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# Deliverable D05.1 Definition of generic ships

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## Abstract

This report presents the selection process and the definition of generic ro-ro ships utilized in the LASH FIRE project for the evaluation of new fire safety solutions. Three main categories of ships were arranged (ro-pax ships, ro-ro cargo ships and vehicle carriers) where one representative existing ship in each category was selected; the ro-ro passenger generic ship Stena Flavia, ro-ro cargo generic ship Magnolia Seaways and vehicle carrier generic ship Torrens. In the selection, consideration was primarily given to the arrangement of ro-ro cargo spaces, in addition to passenger and cargo capacity, gross tonnage and length of the ship in comparison to the statistical data of the world fleet.



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## 1 Executive summary

## 1.1 Problem definition

The LASH FIRE project aims to develop and demonstrate operational and design solutions which strengthen the fire protection of ro-ro ships in all stages of a fire. Twenty specific challenges have been identified, which will be addressed by new solutions developed and demonstrated with regards to performance and ship integration feasibility. Real ship application cases are important, as a starting point for the development, and later for the evaluation and demonstration of ship integration feasibility as well as for cost quantification. Representative generic ships were therefore required, covering all types of ro-ro ships and all types of ro-ro spaces, namely closed ro-ro spaces, open ro-ro spaces and weather decks.

The main challenges in the generic ships selection process were to represent the world ro-ro fleet as well as to represent the project application areas, targeted by developed solutions. Further, many ro-ro space type arrangements, ships dimensions, cargo and passenger capacities exist in the world's ro-ro fleet, and the number of selected generic ships needed to be manageably low.

## 1.2 Technical approach

One of the ambitions in the LASH FIRE project, in WP04, is to construct a risk model based on the type of ro-ro space (and not based on the type of ship, as previous FSAs), aligned with the regulations which are based on the type of ro-ro space, as described in D04.2 'Ro-ro space fire database and statistical analysis report'. An objective in WP05 was therefore to obtain generic ships with a variety of both ro-ro space types and ro-ro ship type categories. The selection also aimed to cover most of the ro-ro world fleet according to statistical data and trends. The generic ship selection process was divided in stages as follows:

- 1. Preliminary selection
  - Definition of ro-ro ship type categories
  - Selection of generic ships within WP05 and exchange of concise input with D&D WPs and WP04
- 2. Evaluation
  - Evaluation of the generic ships with respect to the specific application area (ro-ro space type), specific D&D WPs development requirements and world fleet statistical data
- 3. Final selection
  - Final selection and update of the generic ship definitions
  - Provision of specific reference data to D&D WPs

In the selection process, priority was primarily given to the arrangement of ro-ro cargo spaces, in addition to passenger and cargo capacity in comparison to the statistical data of the world fleet.

## 1.3 Results and achievements

This report presents the selection process and the definition of generic ships in the three main categories: ro-ro passenger ships, ro-ro cargo ships and vehicle carriers. Further, one representative existing ship in each category was selected. Three selection loops were performed, resulting in the final selection of the ro-ro passenger generic ship (Stena Flavia), ro-ro cargo generic ship (Magnolia Seaways) and vehicle carrier generic ship (Torrens).

Specific input related to the assessed ship types, including 3D models as well as additional requested details were provided to the Development and Demonstration work packages in LASH FIRE. Further,



several ship visits and interviews with crew were organised, extensive video material on onboard handling of fire were produced to allow a further understanding of the specifics of the types of ro-ro ships considered in the project.

## 1.3.1 Shortcomings and comprimises

Due to a large variety in ship designs, including ro-ro space type arrangement, ship main particulars, etc. within each ro-ro ship type category, the selected ships will not ideally represent all ro-ro ships in the world fleet within the specified selection parameters. For a better representation of the world fleet against the statistical data, several ships of each ship category should be selected. Hence, the performed selection with only one ship per ship type category may be found inappropriate to represent the whole world fleet in the assessment of the developed solutions. Further, priority was given to the ro-ro space arrangement, with the main objective to represent all ro-ro space types for each ship type category, having in mind the ambitions in the LASH FIRE project to construct a risk model based on the types of ro-ro spaces. This approach also made the selection less representative of the world fleet, even if it may better reflect the effectiveness of solutions depending on ship particulars.

## 1.4 Contribution to LASH FIRE objectives

One of the main LASH FIRE objectives (Objective 2) is addressed by the ship integration work package (WP05), and selection of the generic ships:

LASH FIRE will evaluate and demonstrate ship integration feasibility and cost of developed operational and design risk control measures for all types of ro-ro ships and all types of ro-ro spaces.

Representation of all ro-ro ships and all types of ro-ro spaces was achieved through the work on generic ship selection reported in this deliverable, which also addresses the goal for Action 5-A in WP05:

Action 5-A: Define generic ro-ro ships for evaluation of risk control measures, with basis in characteristic ship types in the world fleet and provide for life cycle assessment.

## 1.5 Exploitation and implementation

The results will be used within LASH FIRE as input for the development of technical and operational solutions, and they will be further used to evaluate integration, lifecycle cost assessment and facilitate for demonstration.

The report can be used by external parties as it provides general knowledge on the identification of types and sizes of ro-ro ships and ro-ro spaces. Further, statistics in this deliverable describes the world fleet of ro-ro ships and can provide an objective picture that can be used to draw the current state of the ro-ro fleet. This information can be useful by any actor in the maritime industry.



## 2 List of symbols and abbreviations

BV	Bureau Veritas. Classification society		
CEU	Cargo Equivalent Unit		
D&D WP	Development and Demonstration Work Package (i.e. WP06-WP11) in LASH FIRE		
EMSA	European Maritime Safety Agency		
FSA	Formal safety assesment		
GT	Gross tonnage		
HSC	High speed craft		
LM	Lane Meters		
Грр	Length between perpendiculars		
MAFI	Product name, diesel and electric tractors used worldwide to move containers and semi-trailers and to load and unload ro-ro ships		
RCM	Risk Control Measures		
Passenger ship	Ship which carries more than twelve passengers (cf. SOLAS I/2(f))		
Cargo ship	Any ship which is not a passenger ship (cf. SOLAS I/2(g))		
Ro-pax	Ro-ro passenger ship		
Ro-ro passenger ship	A passenger ship with ro-ro spaces or special category spaces (cf. SOLAS II-2/3.42)		
Ro-ro cargo ship	A cargo ship with ro-ro spaces or special category spaces (cf. SOLAS I/2(g) and SOLAS II-2/3.42)		
Vehicle carrier	A cargo ship which only carries cargo in ro-ro spaces or vehicle spaces, and which is designed for the carriage of unoccupied motor vehicles without cargo, as cargo (cf. SOLAS II-2/3.56)		
WP	Work Package		



## 3 List of definitions

A **weather deck** is a deck which is completely exposed to the weather from above and from at least two sides. (SOLAS II-2/3) [2]

IACS UI SC 86 [3] additionally details that: "For the purposes of Reg. II-2/19 a ro-ro space fully open above and with full openings in both ends may be treated as a weather deck."

For practical purposes, a drencher fire-extinguishing system cannot be fitted on weather decks due to the absence of a deckhead. This criterion is often used for a practical definition of weather decks.

An **open vehicle or ro-ro space** is either open at both ends or [has] an opening at one end and [is] provided with adequate natural ventilation effective over [its] entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides. (SOLAS II-2/3) [2]

A **closed vehicle or ro-ro space** is any vehicle or ro-ro space which is neither open nor a weather deck. (SOLAS II-2/3) [2]



## 4 Introduction

Main author of the chapter: Vito Radolovic, FLOW

One of the LASH FIRE objectives (Objective 2) is to evaluate and demonstrate ship integration feasibility and cost of developed operational and design risk control measures for all types of ro-ro ships and all types of ro-ro spaces.

To consider the diverse world fleet of ro-ro ships, generic categories of ships were defined based on cargo and passenger capacity, cargo type, ro-ro space arrangements, etc. The LASH FIRE study considered open ro-ro spaces, closed ro-ro spaces as well as weather decks, for both newbuilds and existing ships.

Further, LASH FIRE will provide a technical basis for future revisions of regulations by assessing risk reduction and economic properties of solutions (Objective 3). In this regard, only SOLAS compliant ships were of interest for the study.

This report presents the selection process and the definition of generic ships, which are used as starting point for the development of fire safety solutions, to evaluate their integration as well as to facilitate for demonstration of technical and operational solutions developed in the project.

Results of the research project FIRESAFE II [1] were considered, where the world fleet of ro-pax ships was considered and generic categories were defined and assessed. The FIRESAFE II study was used as a starting point for the generic ship selection assessments within LASH FIRE.



## 5 Generic ships selection

Main author of the chapter: Vito Radolovic, FLOW

In this chapter the generic ship selection assessment and results are described according to the technical approach described in Chapter 1.2. Dedicated subchapters include the descriptions of the selection criteria, statistical data used, selection and evaluation process, results and information provided to the D&D WPs.

## 5.1 Selection criteria

The used selection criteria are listed below:

- 1. Existing ships operated by ship operators (members of LASH FIRE consortium), restricted to:
  - a. classed as passenger/ro-ro ship, ro-ro ship, vehicle carrier;
  - b. gross tonnage equal or greater than 5.000<sup>1</sup>;
  - c. delivery date on or after 2000-01-01; and
  - d. classed or having been classed by one of the IACS members.
- 2. One ship per ship type/group (stage 1)
- 3. Cargo space type (closed ro-ro space, open ro-ro space, weather deck)

The criteria 1a. to 1d., with the exception of the delivery date, and gross tonnage were taken from the FIRESAFE II project. Explanations and justification for FIRESAFE II criteria can be found in Ref. [1].

The decision was made to consider only ships of which delivery was on or after 2000-01-01. The reason for that is to focus on ships built in the recent past and newbuilds to be delivered in the near future, for which the results of LASH FIRE aim to be implemented.

Initially, a threshold of 1.000GT was used, as it is commonly used to separate domestic ships from international ships in other FSA studies. LASH FIRE studied different thresholds on a dataset of EU domestic and international ships provided by the EMSA; and a threshold of 5.000GT is considered in WP04 to separate of domestic and international ships. Further, a threshold of 5.000GT was used for the final selection assessment of generic ships in WP05. For further explanations and justification of the gross tonnage criterion, please refer to LASH FIRE deliverable D04.2 'Ro-ro space fire database and statistical analysis report'.

## 5.2 Statistical data supporting the selection

In this section the world fleet statistical data and trend of relevant parameters are presented for the ro-ro ship subgroups:

- 1) Ro-ro passenger ships (Parameters considered: Lpp, GT, lane meters, passenger capacity)
- 2) Ro-ro cargo ships (Parameters considered: Lpp, GT, lane meters, crew capacity)
- 3) Vehicle carriers (Parameters considered: Lpp, GT, CEU capacity, crew capacity)

<sup>&</sup>lt;sup>1</sup> It is to be noted that the gross tonnage criteria equal or greater of 1.000 has been considered for the first selection loop, same as in the FIRESAFE II project.



The following fleet parameters were considered:

- SOLAS ships
- Gross Tonnage >= 5.000 GT
- Ships that have been classed by IACS members during their life
- delivery date >= 2000-01-01 (Ass.1)
- Non HSC: Froude <= 0.5 (Ass.2)

In the following sub sections, the evolution of relevant parameters median at delivery over the years, as well as the first quartile, third quartile (blue zone) and median average over 7 years (dashed line) are illustrated for the ro-ro ship subgroups. The aim was to provide a general overview of the LASHFIRE fleet. The fleet database has been built within WP04, and information was provided to WP05 for the generic ships selection process requirements. For detailed information on the world fleet statistical data, please refer to LASH FIRE deliverable D04.2 'Ro-ro space fire database and statistical analysis report'.

#### 5.2.1 Ro-pax fleet trends vs delivery date

In this section the evolution of the ro-pax fleet relevant parameters (Lpp, GT, lane meters, passenger capacity) median at delivery over the years, as well as the first quartile, third quartile (blue zone) and median average over 7 years (dashed line) are illustrated on Figure 1-4.



Figure 1. Lpp of ro-pax vessels, trend and their 0.25 and 0.75 quantile.





Figure 2. Gross tonnage of ro-pax vessels, trend and their 0.25 and 0.75 quantile.



Figure 3. Lane meters of ro-pax vessels, trend and their 0.25 and 0.75 quantile.





Figure 4.Passenger capacity of ro-pax vessels, trend and their 0.25 and 0.75 quantile.

#### 5.2.2 Ro-ro cargo fleet trends vs delivery date

In this section the evolution of the ro-ro cargo fleet relevant parameters (Lpp, GT, lane meters, crew capacity) median at delivery over the years, as well as the first quartile, third quartile (blue zone) and median average over 7 years (dashed line) are illustrated on Figures 5-8.



Figure 5. Lpp of ro-ro cargo vessels, trend and their 0.25 and 0.75 quantile.





Figure 6. Gross tonnage of ro-ro cargo vessels, trend and their 0.25 and 0.75 quantile.



Figure 7. Lane meters of ro-ro cargo vessels, trend and their 0.25 and 0.75 quantile.





Figure 8. Crew Capacity of ro-ro cargo vessels, trend and their 0.25 and 0.75 quantile.

### 5.2.3 Vehicle carrier fleet trends vs delivery date

In this section the evolution of the vehicle carrier fleet relevant parameters (Lpp, GT, lane meters, crew capacity) median at delivery over the years, as well as the first quartile, third quartile (blue zone) and median average over 7 years (dashed line) are illustrated on Figures 9-12.



Figure 9. Lpp of vehicle carriers, trend and their 0.25 and 0.75 quantile.





Figure 10. Gross tonnage of vehicle carriers, trend and their 0.25 and 0.75 quantile.



Figure 11. CEU capacity of vehicle carriers, trend and their 0.25 and 0.75 quantile.





Figure 12. Crew capacity of vehicle carriers, trend and their 0.25 and 0.75 quantile.

## 5.3 Generic ships selection process

Three main groups of ships were arranged where one existing ship for each ship type group was selected in the first loop (Stage 1), considering the arrangement of ro-ro cargo spaces as the main parameter, followed by passenger and cargo capacity and statistical data of the world fleet:

- 1) Ro-ro passenger ships
- 2) Ro-ro cargo ships
- 3) Vehicle carrier

Preliminary information was exchanged with Development & Demonstration WPs (WP06-WP11) and WP04 in order to receive feedback on expected input from WP05 i.e. selected generic ships.

Received information was evaluated with respect to the selected generic ships, where particular ship types and application areas (ro-ro space arrangement) were further defined in the above groups to assess ship integration (specific D&D action) for a representable range of ro-ro ships and especially for ro-ro passenger ships in the following selection loop (Stage 2).

After the evaluation, a final selection was made (Stage 3), resulting in the detailed information of the selected ships provided in Chapter 7.

The assessment covered the range of ship types and application areas as follows:

#### Ship type subdivision

- 1) Ro-ro passenger ships
- 2) Ro-ro cargo ships
- 3) Vehicle carriers

#### **Application areas**

- arrangement of ro-ro cargo spaces (open ro-ro space, weather deck, closed ro-ro space)
- ro-ro cargo space categories (vehicle spaces, ro-ro spaces, special category spaces)



The FIRESAFE II research project results were considered, Ref. [1], in which the world fleet of ro-pax ships was considered and where generic categories were defined based on a lane meter to passenger capacity ratio. These groups are described in Table 1. At LASH FIRE the decision was made not to further subdivide the ro-pax ships category based on the FIRESAFE parameters, but to focus on the ro-ro space type arrangement.

Figures below on passenger capacity and lane metre capacity are examples picked from the Stena fleet cross check and shall be seen as examples only.							
	For world fleet grouping LM/Pax ratio is used.						
	Ferry RoPax	Large RoPax	Standard RoPax	Cargo RoPax			
General description	RoPax or Ferry with focus on carriage of passengers but which can also carry cargo similar to a <i>Standard</i> <i>RoPax</i> .	RoPax with focus on carriage of cargo and of passengers. High lane metre capacity	RoPax with focus on carriage of cargo and of passengers. Standard lane metre capacity.	RoPax with focus on carriage of cargo.			
Passenger capacity	900-2 300	600-1 500	900-1400	Just enough to carry the number of drivers necessary to load the ro-ro spaces with accompanied trailers. Less than 400.			
Lane metre capacity	1 000-2 300 m	Above 3 000 m	1 000-2 300 m	1 000-2 300 m			
Deck type	Only closed ro-ro spaces or mainly closed ro-ro spaces and a small weather deck.	All three types of ro-ro spaces: closed ro-ro spaces, open ro-ro spaces and weather deck. The size of weather deck is generally medium to large within this category.	All three types of ro-ro spaces: closed ro-ro spaces, open ro- ro spaces and weather deck. The size of weather deck is generally medium to large within this category.	Closed ro-ro spaces and large weather decks.			
LM/Passenger	Less than 2	2-7	2-7 2-7				
Visualization	Stena Superfast	Stena Scandinavica or Hollandica	Stena Flavia or Mersey	Stena Gothica			
Final Grouping	Ferry RoPax	Standard RoPax Cargo RoPax					

Table 1. Description of the main ro-pax groups used in FIRESAFE II.



#### 5.3.1 Selection assessment summary

The generic ship selection assessment was performed in order to clearly present the selection parameters. This was done through a selection matrix, developed to assess existing ships according to the selection criteria defined in Chapter 5.1. with exception to the ship operator. For the scope of the study, existing ships from other operators (not part of LASH FIRE consortium) have been assessed as well.

The analysis of the ro-pax, ro-ro cargo and vehicle carrier fleet was performed with respect to the selection criteria as well as relevant LASH FIRE objectives and ship operators' practices (prevention, detection, extinguishment, decision making, cargo management, etc.). The shortlist of the most promising ships, developed in the first selection loop, is presented in Table 2.

The preliminary evaluation resulted in three selected ships, one per ship type, further evaluated by BV with respect to world fleet statistical data, presented in Chapter 6:

- 1) Ro-ro passenger ship: Victoria seaways (DFDS)
- 2) Ro-ro cargo ship: Stena Scotia
- 3) vehicle carrier: Höegh Trigger

For the description of the preliminary selected ships and their main characteristics, please refer to ANNEX A - Selected generic ships for evaluation – preliminary.

According to the evaluation of the above selection, it was decided to perform a new selection loop to fulfil the "Statistical box" requirements. The main reason to compare the generic ships with the ro-pax ship, ro-ro cargo ship, and vehicle carrier fleets was to ensure that the selected ships were not outliers (as it would not, by definition, well represent the world fleet). Further, the focus was on the variety of types of ro-ro spaces represented by the selected generic ships.

Finally, the selection assessment resulted in three selected ships, one existing ship for each ship type group:

1)	Ro-ro passenger ships:	Stena Flavia (STL)
2)	Ro-ro cargo ships:	Magnolia seaways (DFDS)
3)	Vehicle carriers:	Torrens (WAL)

Descriptions and their main characteristics of the selected ships are given in Chapter 7.



#### Table 2. Generic ships - Selection matrix.

Proposed Vessel	Stena Hollandica	Stena Germanica	Victoria Seaways	Stena Flavia	Stena Gothica	Ulysses	Abel Matutes	Volcan del Teide	Spirit of Britain
IMO	9419163	9145176	9350721	9417919	7826867	9214991	9441130	9506289	9524231
Vessel category	Large RoPax	Large RoPax	Large RoPax	STD Ropax	Cargo RoPax	Large RoPax	STD RoPax	Ferry RoPax	Ferry RoPax
Ship Operator	STENA	STENA	DFDS	STENA	STENA	Irish Ferries	Balearia - Fred Olsen	Naviera Armas	P&O Ferries
Cargo volume type									
Closed RoRo dk, closed aft	X (sides open <2%)	X (sides open <2%)	x	X (sides open <2%)	X (sides open <2%)	x	х	x	х
		x			х	х			х
Closed RoRo dk, open aft	0	(sides open <2%)	x	0	(sides open <2%)	(sides open <2%)	0	0	(sides open <2%)
Open RoRo dk, open aft	X (sides open >10%)	0	x	X (sides open >10%)	0	0	X (sides open >10%)	0	0
Confined weather dk	х	х	0	х	0	0	0	0	х
Large weather dk aft	0	0	x	х	х	0	х	0	0
Large weather dk fwd	0	0	0	0	0	0	0	0	0
Closed car dk, limited height (typ 2.1 m)	х	х	х	0	0	X (hoistable)	0	X (hoistable)	х
Other relevant									
Passenger capacity	1200	1300	600	880	186	1938	900	1500	2000
Total Cargo capacity (lane meters)	5600	3800	2684	2300	1600	4076	2235	2010	3750
Weather dk capacity (lane meters)	330	400	1209	120	500	0	134	0	0
Open dk capacity (lane meters)	1300	0	700	1000	0	0	113	0	0
car deck capacity (meters)			400				247		946

Dranasad Vascal	Primula	Hollandia	Stena	Stone Centia	Höngh Trigor	
Proposed vessel	Seaways	seaways	Forerunner	Stena Scotia	Hoegn Inger	
IMO	9259513	9832585	9227259	9121625	9684988	
Vascal estagen	Cargo DoDo		Cargo DoDo	Cargo DoDo	Vehicle	
vesser category	Cargo Koko	Cargo KORO	Cargo Koko	Cargo Roko	carrier	
Ship Operator	DFDS	DFDS	STENA	STENA	Hoegh	
Cargo volume type						
Closed PoPo dk			х	х		
closed lott	х	x	(sides open	(sides open	х	
ciosed alt			<2%)	<2%)		
Closed PoPo dk open				х		
oft	0	0	0	(sides open	0	
ait				<2%)		
Open RoRo dk, open	×	×	0	0	0	
aft	*	*	0	0	0	
Confined weather dk	х	x	0	0	0	
Large weather dk aft	х	x	Х		0	
Large weather dk fwd	х	х	0	0	0	
Closed car dk, limited	x (hoistable	x (hoistable	0	0	v	
height (typ 2.1 m)	decks)	decks)	0	0	^	
Other relevant						
Passenger capacity	0	0	12	12	0	
Total Cargo capacity	4650	6605	3000	1700	21715*	
(lane meters)	4050	0095	3000	1700	21/15	
Weather dk capacity	1/07	3080	abt 1200	500	0	
(lane meters)	1497	3080	abt 1200	500	0	
Open dk capacity (lane	1/07	1750	0	0	0	
meters)	1497	1750	0	0	0	
car deck capacity	2470 F	600				
(meters)	2479.5	600				

\*= Total sqm divided by 2,5



## 6 Generic ships evaluation

Main author of the chapter: Jérome Leroux, BV

In this section the selection evaluation for the ro-ro ships subgroups with respect to world fleet statistical data is presented.

### 6.1 Ro-ro passenger ship selection evaluation

Evaluation of the selected ro-ro passenger ship was performed by BV with respect to the ro-pax fleet statistical data. It was checked against the gross tonnage, passenger capacity (Pax), cargo capacity (ro-ro lane meters) and length of the ship.

Further to the above parameters, the selected ship has been checked against a ratio between lane meter and passenger number (LM/Pax ratio). According to the FIRESAFE II project results, this ratio was proven to match the characteristics of the ship to a large extent and assumed to be used as a key figure when grouping the world fleet. According to the assessment results of the FIRESAFE II project, the targeted ratio for the generic ro-ro passenger ship in LASH FIRE is between 2 and 4.

In the first loop, statistical data of the ships built after 1970-01-01 have been used. The results showed that the selected parameters were above the upper limits of the statistical box with exception to the passenger capacity which was close to the lower limit. The results are shown in Figure 13.

In the second loop, statistical data of the ships built after 2000-01-01 were used. The reason for that was to focus on ships built in the recent past and newbuilds to be delivered in the near future, for which the results of LASH FIRE are aiming to be implemented.

The results showed that the gross tonnage of the Victoria Seaways is within the interquartile range, slightly below the upper quartile. Length and cargo capacity parameters are above the upper quartile while the Passenger capacity fits into the interquartile range but is close to the lower quartile. The results are shown in Figure 14.





Figure 13. Victoria Seaways (DFDS) ro-pax ship vs ships built after year 1970 (Statistical data<sup>2</sup>).



Figure 14. Victoria Seaways(DFDS) ro-pax ship vs ships built after year 2000 (Statistical data<sup>2</sup>).

According to the evaluation of relevant parameters, Victoria Seaways was not an outlier of the considered fleet of ro-ro passenger ships. However, the relatively small superstructure results in a passenger capacity of only 600, which is not fully representative.

 $<sup>^{\</sup>rm 2}\,{\rm gross}$  tonnage criteria equal or greater of 1000 has been considered



Further investigations have been performed to find the most feasible solution to make the selected generic ship suitable for the LASH FIRE study such as adjusting the passenger capacity parameter, modify the superstructure geometry to increase the passenger capacity and a new generic ship selection loop. Finally, with further investigation of relevant parameters of similar ships <sup>3</sup> presented in the Table 3, it was found that some ships have a larger passenger capacity due to a larger superstructure but combined with a relatively small weather deck. Considering the needs of the project this is a less favourable cargo space arrangement compared to the Victoria Seaways. On the other side, some of the Victoria Seaways sister ships have a larger passenger capacity, close to 1.000 Pax, with the similar superstructure arrangement, which fits into the statistical box. The explanation of this is a different internal superstructure arrangement.

Ship Name	Victorya Seaways	Stena Flavia	Stena Holandica
Length	199	186	240
GT	25675	26904	64034
RoRoLanes	2684	2200	5600
Passengers	600	880	1200
Wather deck	Large, Aft	Small weather deck aft+Weather deck for cars only	Aft
Ship photo		and the state of t	stenaline Stenaline
Ship Name	Trasmediterranea Forza	Superfast I	
Length	199	199	
GT	25518	25757	
RoRoLanes	2499	2684	
Passengers	969	928	
Wather deck	Large, Aft	Large, Aft	
Ship photo	Trasmediterranes	SUPERFAST con	

Table 3. ro-pax ships – evaluation matrix.

Assessment results of the considered ships relevant parameters with respect to statistical data of the ships built after 2000-01-01 are presented in Figure 15.

The Victoria Seaways with an increased Passenger capacity of 1.000 Pax fits well into the LASH FIRE study as the ro-ro passenger generic ship.

<sup>&</sup>lt;sup>3</sup> Stena Flavia [880Pax], Stena Holandica [1.200Pax], and Abel Matutes [~900Pax]) and the Victoria Seaways sister ships (Regina Seaways, Athena Seaways, Trasmediterranea Forza [~969Pax], Superfast I [~928Pax], Superfast II [~928Pax], Rizhao Orient [~500Pax], Tenacia [~500Pax]





Figure 15. ro-pax ships vs ships built after year 2000 (Statistical data).

Finally, the third selection loop was performed for the ro-ro passenger ship although the Victoria Seaways is fulfilling all required parameters. The reason being that after the evaluation of the generic ro-ro cargo ship, showed the most suitable ship was found in the DFDS fleet. This led to a selection of a generic ro-ro passenger ship from the Stena fleet in order to represent generic ships by all ship operators in the LASH FIRE consortium. Therefore, Stena Flavia was selected as generic ro-ro passenger ship for the study. Stena Flavia was also assessed in the previous selection assessment and found suitable. Moreover, Stena Flavia has been used as generic Standard ro-pax ship in the FIRESAFE II project, from which relevant parameters and results should be used for the LASH FIRE study.



Figure 16. Stena Flavia - side view.

Assessment results of the Stena Flavia relevant parameters with respect to statistical data of the ships built after 2000-01-01 are presented in the following diagrams.





Figure 17. Stena Flavia GT vs Statistical data (1).



Figure 18. Stena Flavia GT vs Statistical data (2).





Figure 19. Stena Flavia Lane meters vs Statistical data (1).



Figure 20. Stena Flavia Lane meters vs Statistical data (2).





Figure 21. Stena Flavia Lpp vs Statistical data (1).



Figure 22. Stena Flavia Lpp vs Statistical data (2).





Figure 23. Stena Flavia Passenger capacity vs Statistical data (1).



Figure 24. Stena Flavia Passenger capacity vs Statistical data (2).



## 6.2 Ro-ro cargo ship selection evaluation

Preliminary evaluation of the selected ro-ro cargo ship was performed by BV with respect to the ro-ro cargo fleet statistical data. It was checked against the gross tonnage, cargo capacity (ro-ro lane meters), length of the ship and crew capacity.

According to the evaluation of relevant parameters, gross tonnage is close to the lower quartile where the cargo capacity (ro-ro lane meters) and length of the ship slightly falls out of the interquartile range, below the lower quartile, which is not fully representative.

Assessment results of the considered ship relevant parameters with respect to statistical data of the ships built after 2000-01-01 are presented in Figure 25 and Figure 27.

Further investigations were performed to find the most feasible solution to make the selected generic ship suitable for the LASH FIRE study, such as adjusting the cargo capacity parameter, modify the ship design/arrangement to increase the cargo capacity or a new generic ship selection loop.



Figure 25. Stena Scotia ro-ro cargo ship vs ships built after year 2000 (Statistical data<sup>4</sup>)

Finally, a new selection loop has been performed where Magnolia Seaways, operated by DFDS, has been selected as the ro-ro cargo generic ship.

<sup>&</sup>lt;sup>4</sup> gross tonnage criteria equal or greater of 1000 has been considered.





Figure 26. Magnolia Seaways (DFDS) - side view

Assessment results of the considered ships relevant parameters with respect to statistical data of the ships built after 2000-01-01 are presented in the following diagrams.



Figure 27. Magnolia Seaways (DFDS) ro-ro cargo ship vs ships built after year 2000 (Statistical data)





Figure 28. Magnolia Seaways GT vs Statistical data (1)



Figure 29. Magnolia Seaways GT vs Statistical data (2)





Figure 30. Magnolia Seaways Lane meters vs Statistical data (1)



Figure 31. Magnolia Seaways Lane meters vs Statistical data (2)





Figure 32. Magnolia Seaways Lpp vs Statistical data (1)



Figure 33. Magnolia Seaways Lpp vs Statistical data (2)





Figure 34. Magnolia Seaways crew capacity vs Statistical data (1)



Figure 35. Magnolia Seaways crew capacity vs Statistical data (2)



## 6.3 Vehicle carrier selection evaluation

Preliminary evaluation of the selected vehicle carrier ship was performed by WP04 (BV) with respect to the ro-ro fleet statistical data. It has been checked against the gross tonnage, cargo capacity (number of CEU), length of the ship and crew capacity, as presented in Figure 36.



Figure 36. Selected Vehicle carrier vs ships built after year 2000 (Statistical data<sup>5</sup>)

According to the parameter evaluation, length of the ship is acceptable but close to the upper limit where the cargo capacity (number of CEU) and gross tonnage falls significantly out of the statistical box, above the upper limit, which is not representative for the world fleet.

Further investigations were performed to find the most feasible solution to make the generic ship suitable for the LASH FIRE study, such as adjusting the cargo capacity parameter in the RCM, modify the ship design/arrangement to decrease the cargo capacity or a new generic ship selection loop.

During the successive selection loop, the change of partner in the LASH FIRE consortium (Hoegh withdraw from the project, Wallenius Marine took over Hoegh assignments) lead to a change of the selected ship, to fulfil the selection criteria listed in Chapter 5.1., where Wallenius & Wilhelmsen Traviata was selected. It was found that the Traviata main particulars are similar as the previous selection, the Hoegh Trigger. Traviata is illustrated in Figure 37.

Finally, a new selection loop has been performed where M/V Torrens, operated by Wallenius and Wilhelmsen, has been selected as the vehicle carrier generic ship. Torrens is illustrated in Figure 38.

Assessment results of the considered ships relevant parameters with respect to statistical data of the ships built after 2000-01-01 are presented in Figure 39.

<sup>&</sup>lt;sup>5</sup> gross tonnage criteria equal or greater of 1000 has been considered.





Figure 37. Traviata – Bow/side view.



Figure 38 Torrens – side view.



Figure 39. Torrens vs Vehicle carriers built after year 2000 (Statistical data).

Assessment results of the Torrens relevant parameters with respect to statistical data of the ships built after 2000-01-01 are presented in the following diagrams.




Figure 40. Torrens CEU Capacity vs Statistical data (1).



Figure 41. Torrens CEU Capacity vs Statistical data (2).





Figure 42. Torrens GT vs Statistical data (1).



Figure 43. Torrens GT vs Statistical data (2).





Figure 44. Torrens Lpp vs Statistical data (1).



Figure 45. Torrens Lpp vs Statistical data (2).





Figure 46. Torrens Crew Capacity vs Statistical data (1).



Figure 47. Torrens Crew Capacity vs Statistical data (2).



# 7 Generic ships final selection and main particulars

According to the evaluation results presented in Chapter 6, it was decided to perform a new selection loop in order to fulfil the "Statistical box" requirements. The main reason to compare the generic ships with the ro-pax ship, ro-ro cargo ship, and vehicle carrier fleets was to ensure that the selected ships were not outliers (as it would not, by definition, well represent the world fleet). The new selection loop was performed in line with the selection process and selection criteria defined in 5.1 and 5.3. Further, the main focus was on the variety of types of ro-ro spaces represented by the selected generic ships.

The selection assessment resulted in three selected ships, one existing ship for each ship type group:

- 1) Ro-ro passenger ships: Stena Flavia (STL)
- 2) Ro-ro cargo ships: Magnolia seaways (DFDS)
- 3) Vehicle carriers:

Descriptions of the selected ships and their main characteristics are shown in the following chapters.

Torrens (WAL)

## 7.1 Generic ro-ro passenger ship

Stena Flavia, operated by STENA, was selected to represent the ro-ro passenger generic ship design. The vessel is compliant with all relevant international rules and regulations.

This ship is a common and popular design of a ro-pax of a size of 26.904 GT. It was designed with a capacity of more than 880 persons onboard and a total cargo capacity of 2.200 LM, located in closed ro-ro spaces (lower hold and main deck), open ro-ro space and weather decks, as presented in

passenger cabins are located in the superstructure on Deck 6, above the restaurant on Deck 5. The remaining part of Deck 5 consists of a weather deck for cars, used mostly in the summer season. Below, on Deck 4, is located an open ro-ro space with a small weather deck in the aft. Deck 3 is the main deck with ro-ro lanes throughout the full length of the ship. A small deck only for about 82 cars is located on Deck 2, but the deck is seldom used. Trailers and trucks can also be situated in the lower hold on Deck 1.

The total ro-ro area (excluding casings, etc.) is 9.446m<sup>2</sup>. The distribution of the different ro-ro spaces is as follows: 53% closed ro-ro spaces (lower hold, main deck and car deck), 32% open ro-ro spaces (garage) and 5% weather decks.

Pictures of the generic ro-ro passenger ship are provided in Figure 49, Figure 50 and Figure 51.



Figure 48. Stena Flavia – ro-ro space arrangement – longitudinal section.



Table 4. Stena Flavia - Main characteristics.

GENERAL	Standard RO-PAX
Length overall	185,60 m
Breath moulded	25,50 m
Load Draught	6,16 m
Built	2008
Deadweight	5875 t
Gross tonnage	26904
Net tonnage	8912
Cargo capacity	2.200 LM
Pax capacity	880
Route	Nynäshamn - Ventspils, day and night
Passage time	6-9 hrs
Fire pump 1	110m3/h
Fire pump 2	n/a
Emergency fire pump	110 m3/h
Drencher pump	960 m3/h



Figure 49. Stena Flavia – Stern/Side view.





Figure 50. Stena Flavia – Bow view.

Table 5. Stena FLavia - Description of Cargo decks.

General description	Weather deck for Cars, Deck 5
Dimensions	74 x 23 m
Load capacity	abt. 125 Cars
Extinguishing system	none
Detection	none
Containment	Weather deck
Ventilation	none
Cargo	Standard cars, minivans
General description	Upper deck (Weather + Garage), Deck 4
Dimensions	WD 10 x 24 m
	G 148 x 24,0 m
Load capacity	1.126 LM
Extinguishing system	Drencher system in garage
	none at weather deck
Detection	Smoke detectors in garage
Containment	Open ro-ro space, side openings >10%, open aft
Containment	towards small WD and ramp
Ventilation	Natural+partly mechanical
Cargo	Trailers/trucks
General description	Main Deck, Deck 3
Dimensions	163 x 24 m
Load capacity	914 LM
Extinguishing system	Drencher



Detection	Smoke detectors
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks, various ro-ro units
General description	Car deck in lower hold, Deck 2
Dimensions	80 x 10 m
Load capacity	abt. 83 Cars
Extinguishing system	Drencher
Detection	Smoke detectors
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Standard Cars
General description	Lower hold, Deck 1
Dimensions	80 x 15 m
Load capacity	250 LM
Extinguishing system	Drencher
Detection	Smoke detectors
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks



Figure 51. Stena Flavia – Weather deck.



## 7.2 Generic ro-ro cargo ship

Magnolia Seaways, operated by DFDS, was selected to represent the ro-ro cargo generic ship design. The vessel is compliant with all relevant international rules and regulations.

The total cargo capacity of the ship is 3.831 LM, located in closed ro-ro spaces (lower hold, main deck), open ro-ro spaces (upper deck, garage) and weather decks in the aft and forward of the superstructure, as presented in Figure 52 and Figure 53.

The vessel can accommodate a total of 18 passengers and the passenger cabins and public spaces are located in the superstructure on Deck 5, above the garage. Crew accommodation is arranged both on Deck 5 and Deck 6.

The main characteristics of the generic ro-ro cargo ship are detailed in Table 6 and the ro-ro space particulars are further described in Table 7.



Figure 52. Magnolia Seaways (DFDS) - Ro-ro space arrangement – longitudinal section.



Figure 53. Magnolia Seaways (DFDS) – Ro-ro space arrangement – cross section.





Figure 54. Magnolia Seaways (DFDS) – stern/side view (1).

Table 6	5. Magnolia	Seaways	(DFDS) -	Main	characteristics.
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GENERAL	Cargo RoRo
Length overall	199,9 m
Breath moulded	26,50 m
Load Draught	7,65 m
Built	2003
Deadweight	11.690 t
Gross tonnage	32.523
Net tonnage	9.757
Cargo capacity	3831 LM
Pax capacity	18
Route	Goteborg (SE) – Gent (BE)
Passage time	30 h
Fire pump 1	80/160 m3/h at 60/30 m pressure height
Fire pump 2	80/160 m3/h at 60/30 m pressure height
Emergency fire pump	63 m3/h at 30 m pressure height
Drencher pump	380 m3/h at 80 m pressure height





Figure 55. Magnolia Seaways (DFDS) – bow view.



Figure 56. Magnolia Seaways (DFDS) – stern/side view (2).



Table 7. Magnolia Seaways (DFDS) - Description of Cargo decks.

General description	Weather deck (aft+fwd) + Garage
	WD aft 51.5 x 24 m
Dimensions	G aft 46 x 24 m
Load canacity	WD forward 83.5 X 24 m
	I.272 LIVI
	Example 2xokg powder extinguisher, 17x12kg powder extinguisher
Extinguish	Sprinkler system in garage
	No water monitors on weather deck
Detection	heat detectors, concillium panel on bridge
Containment	CCTV - 4 cameras on WD (no cameras in garage)
	WD + Garage open art and two
Cargo	Trailers/trucks
General description	Upper Deck
Dimensions	170 x 24 m
Load capacity	1.137 LM
Extinguishing system	Sprinkler system, 18x12kg powder extinguishers Foam
Detection	heat detectors
	CCTV – 2 cameras
Containment	Open ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks
General description	Main Deck
Dimensions	175 x 24 m
Load capacity	1046 LM
	Sprinkler system
Extinguish	28x12kg powder extinguishers
	Foam Smoke detectors
Detection	CCTV – 6 cameras
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks
General description	Lower Hold
Dimensions	90 x 17.6 m
	3761M
	Snrinkler system
Extinguishing system	9x12kg powder extinguishers
Detection	Smoke detectors
	CCTV - 1 camera
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks



## 7.3 Generic vehicle carrier

Torrens, operated by Wallenius and Wilhelmsen, was selected to represent the vehicle carrier generic ship design. The vessel is compliant with all relevant international rules and regulations.

The vessel was designed as a vehicle carrier, suitable to carry passenger cars, vans, buses and containers loaded on MAFI trailers and trucks, with a total cargo capacity of 6 500 cars. The cargo area of 55 000 square meters is distributed in closed ro-ro spaces on 12 decks, where decks no. 2, 4, 6 and 8 are liftable and decks no. 1, 3, 5 and 7 have been reinforced for stowage of trucks and trailers. A typical cross section of the cargo area is presented in Figure 57. A stern/quarter ramp-door and a, midship/aft area side ramp-door for loading/unloading vehicles are provided. A set of internal fixed ramps and watertight/gastight doors are provided, giving access to fixed and hoistable decks within the holds. A low pressure "total flooding" CO2 fire extinguishing system has been provided for the protection of the cargo holds, where the cargo spaces of the ship are divided by four gastight divisions, illustrated in Figure 58.

A picture of this ship is provided in Figure 59 and Figure 60. While the main characteristics are detailed in Table 8. The cargo space particulars are further described in Table 9 and Table 10.



Figure 57. Torrens – ro-ro space arrangement - cross section.



Figure 58. Torrens – gas tight zones.



#### Table 8. Torrens - Main characteristics.

GENERAL	Vehicle Carrier
Length overall	199,99 m
Breath moulded	32,26 m
Load Draught	10,525 m
Built	2015
Deadweight	19.628 t
Gross tonnage	61.321
Net tonnage	22.650
Cargo capacity	6.550 CEU
Pax capacity	N/A
Route	Deep sea worldwide
Passage time	N/A



Figure 59. Torrens-Side/Bow view.

Table 9. Torrens - Description of Cargo space.

Common for all cargo decks		
Extinguish	CO2 + Portable powder extinguishers	
Detection	Smoke detectors	
Containment	Closed ro-ro space	
Ventilation	Mechanical	



Table 10. Torrens - Description of Cargo decks.

General description	Deck1
Area	1.790 m <sup>2</sup>
Load capacity	201 cars
Cargo	Trailers/cars/trucks
General description	Deck 2 (liftable)
Area	1.810 m <sup>2</sup>
Load capacity	210 cars
Cargo	Cars
General description	Deck 3
Area	3.140 m <sup>2</sup>
Load capacity	372 cars
Cargo	Trailers/trucks/cars
General description	Deck 4 (liftable)
Area	3300 m <sup>2</sup>
Load capacity	401 cars
Cargo	Cars
General description	Deck 5
Area	4.950 m <sup>2</sup>
Load capacity	609 cars
Cargo	Trailers/trucks/cars
General description	Deck 6 (liftable)
Area	5.100 m <sup>2</sup>
Load capacity	615cars
Cargo	Cars
General description	Deck 7
Area	5.010 m <sup>2</sup>
Load capacity	605 cars
Cargo	Trailers/trucks/cars
General description	Deck 8 (liftable)
Area	5.770 m <sup>2</sup>
Load capacity	697 cars
Cargo	Cars
General description	Deck 9
Area	5.810 m <sup>2</sup>
Load capacity	719 cars
Cargo	Cars
General description	Deck 10
Area	5.810 m <sup>2</sup>
Load capacity	717 cars
Cargo	Cars
General description	Deck 11



Area	5.800 m <sup>2</sup>
Load capacity	710 cars
Cargo	Cars
General description	Deck 12
Area	5.760 m <sup>2</sup>
Load capacity	708 cars
Cargo	Cars



Figure 60. Torrens-Side/Aft view.



# 8 Specific input to Development and Demonstration WPs

Specific input related to the assessed ship types, as well as additional input not directly related to the selected generic ships, that can be useful for the Development and Demonstration work packages in LASH FIRE was shared. This includes 3D models (seeFigure 61 and Figure 62) of the ships as well as drawings and technical specification, port and routes data and other operational information. The further information requested and specified is described in the sections below.



Figure 61. 3D model of the ro-ro passenger ship (Victoria Seaways)



Figure 62. Ro-ro passenger ship 3D model view (Victoria Seaways) - sailing with smoke (rendered)

### 8.1 3D models

3D models were prepared for the finally selected generic ships: Stena Flavia, Magnolia Seaways and Torrens.



The modelling was prepared according to D&D WPs requirements, including rampways, structure, ventilation ducts, openings, cargo units, deck equipment, detectors and reefer sockets and other. Models are illustrated in the following Figures.



Figure 63. Magnolia Seaways 3D model



Figure 64. Magnolia Seaways 3D model – longitudinal section





Figure 65. Magnolia Seaways 3D model –flame detector coverage





Figure 66 Stena Flavia 3D model – detectors and reefer connections





Figure 67. Stena Flavia 3D model- flame detector coverage



Figure 68. Torrens 3D Model





Figure 69. Torrens 3D Model -Longitudinal section

## 8.2 Generic ports and routes

Information was provided for Stena ports and routes.

## 8.3 Reference information

Extensive information was provided for the demonstration and development purposes related to the generic and other ships from the Stena, DFDS and Wallenius fleet. A concise list of provided data is given below and illustrated in Figure 70.



Figure 70. Reference information illustration



#### **Drawings**

- General arrangement plans
- Capacity plans
- Structural drawings
- Fire safety plans
- Fire control plans
- Structural integrity plan
- Reefer sockets and detectors position
- Ventilation system
- Drainage system

### Other info

- Booking system information
- Cargo stowage (Cargo manifests, tools and procedures)
- Decision support documents and instructions
- Ship and terminal photos, videos
- Onboard and terminal equipment info
- Onboard operations info

### Reference projects info

• Stena's Karlskrona GateLab

### Remote visits

Fire drills, and demonstration of equipment on board, as well as walks through the ship and ship familiarization rounds done by crew members with gopro cameras on the generic vessels Stena Flavia and Magnolia Seaways

#### Ship visits and interviews with the crew

Several ship visits were organised both for LASH FIRE development teams and ship operator internally. The organisation included planning of tasks according to the Development and Demonstration WPs requirements, interviews with the crew, guided ship and port tours. Due to the situation with COVID-19, in the beginning of Year 2020, the visits were postponed until further notice.

Extensive information was made available for the LASH FIRE partners



# 9 Conclusion

Main author of the chapter: Vito Radolovic, FLOW

This report presents the selection process and the definition of generic ships where three main categories of ships have been defined: ro-ro passenger ships, ro-ro cargo ships and vehicle carriers. Further, one representative existing ship in each category was selected. In the selection process, focus was primarily given to the arrangement of ro-ro cargo spaces with the main objective to represent all ro-ro space types for each ship type category, in addition to passenger and cargo capacity in comparison to statistical data of the world fleet.

Due to a large variety in ship designs, including ro-ro space type arrangement, ship main particulars, etc. within each ro-ro ship type category, the performed selection with only one ship per ship type category may be found inappropriate to represent the whole world fleet in the assessment of the developed solutions. Having in mind the ambitions in the LASH FIRE project to construct a risk model based on the types of ro-ro spaces, this approach also made the selection less representative of the world fleet, even if it may better reflect the effectiveness of solutions depending on ship particulars.

Three selection loops were performed, resulting in the final selection of the generic ro-ro passenger ship (Stena Flavia), generic ro-ro cargo ship (Magnolia Seaways) and generic vehicle carrier (Torrens).

The selected and defined generic ships will be used as a starting point for the development of solutions, to evaluate integration and to facilitate for demonstration of technical and operational solutions developed in the project. This supports one of the main LASH FIRE objectives (Objective 2) and also the specific goal to Action 5-A, to "define generic ro-ro ships for evaluation of risk control measures, with basis in characteristic ship types in the world fleet and provide for life cycle assessment".

In addition to general data for the ships, detailed input is required for the assessment of new fire safety solutions. 3D models as well as additional requested details were provided to the Development and Demonstration work packages in LASH FIRE. Further, several ship visits and interviews with crew were organised, to allow a further understanding of the specifics of the types of ro-ro ships considered in the project. Additional data will be further provided and ship visits organised according to the requirements from Development and Demonstration work packages in LASH FIRE.



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## ANNEXES

## ANNEX A - Selected generic ships for evaluation - preliminary

The preliminary selection of generic ships consists of one existing ship for each ship type. Ships which were pre-selected but excluded from the final selection are presented below.

#### A.1. Generic ro-ro passenger ship

Victoria Seaways, operated by DFDS, was first selected to represent the ro-pax generic ship design. It was designed with a capacity of 600 passengers and a total cargo capacity is 2.684 LM, located in closed ro-ro spaces (lower hold and main deck), open ro-ro space (garage) and weather deck, as presented in Figure and Figure .

Passenger cabins are located in the superstructure on Decks 6 and 7. A restaurant is located on Deck 5. Deck 4 consists of an open ro-ro space (garage) and a weather deck. Deck 3 is the main deck, consisting of a closed ro-ro space with ro-ro lanes throughout the full length of the ship. There is also a lower hold on Deck 2 (closed ro-ro space) and on the tank top (closed ro-ro space). A picture of the ship is provided in Figure and Figure .



Figure 1. Victoria Seaways - ro-ro space arrangement – longitudinal section.



Figure 2. Victoria Seaways – ro-ro space arrangement – cross section.



Table 1. Victoria Seaways - Main characteristics.

GENERAL	Cargo RO-PAX
Length overall	199,14 m
Breath moulded	26,60 m
Load Draught	6,40 m
Built	2009
Deadweight	8.400 t
Gross tonnage	25.675
Net tonnage	11.463
Cargo capacity	2684 LM, 176 trailers
Pax capacity *	1.000 *
Route	Karlshamn (SE) — Klaipeda (LT)/ Klaipeda (LT) - Kiel (GE)
Passage time	12-13 h/ 20 h
Fire pump 1	130m3/h 90m pressure height
Fire pump 2	130m3/h 90m pressure height
Emergency fire pump	130m3/h 90m pressure height
Drencher pump	825 m3/h 32 m pressure height

\* Passenger Capacity increased to 1000 according to Chapter 6.1 Conclusion, originally 600 passengers



Figure 3. Victoria Seaways (DFDS) – Bow view.





Figure 4. Victoria Seaways (DFDS) – Stern/Side view.



Table 2. Victoria Seaways - Description of Cargo decks.

General description	Upper deck (Weather + Garage)
Dimensions	WD 104,5 x 24,5 m
	G 65,5 x 25,0 m
Load capacity	1.209 LM
	Drencher system in garage
Extinguish	Two water monitors at weather deck
Detection	Smoke detectors
	CCTV cameras 3pcs. In garage
Containment	Weather deck and garage open aft
Ventilation	Mechanical
Cargo	Trailers/trucks
General description	Main Deck
Dimensions	170 x 24,5 m
Load capacity	1.050 LM
Extinguish	Drencher
Detection	Smoke detectors, 3 CCTV
Containment	Closed RORO-space
Ventilation	Mechanical
Cargo	Trailers/trucks
General description	Lower Deck
Dimensions	90 x 16 m
Load capacity	240 LM
Extinguish	Drencher
Detection	Smoke detection, 2 CCTV
Containment	Closed RORO-Space
Ventilation	Mechanical
Cargo	Trailers
General description	Tank top
Dimensions	90 x 16 m
Load capacity	368 LM
Extinguish	Drencher
Detection	Smoke detectors, 2 CCTV
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Cars



### A.2. Generic ro-ro cargo ship

Stena Scotia, operated by Stena, was first selected to represent the ro-ro cargo generic ship design. The total cargo capacity of the ship is 1.562 LM, located in closed spaces (lower hold, main deck and garage) and weather deck, as presented in Figure and Figure .



Figure 53



Figure 1. Stena Scotia - RO-RO space arrangement – longitudinal section.



Figure 2. Stena Scotia - ro-ro space arrangement – cross section.





Figure 3. Stena Scotia – stern/side view (1).

The main characteristics are detailed in Table and the cargo decks particulars are further described in



### Table .

Table 1. Stena Scotia - Main characteristics

GENERAL	Cargo RoRo
Length overall	142,50 m
Breath moulded	23,20 m
Load Draught	5 <i>,</i> 40 m
Built	1996
Deadweight	5.928 t
Gross tonnage	13.017
Net tonnage	3.905
Cargo capacity	1.562 LM, 120 trailers
Pax capacity	12
Route	Belfast - Heysham
Passage time	8-9 h
Fire pump 1	80/160 m3/h at 60/30 m pressure height
Fire pump 2	80/160 m3/h at 60/30 m pressure height
Emergency fire pump	63 m3/h at 30 m pressure height
Drencher pump	380 m3/h at 80 m pressure height



Figure 4. Stena Scotia – bow view.



Table 2. Stena Scotia - Description of Cargo decks

General description	Upper deck (Weather + Garage)
Dimensions	WD 82,5 x 21,6 m
	G 37,5 x 21,6 m
Load capacity	637 LM
Extinguish	Sprinkler System in garage
	(No Water monitors at WD)
Detection	Smoke detectors
	CCTV - 2 cameras on WD (no cameras in garage)
Containment	WD + Garage open aft
Ventilation	Mechanical
Cargo	Trailers/trucks
General description	Main Deck
Dimensions	129 x 21,6 m
Load capacity	601 LM
Extinguish	Drencher
Detection	Smoke detectors
Detection	CCTV – 1 camera
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks
General description	Lower Hold
Dimensions	78 x 18 m
Load capacity	324 LM
Extinguish	Drencher
Detection	Smoke detectors
	CCTV - 1 camera
Containment	Closed ro-ro space
Ventilation	Mechanical
Cargo	Trailers/trucks



Figure 5. Stena Scotia – stern/side view (2).



#### A.3. Generic vehicle carrier

Höegh Trigger, operated by Höegh Autoliners, was selected to represent the vehicle carrier generic ship design. The vessel is compliant with all relevant international rules and regulations.

The vessel was designed as a vehicle carrier, suitable to carry passenger cars, vans, buses and containers loaded on MAFI trailers and trucks, with a total cargo capacity of 8.500 cars. The cargo area of 71.400 square meters is distributed in closed ro-ro spaces on 14 decks, where decks no. 2, 4, 6, 7 and 9 are hoistable and decks no. 1, 3, 5 and 8 have been reinforced for stowage of trucks and trailers. A typical cross section of the cargo area is presented in Figure . A stern/quarter ramp-door and a, midship/aft area side ramp-door for loading/unloading vehicles are provided. A set of internal fixed ramps and watertight/gastight doors are provided, giving access to fixed and hoistable decks within the holds. A low pressure "total flooding" CO2 fire extinguishing system has been provided for the protection of the cargo holds, where the cargo spaces of the ship are divided by gastight divisions A, B, C and D, illustrated in Figure .

A picture of this ship is provided in **Error! Reference source not found.** While the main characteristics are detailed in Table . The cargo space particulars are further described in Table .



Figure 1. Höegh Trigger – ro-ro space arrangement - cross section.



Figure 2. Höegh Trigger – gas tight zones.



Table 1. Höegh Trigger - Main characteristics.

GENERAL	Vehicle Carrier
Length overall	199,90 m
Breath moulded	33,50 m
Load Draught	10,30 m
Built	2015
Deadweight	21.918 t
Gross tonnage	76.420
Net tonnage	23.242
Cargo capacity	8.500 CEU
Pax capacity	N/A
Route	Deep sea worldwide
Passage time	N/A



Figure 3. Höegh Trigger-Side/Bow view.

Table 2. Höegh Trigger - Description of Cargo space.

Common for all cargo decks		
Extinguish	CO2 + Portable powder extinguishers	
Detection	Smoke detectors	
Containment	Closed ro-ro space	
Ventilation	Mechanical	


Table 3. Höegh Trigger - Description of Cargo decks.

General description	Deck1
Area	2.400 m <sup>2</sup>
Load capacity	285 cars
Cargo	Trailers/cars/trucks
General description	Deck2 (liftable)
Area	2.760 m <sup>2</sup>
Load capacity	328 cars
Cargo	Cars
General description	Deck 3
Area	3.690 m <sup>2</sup>
Load capacity	439 cars
Cargo	Trailers/trucks/cars
General description	Deck 4 (liftable)
Area	4.000 m <sup>2</sup>
Load capacity	476 cars
Cargo	Cars
General description	Deck 5
Area	5.620 m <sup>2</sup>
Load capacity	669 cars
Cargo	Trailers/trucks/cars
General description	Deck 6 (Liftable)
Area	6.000 m <sup>2</sup>
Load capacity	714 cars
Cargo	Cars
General description	Deck 7 (Liftable)
Area	5.810 m <sup>2</sup>
Load capacity	691 cars
Cargo	Cars
General description	Deck 8
Area	6.270 m <sup>2</sup>
Load capacity	746 cars
Cargo	Trailers/Trucks/cars
General description	Deck 9 (Liftable)
Area	6.590 m <sup>2</sup>
Load capacity	784 cars
Cargo	Cars
General description	Deck 10
Area	6.640 m <sup>2</sup>
Load capacity	790 cars
Cargo	Cars
General description	Deck 11



Area	6.630 m <sup>2</sup>
Load capacity	7.789 cars
Cargo	Cars
General description	Deck 12
Area	6.600 m <sup>2</sup>
Load capacity	786 cars
Cargo	Cars
General description	Deck 13
Area	6.420 m <sup>2</sup>
Load capacity	764 cars
Cargo	Cars
General description	Deck 14
Area	1.970 m <sup>2</sup>
Load capacity	235 cars
Cargo	Cars