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## **Deliverable D03.5**

# First proposal on updated rules and regulations on fire safety

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### Abstract

The LASH FIRE Strategic objective is to provide a recognized technical basis for the revision of international IMO regulations, which greatly enhances fire prevention and ensures independent management of fires on ro-ro ships in current and future fire safety challenges.

The present deliverable makes a series of preliminary proposals on updated rules and regulations on fire safety based on the assessment made by the LASH FIRE Advisory Groups.



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#### 1 Executive summary

The LASH FIRE main strategic objective is to provide a recognized technical basis for the revision of international IMO regulations, which greatly enhances fire prevention and ensures independent management of fires on ro-ro ships in current and future fire safety challenges.

The present deliverable makes a series of proposals on updated regulations on fire safety based on the assessment made by the LASH FIRE Advisory Groups.

#### 1.1 Problem definition

Ro-ro ships are an important component of global transportation. However, a significant number of fire incidents on ro-ro ships in recent years and lacking signs of improvement, called for improved fire protection. Several initiatives to minimize the incidence and consequences of fires on ro-ro spaces of new and existing ro-ro passenger ships were successfully conducted (e.g., the FIRESAFE studies by EMSA) or are still on-going (e.g., review of SOLAS Chapter II-2 and associated codes by the International Maritime Organization (IMO)). However, there is also a need to address cargo transformation, such as Alternatively Powered Vehicles, and to address other types of ro-ro ships (i.e., ro-ro cargo ships and vehicle carriers) and not only the ro-ro passenger ships.

Hence, there is still a need to update the fire protection of ro-ro ships from a wide and long-term perspective. There are significant challenges to address but there is also great potential in using new and advancing technologies and procedures. The innovative solutions need to be in balance with effects on the environment, costs and crew operations, in order to be considered for regulatory amendments.

#### 1.2 Technical approach

The objective of this report is to make a series of preliminary proposals on updated rules and regulations on fire safety based on the assessment made by the LASH FIRE MAAG & MOAG Advisory Groups (Hereafter: 'LASH FIRE Advisory Groups') established following LASH FIRE task T03.3 on *Establishment and facilitation of Maritime Advisory Groups*.

Those two Maritime Advisory Groups are respectively composed of Authorities, Flag States and Rule Making Bodies (*Maritime Authorities Advisory Group*, MAAG) and of Ship Owners and Operators, Shipyards and Insurers (*Maritime Operators Advisory Group*, MOAG). Those bodies primarily aim to analyse and discuss future regulations and legislations based on input that has been collected by the project, and to find consensus in view of the proposals to be elaborated by the LASH FIRE project.

#### 1.3 Results and achievements

The continued involvement of the LASH FIRE Advisory Groups has played an important role in assessing and selecting several solutions, also called Risk Control Measures (RCMs), which are developed, validated, and demonstrated to address the challenges to strengthen fire protection of ro-ro ships. The most promising ones are grouped into Risk Control Options (RCOs), evaluated, and demonstrated mainly in terms of ship integration feasibility, cost and risk reduction in order to finally propose (at least fifteen) regulatory proposals on effective operative and design solutions.



#### 1.4 Contribution to LASH FIRE objectives

The IMO strategic plan for 2018-2023 highlights the importance of integrating new and advancing technologies in the regulatory framework. One of the objectives of LASH FIRE is to support the aforementioned strategic plan, in part through this deliverable.

This deliverable furthermore lays the groundwork for achieving the LASH FIRE strategic objective which is "to provide a recognized technical basis for the revision of international IMO regulations, which greatly enhances fire prevention and ensures independent management of fires on ro-ro ships in current and future fire safety challenges".

More specifically, this deliverable addresses the specific objective to propose new regulations and guidelines founded on common positions by drawing upon global research and experience and by facilitating international cooperation.

#### 1.5 Exploitation and implementation

In conjunction with LASH FIRE report D04.6 on *Cost-effectiveness assessment*, the present deliverable serves as an input to the LASH FIRE report D04.8 on the *Impact on regulations by new solutions and consolidation of new proposals for regulations*. The latter report (D04.8) will provide an assessment of the cost-effective technical and operational solutions (D04.6) against the current status of the regulations to identify any potential conflicting regulations or barriers to their implementation. The specific regulatory proposals will be developed in a way to be presentable to the relevant decision makers in an auditable and traceable manner.

The present deliverable also helps the development and update of the exploitation plan of the project of which D03.9 *Final exploitation plan* is meant to present how to initiate, facilitate, monitor and report dissemination activities and to elaborate the exploitation plan, relying on the technical input from all partners and work packages.



## 2 List of symbols and abbreviations

APV	Alternative Powered Vehicle
Cargo ship	Any ship which is not a passenger ship (cf. SOLAS I/2(g))
CG	Correspondence Group
CRS	Closed ro-ro space
D&D WP	LASH FIRE Development and Demonstration Work Package
EV	Electric Vehicle
Ex	Existing ship
FSS Code	Fire Safety Systems Code
ICE	Internal Combustion Engine
IMO	International Maritime Organization
MAAG	LASH FIRE Maritime Authorities Advisory Group
MOAG	LASH FIRE Maritime Operators Advisory Group
NB	Newbuild ship
ORS	Open ro-ro space
P&I	Protection and Indemnity insurance
Passenger ship	Ship which carries more than twelve passengers (cf. SOLAS I/2(f))
RCM	Risk Control Measure
RCO	Risk Control Option
Ro-pax ship	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)
SSE	IMO sub-committee on Ship Systems and Equipment
TRL	Technology Readiness Level
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)
WD	Weather deck



WP	Work Package
WP03	LASH FIRE Cooperation and Communication Work Package
WP04	LASH FIRE Formal Safety Assessment Work Package
WP05	LASH FIRE Ship Integration Work Package

### 3 Terminology

The IMO Formal Safety Assessment (FSA) guidelines defines risk control measure and risk control option as it follows:

Risk control measure:	A means of controlling a single element of risk.
Risk control option:	A combination of risk control measures.

In LASH FIRE, the terms 'Risk Control Measure' (RCM) and 'solution' are used as equivalent, even if risk control measures developed in LASH FIRE may control more than one single element of risk.



### 4 Introduction

The LASH FIRE Strategic objective is to provide a recognized technical basis for the revision of international IMO regulations, which greatly enhances fire prevention and ensures independent management of fires on ro-ro ships in current and future fire safety challenges.

LASH FIRE is a European Union-funded research project, aiming to strengthen the independent fire protection of ro-ro ships by developing and validating effective operative and design solutions. For that purpose, six Development and Demonstration Work Packages (D&D WPs) address a total of twenty challenges, also called actions, in all stages of fire course originating in ro-ro spaces (**Figure 1**).

WP06	Effective Manual Operations
6-A	Manual screening of cargo fire hazards and effective fire patrols
6-B	Quick manual fire confirmation and localization
6-C	Efficient first response
6-D	Effective and efficient manual firefighting
WP07	Inherently Safe Design
7-A	Improved fire detection system interface design
7-B	Efficient extinguishing system activation and inherently safe design
7-C	Firefighting resource management centre
WP08	Ignition Prevention
8-A	Automatic screening and management of cargo fire hazards
8-B	Guidelines and solutions for safe electrical connections
8-C	Fire requirements for new ro-ro space materials
WP09	Detection
9-A	Detection on weather deck
9-B	Detection in closed and open ro-ro spaces
9-C	Technologies for visual fire confirmation and localization
WP10	Extinguishment
10-A	Local application fire-extinguishing systems
10-B	Weather deck fixed fire-extinguishing systems
10-C	Updated performance of alternative fixed fire-fighting systems
WP11	Containment
11-A	Division of ro-ro spaces
11-B	Ensuring safe evacuation
11-C	Safe design with ro-ro space openings
11-D	Ro-ro space ventilation and smoke extraction

Figure 1: LASH FIRE 20 challenges (or actions).

Throughout the project, several solutions, also called Risk Control Measures (RCMs), are developed, validated, and demonstrated to address those challenges. The most promising ones are grouped into Risk Control Options (RCOs), evaluated, and demonstrated mainly in terms of ship integration feasibility, cost and risk reduction in order to finally propose at least fifteen regulatory proposals.



### 5 First proposal on updated rules and regulations on fire safety

In conjunction with LASH FIRE report D04.6 on *Cost-effectiveness assessment*, the present deliverable serves as an input to the LASH FIRE report D04.8 on *the Impact on regulations by new solutions and consolidation of new proposals for regulations*. With the supportive Task T04.8 *Screening of relevant regulations*, detailed input has been provided on relevant regulations for each action in the Development & Demonstration work packages (WP06-WP11). The latter report (D04.8) will provide an assessment of the cost-effective technical and operational solutions (D04.6) against the current status of the regulations to identify any potential conflicting regulations or barriers to their implementation. The specific regulatory proposals will be developed in a way to be presentable to the relevant decision-makers in an auditable and traceable manner.

A preliminary list of selected solutions is provided with the LASH FIRE Report D04.9 on *Preliminary impact of solutions and related testing and demonstrations plan*. It presents an intermediate compilation of the actual or foreseen fire safety improvements gained by the selected solutions. The deliverable shall not be understood or used as a final outcome of the LASH FIRE project. This deliverable provides a status and summary of the preliminary developments of the different solutions.

#### 5.1 Fire safety of RoRo ship challenges

#### 5.1.1 Introduction

Ro-ro ships are an important component of the global transportation. Hence, there is a need to keep updating the fire protection of ro-ro ships from a wide and long-term perspective. There are significant challenges to address but there is also great potential in using new and advancing technologies and procedures. The innovative solutions need to be in balance with effects on the environment, costs and crew operations, in order to be considered for regulatory amendments.

#### 5.1.2 Definition of conditions for identified challenges and related solutions

To address the described problems above, LASH FIRE aims to strengthen the independent fire protection of ro-ro ships by developing and validating effective operative and design solutions. For that purpose, six Development and Demonstration Work Packages (D&D WPs) address a total of twenty challenges, also called actions, in all stages of the course of fires originating in ro-ro spaces. Each action was initiated by a task for "Definition of conditions", including regulation review by Work Package 04 (WP04) and definition of ship requirements by Work Package 05 (WP05), related to the challenge to be addressed. This input defined the scope and required functions for the solutions to be developed. Next, the development of new solutions used the generic ships selected by WP05 as starting point and included theoretical investigations, small-scale development testing and manufacturing of selected solutions. In parallel and in communication with the developers, the test facilitating research partners started planning the tests to validate the performance of the solutions.

A preliminary list of 44 selected solutions (**ANNEX A**) is provided with the LASH FIRE Report D04.9 on *Preliminary impact of solutions and related testing and demonstrations plan.* It presents an intermediate compilation of the actual or foreseen fire safety improvements gained by the selected solutions. It comprises both preventive and mitigating risk controls, as well as both engineering, inherent and procedural risk controls. The Report D04.9 provides a status and summary about the preliminary developments of the different solutions and does not constitute a final outcome of the LASH FIRE project.



In a next step, those 44 solutions were assessed by WP03, WP04 and WP05 through:

- Ship integration feasibility evaluation
- Cost assessment
- Cost-effectiveness assessment
- Other assessments

Meanwhile, the D&D WPs continue to refine the solutions and to conduct validations and demonstration of solutions. Both ship integration and cost assessment results are considered to further improve the solution integrability and acceptance by the maritime stakeholders. Validation and demonstration of solutions, especially the ones planned on board, are conducted in close cooperation with the ship operators. Additionally, there was an extensive consultation regarding these 44 solutions with the two Advisory Groups as described in Chapter 5.2 'Consultation process with LASH FIRE Advisory Groups' of this deliverable.

Finally, a workshop organised at LASH FIRE consortium level in early June 2022 made a selection of the RCOs on the basis of the preliminary and qualitative assessments of a reduced set of 41 solutions performed by WP04 and WP05, with a view to perform the quantitative cost-effectiveness assessment (Ref.: LASH FIRE Report D04.6 on *Cost-effectiveness assessment*). In order to achieve a consensus and involve stakeholders from the maritime community from broad horizons, the RCOs selection and definition workshop gathered:

- All the WP leaders and D&D action leaders: representatives of the development of the RCMs;
- Ship operators (Stena Line, DFDS and Wallenius Wilhelmsen), SEA Europe and Interferry: representatives of the maritime stakeholders; and
- Risk engineers from WP04: facilitator and responsible for the FSA methodology.

This 2-day workshop's iterative process led to the selection and definition of the following RCOs:

- <u>Step 1</u>: 41 RCMs were screened one by one. Their preliminary assessments (i.e., ship integration, cost, regulatory compatibility, risk reduction and level of support from the LASH FIRE Advisory Groups) were discussed. Potential showstopper(s) and low-hanging fruit(s) were identified. At the end of step 1, 31 RCMs were identified as potential RCOs.
- <u>Step 2</u>: The 31 RCMs were ranked in terms of TRL, level of support from the LASH FIRE Advisory Groups, ship integration and preliminary cost-effectiveness. The RCOs were selected and defined. The final applicability (i.e., ro-ro ship type, ro-ro space type and new vs. existing ships) was defined and combinations of RCMs were performed, when needed. At the end of step 2, 16 RCOs were selected and defined for quantitative cost-effectiveness assessment.

The final list of 16 RCOS is summarized in **Table 1**. Further details about the RCOs workshop and the RCOs will be provided in the LASH FIRE deliverable D04.6 *Cost-effectiveness assessment report*.

ID of RCO	Title of RCO	Ship types	Ro-ro space types	NB / Ex
RCO 1	Fire patrol. Fire confirmation & localization	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex
RCO 2	Signage and markings for effective wayfinding and localization	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex
RCO 3	Efficient first response	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex

Table 1: List of Risk Control Options



ID of RCO	Title of RCO	Ship types	Ro-ro space types	NB / Ex
RCO 4	Manual firefighting for Alternatively Powered Vehicles	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex
RCO 5	Alarm system interface prototype	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB
RCO 6	Process for development of procedures and design for efficient activation of extinguishing system	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB + Ex
RCO 7	Training module for efficient activation of extinguishing system	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB + Ex
RCO 8	Safe electrical connection for reefers	Ro-Pax, Ro-Ro	CRS, ORS, WD	NB + Ex
RCO 9	Safe electrical connection of reefers and electric vehicles (EVs)	Ro-Pax	CRS, ORS, WD	NB + Ex
RCO 10	Fire detection on weather decks	Ro-Pax, Ro-Ro	WD	NB + Ex
RCO 11	Fire detection in closed ro-ro spaces & open ro-ro spaces	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB
RCO 12	Visual system for fire confirmation and localization	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex
RCO 13	Dry-pipe sprinkler system for vehicle carriers	VC	CRS	NB
RCO 14	Fixed remotely controlled fire monitor system using water for weather decks	Ro-Pax, Ro-Ro	WD	NB + Ex
RCO 15	Fixed autonomous fire monitor system using water for weather decks	Ro-Pax, Ro-Ro	WD	NB + Ex
RCO 16	Guideline for fire ventilation in closed ro-ro space	Ro-Pax, Ro-Ro	CRS	NB + Ex
Ro-Pax = Ro-ro passenger ships, Ro-Ro = Ro-ro cargo ships, VC = Vehicle carriers.				
CRS = Clos	sed ro-ro spaces, ORS = Open ro-ro spaces, WD = V	Weather decks.		
NB = New	buildings, Ex = Existing ships.			

Across the selection process of the various RCOs, particular attention was given to fire detection and extinguishment of Alternative Powered Vehicles, which represent other hazards than traditional Internal Combustion Engine (ICE) vehicles; they require new routines, tactics, equipment and training to ensure the safety of crew and passengers on ro-ro vessels, and notably:

- Real time tracking of different types of APVs.
- Special instructions for APV that will help in the identification of type of vehicle, detection of risk indicators, safe approach and thermal runaway confirmation.
- Training: Specification of minimum standard of competence in safety awareness of APV risks on board ro-ro vessels. Developing guidelines and a training module for APV firefighting in ro-ro spaces, based on evaluation and full-scale demonstration of new equipment.



## 5.2 Consultation process with LASH FIRE Advisory Groups (incl. IMO stakeholders)

#### 5.2.1 Introduction

Between June 2021 and June 2022, a series of 9 technical workshops (**Table 2**) were held with the representatives of the two LASH FIRE Advisory Groups to assess the 20 challenges/actions and the 44 associated Risk Control Measures (RCMs).

Table 2: Series of LASH FIRE Advisory Groups technical workshops

Dates	Challenges/actions
02.06.2021	6-A: Manual screening of cargo fire hazards and effective fire patrols
	10-A: Automatic first response fire protection systems
01.09.2021	6-B: Quick manual fire confirmation and localization
	11-A: Division of ro-ro spaces
13.10.2021	11-B: Ensuring safe evacuation
	11-C: Safe design with ro-ro space openings
24.11.2021	7-A: Improved fire detection system interface design
	9-A: Detection on weather deck
15.12.2021	6-C: Efficient first response
	8-B: Guidelines and solutions for safe electrical connections
	10-B: Weather deck fixed fire-extinguishing systems
	11-D: Ro-ro space ventilation and smoke extraction
23.02.2022	9-B: Detection in closed and open ro-ro spaces
	10-C: Updated performance of alternative fixed fire-fighting systems
06.04.2022	7-B: Efficient extinguishing system activation and inherently safe design
	8-A: Automatic screening and management of cargo fire hazards
	9-C: Technologies for visual fire confirmation and localisation
11.05.2022	6-D: Effective and efficient manual firefighting
	7-C: Firefighting resource management centre
	8-C: Fire requirements for new ro-ro space materials
01.06.2022	Final Review Workshop (level of support for solutions)

A concluding workshop was organised on 1 June 2022 to involve the representatives of the LASH FIRE Advisory Groups in the decision making and selection process of the Risk Control Options (RCOs) emerging from the review results of the of the Risk Control Measures (RCMs). In doing so, the stakeholders of the two Advisory Groups were invited to indicate their level of support for the solutions to be taken forward. The Advisory Groups' input served as an indication in the assessment process by the LASH FIRE Consortium along other categorized assessment criteria i.e., Ship integration, Cost, Regulatory compatibility, and Risk reduction (**Table 3**).







A total of 15 people from the maritime community participated to the final workshop. A distribution per field of work is provided in **Figure**. The total number and distribution are deemed a fair representation of maritime stakeholders.



Figure 2: Participants to LASH FIRE Advisory Groups concluding workshop – Final review of RCMs.

The possibility to not vote for or to not provide support for any RCM was given during the workshop. For example, for a RCM only applicable to vehicle carriers, ship operators not operating vehicle carriers were asked to not vote. This was to not bias the results of the vote.

#### 5.2.2 Consultation process outcome

In order to ease the evaluation during the final workshop organized on 1 June 2022, the application 'Mentimeter' was used (<u>www.menti.com</u>) allowing participants to score the various solutions. The results in the form of screenshots of the 'Mentimeter' application are presented in **ANNEX B** of the present deliverable.

**Table** summarizes the level of support provided by the LASH FIRE Advisory Groups. The level of support to each RCM was asked to Advisory Groups as a number from 1 to 5, with 1 for 'no support' and 5 for 'full support'. The votes were then post-processed, averaged for analysis purpose ('avg score') and categorized as high, medium, and low level of support. In order to verify the dispersion of the votes and the level of agreement between the participants, the standard deviation was calculated ('std'). No clear trend can be drawn, but it seems that lower standard deviations (lower dispersion) are found for the highest levels of support.



#### Table 4: Levels of support from LASH FIRE Advisory Groups

ID of RCM	Title of RCM	Avg score	Level of support	Std
Pre4	Develop guidelines for safe electrical power connections in ro-ro spaces for charging of EVs	4.8	High	0.400
Ext1a	Dry pipe sprinkler system for ro-ro spaces on vehicle carriers	4.4	High	0.484
Op7	Training, new equipment & procedures to suppress fires in APVs with special focus on Li-ion batteries fires	4.3	High	0.862
Ext3a	Remotely controlled fire monitor (water only) system for the protection of weather decks	4.3	High	0.862
Cont11	Guidance on calculation of side openings in ro-ro spaces	4.3	High	0.433
Des3	Procedures & design for efficient extinguishment system activation	4.2	High	1.143
Cont14	SOLAS requirement of reversible fans	4.1	High	0.567
Cont13	Tactical guidelines for manual interventions	4.1	High	0.539
Op5	First response guidelines & new equipment to put out the fire in the initial stage	4.1	High	0.514
Des4	Training module for activation of extinguishment systems	4.1	High	1.071
Pre3	Develop guidelines for safe electrical power connections in ro-ro spaces for reefer units	4.0	High	1.183
Det7	Fibre optic linear heat detection	3.9	Medium	0.943
Ext3	Autonomous fire monitor (water only) system for the protection of weather decks	3.8	Medium	0.833
Op3	Improvement of current signage, markings, standards, conditions to support effective wayfinding & localization	3.8	Medium	0.748
Cont10	Safety distances between side and end openings and critical areas	3.7	Medium	1.333
Des1	User friendly alarm system interface design guidelines	3.6	Medium	0.771
Det8	Thermal imaging (infrared) cameras	3.6	Medium	1.298
Det3	Video fire detection	3.6	Medium	0.917
Ext5	Relevant fire test standard for alternative fixed water-based fire- fighting systems intended for ro-ro spaces & special category spaces	3.6	Medium	0.917
Pre1a	Cargo scanning, identification & tracking system by the means of a Vehicle Hot Spot Detector system	3.5	Medium	1.118
Op1	Improved fire patrol procedures & minimum assisting equipment for more effective screening of fire hazards	3.4	Medium	1.443
Pre5	Requirements of surface materials in ro-ro spaces, with reference to suitable test method & material property performance criteria	3.4	Medium	1.146
Det6	Thermal imaging (infrared) cameras	3.3	Medium	1.164
Op4	Guidelines for the standardization & formalization of manual fire confirmation and localization	3.2	Medium	1.249
Des2	Alarm system interface prototype	3.2	Medium	0.936
Cont1b1	A-30 fire insulation	3.1	Medium	1.286



ID of RCM	Title of RCM	Avg score	Level of support	Std
Det4	Adaptive threshold settings for detection	2.9	Low	0.539
oDes5	Integrated solutions for fire resource management, combining relevant sources of information, drone & camera system	2.8	Low	1.280
Det1	Flame wavelength detectors	2.8	Low	0.716
Det5	Video fire detection	2.8	Low	1.010
Op2	Manual screening of cargo at port before the loading operations	2.7	Low	1.323
Cont1b2	Extinguishing system simultaneously activated above and below sub- dividing deck	2.7	Low	0.816
Cont3b	Solid curtain, transversal mounting, fully rolled down	2.7	Low	1.247
Des6	Guidelines for organizing the response in case of a fire emergency	2.6	Low	1.256
Cont9	Ship manoeuvring/operation to limit the effect of fire at least in critical areas	2.6	Low	0.831
Ext4	Remotely controlled Compressed Air Foam fire monitor system for the protection of weather decks	2.5	Low	0.988
Pre2	Stowage planning tool with optimization algorithm for cargo distribution	2.4	Low	1.020
Ext4a	Autonomous Compressed Air Foam fire monitor system for the protection of weather decks	2.3	Low	0.862
Cont3d	Solid striped curtain, transversal mounting, fully/partly rolled down	2.2	Low	0.786
Pre1b	Automatic screening and management of cargo fire hazards by means of Automated Guided Vehicles	2.0	Low	0.816
Op6	Technology for localization of first responders through digital information processed via network	1.9	Low	0.900

#### 5.2.3 External knowledge and established cooperation

Under work package WP03 task T03.2 of LASH FIRE, a review/analysis and cooperation with external technical developments and projects were conducted with contribution of the LASH FIRE Advisory Groups. This analysis represented an important exercise in understanding how the project relates to the current knowledge and state of the art, with other developing projects and with improving its area of impact through the collaboration with stakeholders active in the same field.

The following distinctions were made to arrive at a set of developments and projects that were deemed pertinent to LASH FIRE:

- Developments in shipbuilding and equipment for fire safety
- Developments in ship operation and fire management
- Developments of fire technologies in other industries

**Table 5** below shows the selected developments and projects (a more detailed description of this review/analysis and cooperation with external technical developments and projects will be made with LASH FIRE Report D03.4 on *Updated dissemination and Communication report and Updated plan*).



Table 5: Selection of external technical developments and projects

Name of Technology or Project	Category
Electronically activated sprinkler system	Shipbuilding and equipment for fire safety
AR technology to facilitate Fire Safety Equipment (FSE) inspection and maintenance	Shipbuilding and equipment for fire safety
DIFFS nozzles (pop-up or non pop-up)	Shipbuilding and equipment for fire safety
HydroPenTM system	Shipbuilding and equipment for fire safety
TWIN Fire detection system	Shipbuilding and equipment for fire safety
Lagging fires	Shipbuilding and equipment for fire safety
ReliS - Reliable Sprinkler	Shipbuilding and equipment for fire safety
Protective clothing during fires and thermal rush in Li-ion batteries in e-vehicles	Shipbuilding and equipment for fire safety
Automonous Fire Fighting Robot	Ship operation and fire management
Smoke and fire curtains for fire containment	Ship operation and fire management
UPTEKO	Ship operation and fire management
Albero - Transport alternativ betriebener Fahrzeuge auf RoRo- Fährschiffen	Ship operation and fire management
E-TOX project. Toxic Gases from Fires in Electric Vehicles Evs)	Ship operation and fire management
Lion Fire II	Ship operation and fire management
FIRST – Fire Strategies for Unmanned Island Ferries (DBI)	Ship operation and fire management
Zoning for rescue operations against vehicles with alternative fuels	Ship operation and fire management
Acoustic wave for fire suppression system	Fire technologies in other industries
Vision based fire detection system	Fire technologies in other industries
Laser-based sensor for fire detection	Fire technologies in other industries
Using BIM for simulating fire growth and evacuation performance	Fire technologies in other industries
Intelligent Fire Monitor for Fire Robot Based on Infrared Image Feedback Control	Fire technologies in other industries
Ultrafog	Fire technologies in other industries



#### 5.3 First proposal on updated rules and regulation on fire safety

#### 5.3.1 Introduction

As above described, 44 RCMs had been identified and developed for the different fire safety challenges addressed in the project. In a special workshop, the 16 most promising RCMs were selected for further and more in-depth assessments.

Subsequently, the project partners will decide on the best ways to exploit each proposed solution with a view to identify those that should be considered in the upcoming revision when the results are discussed at the next related IMO meeting SSE 9.

In the present chapter, the proposals are limited to technical specification of solutions referring to Annex MSC.1/Circ.1615. Proposals for amendments to IMO regulations will be provided in LASH FIRE Report D04.8 on the *Impact on regulations by new solutions and consolidation of new proposals for regulations*, after the results from the cost-effectiveness assessment and the screening of impact on regulations. How project results will be carried forward beyond the LASH FIRE project end, including in those areas where regulations are not yet finalized, is subject to a plan elaborated under LASH FIRE Task T03.4. The latter task outcome is meant to provide structured elaboration and communication of proposals related to maritime fire safety to relevant authorities and rule-making bodies.

#### 5.3.2 IMO developments

The IMO sub-committee "Ship Systems and Equipment" (SSE 8 / 28.02.2022-04.03.2022) addressed the item "REVIEW OF SOLAS CHAPTER II-2 AND ASSOCIATED CODES TO MINIMIZE THE INCIDENCE AND CONSEQUENCES OF FIRES ON RO-RO SPACES AND SPECIAL CATEGORY SPACES OF NEW AND EXISTING RO-RO PASSENGER SHIPS".

The main submission to this item (SSE 8/6) was issued by the correspondence group (led by Norway), which included amendment proposals to SOLAS and the FSS Code.

SSE 8 agreed to a series of proposed amendments for new ro-ro passenger ships relating to:

- Heat detectors and video monitoring
- Specification of structural fire protection of decks within ro-ro spaces when the deluge system cannot cover both levels
- Fire detection and water monitors for weather decks
- Decision support procedure

SSE 8 also agreed to a set of new SOLAS requirements for existing ro-ro passenger ships, which include requirements for new heat detectors and video monitoring on ro-ro decks.

The Fire Safety Systems (FSS) Code was amended to cover the new draft requirements for fixed waterbased fire-extinguishing systems on weather decks (Chapter 7), and to cover the new draft requirement for both smoke and heat detectors for vehicle spaces (Chapter 9).

The draft amendments are targeted to enter into force on 1 January 2026, with 1 January 2028 as the implementation date for existing ships, pending finalization at SSE 9 (March 2023) and subsequent approval and adoption by the IMO Maritime Safety Committee (MSC).



Following the discussions at SSE 8, a correspondence group continued the work which will remain open until SSE 9. This session will consider the following topics related to fire safety in ro-ro spaces:

- Safety distances from openings of ro-ro spaces and weather decks (including requirements for water monitors on weather deck for existing ships)
- Interpretation of the term "free height" in IMO MSC.1/Circ.1430
- Development of requirements for linear heat detection systems

Furthermore, detailed suggestions were elaborated in the context of SSE relating to fire detection (LASH FIRE WP09), Video monitoring (LASH FIRE WP09), Structural fire protection (LASH FIRE WP11), Openings/Weather Decks and safety arrangements (LASH FIRE WP11), Fixed water-based fire-extinguishing system on weather decks (LASH FIRE WP10), and Decision making (LASH FIRE WP06 & WP07).

#### 5.3.3 LASH FIRE Regulatory proposal assessment

#### Regulatory proposal assessment in line with current IMO developments

The output of the revision of SOLAS Chapter II-2 and associated codes to minimize the incidence and consequences of fire in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships, will be proposed at SSE 9, meeting in March 2023, and then approved by the Maritime Safety Committee in June 2023. LASH FIRE can provide some input as below described in the current IMO process and any other recommendations related to Ro-ro cargo ships and Vehicle Carriers could be communicated to IMO for future work.

From the latest regulatory proposals from the report of the SSE 8 Working Group on Fire Safety, three areas were noticed where it is crucial for LASH FIRE to provide input:

- Scientific method: simple method to make an individual assessment of safety distance from Openings/Weather Decks (LASH FIRE WP11);
- Validation of safety distance from Openings/Weather Decks and requirements for accommodation spaces: simulations and tests were carried out in LASH FIRE to verify/update the incident heat flux rates from openings proposed based on simulations in FIRESAFE 2, which gave safety distances to humans and lifesaving appliances. Another important question was what safety distances should apply for 'accommodation spaces, service spaces and control stations' or what fire integrity should be required without a safety distance (LASH FIRE WP11);
- Water monitors for existing ships: To be considered what alleviations should be accepted if retroactively requiring fixed water-based fire-extinguishing systems for weather decks on existing ships. There was consensus at SSE 8 that effects on pumps and main feeding pipes is not acceptable (LASH FIRE WP10).

Additional work was done to assess the related regulatory amendments being envisaged by LASH FIRE with regard to the preliminary list of 44 selected solutions previously provided (**ANNEX A**) and LASH FIRE Report D04.9 on *Preliminary impact of solutions and related testing and demonstrations plan*. This additional work consisted of mapping the emerging LASH FIRE solutions with the outputs of the IMO SSE 8 session and the ongoing work in the Correspondence Group (CG) prior to SSE 9, and was done to identify synergies, similarities and differences between both work outputs.



These 44 emerging solutions have been mapped against the following criteria:

- IMO SSE 8 Decisions or CG/SSE 9 Decisions to be considered captured in SSE8-WP.4 WG Report;
- SOLAS II-2 Regulation 20 Draft Amendments which apply to RCMs for New Ships constructed on or after 1st January 2026;
- SOLAS II-2 Regulation 20 Draft Amendments which apply to RCMs for Existing Ships constructed before 1st January 2026;
- FSS Code Chapters 7, 9, & 11 apply to new ships constructed on or after 1st January 2026 & existing ships on or after 1st January 2028;
- SOLAS II-2 Regulation 20 Draft Amendments which apply to RCMs for Cargo Ships;
- Which Existing MSC Circulars Apply;
- Which Existing STCW Regulations, Tables, Model Courses Apply.

Based on this mapping exercise, high level comments are provided below on the suitability of the emerging solutions to provide related regulatory amendments:

#### Effective Manual Operations (Op) - Work Package 06

There is a range of effective synergies in WP06 Effective Manual Operations of the emerging solutions with the outputs of SSE 8 and CG prior to SSE 9. These are primarily in relation to manual screening of cargo fire hazards and effective fire patrols and quick manual fire confirmation and localization of the fire. There is also a range of analogies with MSC Circulars 1471 and 1615.

Potential improvements to the regulations have been identified in:

- (Op 1) Improved fire patrol procedures & minimum assisting equipment for more effective screening of fire hazards, (Improve STCW Advanced Fire Fighting Table A-VI/3/5)
- (Op 5) First response guidelines & new equipment to put out the fire in the initial stage (Develop first responder guidelines) and
- (Op 7) Training, new equipment & procedures to suppress fires in APVs with special focus on Li-ion batteries fires, (EMSA Guidelines issued 23<sup>rd</sup> May 2022 but no regulations yet in place)

#### Inherently Safe Design (Des) - Work Package 07

There is a range of effective synergies of the emerging solutions in WP07 Inherently Safe Design with the outputs of SSE 8 and CG prior to SSE 9. These are primarily in relation to user friendly alarm system interface design guidelines and alarm system interface prototype. There is also a range of analogies with MSC Circulars 1368 and 1615.

Potential improvements to the regulations have been identified in:

- (Des 3) Procedures and design for efficient extinguishment system activation
- (Des 4) Training module for activation of extinguishment systems (STCW Advanced Fire Fighting Table A-VI/3 Model Course 2.03 does not include training proposed for hands on activation of fire extinguishing systems in Des 4)



#### Ignition Prevention (Pre) - Work Package 08

There are no effective synergies of the emerging solutions in WP08 Ignition Prevention with the outputs of SSE 8 and CG prior to SSE 9. This is primarily due to that WP08 deals mainly with screening and management of cargo fire hazards. However, similarities with SOLAS Chapter 6 Regulation 2, Resolution A 714 and MSC Circulars 1615 apply.

Potential improvements to the regulations have been identified in relation to the following solutions:

- (Pre 4) Develop guidelines for safe electrical power connections in ro-ro spaces for charging of EVs
- (Pre 3) Develop guidelines for safe electrical power connections in ro-ro spaces for reefer units

#### Detection (Det) - Work Package 09

There are a range of effective synergies in WP09 Detection of the emerging solutions with the outputs of SSE 8 and CG prior to SSE 9. These are primarily in relation to detection on weather deck, detection in closed and open ro-ro spaces and technologies for visual fire confirmation and localization. There are similarities with MSC Circulars 1615 paragraphs 2.2, 2.3 and 2.4 which applies.

However, a major area of potential improvement to the regulations has been identified in relation to the following solutions:

- (Det 6) Thermal imaging (infrared) cameras
- (Det 7) Fibre optic linear heat detection

#### Extinguishment (Ext) - Work Package 10

There are some effective synergies in WP10 Extinguishment of the emerging solutions with the outputs of SSE 8 and CG prior to SSE 9. These are primarily in relation to weather deck fixed fire-extinguishing systems. There are similarities with MSC Circulars 1320 [20] which is assumed to be implemented and MSC Circular 1430 which applies.

However, a major area of potential improvement to the regulations has been identified in relation to the following solutions:

- (Ext 1a) Dry pipe sprinkler system for ro-ro spaces on vehicle carriers
- (Ext 3) Autonomous fire monitor (water only) system for the protection of weather decks

#### Containment (Cont) - Work Package 11

There are a range of effective synergies in WP11 containment of the emerging solutions with the outputs of SSE 8 and CG prior to SSE 9. These are primarily in relation to Safe design with ro-ro space openings as well as ro-ro space ventilation and smoke extraction. There are similarities with MSC.1/CIRC 1615 [3] which applies for Safety Distances.



However, a major area of potential improvement to the regulations has been identified in relation to the following solutions:

- (Cont 10) Safety distances between side and end openings and critical areas
- (Cont 11) Guidance on calculation of side openings in ro-ro spaces
- (Cont 13) Tactical guidelines for manual interventions
- (Cont 14) SOLAS requirement of reversible fans

#### **Alternative Powered Vehicles**

In addition, various of the actions have been addressing fires of Alternative Powered Vehicles (APVs):

- In action '6-D Effective and efficient manual firefighting', the team was investigating multiple extinguishment and containment methods for electric car fires.
- In action '8-B Guidelines and solutions for safe electrical connections' safe charging methods have been investigated and respective guidelines have been developed.
- In action '9-B Detection in closed and open ro-ro spaces' different detection systems have been considered, covering not only heat and smoke detection, but also alternative systems like linear heat detection, video detection, flame detectors and infrared heat detectors.
- In action '10-A Local application fire-extinguishing systems' was addressing the development and demonstration of water-based fire protection system solutions for closed ro-ro spaces on vehicle carriers, that supplements the total-flooding Carbon Dioxide system typically used.

The outcomes of the studies and large-scale tests will be disseminated in a dedicated report summarizing the main findings, with the intention to clear up widespread misconceptions regarding fires in APVs. The report '*Myths and Facts about Fires in Battery Electric Vehicles*' will be made available for download at the project website (www.lashfire.eu).

The identified channel for LASH FIRE recommendations will be the IMO new output on 'Evaluation of adequacy of fire protection, detection and extinction arrangements in vehicle, special category and roro spaces in order to reduce the fire risk of ships carrying new energy vehicles' which has been created at MSC 105 in April 2022. The discussions about this item will start at SSE 9 in March 2023. The target is that the amendments to be developed should enter into force on 1 January 2028, provided that they are adopted before 1 July 2026.

In addition, the EMSA 'Guidance for the safe carriage of Alternative Powered Vehicles (APVs) in ro-ro space of cargo and passenger ships' has been issued in May 2022. This Guidance has been developed with some input from the LASH FIRE project to assist relevant authorities and stakeholders with ensuring that the carriage of AFVs onboard ships is conducted safely and with due regard for protection of the environment. It addresses all types of ro-ro ships. This guidance provides high-level recommendations and will likely be completed in the future with more details and specifications, based on the results of on-going research programs and lessons learnt from the group of experts.



### 6 Conclusion

Throughout its development phase, the LASH FIRE project has been advising the European Commission and the European Maritime Safety Agency, as well as Flag states, classification societies, marine insurers (P&I Clubs), and maritime & shipping industry stakeholders.

Whilst the amendment opportunities are coming to an end and concern the output on the revision of SOLAS Chapter II-2 and associated codes to minimize the incidence and consequences of fire in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships, LASH FIRE has and will continue to provide relevant input in the IMO process. However, recommendations related to ro-ro cargo ships and Vehicle carriers should be communicated to IMO for future work. Concrete proposals for amendments to IMO regulations will be provided in LASH FIRE Report D04.8 on the *Impact on regulations by new solutions and consolidation of new proposals for regulations,* after the results from the cost-effectiveness assessment and the screening of impacts on regulations.

Moreover, the LASH FIRE findings related to Alternatively Powered Vehicles will contribute to the IMO new output on 'Evaluation of adequacy of fire protection, detection and extinction arrangements in vehicle, special category and ro-ro spaces in order to reduce the fire risk of ships carrying new energy vehicles'.

Finally, LASH FIRE results can be subject to recommendations for additional IMO guidance, involving classification societies/P&I or be the basis for requesting new outputs in the context of SOLAS 2028. Outside of IMO framework, the LASH FIRE outcomes will serve as a basis for knowledge for P&I Clubs or classification societies to issue guidelines (input on revision of class notations), or national/EU regulations, as well as a knowledge base for shipyards and operators e.g., for design and operational purposes.



## 7 References

- [1] IMO, Revised Guidelines for Formal Safety Assessment (FSA) for the use in the IMO rulemaking process, MSC-MEPC.2/Circ.12/Rev.2, 2018.
- [2] LASH FIRE, LASH FIRE Grant Agreement, 2019.



## 8 Indexes

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## 9 ANNEXES

### 9.1 ANNEX A: Summary of solutions

WP	Action	ID	Title of solution	Ship types <sup>(1)</sup>	Ro-ro spaces types <sup>(2)</sup>	NB, Ex <sup>(3)</sup>	TRL	Attribute(s) Category A <sup>(4)</sup>	Attribute(s) Category B <sup>(4)</sup>
	6-A	<u>Op1</u>	Improved fire patrol procedures and minimum assisting equipment for a more effective screening of fire hazards	Ro-Pax, Ro-Ro	CRS, ORS, WD	NB + Ex	6, 7	Preventive, Mitigating	Engineering, Procedural
06		<u>Op2</u>	Manual screening of cargo at port before the loading operations	Ro-Pax, Ro-Ro	CRS, ORS, WD	NB + Ex	6, 7	Preventive	Engineering, Procedural
	6-В	<u>Op3</u>	Improvement of current signage and markings standards/conditions to support effective wayfinding and localization	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6, 7	Mitigating	Inherent
		<u>Op4</u>	Guidelines for the standardization and formalization of manual fire confirmation and localization	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6, 7	Mitigating	Engineering, Procedural
	6-C	<u>Op5</u>	First response guidelines and new equipment to put out the fire in the initial stage	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5, 6	Mitigating	Engineering, Procedural
		<u>Op6</u>	Technology for localization of first responders through digital information processed via network	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	4, 5, 6, 7	Mitigating	Engineering
	6-D	<u>Op7</u>	Training, new equipment and procedures to suppress fires in Alternatively Powered Vehicles with special focus on Li-ion batteries fires	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5, 6	Mitigating	Engineering, Procedural
07	7-0	<u>Des1</u>	User friendly alarm system interface design guidelines	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex		Mitigating	Engineering, Inherent
07	/-A	Des2	Alarm system interface prototype	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5	Mitigating	Engineering, Inherent



WP	Action	ID	Title of solution	Ship types <sup>(1)</sup>	Ro-ro spaces types <sup>(2)</sup>	NB, Ex <sup>(3)</sup>	TRL	Attribute(s) Category A <sup>(4)</sup>	Attribute(s) Category B <sup>(4)</sup>
		Des3	Procedures and design for efficient extinguishment system activation	Ro-Pax, Ro-Ro, VC	CRS, ORS, (WD)	NB + Ex	6	Mitigating	Procedural
	7-В	Des4	Training module for activation of extinguishment systems	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB + Ex	5	Mitigating	Procedural
	7-C	<u>Des5</u>	Integrated solutions for fire resource management, combining relevant sources of information, including drone and camera monitoring system	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6	Mitigating	Engineering, Inherent
		<u>Des6</u>	Guidelines for organizing the response in case of a fire emergency	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6	Mitigating	Procedural
08	8-A	<u>Pre1a</u>	Cargo scanning and identification and tracking system by the means of a called Vehicle Hot Spot Detector system	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5	Preventive	Engineering
		Pre1b	Automatic screening and management of cargo fire hazards by means of Automated Guided Vehicles	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5	Preventive, Mitigating	Engineering
		Pre2	Stowage planning tool with optimization algorithm for cargo distribution	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5	Preventive, Mitigating	Engineering, Inherent
	8-B	Pre3	Develop guidelines for safe electrical power connections in ro-ro spaces for reefer units	Ro-Pax, Ro-Ro	CRS, ORS, WD	NB + Ex	6, 7	Preventive	Engineering
		Pre4	Develop guidelines for safe electrical power connections in ro-ro spaces for charging of electric vehicles	Ro-Pax	CRS, ORS, WD	NB + Ex	6, 7	Preventive	Engineering
	8-C	<u>Pre5</u>	Proposal for requirements of surface materials in ro-ro spaces, with reference to suitable test method and material property performance criteria	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6, 7	Mitigating	Engineering, Inherent
09	9-A	Det1	Flame wavelength detectors	Ro-Pax, Ro-Ro, (VC)	WD, (CRS), (ORS)	NB + Ex	7	Mitigating	Engineering



WP	Action	ID	Title of solution	Ship types <sup>(1)</sup>	Ro-ro spaces types <sup>(2)</sup>	NB, Ex <sup>(3)</sup>	TRL	Attribute(s) Category A <sup>(4)</sup>	Attribute(s) Category B <sup>(4)</sup>
		Det8	Thermal imaging (infrared) cameras	Ro-Pax, Ro-Ro, (VC)	WD, (CRS), (ORS)	NB + Ex	7	Mitigating	Engineering
		Det2	Deck mounted linear heat detection by fibre optic cables	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6	Mitigating	Engineering
		Det3	Video detection	Ro-Pax, Ro-Ro, VC	CRS	NB + Ex	7	Mitigating	Engineering
	9-B	Det4	Adaptive detection threshold settings	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	6	Mitigating	Engineering
		Det7	Fibre optic linear heat detection	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB + Ex	7	Mitigating	Engineering
	0.0	Det5	Video detection	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	7	Mitigating	Engineering
	9-0	Det6	Thermal imaging (infrared) cameras	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	7	Mitigating	Engineering
	10-A	Ext1a	Dry pipe sprinkler system for ro-ro spaces on vehicle carriers	VC	CRS	NB + Ex	5	Mitigating	Engineering
		Ext1b	Automatic deluge water spray for ro-ro spaces system on vehicle carriers	VC	CRS	NB + Ex	5	Mitigating	Engineering
	10-B	Ext3	Autonomous fire monitor (water only) system for the protection of weather decks	Ro-Pax, Ro-Ro	WD	NB + Ex	6	Mitigating	Engineering
10		Ext4	Remotely-controlled Compressed Air Foam fire monitor system for the protection of weather deck	Ro-Pax, Ro-Ro	WD	NB + Ex	6	Mitigating	Engineering
	10-C	Ext5	Development of a relevant fire test standard for alternative fixed water- based fire-fighting systems intended for ro-ro spaces and special category spaces	Ro-Pax, Ro-Ro	CRS, ORS	NB	6	Mitigating	Engineering
		Cont1b1	A-30 fire integrity	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB	9	Mitigating	Engineering, Inherent
11	11-A	Cont1b2	Extinguishing system simultaneously activated above and below sub- dividing deck	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB	9	Mitigating	Engineering
		<u>Cont3a</u>	Solid curtain, horizontal mounting, fully rolled down	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB	5	Mitigating	Engineering



WP	Action	ID	Title of solution	Ship types <sup>(1)</sup>	Ro-ro spaces	NB, Ex <sup>(3)</sup>	TRL	Attribute(s)	Attribute(s)
		Cont3b	Solid curtain, vertical mounting, fully rolled down	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB	5	Mitigating	Engineering
		Cont3c	Solid curtain, vertical mounting, partly rolled down	Ro-Pax, Ro-Ro, VC	CRS, ORS	NB + Ex	5	Mitigating	Engineering
	11-B	Cont5	Alternative disembarkation path through "dedicated side door"	Ro-Pax, Ro-Ro, VC?	CRS, ORS, WD	NB	5	Mitigating	Engineering
	11-C	<u>Cont9</u>	Ship manoeuvring/operation to limit the effect of fire at least in critical areas	Ro-Pax, Ro-Ro, VC	CRS, ORS, WD	NB + Ex	5	Mitigating	Procedural
		<u>Cont10</u>	Safety distances between side and end openings and critical areas	Ro-Pax, Ro-Ro	ORS	NB + Ex	5	Mitigating	Inherent
	11-D	<u>Cont11</u>	Guidance on calculation of side openings in ro-ro spaces	Ro-Pax, Ro-Ro	CRS, ORS	NB	5	Mitigating	Inherent
		Cont12	Configuration of side openings in ro-ro spaces	Ro-Pax, Ro-Ro	CRS, ORS	NB	5	Mitigating	Inherent
		Cont13	Tactical guidelines for manual interventions	Ro-Pax, Ro-Ro	CRS	NB + Ex	5	Mitigating	Procedural?
		Cont14	SOLAS requirement of reversible fans	Ro-Pax, Ro-Ro	CRS	NB	5	Mitigating	Engineering, Procedural
<sup>(1)</sup> Ro	-Pax = Ro-re	o passenge	r ships, Ro-Ro = Ro-ro cargo ships, VC = Ve	hicle carriers.					
<sup>(2)</sup> CR	S = Closed r	o-ro space	s, ORS = Open ro-ro spaces, WD = Weather	r decks.					
<sup>(3)</sup> NB	= New ship	os, Ex = Exis	ting ships.						
(4) Att	ributes as o	defined in N	MSC-MEPC.2/Circ.12/Rev.2 [1].						



9.2 ANNEX B: Mentimeter results



## Action 6-B: Quick manual fire confirmation & localization

## Action 6-C: Efficient first response

🞽 Mentimeter



Op3: Improvement of current signage, markings, standards, conditions to support effective wayfind 3.8 localization Op4: Guidelines for the standardization & formalization of manual fire confirmation and log 2 lization

Op5: First response guidelines & new equipment to put out the fire in the initial stage 4.1 Op6: Technology for localization of first responders through dicipal information processed via network

Mentimeter

Strongly agree

## Action 6-D: Effective & efficient manual firefighting

## Mentimeter Action 7-A: Improved fire detection system interface design



🔰 Mentimeter

Action 7-B: Efficient extinguishing system activation & inherently safe design

## Action 7-C: Firefighting resource management centre



Des3: Procedures & design for efficient extinguishment system activation 4.2 Des4: Training module for activation of extinguishment systems 4.1



Mentimeter

## Action 8-A: Automatic screening & management of cargo fire hazards



the means of a Vehicle Hot Spot Detector system Strongly agree Pre1b: Automatic screening and management of cargo fire

Pre1a: Cargo scanning, identification & tracking system by

Strongly disagree Pre2: Stowage planning tool with optimization algorithm for cargo distribution

hazards by means of Automated Guided Vehicles

Action 8-B: Guidelines and solutions for safe electrical connections. (application: ro-ro passenger and cargo ships)



## Action 8-C: Fire requirements for new ro-ro space materials

#### Action 9-A: Detection on weather deck. (application: Mentimeter weather decks)



Strongly disagre Pre5: Requirements of surface materials in ro-ro spaces, with reference to suitable test method & material property performance



Strongly agree

## Action 9-B: Detection in closed and open ro-ro spaces

## Action 9-C: Technologies for visual fire confirmation Mentimeter and localization









Action 10-A: Local application fire-extinguishing systems. (application: vehicle carriers)

## Action 10-B: Weather deck fixed fire-extinguishing systems. (application: weather decks)

Mentimeter



Strongly agree

Mentimeter





Action 10-C: Updated performance of alternative fixed fire-fighting systems. (application: ro-ro passenger and cargo ships)

Action 11-A: Division of ro-ro spaces. (application: ro-ro passenger and cargo ships)



Mentimeter

## Action 11-C: Safe design with ro-ro space openings

### Action 11-D: Ro-ro space ventilation and smoke extraction. Mentimete (application: ro-ro passenger and cargo ships)









Mentimeter