require the minimum of crew training
- Allow for more frequent offline training
- Keep life cycle costs to a minimum
- Integrate with the SafePASS smart phone application
- Give enough comfort to passengers
- Integrated as far as practical into vessel so as to provide scope for multi use and flexible vessel layouts
- When stowed 'advertise' what it does

COULD

(The product could meet thesecriteria)
The nice to haves
- Be remotely deployed from the bridge by one person
- Operate as emergency exit whilst in port
- Up to date Navigation aids
- Evacuation to minimize stress to the PAX during process as far possible
- Passengers to be educated & made aware of the system and how to use

The MUST section summarises and groups criteria that came to mind upon which hard-shell LSA equipment must meet and resulted in a classification of different priority headings:

- Comfort,
- Performance
- Functional requirements.

Table 9: Must Requirements, Hardshell

MUST

(The product must meet thesecriteria.)

Minimum performance standards

Comfort

- Passengers must have direct access to the LSA and be protected from the weather conditions.
- Be able to evacuate disable/elderly/mobility impaired and excess of weight persons/children wearing a lifejacket, infants.
- Habitable environment for all persons.
- Protection against hypothermia (death from hypothermia).
- Protection against Hyperthermia (death from Hyperthermia).
- Provide sufficient space for passenger wearing heavy weather clothing and PSE.

Performance

- Craft canopy should be in conspicuous color.
- Allow the transfer of persons in a stretcher or wheelchair.
- Must be resistant to the marine environment.
- Easy access for all demographics in the worst-case damage condition for the vessel.
- Have a safe and dry boarding passage.
- Facilities to provide survival for at least 24 hrs & extended water-making.
- Operable independently of ship's power supplies.
- Be designed to prevent injuries.
- Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).

Functional Requirements

- Deploy by one person from the bridge or the evacuation station using minimum number of actions.
- Location of the system should give easy access to the passengers from the Muster areas in less than 10 mins.
- Have a reliability plan to demonstrate the performance including risk analysis – Ensure that the system has high reliability.
- Escape and make way in sea state associated to Beaufort 7.
- Be able to evacuate the full capacity in less than 30 mins (similar to ISO/CD 16707).
- Instructions must not be language dependent.
- Be designed for average passenger weight of 82.5 kg.
- Reduce the possibility of human error during install maintenance, training and use.
- Hands-on training equipment must be available.
- Be functional with the maximum damage conditions of the ship.
- Provide means of external communication to alert and guide ships/ aircraft.

The classification (Comfort, Performance, Function) was disregarded for the other sections:

Table 10: Should Requirements – Hardshell Requirements

SHOULD

(The product should meet thesecriteria.)

Added value for thecustomer

- Require the minimum of maintenance.
- Include a System Status monitoring system (that can be easily upgraded).
- Have technology for electronic counting system and monitoring of the evacuation, which is interactive with the vessel.
- Require the minimum of crew training.
- Allow for more frequent offline training.
- Be easy to service.
- System is easy to maintain onboard (reducing crew effort).
- Dedicated space for persons in need of assistance.
- Keep life cycle costs to a minimum.
- Include up-to-date location devices.
- Deployment sequence to be automated as far as practical.
- Give enough comfort to passengers.
- Integrated as far as practical into vessel, so as to provide scope for multi-use and flexible vessel layouts.
- When stowed, “advertise” what it does.

Table 11: Could Requirements – Hardshell Requirements

COULD

(The product could meet thesecriteria.)

The nice to haves

- Be remotely deployed from the bridge by one person.
- Operate as emergency exit whilst in port.
- Up-to-date Navigation aids.
- Integrate with the SafePASS smart phone application.
- Evacuation to minimize stress to the PAX during process as far possible.
- Passengers to be educated & made aware of the system and how to use.

During the meetings and pre meeting preparations, it was decided to group some of the statements and typical wording into groups. Words like “easy to use”, “easy to access” etc. were regrouped and reworded into statements like ALARP deployment or ALARP probability for injury.

Analyzing the requirements from the groups also caused goal-based guidelines. For this purpose, the SHOULD section was suggested to relate to other (offshore) way of

thinking standardization solutions. Performance safety critical areas: Passenger safety (incl. comfort), Structural integrity of LSA and Sea keeping/no collision sail away are three headings upon which future requirements are suggested to relate to and the resulting classification of the performance and functional requirements. The next section will start with the working groups summary of this regrouped way of thinking.

6.1.3 Performance & Function Requirements

Table 12: Could Requirements – Hardshell Requirements – Must/Could/Should

MUST

(The product must meet thesecriteria.)

Minimum performance standards

a. COMPLY to performance standard safety levels for:
    i. Passenger safety (comfort)
    ii. Strength
    iii. Sea keeping and no collision requirements (launch → safe distance)
b. ALARP deployment
c. ALARP integration in layout on board ship, easy to find, safe to board.
d. ALARP design to cover all demographics, pre-injured people, stretcher handling.
e. COMFORT:
    i. ALARP Space, including climate issues, cold weather, PSE etc.
    ii. ALARP fresh air and cooling/heating – hypothermic protection
    iii. ALARP accessibility for all demographics in the worst-case damage condition for the vessel
    iv. Passenger weight to allow for increase with respect to current SOLAS requirements. 95 kg
    v. ALARP solutions for long rescue times and necessity to be in LSA for more than 24h.
    vi. ALARP probability for injury.
    vii. Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).
f. PERFORMANCE:
    i. FMECA / negative test documentation to measure system and functional reliability.
    ii. Escape and make way in sea state associated to at least Beaufort 7.
    iii. Be able to evacuate the full capacity in less than 30 mins (similar to ISO/CD 16707).
    iv. Be functional with the maximum damage conditions of the ship.
g. Functional requirements:
    i. Operable independently of ship's power supplies
    ii. Location devices, satellite, GPS, EPIRB, ++
    iii. Provide means of efficient communication.
    iv. Hands-on training availability.

SHOULD

(The product should meet thesecriteria.)

Added value for thecustomer

1. Evacuation instructions independent of language
2. Include a System Status/ condition monitoring system.
3. Have technology for electronic counting and evacuation evaluation.
4. ALARP training
5. ALARP maintenance
6. Dedicated space for persons in need of assistance
7. Integrated as far as practical into vessel, so as to provide scope for multi-use and flexible vessel layouts
8. When stowed, “advertise” what it does and how.

COULD

(The product could meet thesecriteria.)

The nice to haves

1. REMOTE deployment
2. Be fully functional as escape route, always, also in port.
3. Perform as full habitat in any condition and over longer periods of time.
4. ALARP easy to educate, make PAX aware, intuitive use.

6.1.4 Performance & Function Requirements

The above-mentioned requirements are all elements covering a certain need, a safety level or experienced lack of something. Each and every element should be brought forward to the table of for example IMO for the evaluation and justification of focusing on changing the current LSA code content as well as test requirements.

Moving to a more goal-based approach is vital to keep the innovation level for future equipment as open as possible while meeting certain safety target levels.

For Hard shell LSA equipment, the following three safety critical areas are found to be describing the necessary focus to reach an as safe and effective solution as possible.

3 Safety Critical Areas

- Passenger Safety
- Structural integrity of the equipment
- Headway – ability of safe sail away, sea keeping and keeping position

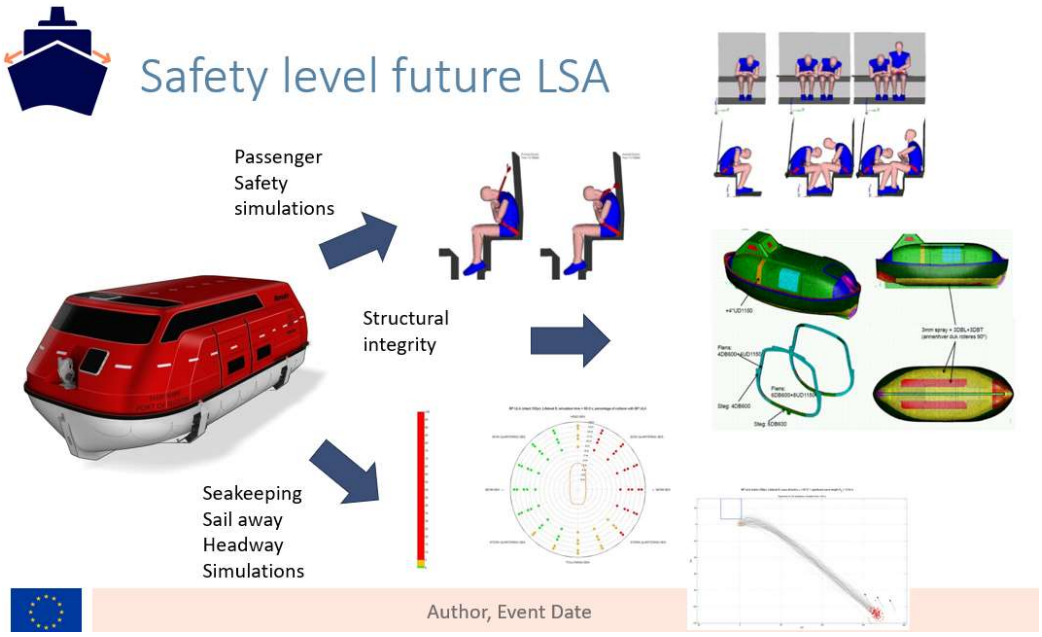


Figure 23: Safety Level Future LSA

One of the main challenges with evaluating LSA equipment is the inability to test prototype solutions for all weather conditions. Besides the obvious differences and knowledge needed to safeguard evacuation to sea level during different environmental conditions, the individual differences from host to host are also largely unknown, due to different layouts and ship performance, both in intact and damaged conditions.

For future safety level target evaluation, it is therefore vital to individually evaluate the evacuation potential and success for each lifeboat station onboard each ship by means of computer software simulations. Cruise ships can/should be classified for different missions, upon which environmental conditions and operational limitations can be adjusted. Once the maximum evacuation environmental condition has been defined, simulations can document safety/success percentage levels for each lifeboat station. Certain percentile levels can be documented, in order to give an idea of the potential for injury, structural failure and/or collision and sea keeping issues.

These simulation tools have been developed by different maritime institutes over the last years and get increasingly accurate. The results are very visual and can document by means of desk top presentation what lifeboat stations are best for evacuation and where potentially to direct passengers and crew. This can then be subject for the daily risk evaluation, based on weather forecast and/or even be subject to change routes to mitigate such risks.

Similar principles have been implemented in recent offshore standards (e.g. DNVGL-ST-E406) and DNVGL has presented maritime solutions of such standards in industry venues, such as NORSHIPPING. DNVGL could play an active role in the establishment of goal setting for cruise ship relevant equipment, based on that experience.

The simulation software principle is also important to maintain a serious attitude in the industry. The accuracy of such tools is based on measurements and validation from full-scale sea trails combined with specific model-scale tests, all going into verification types of software development. These, when endorsed by independent third-party classification societies, can create very accurate and rewarding results for the industry.

7. Combined LSA – Life Saving Appliances

7.1 Identifying the Future Requirements

With reference to the finding from the Glasgow Workshop and Report (D3.1), the outcomes of the LSA Questionnaires carried out online after the Glasgow session there has been set as series of future requirements for future combined LSA.

> **Definition:** By Combined LSA is understood a new future LSA type that combines the advantages of the inflatable LSA (Marine Evacuation Systems and Rafts) and the advantages of hard-shell LSA (Lifeboats). This new type of LSA is 100% autonomous, self-propelled and maneuverable.

The requirements also take into account the findings from the interviews with key stakeholders onboard RCCL "Jewel of the Seas", during a deployment and training exercise.

The requirements are based on the matrix defining Must, Should and Could requirements, Annex 3.

In order to fulfil all intended requirements, the Combined LSA has to go outside the SOLAS & LSA Directive requirements, as Novel equipment following SOLAS 74, Chapter 3, part C, Regulation 38 and Resolution A.520 (13), within the specified areas:

- Comfort
- Performance
- Future Requirements

The focus shall be goal-based targets, in order to ensure innovation and not only a regulation-restricted approach.

The primary goal of LSA is to ensure safe evacuation and to ensure that evacuated passengers and crew are in a safe environment while they await rescue. There can be three stages to define the evacuation/rescue process:

1. Abandon ship phase = the actual evacuation process
2. Await rescue phase = the time spend in the LSA equipment
3. Rescue phase = bringing passenger and crew in safety through SAR operation

Abandon ship phase

In the abandon ship phase, the primary focus is safe evacuation of all passenger and crew onboard the vessel, while this brings several aspects into play:

- All passengers and crew need to be accounted for. Within this element, SafePASS shall ensure easy monitoring of all passenger and crew and the LSA equipment shall register all evacuated persons.
- Dry shod evacuation of all passengers and crew through a slide or chute from deck to survival craft/crafts on the water.

- By evacuation one by one, the injury risk is reduced to the individual person.
- There is an increased focus on the reliability of the LSA equipment, during launch of the equipment and during the evacuation.
- The survival crafts used in connection with the Novel LSA will have a capacity above 150 persons.

The key aspects are the reliability of the LSA at launch and during the whole evacuation process, as well as the count of all persons being evacuated in order to support the SAR operation.

Await rescue phase

In the await rescue phase, the comfort and safety of all evacuated persons are the central point. In connection with long international voyages, the await rescue phase might take more than 24+ hours, therefore the following needs to be observed:

- Adequate amount of food and water need to be available.
- The environment in the survival craft need to be safe and secure the persons onboard against injuries.
- The stay in the survival craft need to be as comfortable as possible to support a 24+ hours stay.
- The crew, responsible for the survival craft, needs to have contact to all persons onboard, in order to manage cowed control.
- The survival craft needs to support ADA USA (reduced mobility) requiring persons.

Rescue phase

In the rescue phase, the survival craft needs to support safe abandonment from the craft to rescue vessel, SAR helicopter or other final rescue point/mean.

7.1.1 Prioritisation Design Criteria Matrix

Through the dividing into Must, Should and Could categories, a precogitation of the various elements lies.

The Must points are to consider as priority 1 elements and are the elements that need to be fulfilled by the Combined LSA, both with regards to the launching appliance and the survival craft.

All priority 1 elements have been divided into three main categories:

Comfort

Covering aspects of safety related to the comfort for passengers and crew who has been evacuated, also taking into consideration ADA USA and full demographic spread.

Performance

Taking into consideration survival elements and safety aspect for the full duration of the potential stay onboard, as well as SAR related elements.

Functional Referments

Aspects of sustainability related for functionality and regulatory elements, in order to ensure full safe functionality of the LSA equipment for the full duration of the rescue process.

Table 13: Must Requirements – Combined LSA Requirements

MUST

(The product must meet thesecriteria.)

Minimum performance standards

Comfort

- Passengers must have direct access to the LSA and be protected from the weather conditions.
- Be able to evacuate disable/elderly/mobility impaired and excess of weight persons/children wearing a lifejacket, infants.
- Habitable environment for all persons.
- Protection against hypothermia (death from hypothermia).
- Provide sufficient space for passenger wearing heavy weather clothing and PSE.

Performance

- Craft canopy should be in conspicuous color.
- Allow the transfer of persons in a stretcher or wheelchair.
- Must be resistant to the marine environment.
- Easy access for all demographics in the worst-case damage condition for the vessel.
- Have a safe and dry boarding passage.
- Facilities to provide survival for at least 24 hrs & extended water-making.
- Operable independently of ship's power supplies.
- Be designed to prevent injuries.
- Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).

Functional Requirements

- Deploy by one person from the bridge or the evacuation station using minimum number of actions.
- Location of the system should give easy access to the passengers from the Muster areas in less than 10 mins.
- Have a reliability plan to demonstrate the performance including risk analysis. – Ensure that the system has high reliability.
- Escape and make way in sea state associated to Beaufort 7.
- Be able to evacuate the full capacity in less than 30 mins (similar to ISO/CD 16707).
- Instructions must not be language dependent.
- Be designed for average passenger weight of 82.5 kg.
- Reduce the possibility of human error during install maintenance, training and use.
- Hands-on training equipment must be available.
- Be functional with the maximum damage conditions of the ship.
- Provide means of external communication to alert and guide ships/ aircraft.

The Should points of requirements are 2nd priority, that shall support the priority 1 elements.

Table 14: Should Requirements – Combined LSA Requirements

SHOULD
(The product should meet thesecriteria.) *Added value for thecustomer* • Require the minimum of maintenance. • Include a System Status monitoring system (that can be easily upgraded). • Have technology for electronic counting system and monitoring of the evacuation which is interactive with the vessel. • Be easy to service. • Require the minimum of crew training. • Allow for more frequent offline training. • System is easy to maintain onboard (reducing crew effort). • Deployment sequence to be automated as far as practical. • Include up-to-date location devices. • Keep life cycle costs to a minimum. • Give enough comfort to passengers. • Dedicated space for persons in need of assistance. • Integrated as far as practical into vessel so as to provide scope for multi-use and flexible vessel layouts. • When stowed, “advertise” what it does.

By fulfilling the Must and Should requirements, it is secured that the Combined LSA is raising the safety level during all three rescue phases as described in 7.1, as well as fulfilling Comfort, Performance and functional requirements.

The Could points are to consider as nice to have elements, that needs to be taken into account in connection with the design requirements if possible.

Table 15: Could Requirements –Combined LSA Requirements

COULD
(The product could meet thesecriteria.) *The nice to haves* • Be remotely deployed from the bridge by one person. • Operate as emergency exit whilst in port. • Up-to-date Navigation aids. • Evacuation to minimize stress to the PAX during process as far possible. • Integrate with the SafePASS smart phone application. • Passengers to be educated & made aware of the system and how to use.

7.1.2 Design Requirements Discussion

With the starting point that the design requirements need to be goal-based, we will have to take the discussion on, regarding the goal concerning safe evacuation and what design requirements will that lead to.

The starting point in an evacuation is a distressed vessel, that has passed the defined point of safe returned to port and therefore the vessel needs to be evacuated.

The core point by safe evacuation is to bring all persons (Passengers and crew) into a position in a safe distance from the vessel, but also staying at the same position as last registered for the vessel, in order to support the SAR operation in the best possible way.

New Novel LSA, here referred to as Combined LSA, has to fulfil the basic design requirement for safe evacuation as identified in 7.1.

Abandon ship starts with securing that the LSA equipment can be held in a controllable and sustainable situation within the three abandon ship zones (see table 7.1.2.1.)

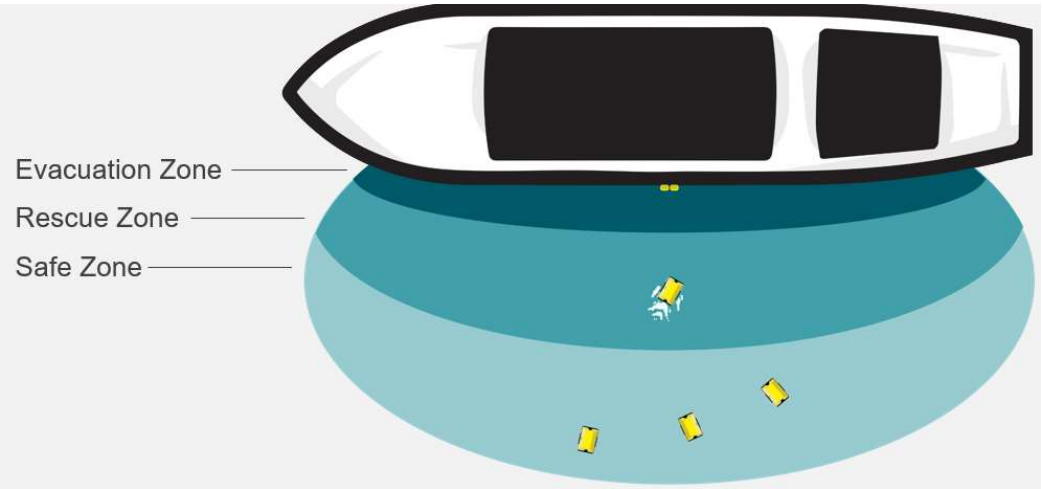


Figure 24: Abandon Ship Zones

The three abandon ship zones (Figure 25) are defined as:

- Evacuation Zone
- Rescue Zone
- Safe Zone

Evacuation Zone

The LSA equipment has to be sustainable and full controllable within the evacuation zone for the full 30 minutes time given by SOLAS for the abandon ship process.

The safe evacuation is done through chutes or slides and, during the whole evacuation proves, the survival crafts are kept in position along the shipside in order to ensure

full safe evacuation and reduce potential technical risk failures. The full sustainability of the novel Combined LSA equipment is documented during a HWST test with 3- to 4-meter significant wave heights and wind of Beauford 6 to 7, or equivalent modelling based on real world data.

To keep the position, bowsing systems, winches, engine power or other means of control giving techniques can be used.

Rescue Zone

The rescue zone is an area of autonomy for the survival craft, where maneuverability of the survival craft is key.

Within the rescue zone, the survival craft shall be so maneuverable that it is easy for the crew to maneuver to the rescue of persons in the water and assist them to into the survival craft.

The survival craft shall be equipped with grab points on the side and easy identifiable entry points, in order to inter the craft for permanent rescue.

Safe Zone

The safe zone is defined as a distance from off the distressed vessel of 100 meters, where havng this minimum distance to the vessel, the survival crafts can await permanent rescue from SAR operations or other vessels.

In order to make it easy for SAR operations, it is essential to stay close to the position of the distressed vessel or the latest know position.

A central design requirement for the Novel Combined LSA is that it is self-propelled and there is sufficient fuel or power/energy to obtain and maintain the position for 24 hours. A second requirement is to be able to switch between being an active and passive survival craft, without compromising the safe environment onboard, leading to injuries or having uncomfortable effects on the rescued passengers and crew.

The possibility of switching between being an active or passive survival craft makes it possible to extend the 24 hours active propulsion, as well as making it possible to preserve energy/propulsion to support the rescue operation.

As the stay in the survival craft can have a duration of more than 24 hours, the comfort, performance and functional requirements discussed earlier become a central element with regards to the functional requirements of the Novel Combined LSA.

7.1.3 Performance & Function Requirements

Performance and functional requirements are driven by the design requirements and the actual environment that the equipment operates in.

An added aspect in the functional requirements can be to try to present the LSA equipment from being affected by the environment in dormant times onboard.

Storing the LSA inside a container/compartment and protecting it from the environment will dramatically increase the reliability of the equipment in an evacuation situation.

If we look at historical failures on LSA equipment, a significant number of the winch, wire, hook and other technical issues, that has led to incidents or mal-functions, can be traced back to the influence of the environment. Unfortunately, this area is not well documented by statistics or official reports from e.g. IMO or other sources.

In the following table, there are a series of functional requirements for the novel combined LSA, in relation to the design requirements and with a link over to which phase in the evacuation and rescue process it has its relevance.

Table 16: Combined LSA – Design and Functional Requirement

ID	Zone	Design requirement	Functional requirement	User Requirement ID (ref D2.3)
LSA COMB01	Evacuation	Dry shod evacuation	One by one evacuation through slide or chute	UR23, UR28
LSA COMB01		All evacuated accounted for	Counting and identification of all evacuated persons	UR04, UR10, UR14, UR15, UR18
LSA COMB02		Evacuation of all demographic groups	All groups of persons shall be able to be handled in the escapeway.	UR34, UR44, UR45
LSA COMB03		ADA group & Injured persons	Special need persons shall have equal access through the escapeway.	UR34, UR44, UR45
LSA COMB04		Average passenger weight 82.5 kg & shoulder width of 510mm	No weight or size restrictions	UR45
LSA COMB05		Shall be able to evacuate full capacity within 30 minutes.	Have several escape ways to insure redundancy.	UR34, UR35, UR36, UR37, UR39, UR42, UR43, UR44, UR56, UR57
LSA COMB06		Evacuation possible by 20/10 list/trim	Escapeway (slide or chute) to fulfil list/trim requirement	UR29, UR30, UR34, UR35, UR36, UR37, UR39, UR42, UR43, UR44, UR56, UR57

LSA COMB07		Dead ship	The LSA shall provide its own power source.	UR41, UR46
LSA COMB08		Avoid human errors	Be automatic as far as feasible.	UR31, UR32, UR33, UR41, UR46
LSA COMB09		Can be launched by one person	One-person functionality	UR05, UR06, UR07, UR08, UR23, UR35, UR36, UR37, UR42, UR43, UR44
LSA COMB10	Rescue	Manageability	The survival craft shall be self-propelled and make escape in a sea state associated with Beaufort 7 conditions.	UR42, UR43, UR46, UR47
LSA COMB11		Easy to board from the water	The craft shall be equipped with clear and easily accessible entrances, that support entry from the water.	UR28, UR45
LSA COMB12		Injured persons	The survival craft shall be able to support 2-4 person on stretcher.	UR44, UR45
LSA COMB13		Visibility of the craft	The craft needs to be in a conspicuous colour.	UR47
LSA COMB14	Safe	Be able to keep the nautical position	The craft shall be self-propelled.	UR42, UR43, UR46, UR47
LSA COMB15		Protect against hypothermia & hypertermia	Floor and seating arrangement elevate from water level.	UR44, UR47, UR48
LSA COMB16		Sustainable in the marine environment	Materials shall be resistant to the influence of the environment.	UR41, UR47
LSA COMB17		By design prevent injuries	Be designed without sharp and hard elements.	UR35, UR36, UR37
LSA COMB18		Operative under all whether conditions	Temperature, humidity and wind not to affect the safe operationin conditions associated with at least Beaufort 7.	UR47

7.1.4 Performance & Function Discussion

Quick and safe evacuation takes its starting point in intuitive functionality and clear instructions. The LSA equipment needs to be easy to launch and prepare for the crew,

so that they can have their attention on passengers and fellow crew members who need to be evacuated, as well as those who need additional assistance.

When the system has been launched, the clear instructions need to support the crew's verbal instructions and the instruction markings also needs to be so clear, so that persons can evacuate in a safe manor without supporting verbal instructions and crew guidance.

Figure 25: Intuitive evacuation for both passenger and crew

When evacuated, all passengers and crew need to be seated in a comfortable way in an environment that protects them against injuries for the whole period of time where they are awaiting rescue inside the survival craft.

Figure 26: One level seating for all evacuated passengers and crew

It needs to be ensured that all demographic groups can be evacuated, including special-need persons, like ADA USA persons or injured persons.

On a cruise vessel, approximately 15-20% of the passengers can be defined as special-need persons, considering all persons that fall outside the normal spectrum. This

covers older persons and oversized persons at one end of the spectrum and at the other end of the spectrum are infants and children under the age of 12.

Figure 27: All demographical groups including injured persons needs to be handled

8. Conclusions

The opportunity to generate a set of requirements for new PSE and LSA has forced all those who assisted in their development to start to think differently, as there is an understanding that in order to generate truly novel or safer solutions, then the current prescriptive guidelines in SOLAS and the LSA Code are not the appropriate guidance. This is clear when looking at the current trends in LSA and PSE development – they are mainly incremental steps – increased capacity, more compact when stowed onboard etc, without necessarily increasing the overall level of safety onboard.

This has encouraged the team to adopt the Goal-Based Approach to what the Function and Performance of the equipment will be. This approach allows for novel designs to be developed and assessed, while also demonstrating that they at least provide the same level of safety as existing equipment.

The review of the current trends in LSA has highlighted that the equipment is approved to a set of prescriptive requirements, which do not normally take into account the performance of the Equipment in the actual installation location and how its performance will change depending on the prevailing conditions or emergency scenario.

With the involvement of SMEs who have extensive experience in the Offshore Oil and Gas sector, this has introduced new ways of approaching and assessing the performance of equipment in differing locations, through the use of ALARP and looking at the requirements at key stages during the whole abandonment process, allowing for a clear understanding of the performance of the equipment and the ability for passengers to board the Systems in differing conditions and scenarios. This has the advantage of further integrating the equipment more into the vessel design and not just being “bolted on”.

The position of the LSA, along with the location of Muster Areas and how passengers can move between Safe Zones onboard should be developed in D3.11 – Ship Architecture. This will allow for better integration of the equipment into the vessel, reducing the risk (mustering, movement to evacuation station, boarding of LSA) associated with the overall evacuation scenario.

From the reviews, it is clear that “one size does not fit all”. This is related to two aspects:

- Passengers
- Integration of the Equipment onboard

With regard to Passengers, the wide demographic onboard a typical cruise vessel needs to be taken into account in the design of the equipment. This can range from the increased size or weight of a passenger through to the mobility impaired, casualties or the very young. Currently, the “extremes” of the demographic are not necessarily well catered for in the design and operation of the equipment.

To address these two issues, the design of the equipment must now cater for the wide demographic onboard and the use of simulations and analysis carried out to determine the actual performance of equipment in that location onboard that particular vessel in differing scenarios.

New GBS requirements have been generated for existing formats of LSA and PSE, however, it was clear that a “novel” or combined set of requirements was needed to truly give the opportunity to break away from “traditional” design solutions. The requirements for the different types of equipment are detailed in Annex 4, 5 6 & 7.

These Requirements will now be used in the generation of the concepts for novel LSA and PSE and the development of prototypes that are the outputs from D3.4, D3.5, D3.6, D3.7.

The Requirements will also form the basis of future discussions with IMO, with the intent of making it easier to introduce new designs to vessel build, while also demonstrating that they are at least equally as safe as traditional equipment.

9. REFERENCES

None.

10. ANNEXES

Annex 1: D2.3 – Table 5 - Consolidated list of User Needs

ID	Name	Need	Source ID
UR01	Safety Command Centre situational awareness	The Safety Command Centre needs to have situational awareness of affected/damaged areas	UR_MO_11
UR02	Incident assessment and awareness time	The time required to assess an incident/damage needs to be reduced, and the coordination of emergency teams should be improved providing enhanced awareness of the emergency situation	UR_WS_6 UR_BTG_17 UR_MO_1 UR_DOA_1 UR_BTG_13
UR03	Availability of emergency signal monitoring	Safety Command Centre should be able to monitor the status of all emergency signals continuously	UR_MO_12
UR04	Smart technologies integration	Integrating of smart technologies with the existing Safety Management Control System	UR_WS_3 UR_BTG_7 UR_BTG_20
UR05	2D/3D Visualization Module	There is a need for improved situation awareness (common operational picture- COP) that can provide 2D/3D visualizations	UR_DOA_12
UR06	Mobile holographic common operation picture (COP)	There is a need to provide to safety personnel anywhere in the ship a complete situational picture utilizing mobile holographic technology	UR_DOA_13
UR07	Augmented reality application	Need for Augmented Reality applications to facilitate ship evacuation for both passengers and crew	UR_DOA_11 UR_BTG_18
UR08	Dynamic decision support tools	There is a need for dynamic decision support tools that provide real-time information, automation capabilities and are capable of integrating sensors, simulations, smart devices and legacy systems	UR_WS_12 UR_BTG_9 UR_DOA_5 UR_BTG_7 UR_DOA_16 UR_BTG_8 UR_BTG_10
UR09	Dynamic evacuation route	Systems that can provide dynamic evacuation route and adapts to the evolving emergency situation	UR_WS_5 UR_BTG_6 DOA_14

ID	Name	Need	Source ID
UR10	Passenger localization	Indoor localization technologies for real-time tracking of passengers i.e. missing passengers, passengers that require medical assistance, passengers who are trapped in a certain location, passengers who cannot move etc. that facilitate decision support and improve mustering time	UR_WS_1 UR_MO_16 UR_BTG_11 UR_DOA_9 UR_BTG_21
UR11	Locate passengers in need of medical assistance	The total time to find/locate missing person(s) that require medical assistance needs to be reduced	UR_MO_17 UR_BTG_12 UR_BTG_48
UR12	Missing people finding	Missing passenger finding technology that can improve mustering time	UR_WS_2
UR13	Passenger vital sings and health monitoring	Crew needs to assess passengers' physiological condition in order to effectively manage the crowd by utilizing systems that can provide passenger vital signs/stress level (i.e. smart wristbands) and further analyze and further analyze human's behavior under panic in an evacuation	UR_WS_11 UR_MO_10 UR_BTG_12 UR_DOA_6 UR_BTG_2
UR14	Passenger communication	Applications that help passengers to communicate with other parties in a group (e.g. a family's children) in case of an emergency	UR_WS_4
UR15	Multilanguage support	Provide passengers with information and instructions in the most commonly spoken language (ideally their mother tongue).	UR_WS_10 UR_MO_20 UR_DOA_8
UR16	Personalized navigation of passengers	Personalized navigation of passengers (i.e. dynamically adapting to crisis situation) for improving the evacuation process.	UR_DOA_10
UR17	Passenger Request for Assistance	The time required for passengers to request assistance should be reduced	UR_MO_18
UR18	Means of Passenger Assistance in Evacuation	Passengers need to be assisted during evacuation by audio-visual signs	UR_MO_21

ID	Name	Need	Source ID
UR19	Familiarization with ship environment	Passengers need to be assisted in getting familiar with the internal structure of the ship and ensure that they understand the safety instructions.	UR_MO_22
UR20	Passenger Response to General Alarm	Technologies and process that can reduce the response time; the time required for passengers to respond to the general alarm	UR_WS_7 UR_MO_19 UR_BTG_23 UR_DOA_2
UR21	Mustering Time	The time required for mustering needs to be reduced	UR_MO_6 UR_DOA_3
UR22	Mustering to embarkation time	The time to reach the embarkation station from the mustering station needs to be reduced	UR_MO_7
UR23	Total evacuation time	The total time from general alarm to abandonment needs to be reduced	UR_MO_8 UR_BTG_4 UR_DOA_4
UR24	Time for Travel Companions Reunification	Time required for travel companions (families etc.) to locate each other during an emergency needs to be reduced	UR_MO_9
UR25	Crew response to emergency, before the general alarm	The time required for the SCC to respond to an emergency (dispatch and intervene) needs to be reduced and thus reduce the time before the decision for the general alarm is taken	UR_WS_8 UR_MO_13
UR26	Passenger Identification during mustering	The crew needs to be able to locate missing passengers in the muster station	UR_MO_14
UR27	Passenger Counting During Mustering	It is required to minimize human error during passenger counting at the muster station and utilize electronic systems with improved performance	UR_MO_15 UR_BTG_19
UR28	Wearing Lifejackets	The crew needs to confirm that all passengers are wearing their lifejackets in case of General Alarm	UR_MO_27
UR29	Withstand harsh weather conditions	System components should withstand harsh weather conditions	UR_MO_4 UR_BTG_1

ID	Name	Need	Source ID
UR30	Minimum impact of weather conditions	Minimize impact of harsh weather conditions on evacuation time	UR_MO_5 UR_DOA_7
UR31	Hazards Identification – Risk Model – Potential Loss of Life	The Risk Assessment and the Potential Loss of Life is crucial for the Safety Stakeholders during both the design and emergencies	UR_MO_2 UR_DOA_17
UR32	Real-time Risk Assessment	It is essential for a risk modelling tool to be able to assess the risk in real time based on readings from various sensors	UR_MO_3 UR_DOA_18 UR_BTG_3 UR_BTG_15
UR33	Evacuation modelling and incident propagation	Evacuation modeling and crowd simulations need to incorporate incident propagation (fire and flooding) information	UR_DOA_15 UR_BTG_15
UR34	Evacuation time modelling	Dynamic evacuation analysis model needs to effectively calculate the available time for evacuation (ASET), the required time to evacuate (RSET) including enhanced awareness time calculation	UR_BTG_14 UR_BTG_16
UR35	LSA ease of use and operation	LSA need to be easy to use and operate; the actions required to board/launch/deploy/release the LSA through to the point of escaping need to be as less as possible and require less training	UR_WS_13 UR_DOA_23 UR_MO_26 UR_BTG_30 UR_BTG_29 UR_BTG_33 UR_BTG_34 UR_DOA_27 UR_BTG_32
UR36	Preparation of LSAs	The actions required to prepare the Lifeboats/Liferafts need to be as minimum as possible	UR_MO_25
UR37	LSA ease of deployment	LSA deployment need to be easy as much as possible (reduced crew actions)	UR_WS_14
UR38	LSA flexible design	Increase LSA flexible design, capable to be installed in wide range of vessel, and incorporate technology in its design	UR_WS_15 UR_BTG_27 UR_BTG_28
UR39	LSA un-hindered access	Provide un-hindered access for all demographics onboard, without introducing additional hazards while moving around the vessel.	UR_WS_16 UR_DOA_25

ID	Name	Need	Source ID
UR40	LSA comfort and safety	The new LSAs need to provide enough comfort for passengers and should be safe for all passengers	UR_WS_17
UR41	LSA maintenance	There is need for improved design of LSAs that can improve the maintenance.	UR_WS_18 UR_BTG_31
UR42	LSA deployment and release height	Optimization of LSA deployment and release height	UR_WS_19 UR_BTG_38
UR43	LSA Launching	Improvement of LSA launching	UR_WS_20 UR_BTG_30 UR_DOA_27
UR44	LSA Embarkation	Improvement of LSA embarkation and time required for embarkation	UR_WS_21 UR_MO_24 UR_DOA_24
UR45	LSA inclusive for all passenger demographics	LSA should be suitable for use by the wide demographic onboard – elderly, infirm, mobility, sight and sound impaired, children, families, stretcher cases and those in excess of the average weight.	UR_WS_22 UR_DOA_25
UR46	LSA reliability	LSA should be highly reliable	UR_WS_23
UR47	LSA in extreme weather/environmental conditions	LSA should be operational in extreme weather conditions and/or environmental conditions (ship damage etc.)	UR_WS_24 UR_DOA_26
UR48	LSA capacity	Increasing the optimum capacity of collective LSA lifeboats	UR_DOA_28
UR49	PSE inclusive for all passenger demographics	PSE should accommodate and be suitable for use by the wide demographic onboard – elderly, infirm, mobility, sight and sound impaired, children, families, stretcher cases and those in excess of the average weight.	UR_WS_25 UR_DOA_20
UR50	Ergonomic and comfort PSE	PSE should have ergonomic design and provide comfort taking into account human factors	UR_WS_26 UR_DOA_19 UR_BTG_35
UR51	PSE ease of use and safe fitment	PSE needs to allow ease and safe fitment and use by all the persons onboard.	UR_WS_27 UR_BTG_36 UR_MO_28

ID	Name	Need	Source ID
UR52	PSE passenger safety and protection	PSE should provide increased passenger safety and protection on-board and in-water	UR_WS_28
UR53	PSE weather and environmental condition	PSE should withstand harsh weather and environmental conditions	UR_WS_29 UR_MO_4 UR_BTG_1
UR54	Technology enabled PSE	PSE needs to be technology enabled, allowing for speedier detection, embarkation and provide location support	UR_WS_30 UR_DOA_21 UR_BTG_37 UR_BTG_38
UR55	PSE size and storage	PSE size and storage should allow for easy maintenance	UR_WS_31 UR_BTG_34
UR56	Crew safety training advanced technology	Improve crew safety training efficiency by incorporating different training scenario and enhanced visualization and interaction (3D models, Augmented Reality features)	UR_WS_32 UR_BTG_26 UR_BTG_24 UR_DOA_11
UR57	Crew training for use of equipment	Increase crew confidence in equipment use and in particular LSA equipment by being able to get hands on the equipment for training purposes, and use alternative training methods such as AR/VR training	UR_WS_33 UR_OM_23 UR_BTG_25 UR_BTG_26 UR_BTG_24 UR_DOA_22

Annex 2: Online Questionnaire Results Statistics: SafePASS 2020 Stakeholder Surveyof Life Saving Appliances

Stakeholder Roles

Please select the stakeholder group that best fits your job role.			
		Answers	***Ratio***
Ship Owner		8	5.1%
Administration (Flag & Class)		5	3.2%
Shipyard		2	1.3%
OEM Manufacture		10	6.4%
Naval Architect		17	10.8%
Vessel Trainer		1	0.6%
OEM Trainer		2	1.3%
Vessel Maintenance		8	5.1%
OEM Maintenance		5	3.2%
Emergency Bridge team		34	21.7%
Emergency LSA team		19	12.1%
Search and Rescue		0	0.0%
Vessel Crew Hotel		0	0.0%
Vessel Crew Marine		60	38.2%
No Answer		0	0.0%

Results

Thinking about current Personal Survival Equipment, rate the following features in order of importance.: Simple donning			
		Answers	***Ratio***
Very Important		94	59.9%
Important		53	33.8%
Neutral		8	5.1%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		2	1.3%

Thinking about current Personal Survival Equipment, rate the following features in order of importance.: Prevention of drowning			
		Answers	***Ratio***
Very Important		132	84.1%
Important		21	13.4%
Neutral		4	2.5%
Not Important		0	0.0%
Un-necessary		0	0.0%

No Answer		0	0.0%

Thinking about current Personal Survival Equipment, rate the following features in			
		Answers	***Ratio***
Very Important		100	63.7%
Important		46	29.3%
Neutral		10	6.4%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		1	0.6%

Thinking about current Personal Survival Equipment, rate the following features in order of importance.: Comfort			
		Answers	***Ratio***
Very Important		30	19.1%
Important		64	40.8%
Neutral		43	27.4%
Not Important		15	9.6%
Un-necessary		5	3.2%
No Answer		0	0.0%

Thinking about current Personal Survival Equipment, rate the following features in order of importance.: Visibility			
		Answers	***Ratio***
Very Important		98	62.4%
Important		49	31.2%
Neutral		8	5.1%
Not Important		1	0.6%
Un-necessary		0	0.0%
No Answer		1	0.6%

Thinking about current Personal Survival Equipment, rate the following features in order of importance.: Location devices (whistle / light)			
		Answers	***Ratio***
Very Important		76	48.4%
Important		64	40.8%
Neutral		12	7.6%
Not Important		3	1.9%
Un-necessary		0	0.0%
No Answer		2	1.3%

Thinking about current Personal Survival Equipment, rate the following features in order of importance.: Location technology (GPS/AIS)			
		Answers	***Ratio***
Very Important		96	61.1%
Important		43	27.4%
Neutral		15	9.6%
Not Important		1	0.6%
Un-necessary		2	1.3%

No Answer		0	0.0%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Simple entry			
		Answers	***Ratio***
Very Important		110	70.1%
Important		44	28.0%
Neutral		2	1.3%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		1	0.6%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Simple to deploy			
		Answers	***Ratio***
Very Important		135	86.0%
Important		18	11.5%
Neutral		3	1.9%
Not Important		1	0.6%
Un-necessary		0	0.0%
No Answer		0	0.0%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Propulsion			
		Answers	***Ratio***
Very Important		38	24.2%
Important		80	51.0%
Neutral		33	21.0%
Not Important		2	1.3%
Un-necessary		3	1.9%
No Answer		1	0.6%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Comfort			
		Answers	***Ratio***
Very Important		18	11.5%
Important		60	38.2%
Neutral		55	35.0%
Not Important		17	10.8%
Un-necessary		4	2.5%
No Answer		3	1.9%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Appearance			
		Answers	***Ratio***
Very Important		13	8.3%
Important		44	28.0%
Neutral		60	38.2%
Not Important		28	17.8%
Un-necessary		12	7.6%
No Answer		0	0.0%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Colour			
		Answers	***Ratio***
Very Important		40	25.5%
Important		64	40.8%
Neutral		35	22.3%
Not Important		13	8.3%
Un-necessary		4	2.5%
No Answer		1	0.6%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Survival Rations			
		Answers	***Ratio***
Very Important		77	49.0%
Important		51	32.5%
Neutral		21	13.4%
Not Important		5	3.2%
Un-necessary		2	1.3%
No Answer		1	0.6%

Thinking about current Life Saving Appliances, rate the following features in order of importance.: Location technology (GPS / AIS)			
		Answers	***Ratio***
Very Important		113	72.0%
Important		33	21.0%
Neutral		8	5.1%
Not Important		2	1.3%
Un-necessary		0	0.0%
No Answer		1	0.6%

Thinking about current Personal Survival Equipment please rate the following according to performance.: User fit / Comfort			
		Answers	***Ratio***
Very Good		20	12.7%
Good		73	46.5%
Average		51	32.5%
Poor		10	6.4%
Very Poor		1	0.6%
No Answer		2	1.3%

Thinking about current Personal Survival Equipment please rate the following according to performance.: Ease of use			
		Answers	***Ratio***
Very Good		41	26.1%
Good		82	52.2%
Average		29	18.5%
Poor		2	1.3%
Very Poor		0	0.0%
No Answer		3	1.9%

Thinking about current Personal Survival Equipment please rate the following according to performance.: Reliability			
		Answers	***Ratio***
Very Good		50	31.8%
Good		73	46.5%
Average		30	19.1%
Poor		0	0.0%
Very Poor		0	0.0%
No Answer		4	2.5%

Thinking about current Personal Survival Equipment please rate the following according to performance.: Location aid (whistle / light)			
		Answers	***Ratio***
Very Good		38	24.2%
Good		87	55.4%
Average		27	17.2%
Poor		1	0.6%
Very Poor		1	0.6%
No Answer		3	1.9%

Thinking about current Personal Survival Equipment please rate the following according to performance.: Function and Performance			
		Answers	***Ratio***
Very Good		43	27.4%
Good		81	51.6%
Average		28	17.8%
Poor		0	0.0%
Very Poor		0	0.0%
No Answer		5	3.2%

Thinking about current Life Saving Appliances please rate the following according to performance.: Capacity			
		Answers	***Ratio***
Very Good		39	24.8%
Good		87	55.4%
Average		24	15.3%
Poor		5	3.2%
Very Poor		0	0.0%
No Answer		2	1.3%

Thinking about current Life Saving Appliances please rate the following according to performance.: Ease of use			
		Answers	***Ratio***
Very Good		33	21.0%
Good		61	38.9%
Average		46	29.3%
Poor		12	7.6%
Very Poor		3	1.9%
No Answer		2	1.3%

Thinking about current Life Saving Appliances please rate the following according to performance.: Reliability			
		Answers	***Ratio***
Very Good		34	21.7%
Good		60	38.2%
Average		40	25.5%
Poor		19	12.1%
Very Poor		1	0.6%
No Answer		3	1.9%

Thinking about current Life Saving Appliances please rate the following according to performance.: Provisions / additional equipment			
		Answers	***Ratio***
Very Good		23	14.6%
Good		77	49.0%
Average		51	32.5%
Poor		2	1.3%
Very Poor		1	0.6%
No Answer		3	1.9%

Thinking about current Life Saving Appliances please rate the following according to performance.: Function and Performance			
		Answers	***Ratio***
Very Good		35	22.3%
Good		69	43.9%
Average		40	25.5%
Poor		8	5.1%
Very Poor		0	0.0%
No Answer		5	3.2%

Have you encountered any of the following problems with Personal Survival Equipment, if so, please indicate how often.: Damage to product			
		Answers	***Ratio***
Very Frequent		4	2.5%
Frequent		20	12.7%
Neither frequent or rare		66	42.0%
Rare		39	24.8%
Very rare		17	10.8%
No Answer		11	7.0%

Have you encountered any of the following problems with Personal Survival Equipment, if so please indicate how often.: Missing parts			
		Answers	***Ratio***
Very Frequent		1	0.6%
Frequent		23	14.6%
Neither frequent or rare		59	37.6%
Rare		37	23.6%
Very rare		24	15.3%
No Answer		13	8.3%

Have you encountered any of the following problems with Personal Survival Equipment, if so please indicate how often.: Parts not functioning			
		Answers	***Ratio***
Very Frequent		0	0.0%
Frequent		28	17.8%
Neither frequent or rare		57	36.3%
Rare		39	24.8%
Very rare		20	12.7%
No Answer		13	8.3%

Have you encountered any of the following problems with Personal Survival Equipment, if so please indicate how often.: Equipment missing			
		Answers	***Ratio***
Very Frequent		0	0.0%
Frequent		12	7.6%
Neither frequent or rare		51	32.5%
Rare		52	33.1%
Very rare		29	18.5%
No Answer		13	8.3%

Have you encountered any of the following problems with Personal Survival Equipment, if so please indicate how often.: Complete product failure			
		Answers	***Ratio***
Very Frequent		1	0.6%
Frequent		4	2.5%
Neither frequent or rare		34	21.7%
Rare		41	26.1%
Very rare		64	40.8%
No Answer		13	8.3%

Have you encountered any of the following problems with Life Saving Appliances, if so please indicate how often.: Damage to product			
		Answers	***Ratio***
Very Frequent		4	2.5%
Frequent		38	24.2%
Neither frequent or rare		47	29.9%
Rare		33	21.0%
Very rare		21	13.4%
No Answer		14	8.9%

Have you encountered any of the following problems with Life Saving Appliances, if so please indicate how often.: Missing parts			
		Answers	***Ratio***
Very Frequent		0	0.0%
Frequent		20	12.7%
Neither frequent or rare		51	32.5%
Rare		48	30.6%
Very rare		25	15.9%
No Answer		13	8.3%

Have you encountered any of the following problems with Life Saving Appliances, if so please indicate how often.: Parts not functioning			
		Answers	***Ratio***
Very Frequent		3	1.9%
Frequent		41	26.1%
Neither frequent or rare		40	25.5%
Rare		42	26.8%
Very rare		20	12.7%
No Answer		11	7.0%

Have you encountered any of the following problems with Life Saving Appliances, if so please indicate how often.: Equipment missing			
		Answers	***Ratio***
Very Frequent		0	0.0%
Frequent		17	10.8%
Neither frequent or rare		47	29.9%
Rare		49	31.2%
Very rare		31	19.7%
No Answer		13	8.3%

Have you encountered any of the following problems with Life Saving Appliances, if so please indicate how often.: Complete product failure			
		Answers	***Ratio***
Very Frequent		0	0.0%
Frequent		5	3.2%
Neither frequent or rare		37	23.6%
Rare		42	26.8%
Very rare		61	38.9%
No Answer		12	7.6%

When selecting Personal Survival Equipment for a particular vessel how important are the following criteria?: Stowage size			
		Answers	***Ratio***
Very Important		8	5.1%
Important		17	10.8%
Neutral		5	3.2%
Not important		0	0.0%
Un-necessary		0	0.0%
No Answer		127	80.9%

When selecting Personal Survival Equipment for a particular vessel how important are the following criteria?: Cost			
		Answers	***Ratio***
Very Important		9	5.7%
Important		12	7.6%
Neutral		7	4.5%
Not important		1	0.6%
Un-necessary		0	0.0%
No Answer		128	81.5%

When selecting Personal Survival Equipment for a particular vessel how important are the following criteria?: Features / benefits			
		Answers	***Ratio***
Very Important		8	5.1%
Important		13	8.3%
Neutral		9	5.7%
Not important		1	0.6%
Un-necessary		0	0.0%
No Answer		126	80.3%

When selecting Personal Survival Equipment for a particular vessel how important are the following criteria?: Reliability			
		Answers	***Ratio***
Very Important		23	14.6%
Important		4	2.5%
Neutral		3	1.9%
Not important		0	0.0%
Un-necessary		0	0.0%
No Answer		127	80.9%

When selecting Life Saving Appliances for a particular vessel how important are the following criteria?: Dimensions			
		Answers	***Ratio***
Very Important		16	10.2%
Important		12	7.6%
Neutral		2	1.3%
Not important		1	0.6%
Un-necessary		0	0.0%
No Answer		126	80.3%

When selecting Life Saving Appliances for a particular vessel how important are the following criteria?: Function			
		Answers	***Ratio***
Very Important		20	12.7%
Important		11	7.0%
Neutral		0	0.0%
Not important		0	0.0%
Un-necessary		0	0.0%
No Answer		126	80.3%

When selecting Life Saving Appliances for a particular vessel how important are the following criteria?: Capacity			
		Answers	***Ratio***
Very Important		25	15.9%
Important		6	3.8%
Neutral		0	0.0%
Not important		0	0.0%
Un-necessary		0	0.0%
No Answer		126	80.3%

When selecting Life Saving Appliances for a particular vessel how important are the following criteria?: Cost			
		Answers	***Ratio***
Very Important		11	7.0%
Important		11	7.0%
Neutral		8	5.1%
Not important		1	0.6%
Un-necessary		0	0.0%
No Answer		126	80.3%

When selecting Life Saving Appliances for a particular vessel how important are the following criteria?: Features / benefits			
		Answers	***Ratio***
Very Important		9	5.7%
Important		12	7.6%
Neutral		9	5.7%
Not important		0	0.0%
Un-necessary		0	0.0%
No Answer		127	80.9%

When selecting Life Saving Appliances for a particular vessel how important are the following criteria?: Reliability			
		Answers	***Ratio***
Very Important		26	16.6%
Important		4	2.5%
Neutral		1	0.6%
Not important		0	0.0%
Un-necessary		0	0.0%
No Answer		126	80.3%

In your opinion what causes the largest problem for integration of life saving appliances, on new build vessels? Please indicate how important each item is.: Knowledge of product range			
		Answers	***Ratio***
Very Important		7	4.5%
Important		9	5.7%
Neutral		9	5.7%
Not Important		2	1.3%
Un-necessary		0	0.0%
No Answer		130	82.8%

In your opinion what causes the largest problem for integration of life saving appliances, on new build vessels? Please indicate how important each item is.: Digital models of available products			
		Answers	***Ratio***
Very Important		2	1.3%
Important		13	8.3%
Neutral		8	5.1%
Not Important		3	1.9%
Un-necessary		0	0.0%
No Answer		131	83.4%

In your opinion what causes the largest problem for integration of life saving appliances, on new build vessels? Please indicate how important each item is.: Understanding of product requirements			
		Answers	***Ratio***
Very Important		9	5.7%
Important		14	8.9%
Neutral		3	1.9%
Not Important		2	1.3%
Un-necessary		0	0.0%
No Answer		129	82.2%

In your opinion what causes the largest problem for integRation of life saving appliances, on new build vessels? Please indicate how important each item is.: Communication links with OEM companies

		Answers	*Ratio*
Very Important		7	4.5%
Important		14	8.9%
Neutral		4	2.5%
Not Important		1	0.6%
Un-necessary		1	0.6%
No Answer		130	82.8%

In your opinion what causes the largest problem for integration of life saving appliances, on new build vessels? Please indicate how important each item is.: Fully certified and qualified product

		Answers	*Ratio*
Very Important		14	8.9%
Important		10	6.4%
Neutral		4	2.5%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		129	82.2%

Which of the following changes do you believe will be seen in future large passenger vessels?

		Answers	*Ratio*
Size increase		13	8.3%
Size Decrease		1	0.6%
Capacity Increase		16	10.2%
Capacity Decrease		1	0.6%
Area of operation (global locations)		18	11.5%
Fundamental design		10	6.4%
No Answer		133	84.7%

How important are the following characteristics when designing the location of life saving appliances on board a large passenger vessel?: Ease of access

		Answers	*Ratio*
Very Important		24	15.3%
Important		7	4.5%
Neutral		1	0.6%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		125	79.6%

How important are the following characteristics when designing the location of life saving appliances on board a large passenger vessel?: Proximity to muster station

		Answers	*Ratio*
Very Important		21	13.4%
Important		10	6.4%
Neutral		1	0.6%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		125	79.6%

How important are the following characteristics when designing the location of life saving appliances on board a large passenger vessel?: Deck height

		Answers	*Ratio*
Very Important		15	9.6%
Important		11	7.0%
Neutral		5	3.2%
Not Important		1	0.6%
Un-necessary		0	0.0%
No Answer		125	79.6%

How important are the following characteristics when designing the location of life saving appliances on board a large passenger vessel?: Location (fore, mid aft)

		Answers	*Ratio*
Very Important		9	5.7%
Important		7	4.5%
Neutral		14	8.9%
Not Important		1	0.6%
Un-necessary		0	0.0%
No Answer		126	80.3%

How important are the following characteristics when designing the location of life saving appliances on board a large passenger vessel?: Vessel layout and proximity to other LSA

		Answers	*Ratio*
Very Important		10	6.4%
Important		15	9.6%
Neutral		5	3.2%
Not Important		2	1.3%
Un-necessary		0	0.0%
No Answer		125	79.6%

On vessels you have knowledge or experience of, will the muster station be effective in location and operation for the safe and rapid evacuation of a vessel?			
		Answers	***Ratio***
Yes		19	12.1%
No		2	1.3%
No Answer		136	86.6%

What key areas would allow the muster station to be effective (please select multiple if appropriate)?			
		Answers	***Ratio***
Deck height		6	3.8%
Ship location (fore,mid,aft)		10	6.4%
Available space		15	9.6%
Number of passengers		11	7.0%
Management of muster station		15	9.6%
vessel layout		13	8.3%
No Answer		138	87.9%

What key areas would prevent the muster station from being effective (please select multiple if appropriate)?			
		Answers	***Ratio***
Deck height		0	0.0%
Ship location (fore,mid,aft)		1	0.6%
Available space		1	0.6%
Number of passengers		2	1.3%
Management of muster station		2	1.3%
vessel layout		1	0.6%
No Answer		155	98.7%

What has the largest impact to on-board maintenance of life saving appliances with regard to the vessel crew? (Select one)			
		Answers	***Ratio***
Time spent completing tasks		35	22.3%
Time spent on training courses		13	8.3%
Understanding of tasks required		23	14.6%
Standard of task completion		6	3.8%
Confidence in completing tasks		4	2.5%
No Answer		76	48.4%

What gives you confidence that lifesaving appliances products are ready for use? (Select one)			
		Answers	***Ratio***
Certification		15	9.6%
Age		0	0.0%
Condition		28	17.8%
Manufacturer		3	1.9%
Recent safety check		28	17.8%
Visual indicator of readiness		8	5.1%
No Answer		75	47.8%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): User fit			
		Answers	***Ratio***
Very Important		15	9.6%
Important		46	29.3%
Neutral		15	9.6%
Not Important		2	1.3%
Un-necessary		2	1.3%
No Answer		77	49.0%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): Comfort			
		Answers	***Ratio***
Very Important		8	5.1%
Important		34	21.7%
Neutral		30	19.1%
Not Important		4	2.5%
Un-necessary		3	1.9%
No Answer		78	49.7%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): Ease of use			
		Answers	***Ratio***
Very Important		40	25.5%
Important		33	21.0%
Neutral		6	3.8%
Not Important		0	0.0%
Un-necessary		2	1.3%
No Answer		76	48.4%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): Reliability

		Answers	*Ratio*
Very Important		47	29.9%
Important		21	13.4%
Neutral		7	4.5%
Not Important		0	0.0%
Un-necessary		3	1.9%
No Answer		79	50.3%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): Equipment function

		Answers	*Ratio*
Very Important		46	29.3%
Important		23	14.6%
Neutral		7	4.5%
Not Important		1	0.6%
Un-necessary		3	1.9%
No Answer		77	49.0%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): Location devices

		Answers	*Ratio*
Very Important		32	20.4%
Important		32	20.4%
Neutral		14	8.9%
Not Important		0	0.0%
Un-necessary		3	1.9%
No Answer		76	48.4%

What are the most common comments made about Personal Lifesaving Equipment on board vessels you have knowledge of? And which do you believe need to be solved. (please indicate the importance): Donning / fitment

		Answers	*Ratio*
Very Important		25	15.9%
Important		38	24.2%
Neutral		15	9.6%
Not Important		0	0.0%
Un-necessary		1	0.6%
No Answer		78	49.7%

Looking at the issues listed below about Life Saving Appliances, indicate how important it is to develop a solution. : Survival provisions

		Answers	*Ratio*
Very Important		22	14.0%
Important		35	22.3%
Neutral		15	9.6%
Not Important		5	3.2%
Un-necessary		2	1.3%
No Answer		78	49.7%

Looking at the issues listed below about Life Saving Appliances, indicate how important it is to develop a solution. : Comfort

		Answers	*Ratio*
Very Important		6	3.8%
Important		42	26.8%
Neutral		22	14.0%
Not Important		9	5.7%
Un-necessary		1	0.6%
No Answer		77	49.0%

Looking at the issues listed below about Life Saving Appliances, indicate how important it is to develop a solution. : Ease of use

		Answers	*Ratio*
Very Important		48	30.6%
Important		26	16.6%
Neutral		3	1.9%
Not Important		2	1.3%
Un-necessary		0	0.0%
No Answer		78	49.7%

Looking at the issues listed below about Life Saving Appliances, indicate how

		Answers	*Ratio*
Very Important		58	36.9%
Important		18	11.5%
Neutral		4	2.5%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		77	49.0%

Looking at the issues listed below about Life Saving Appliances, indicate how important it is to develop a solution. : Equipment function			
		Answers	***Ratio***
Very Important		58	36.9%
Important		19	12.1%
Neutral		4	2.5%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		76	48.4%

Looking at the issues listed below about Life Saving Appliances, indicate how important it is to develop a solution. : Location devices			
		Answers	***Ratio***
Very Important		37	23.6%
Important		31	19.7%
Neutral		11	7.0%
Not Important		0	0.0%
Un-necessary		1	0.6%
No Answer		77	49.0%

Looking at the issues listed below about Life Saving Appliances, indicate how important it is to develop a solution. : Ease of access			
		Answers	***Ratio***
Very Important		49	31.2%
Important		25	15.9%
Neutral		6	3.8%
Not Important		0	0.0%
Un-necessary		1	0.6%
No Answer		76	48.4%

Thinking about current Life Saving Appliances, which of the following is the most frequent cause of failure. (Select as many as required)			
		Answers	***Ratio***
Winch		33 47	21.0%
Foundations		3	1.9%
Sheaves		15	9.6%
Davits		25	15.9%
Ropes		30	19.1%
Rope Terminations		11	7.0%
Hooks		26	16.6%
Release mechanism		35	22.3%
Steering		13	8.3%
Engine Controls		24	15.3%
Inflation		7	4.5%
Bowsing		10	6.4%
No Answer		76	48.4%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Preparation for launching			
		Answers	***Ratio***
Very Difficult		2	1.3%
Difficult		12	7.6%
Neither difficult or easy		35	22.3%
Easy		26	16.6%
Very Easy		5	3.2%
No Answer		77	49.0%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Turning out			
		Answers	***Ratio***
Very Difficult		0	0.0%
Difficult		7	4.5%
Neither difficult or easy		35	22.3%
Easy		31	19.7%
Very Easy		6	3.8%
No Answer		78	49.7%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Boarding at deck level			
		Answers	***Ratio***
Very Difficult		0	0.0%
Difficult		12	7.6%
Neither difficult or easy		24	15.3%
Easy		37	23.6%
Very Easy		8	5.1%
No Answer		76	48.4%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Lowering to the waterline			
		Answers	***Ratio***
Very Difficult		0	0.0%
Difficult		3	1.9%
Neither difficult or easy		27	17.2%
Easy		40	25.5%
Very Easy		11	7.0%
No Answer		76	48.4%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Use of passage (slide/ chute)			
		Answers	***Ratio***
Very Difficult		1	0.6%
Difficult		9	5.7%
Neither difficult or easy		27	17.2%
Easy		33	21.0%
Very Easy		11	7.0%
No Answer		76	48.4%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Seating of passengers			
		Answers	***Ratio***
Very Difficult		19	12.1%
Difficult		28	17.8%
Neither difficult or easy		23	14.6%
Easy		10	6.4%
Very Easy		1	0.6%
No Answer		76	48.4%

Thinking about current evacuation procedure please rate the following with regard to ability to complete.: Management of passengers			
		Answers	***Ratio***
Very Difficult		20	12.7%
Difficult		29	18.5%
Neither difficult or easy		23	14.6%
Easy		9	5.7%
Very Easy		0	0.0%
No Answer		76	48.4%

In your opinion what risks are associated with Personal Survival Equipment during evacuation? (Please rank importance of each): Incorrect fitment			
		Answers	***Ratio***
Very Important		42	26.8%
Important		46	29.3%
Neutral		13	8.3%
Not Important		1	0.6%
Un-necessary		1	0.6%
No Answer		54	34.4%

In your opinion what risks are associated with Personal Survival Equipment during evacuation? (Please rank importance of each): Trip hazard			
		Answers	***Ratio***
Very Important		25	15.9%
Important		46	29.3%
Neutral		29	18.5%
Not Important		2	1.3%
Un-necessary		1	0.6%
No Answer		54	34.4%

In your opinion what risks are associated with Personal Survival Equipment during evacuation? (Please rank importance of each): Movement impairment			
		Answers	***Ratio***
Very Important		40	25.5%
Important		50	31.8%
Neutral		10	6.4%
Not Important		1	0.6%
Un-necessary		2	1.3%
No Answer		54	34.4%

In your opinion what risks are associated with Personal Survival Equipment during evacuation? (Please rank importance of each): Personal injury during use			
		Answers	***Ratio***
Very Important		35	22.3%
Important		42	26.8%
Neutral		20	12.7%
Not Important		3	1.9%
Un-necessary		2	1.3%
No Answer		55	35.0%

In your opinion what risks are associated with Life Saving Appliances during evacuation? (Please rank importance of each): Fall from height			
		Answers	***Ratio***
Very Important		62 [47]	39.5%
Important		30	19.1%
Neutral		7	4.5%
Not Important		3	1.9%
Un-necessary		1	0.6%
No Answer		54	34.4%

In your opinion what risks are associated with Life Saving Appliances during evacuation? (Please rank importance of each): Entrapment			
		Answers	***Ratio***
Very Important		20	12.7%
Important		53	33.8%
Neutral		27	17.2%
Not Important		3	1.9%
Un-necessary		0	0.0%
No Answer		54	34.4%

In your opinion what risks are associated with Life Saving Appliances during evacuation? (Please rank importance of each): Equipment failure			
		Answers	***Ratio***
Very Important		58	36.9%
Important		35	22.3%
Neutral		8	5.1%
Not Important		1	0.6%
Un-necessary		0	0.0%
No Answer		55	35.0%

In your opinion what risks are associated with Life Saving Appliances during evacuation? (Please rank importance of each): Overloading			
		Answers	***Ratio***
Very Important		41	26.1%
Important		38	24.2%
Neutral		21	13.4%
Not Important		2	1.3%
Un-necessary		0	0.0%
No Answer		55	35.0%

In your opinion what risks are associated with Life Saving Appliances during evacuation? (Please rank importance of each): Incorrect use of equipment			
		Answers	***Ratio***
Very Important		63 47	40.1%
Important		34	21.7%
Neutral		3	1.9%
Not Important		1	0.6%
Un-necessary		1	0.6%
No Answer		55	35.0%

In your opinion what risks are associated with Life Saving Appliances during evacuation? (Please rank importance of each): Human error			
		Answers	***Ratio***
Very Important		76	48.4%
Important		25	15.9%
Neutral		1	0.6%
Not Important		0	0.0%
Un-necessary		0	0.0%
No Answer		55	35.0%

For the above-mentioned risks which of the following would have the greatest impact on reducing the risk?			
		Answers	***Ratio***
Clear instructions		7	4.5%
Improved training		31	19.7%
Easy to understand equipment		53	33.8%
Design of access arrangement		13	8.3%
No Answer		53	33.8%

What is your experience of using Life Saving Appliances?			
		Answers	***Ratio***
None		1	0.6%
Passenger		4	2.5%
Basic crew training		13	8.3%
Evacuation station team member		2	1.3%
Evacuation station leader		18	11.5%
Craft crew		8	5.1%
Craft leader		57	36.3%
No Answer		54	34.4%

In your opinion how long do you expect to be in a survival craft if you are out of sight of land or any other vessel and awaiting rescue. (in average northern hemisphere conditions)			
		Answers	***Ratio***
0 - 12 hours		25	15.9%
13 - 24 hours		47	29.9%
2 - 5 days		28	17.8%
5 days +		4	2.5%
No Answer		53	33.8%

In your opinion how long would you expect a person to survive in the ocean whilst wearing a Lifejacket and normal outdoor clothing? (in average northern hemisphere seas)			
		Answers	***Ratio***
less than 30 mins		10	6.4%
1 - 12 hours		52	33.1%
13-24 hours		23	14.6%
2 - 5 days		15	9.6%
5 days +		4	2.5%
No Answer		53	33.8%

Which features of the current LSA need changing to allow access and safe passage for mobility impaired people?			
		Answers	***Ratio***
Access route		22	14.0%
Seating arrangement		58	36.9%
Facilities for securing chair / stretcher		23	14.6%
No Answer		54	34.4%

In your opinion what would improve Personal survival equipment?: Clear instructions			
		Answers	***Ratio***
Largest improvement		38	24.2%
Above average		70	44.6%
Average		31	19.7%
Minimal improvement		9	5.7%
No improvement		5	3.2%
No Answer		4	2.5%

In your opinion what would improve Personal survival equipment?: Improved training			
		Answers	***Ratio***
Largest improvement		49	31.2%
Above average		62	39.5%
Average		30	19.1%
Minimal improvement		5	3.2%
No improvement		5	3.2%
No Answer		6	3.8%

In your opinion what would improve Personal survival equipment?: Easy to understand equipment			
		Answers	***Ratio***
Largest improvement		79	50.3%
Above average		57	36.3%
Average		13	8.3%
Minimal improvement		2	1.3%
No improvement		2	1.3%
No Answer		4	2.5%

In your opinion what would improve Personal survival equipment?: Improved donning and fit			
		Answers	***Ratio***
Largest improvement		59	37.6%
Above average		55	35.0%
Average		34	21.7%
Minimal improvement		4	2.5%
No improvement		1	0.6%
No Answer		4	2.5%

In your opinion what would improve Life Saving Appliances?: Clear instructions			
		Answers	***Ratio***
Largest improvement		50	31.8%
Above average		71	45.2%
Average		25	15.9%
Minimal improvement		6	3.8%
No improvement		2	1.3%
No Answer		3	1.9%

In your opinion what would improve Life Saving Appliances?: Improved training			
		Answers	***Ratio***
Largest improvement		66	42.0%
Above average		60	38.2%
Average		23	14.6%
Minimal improvement		3	1.9%
No improvement		1	0.6%
No Answer		4	2.5%

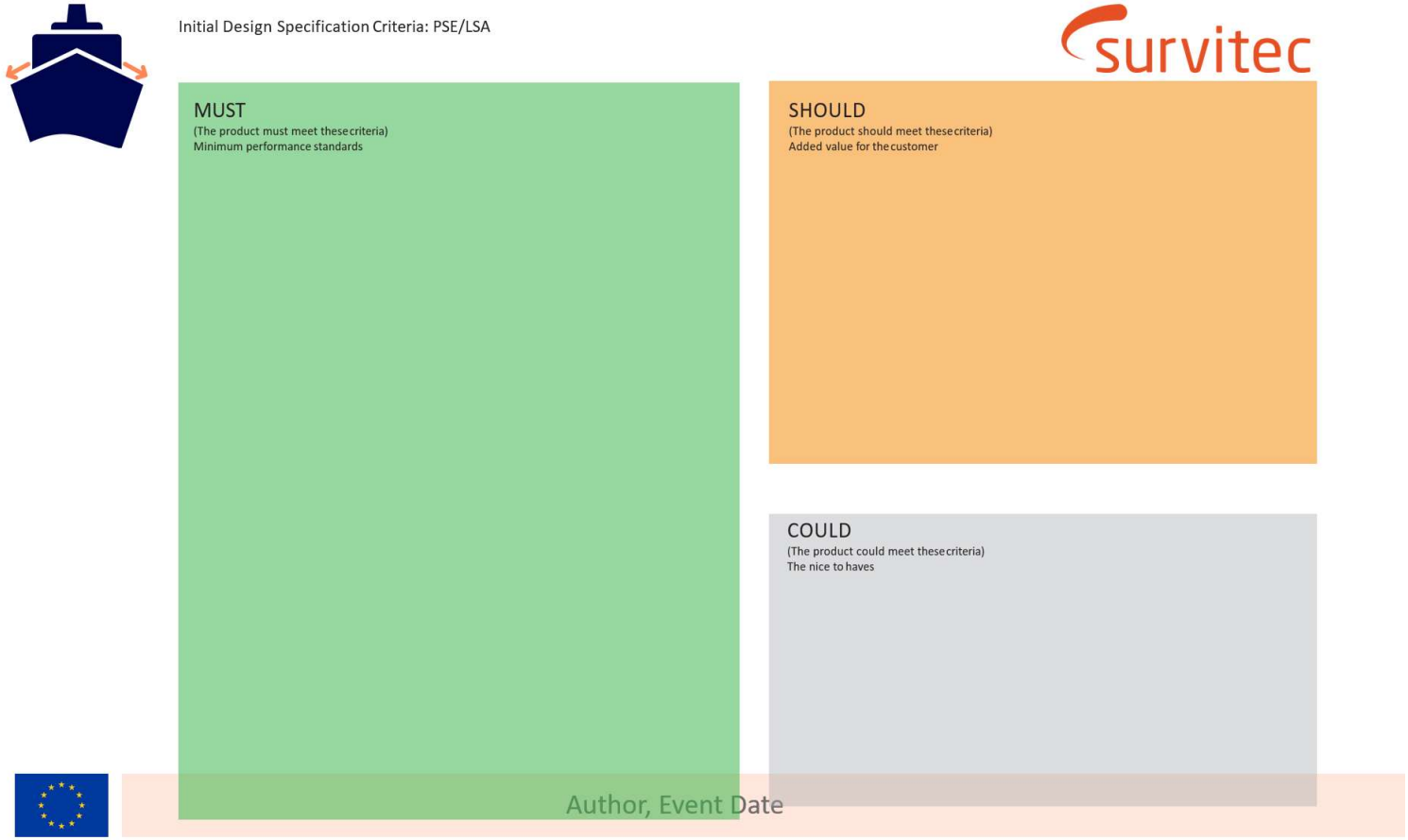
In your opinion what would improve Life Saving Appliances?: Easy to understand equipment			
		Answers	***Ratio***
Largest improvement		96	61.1%
Above average		41	26.1%
Average		17	10.8%
Minimal improvement		0	0.0%
No improvement		1	0.6%
No Answer		2	1.3%

In your opinion what would improve Life Saving Appliances?: Embarkment process			
		Answers	***Ratio***
Largest improvement		63	40.1%
Above average		54	34.4%
Average		32	20.4%
Minimal improvement		3	1.9%
No improvement		1	0.6%
No Answer		4	2.5%

In your opinion what would improve Life Saving Appliances?: Deployment procedure			
		Answers	***Ratio***
Largest improvement		81	51.6%
Above average		51	32.5%
Average		20	12.7%
Minimal improvement		2	1.3%
No improvement		1	0.6%
No Answer		2	1.3%

Annex 3: Prioritisation Design Criteria Template

A Blank template that is used to assist in capturing the Design Criteria and prioritising them - Must, Could and Should requirements.



Annex 4: Future Requirement Specifications - PSE

ID	Function	Expected Performance	Specific Performance
1	**Provide adequate protection from drowning**	Provide protection to the airways and from wave splash. Prevent channeling of water onto the face. Provide an average freeboard of not less than 130mm, individual no less than 120mm (+/-10mm). Provide an average face plane angle of not less than 40º from the horizontal, individual not less than 30º. Provide an average torso angle of not less 30º from the vertical, individual not less than 20º. Buoyancy >150N (graded to size)	BS EN ISO 12402-3:2006+A1:2010 5.6.1.6 Performance BS EN ISO 12402-9:2006+A1:2011 5.6. Human subject performance test MSC200(80) as amended 2.8.6 Static balance measurements
2	**Self-right an unconscious person**	Self-right an unconscious person within 5 seconds when tested in accordance with	ISO 12402-(3):2006+A1 :2010ISO 5.6.3.2 When tested in accordance ISO 12402-9:2006, 5.6
3	**Provided with means of recovery**	Lifting becket which must withstand a horizontal load of 3200N for 30mins when wet or 2400N for child when wet. Shoulder strength test for 30mins of 900N for Adult or 700N for child	BS EN ISO 12402-9:2006+A1:2011 5.5.2.4 Lifting loop test 5.5.2.3.2 Horizontal load test 5.5.2.33 Vertical load test BS EN ISO 12402-8:+A1:2011

		Floating buddy line (to have a breaking strain between 750N and 1500N)	5.4 Buddy Line
4	**Provide in water performance representative of use,**	Tested on a minimum of 12 Adult test subjects or a minimum of 9 child test subjects as outlined in Testing must be conducted in both swimwear and clothing deemed suitable for heavy weather. Available in three sizes, Infant, Child and Adult: Less than 15Kg, 15 - 43Kg, 43Kg+ Fit chest girth of 1750mm - can be catered for with an accessory. Must maintain 95% buoyancy over 24hrs when immersed in fresh water.	MSC 200(80) 2.7.2 Test subjects 2.9.1 Infant and Child test subjects MSC 207(81) 2.2.1.2 Lifejacket sizes MSC 207(81) 2.2.1.3 Persons of 140K MSC 81(70) as amended 2.2 Buoyancy test
5	**Be suitable to be worn with or without heavy weather clothing**	Provide the in-water performance representative of use, tested on a minimum of 12 Adult test subjects or a minimum of 9 child test subjects.	MSC 200(80) 2.7.2 Test subjects 2.9.1 Infant and Child test subjects
6	**Testing must be conducted in both swimwear and clothing deemed suitable for heavy weather**	Provide the in-water performance representative of use.	Clothing defined as: Underwear T-shirt Jumper Jeans

			Socks Training shoes Offshore Jacket Offshore trousers
7	**Enable the user to board rescue or survival crafts**	Be able to board a Liferaft or a rigid platform with its surface 300 mm above the water surface.	MSC 81(70) 2.9.9 Swimming and water emergence test
8	**Be simple to don and adjust securely**	Be capable of being donned correctly within 1 minute. Be a secure fit – ensure adequate protection from drowning following a 1m jump without holding the device. Not dislodge or cause harm during a 4.5m jump during which the device maybe held. Maintain sufficient protection from drowning (MFB) following the jump test. Be marked clearly with instructions for use, applicable warnings, conditions of use, in particular, providing information on compatibility and advise on limitations for use. No language issues, ideally use pictograms only.	MSC 200(80) 2.7.4.1 Test without instruction 2.7.4.2 Test after instruction MSC 200(80) 2.8.8 Jump and drop test BS EN ISO 12402-3:2006+A1:2010 6 Marking
9	**Provide means of identification night and day**	Be fitted with 400cm2 of SOLAS approved reflective tape. Conspicuous colour within the range detailed in	IMO Res. A.658(16) Annex 2 BS EN ISO12402-7:2007+A1:2011 4.3.3 Colour

		Fitted with a whistle (ISO12402-8) Light Provide the facility to integrate smart tech & allow its easy upgrading.	BS EN ISO12402-8:2006+A1:2011 5.2 Whistle MSC 81(70), MSC 200(80) MSC226(82) MSC200(80) 2.8.8 Jump and drop test BS EN ISO12402-9:2006+A1:2011 5.5.3 Rotating shock bin test
10	**Not cause undue restriction to abandonment**	Ensure that the System has high Reliability. Comfortable to wear on deck, during recovery or whilst seated in survival craft for at least 24 hrs. Reduce chance of lifejacket becoming caught/snagged. Should not interfere with other passengers when sitting back to back or against bulkheads.	BS EN ISO 12402-3:2006+A1:2010 5.6.1.3 Performance 5.6.1.4 Performance
11	**Not cause injury or harm to the user**	Where possible accommodate all demographics and including bariatric, partially sighted and disabled and if possible “live” tested with manikins or selected representative subjects. Withstand drop test of 4.5m when jumping into the water with any accessories attached.	MSC200(80) 2.8.8 Jump and drop test
12	**Passenger Safety**	Reduce snagging hazards e.g. whistle, oral tube.	

		Prevent trip hazards	
13	**Crew visibility**	Colour coded lifejackets for crew and passengers e.g. Yellow = Crew, Orange = Passengers Be self-illuminating Day-Glo and nightglow.	BS EN ISO12402-7:2007+A1:2011 4.3.3 Colour MSC 81(70), MSC 200(80) MSC226(82)
14	**Storage**	Require minimal storage space. Ease of access	
15	**Self-Rescue**	Location device to interact with other "smart technologies" such as self-guiding evacuation systems. Include "homing" device to bring family members together. Provide the facility to communicate with the Vessel, providing status information. Passive UHF RFID	MSC200(80) 2.8.8 Jump and drop test BS EN ISO12402-9:2006+A1:2011 5.5.3 Rotating shock bin test
16	**Haptic, Optic, Acoustic Integration**	Have audio receiving system incorporated in Lifejacket neck area. Have Optical display incorporated in Lifejacket neck area. Have Haptic system incorporated in Lifejacket neck area.	
17	**Provide protection from wave splash and wind chill**	Be fitted with a Spray hood. Be fitted with a thermal hood.	BS EN ISO 12402-8:2006+A1:2011 5.5 Spray hood

		Some protection from hypothermia and/or be able to regulate thermal control of body temperature.	
18	**Secure fitting of lifejacket**	Some form of automatic tensioning of the belt (Inflatable) Automatic fit and self-adjusting	
19	**Hygienic protection**	Be fitted with Protective replaceable cover.	
20	**Inflatable chambers**	If inflatable, have a “smart” inflator for gas inflation system. If Lifejacket is inflatable, to be self-inflating or expanding that requires no compressed gas system.	

Annex 5: Future Requirement Specifications – Soft Shell LSA

	Functional Requirements	*Expected Performance*	*Specific Performance Requirements*
1	***Provide Comfort***	Passengers must have direct access to the LSA and be protected from the weather conditions.	Demonstrate that: - there are no obstructions on the route to and into the LSA;
			- the route to the LSA is covered as far as practical;
			- after entering the LSA station, the persons are protected from the external environment.
		Provide sufficient space for all passengers, wearing heavy weather clothing and PSE, and be seated safely and comfortably for the expected time to recovery.	Demonstrate by means of a seating tests, that there is sufficient space in the craft for the specified normal capacity. All persons must be wearing a recognised lifejacket/PSE. All persons should be wearing “heavy weather” clothing, as per PSE requirements. Clothing defined as: - Underwear - T-shirt - Jumper - Jeans - Socks - Training shoes - Offshore Jacket - Offshore trousers

			Demonstrate that the seats are sufficiently strong to support persons weighing up to 100 kg.
		Allow the transfer of mobility impaired persons and provide appropriate space in the survival craft.	Confirm the max stretcher capacity of the craft and the impact, if any, on overall normal capacity. Stretcher dimensions to be 2130mm Long by 610mm Max Width
			2130 x 610 max width
			If there are dedicated seats for mobility impaired persons, demonstrate that they are accessible, and secure with appropriate restraints.
		Be designed for average passenger weight of 82.5 kg.	All testing and verification are to be carried out using persons of an average weight of 82.5kg or ballast equivalents to 82.5kg per person.
		Provide a habitable environment for all persons, providing prevention against hypothermia and hyperthermia.	The Survival craft must insulate the persons onboard from the cooling effects on body temperature of seawater temperature.
			The Survival Craft must provide protection from the actions of wave and rain, and if fitted with access doorways, these must be closed and opened from the inside and outside using a gloved hand. These actions must be able of be completed with a fully occupied craft.
			The Survival Craft must provide a means to ensure that, in any 60-minute period, the CO_2 level within the craft does not exceed 5000ppm, when fully occupied, all weather side doorways/access arrangements are closed or secured and any propulsion units running.

		Provide facilities to provide survival for at least 24 hrs. & extended water-making.	Sufficient Food for Survival for 24 hours for all persons onboard the Survival Craft must be provided. The Food ration should be packaged so that it can easily managed and distributed.
			There must be provision of 0.5L of fresh water per person per 24-hour period available. If mechanically generated, then suitable storage must be provided, and a backup arrangement means of generating fresh water must be available.
2	***Integrity***	Craft canopy should be in conspicuous colour.	Conspicuous colour within the range detailed in BS EN ISO12402-7:2007+A1:2011 4.3.3 Colour
		Provide high reliability to effect evacuation, escape and survival.	Have a Reliability Plan to demonstrate the performance including risk analysis. The following reports are to be generated: -HAZOPS -HAZID -FTA The FTA should demonstrate that the System has a probability of incomplete evacuation and escape that is ALARP.
			Demonstrate through an appropriate number of full System Tests that the System can successfully deploy and effect escape within the prescribed timeline.
		Provide Evacuation Instructions which are not language dependent.	All labelling and instructions must be in pictogram format. No text to be used.

		The System must be resistant to the marine environment.	All components must be suitable for use in a marine environment and not deteriorate between services. All metal components to be marine grade or suitably protected. All materials to conform with ISO142, ISO2411, ISO4892-4, ISO4675, ISO7854, ISO6065, ISO5978, ISO3011. Inflation System if fitted to comply with ISO 15738.
		The System must be designed so as to reduce ALARP of human error during install, maintenance, training and use.	ALARP study (and demonstration if necessary) to be carried out to validate that the System has been designed to reduce the opportunity for human error during install, maintenance training and use.
		Provide a safe environment when damaged.	Demonstrate separately that with each of the key chambers damaged, there is sufficient freeboard to maintain the safety of the persons onboard.
			Demonstrate that if flooded, the craft is stable, and the water can be removed effectively.
			Demonstrate that if only partially loaded the craft is stable with 50% of persons onboard in one half of the craft.
3	***Training***	Training & suitable equipment, which is current & appropriate, must be available so that crew can train offline without using live equipment.	Training equipment, which allows the Crew to simulate frequently the deployment, boarding, craft and escape actions, must be available onboard. Training Syllabus's and records must be in place to support the training equipment. Training material to make passengers aware of the equipment must be available.

			Training Syllabus's and records must be in place to support the training equipment.
			Training material to make passengers aware of the equipment must be available.
4	***Function***	Deploy by one person from the bridge or the evacuation station using minimum number of actions, automating ALARP the process.	Demonstrate by means of deployments - local and remote activation.
			Demonstrate the backup actions are effective at deploying the system if necessary.
			Demonstrate that the deployment sequence, if more than one action is unambiguous and cannot be actioned incorrectly.
			Validate that the number of actions to deploy is ALARP.
		Have the ability to deploy, board & provide for escape from the vessel in distress in less than 30 mins, independent of the vessels power supply.	Demonstrate by means of a full test - the deployment, evacuation and escape can be achieved with 30 mins.
			It should be demonstrated that when persons of reduced mobility are evacuated, it does not adversely affect the evacuation rate. Appropriate timings and rates are to be captured, so that the capacity of the system in 30 mins can be determined if a population of 10% of mobility impaired persons is included in the evacuation and escape.
			Demonstrate that the equipment can be deployed in a combined list & trim angle (combined inclined angle).

		Be functional with the maximum damage conditions of the ship and allow effective boarding of all demographics onboard.	Demonstrate that the System can be boarded by all types of persons in the combined inclined angle condition.
		Have dry boarding passage, which ALARP reduces injury to persons.	Demonstrate that the Passage does not generate a significant hazard in its minimum and maximum conditions.
		Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).	Demonstrate that the key components of the System operate effectively at ambient temperature.
			Verify the operation of the equipment at elevated and low temperature, according to where the vessel is to be in service. The temperature to +/- 10 deg C pf the vessel's operating temperature.
			Demonstrate or validate that if appropriate, key components are not adversely affected by humidity and condensation.
		Provide the possibility to board, escape and make way in sea state associated to Beaufort 7.	Validate the operation of the equipment in a 4.5m Hs and 30 kts (55 km/h) wind. This may be means of modelling/analysis and real-world empirical data.
		Have technology for electronic counting system and monitoring of the evacuation, which is interactive with the vessel, (including SafePASS Smart technology).	The LSA should be fitted with a system to count the number of persons, irrespective of mobility, who enter the passage/board the craft. This System should display this information locally in the LSA station and in the Emergency Control Centre.
			The operation of the System should be demonstrated during a simulated evacuation.

		Integrated as far as practical into vessel, so as to provide scope for multi-use and flexible vessel layouts	The System is to be designed so that it has a configuration which can installed in a position other than an open boat deck.
			The System is to be designed so that it can be installed in a Muster Area, to allow direct entry into the LSA and ensure persons with reduced mobility are not delayed in the evacuation.
		When stowed, “advertise” what it does.	Provide appropriate details of the System when stored onboard by means of markings, pictograms, video screens or suitable media to explain the function, basic operation and capability of the novel LSA.
		As far as practical in the event of sinking provide means of floating free	Document the sequence of events that will allow the equipment to float free of its storage arrangement in the event of a catastrophic sinking.
		Be either self-righting or provide means of boarding and protection if inverted.	If craft is self-righting, then this should be demonstrated by inverting the craft on open water and the craft righting itself without assistance (including wind or wave). If craft is not self-righting, then it must be fitted with a means of boarding from the water, be fitted with suitable hand holds and fitted with a means of providing shelter from the weather. The means of protection must be a highly visible colour.
		Include a System Status monitoring system (that can be easily upgraded).	The LSA should be fitted with a monitoring system that captures data on the status of critical components in the System while it is stored e.g. cylinder pressures. Critical components are ones which in the event of not being fully functional/operational could result in a delayed or failed evacuation or escape.

Annex 6: Future Requirement Specifications – Hardshell LSA

Function	*Performance*
OPERATION	Provide Passenger safety (comfort) for at least 24 hrs.
	Be of sufficient strength for the intended conditions.
	Sea keeping and no collision requirements (launch à safe distance)
	ALARP deployment, which can also be remotely activated
	ALARP integration in lay out on board ship, easy to find, safe to board.
	ALARP design to cover all demographics, pre-injured people, stretcher handling.
	Be fully functional as escape route, always, also in port.
	Integrated as far as practical into vessel, so as to provide scope for multi-use and flexible vessel layouts
	Evacuation instructions independent of language
COMFORT:	ALARP Space, including climate issues, cold weather, PSE etc.
	ALARP fresh air and cooling/heating – hypothermic protection
	ALARP accessibility for all demographics in the worst-case damage condition for the vessel

	Passenger weight to allow for increase with respect to current SOLAS requirements. 95 kg
	ALARP solutions for long rescue times and necessity to be in LSA for more than 24h.
	ALARP probability for injury.
	Dedicated space for persons in need of assistance
	Be capable of operating in the environmental envelope for the vessel concerned (temperature & humidity).
	Perform as full habitat in any condition and over longer periods of time.
PERFORMANCE:	FMECA / negative test documentation to measure system and functional reliability.
	Escape and make way in sea state associated to at least Beaufort 7.
	Be able to evacuate the full capacity in less than 30 mins (similar to ISO/CD 16707)
	Be functional with the maximum damage conditions of the ship.
	Functional requirements:
	Operable independently of ship's power supplies
	Location devices, satellite, GPS, EPIRB, ++
	Provide means of efficient communication
	Hands on training availability which is ALARP

	Integrated technology for condition monitoring and electronic counting & evacuation evaluation
	ALARP maintenance
	ALARP easy to educate, make PAX aware, intuitive use, and advertises function

(Note – Specific Performance requirements will be added as required during subsequent Tasks)

Annex 7: Future Requirement Specifications – Combined LSA

Zone	Design requirement	Functional requirement
Evacuation	Dry shod evacuation	One-by-one evacuation through slide or chute
	All evacuated accounted for	Counting and identification of all evacuated persons
	Evacuation of all demographic groups	All groups of persons shall be able to be handled in the escapeway
	ADA group & Injured persons	Special need persons shall have equal access through the escapeway
	Average passenger weight 82.5 kg	No weight or size restrictions
	Shall be able to evacuate full capacity within 30 minutes.	Have several escape ways to insure redundancy
	Evacuation possible by 20/10 list/trim	Escapeway (slide or chute) to fulfil list/trim requirement
	Dead ship	The LSA shall provide it own power source
	Avoid human errors.	Be automatic as fare as feasible

	Can be launched by one person.	One-person functionality
Rescue	Manageability	The survival craft shall be self-propelled.
	Easy to board from the water.	The craft shall be equipped with clear and easily accessible entrances, that support entry from the water.
	Injured persons	The survival craft shall be able to support 2-4 person on stretcher.
	Visibility of the craft	The craft needs to be in a conspicuous colour.
Safe	Be able to keep the nautical position.	The craft shall be self-propelled.
	Protect against hypothermia	Flor and seating arrangement elevate from water level
	Sustainable in the marine environment	Materials shall be resistant to the influence of the environment.
	By design prevent injuries.	Be designed without sharp and hard elements.
	Operative under all whether conditions	Temperature, humidity and wind not to affect the safe operation.

(Note – Specific Performance requirements will be added as required during subsequent Tasks)