Horizon 2020

Project acronym:	**LASH FIRE**
Project full title:	**Legislative Assessment for Safety Hazard of Fire and Innovations in Ro-ro ship Environment**
Grant Agreement No:	**814975**
Coordinator:	**RISE Research Institutes of Sweden**

LASH FIRE

Deliverable D06.1

Development of and guidelines for quick manual fire confirmation and localization

May 2022

Dissemination level: **Public**

Call identifier: H2020-MG-2018-Two-Stages Starting date: 2019-09-01 Duration: 48 months
MG-2.2-2018: Marine Accident Response, Subtopic C)

Abstract

When a fire signal like heat or smoke is detected by technical equipment and alarmed, the vessel crew will check if it is a real fire or not. If fire signals are detected by several sensors, in several areas, or if a fire is seen on CCTV, the fire is confirmed, and the firefighting team will be mustered. However, often only one sensor has gone off. Then, the fire must be manually confirmed or dismissed by a crew member. Current practice is that the officer on watch ask an able seaman (AB) (often bridge watch or fire patrol) to run to manually confirm and identify the fire (Bram, Millgård, & Degerman, 2019). This person can thus be called the runner. The response to a fire alarm must be as fast as possible, to tackle the fire at the initial stage. However, previous research shows that the task often takes some time and have identified several challenges delaying the manual confirmation and localization. These practices thus could be improved to increase the chance to successfully fight a fire.

The objective of Action 6-B in the LASH FIRE project is to set a standard for quick manual fire confirmation, localization and assessment. This report both, describes Action 6-B's work to develop the guidelines, and presents the guidelines' final version. Action 6-B has reviewed existing conditions for manual fire confirmation and localization by conducting a qualitative document study of regulation, shipping company procedures and operations, earlier research projects, accident investigations reports and theoretical perspectives about organizational conditions. Action 6-B has also carried out interviews and observation of crewmembers onboard. As a step to gather more knowledge to develop guidelines, an onboard trial to raise the alarm and confirm the existence and position of fire by crew was performed.

Findings show how current praxis of sending a runner to manually confirm and localize the fire takes significant time due to human, organizational and technical factors. Overall, our findings highlight the following challenges:

- Lack of easily readable position descriptions (drencher zones, frame markings, decks, etc)
- Common mismatches between naming/framing of vertical zones in the cargo space and the information gathered at the bridge
- Runner's lack of familiarization with the vessel
- Very scarce scientific literature on the manual fire confirmation that happens in this time gap between a fire alarm and the fire fighting
- Manual fire confirmation and localization is rarely systematized and trained for: lack of standards, company procedures and/or description of routines regarding the manual fire confirmation and localization
- Poor communication with bridge (radio shadows, lack of a common language, etc)

The guidelines comprise two different solutions to address these challenges: (1) To support a quicker manual fire confirmation and localization, Action 6-B proposes to improve the current signage and marking standards/conditions by adopting the following measures: the identification and alignment of signage and markings mismatches between bridge and vessel; the replacement of challenging readable position descriptions for easily identifiable and interpretable ones that support effective wayfinding and localization. (2) To support quick manual fire confirmation and localization, Action 6-B proposes guidelines to improve the condition, training and performance of the task. The guidelines should be included in companies' procedures and comprises: a description of the role, the activity and the conditions for performance; a description of the practical measures to ensure a clear communication between bridge and runner; and a description of the practical measures to ensure familiarization with the task.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814975

Document data

Document Title:	D06.1 – Development of and guidelines for quick manual fire confirmation and localization		
Work Package:	WP6 – Effective Manual Operations		
Related Task(s):	T06.6 Development and demonstration of fire confirmation and localization		
Dissemination level:	Confidential		
Lead beneficiary:	19 – NSR		
Responsible author:	Lucía Liste		
Co-authors:	Gudveig Gjøsund, Kristine Størkersen		
Date of delivery:	2022-05-02		
References:	n/a		
Approved by	Jaime Bleye on 2022-04-26	Jonatan Gehandler on 2022-04-21	Maria Hjohlman on 2022-04-25

Involved partners

No.	Short name	Full name of Partner	Name and contact info of persons involved
19	NSR	NTNU Samfunnsforskning	**Lucía Liste,** lucia.liste@samforsk.no **Gudveig Gjøsund,** gudveig.gjosund@samforsk.no **Kristine Størkersen,** kristine.storkersen@samforsk.no
15	SAS	Sociedad de Salvamento y Seguridad Marítima	**Jaime Bleye,** jaimebv@centrojovellanos.es
17	MAG	Magellan-Associacao para a Representacao dos Intresses Portugueses no Exterior	**Manuela Flacchi,** maf@magellan-association.org

Document history

Version	Date	Prepared by	Description
01	2020-07-02	Kristine Størkersen	Draft of structure
02	2021-11-15	Lucía Liste	Draft of final report, circulated to reviewers
03	2021-12-15	Lucía Liste	Draf of final report with revisions
04	2022-04-20	Lucía Liste	Draf of final report with revisions
05	2022-05-02	Lucía Liste	Final report

Content

1 Executive summary

1.1 Problem definition

The response to a fire alarm must be as fast as possible, to ensure efficient first response and tackle the fire at the initial stage. However, previous research results have identified that manual confirmation and localization often takes some time. Thus, these actions could be improved to increase the chance to successfully fight a fire. Furthermore, existing information and knowledge confirm the need to improve manual fire confirmation and localization standards.

1.2 Technical approach

The technical approach consists of of three different phases. First, existing conditions for manual fire confirmation and localization have been examined by conducting a qualitative document study of regulation, shipping company procedures and operations, earlier research projects, accident investigations reports and theoretical perspectives about organizational conditions. Second, interviews and observation of crewmembers onboard have been conducted. Third, onboard trial to raise the alarm and confirm the reality and position of fire by crew was performed to gather more insights to develop guidelines.

1.3 Results and achievements

The findings highlight the following challenges for manual fire confirmation and localization:

Runner's difficulties regarding wayfinding and orientation:

- Lack of easily readable position descriptions (drencher zones, frame markings, decks, etc)
- Common mismatches between naming/framing of vertical zones in the cargo space and the information gathered at the bridge
- Lack of familiarization with the vessel
- Manual fire confirmation and localization is rarely examined, systematized, and trained for (lack of scientific literature, standards, company procedures and/or description of routines)
- Poor communication with bridge (radio shadows, dead spots, lack of a common language, etc.)

The guideline comprises two different solutions to address these challenges:

- To support a quicker manual fire confirmation and localization, Action 6-B proposes to improve the current signage and marking standards/conditions by adopting the following measures: the identification and alignment of signage and markings mismatches between bridge and vessel; the replacement of challenging readable position descriptions for easily identifiable and interpretable ones that support effective wayfinding and localization.
- To support quick manual fire confirmation and localization, Action 6-B proposes guidelines to improve the condition, training and performance of the task. The guidelines should be included in companies' procedures and comprises: a description of the role, the activity and the conditions for performance; a description of the practical measures to ensure a clear communication between bridge and runner; and a description of the practical measures to ensure familiarization with the task

With the development of the guidelines, Action 6-B aim, namely, to "set a standard for quick manual fire confirmation, localization and assessment", is achieved.

Action 6-B's findings and resulting guidelines are valuable due to their overall positive impact on safety on board. Arguably, Action 6-B's results increase awaraness about the importance of this task, set new standards for the conditions of performance, and address widspread communication and wayfinding challenges. These contributions support quicker manual fire confirmation and localization, leading to improved information and conditions for first response and fire containment.

1.4 Contribution to LASH FIRE objectives

The strategic objective of LASH FIRE 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." This report addresses the strategic objective by giving insight regarding the current conditions and functions for manual fire detection and localization. Main concerns are identified and solutions to them proposed.

- Specific objective 1: "LASH FIRE will strengthen the independent fire protection of ro-ro ships by developing and validating effective operative and design solutions addressing current and future challenges in all stages of a fire. "
    - This report addresses the specific objective by diving into the challenges of manual fire detection and localization. Quick manual detection and localization is important to support early decision-making process and for a successful containment of a fire. This report describes conditions and challenges, and suggests potential improvements and solutions regarding design, management, tasks, and equipment. We thus address detection and design, as called for by the EU commission, and contribute to "greatly enhance the prevention and management of fires at sea".
- Objective for Action 6-B: "Set a standard for quick manual fire confirmation, localization and assessment."
    - In this report, we describe the process and findings in which the development of the guidelines draws. The guidelines comprise two solutions to improve the standard for quick manual fire confirmation and localization.

1.5 Exploitation and implementation

The standards for manual fire confirmation provided in this report should inform industry actors and regulators on how to enhance management and containment of fire. D06.1 Development of and guidelines for quick manual fire confirmation and localization of fire can be used as a reference resource by LASH FIRE consortium partners, as well as:

- Ship operators and crews
- Shipyards
- Ship equipment and component suppliers
- Service providers
- Research centres and University departments
- Classification Societies
- Insurance companies
- Regulatory and standardisation bodies

The suggested guidelines have been discussed with LASH FIRE partners and external parties, to communicate the potential for improvement and industry implementation.

2 List of symbols and abbreviations

AB	Able Seaman
CCTV	Closed Circuit Television
DECT	Digital Enhanced Cordless Telephone
ECR	Engine Control Room
FRMC	Fire Resource Management Centre
FSS	Fire Safety Systems Code
IACS	International Association of Classification Societies
IMDG code	The International Maritime Dangerous Goods code
IMO	International Maritime Organization
IR	Infra Red
MFAG	Medical First Aid Guide for Use in Accidents Involving Dangerous Goods
MSC	Maritime Safety Committee
OOW	Officer On Watch
PA	Public Announcement System
SOLAS	International Convention for the Safety of Life at Sea
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
UHF radio	Ultra Hight Frequency radio
WAB	Watch Able seaman

Introduction

Main author of the chapter: Lucía Liste, NSR

When a fire signal such as heat or smoke is detected by technical equipment and alarmed, the vessel crew will check if it is a real fire or not (e.g. false or nuisance alarms). If fire signals are detected by several sensors, in several areas, or if a fire is seen on CCTV, the fire is confirmed, and the firefighting team will be mustered. However, often only one sensor has been activated. Then, the fire must be manually confirmed and localized or be dismissed by a crew member. Through this confirmation the firefighting team will be able to direct their work as accurately as possible from the start. Current practice is that the officer on watch ask an able seaman (AB) (often bridge watch or fire patrol) to run to manually confirm and identify the fire (Bram, Millgård, & Degerman, 2019). This person is thus often called the runner.

The response to a fire alarm must be as fast as possible, to ensure efficient first response and tackle the fire at the initial stage. However, previous research shows that the task often takes some time (at least four minutes) and have identified several challenges delaying the manual confirmation and localization. These practices thus could be improved to increase the chance to successfully fight a fire.

The objective of Action 6-B in the LASH FIRE project is to set a standard for quick manual fire confirmation, localization and assessment. This report both describes Action 6-B's work to develop the guidelines and presents the guidelines' final version. The development of the guidelines comprises three different phases. First, Action 6-B reviewed existing information finding that even if the technical fire detection is quick, the manual fire confirmation and localization is generally time consuming. This is reported by several accident investigations and a few research projects, e.g., FIRESAFE2 (Bram et al., 2019). Except from in the earlier FIRESAFE2 and related projects by RISE, however, there is no scientific literature on the manual fire confirmation that happens in this time gap between a fire alarm goes off and the firefighting team starts the extinguishing work.

Action 6-B performed telephone interviews and observation of crewmembers onboard finding that even if the manual fire confirmation and localization is carried out, it is rarely systematized and trained for. As a step to gather more knowledge to develop guidelines, Action 6-B was part of the organization of a remote trial in which the alarm was raised and the existence and position of fire by crew was confirmed. Special findings from the trial, that is not described in prior research, are that the runner's information about the fire's detailed localization is vital for the firefighting (since technology cannot be fully trusted). Important topics identified are the conditions relevant for their decision-making and situation awareness (such as their technology and procedures for operation, communication, training, familiarization, and drills). The data gathered and existing knowledge confirm the need for guidelines for effective manual fire confirmation, localization and assessment.

Therefore, building on the results of the document analysis, interview study and the remote trial, this report presents the action 6-B's guidelines for quick manual fire confirmation and localization, including requirements regarding two main concerns: (1) the improvement of current signage and marking standards/conditions to support effective wayfinding and localization; and (2) the standardization and formalization of manual fire confirmation and localization.

The report is organized as follows. First, we present the technical approach, where we describe data gathering efforts in the different studies conducted which are the knowledge base for the development of the guidelines for quick manual confirmation and localization. Second, we discuss the theoretical approach: two different organizational perspectives that enlighten the analysis of the

data gathered; naturalistic decision-making and situational awareness. Third, we review the state-of-the-art regarding manual fire confirmation and localization by summarizing findings from previous research projects addressing manual fire confirmation and localization. Then, the findings from our empirical studies of the conditions and functions for quick manual confirmation and localization are discussed. Finally, we present the proposed guidelines for quick manual fire conformation and localization, including both, a summarized description of the development of and the concrete measures.

3 Technical approach

Main author of the chapter: Lucía Liste, Kristine Størkersen and Gudveig Gjøsund, NSR

This section presents the technical approach used for gathering the knowledge base for the development of the guidelines for quick manual fire confirmation and localization. The knowledge base draw on findings from three different studies examining the conditions and functions for manual confirmation and localization of a fire on board – namely, a document study, an interview study and a remote trial on Stena Judtlandica.

Furthermore, as part of our data gathering efforts, Action 6-B researchers contributed to the elaboration of an electronic survey leaded by RISE researchers. The questionnaire included among other topics, several questions about manual confirmation and localization. The survey was sent by RISE researchers in the spring 2021. However not a single respondent has answered the questions regarding manual fire confirmation and localization. For this reason, the electronic survey is not included in the table summarizing Action 6-B's technical approach nor further discussed in this report.

In October 2021 a second LASH FIRE drill was carried out by WP07 at Stena Flavia in addition to the first one mentioned above. However, the debrief was not organized before this report was written. Thus, this second drill is not included as a case in this deliverable. Yet, a preliminary analysis of the resulting videos has been conducted to triangulate and confirm our findings.

Table 1 summarizes Action 6-B technical approach, encompassing methods used, timeline and data sources forming the knowledge base for the development of the guidelines for quick manual fire confirmation and localization.

Table 1. Summary of Action 6-B technical approach (methods, timeline and data sources)

Method	Timeline	Data sources
Document study	Spring 2020	Qualitative content analysis of regulations, ship company procedures and operations (gathered by WP4 and WP5), accident investigation reports, prior empirical research results, as well as theoretical perspectives about organizational conditions and human factors.
Interviews study	Spring 2020-Spring 2021	Qualitative analysis of 15 interviews (more information about respondents in the section 4.2)
Onboard trials	Spring 2021	Content analysis of recorded remote trial and debrief (more information provided in section 4.3)

3.1 Document study

The document study comprises an analysis of existing regulations (gathered by WP04), ship company procedures and operations (gathered by WP05), accident investigation reports, prior empirical research results, as well as theoretical perspectives about organizational conditions and human factors. The research method used resembles a document review. The gathered information about regulations, procedures and literature was consolidated through an analysis of patterns and common categories in the data material. Annex A comprised some graphical examples of the identified conditions for manual fire confirmation and localization. Annexes B, C and D can be consulted for more information about the sources examined.

Table 2. List of documents used for the review of regulations

IMO Documents	SOLAS Convention, as amended
	ISM Code – International management code for the safe operation of ships and for pollution prevention
	MSC.1/Circ.1615, Interim Guidelines for minimizing the incidence and consequences of fires in ro-ro spaces and special category spaces of new and existing ro-ro passenger ships
IACS & Class Rules	IACS Blue book dated January 2019
	BV Rules for Steel Ships (NR467), as amended in July 2019
Flag Administration Rules	SOR/2017-14 - Vessel Fire Safety regulations published by the Minister of Justice of Canada, Current to March 19, 2020
	UK MSIS 12 - Statutory guidance for fire protection arrangements, dated June 2014

Since the task of manual fire confirmation and localization is scarcely regulated, we looked also to company procedures for more detailed descriptions than the regulations of the confirmation and localization of vessel fire (Stena).

The main purpose of investigating a marine accident was to identify the factors causing the accident, with the aim of improving the safety for personnel and passengers at sea, preventing similar accidents in the future and enhancing safety of navigation. It was not the purpose to apportion liability, nor apportion blame to anyone or any party. Instead, we aimed to gain insights about how manual localization and confirmation phase is done in practice and how it can be improved. We examined a total of 18 reports including both ro-ro and ro-pax fire incidents, as well as a report examining casualty statistics and investigation analyses. The reports have been analyzed by searching for the following keywords: “manual detection”, “identification”, “communication”, “confirmation”, “localization”, “runner” and “AB”. Furthermore, sections dealing directly or indirectly with the phase between the sounding of an alarm and identification of fire have been carefully examined.

List of investigation reports examined

- Fire on Vehicle Deck - Roll-on/Roll-off Passenger Ferry- Joseph and Clara Smallwood 2003
- Preliminary investigation report M/V Al Salam Boccaccio 2006
- Fire on board Und Adriyatik 2008
- Fire aboard Vehicle Carrier Pyxis 2008
- Fire onboard Queen of Scandinavia 2009
- Fire on the ro-ro passenger vessel Lisco Floria 2010
- Report on the investigation of the fire on the main vehicle deck of Commodore Clipper 2010
- Fire aboard Pearl of Scandinavia 2010
- Fire on a semi-trailer on board the ferry MECKLENBURG VORPOMMERN 2012

- IMO – Casualty Statistics and Investigation. Report of the Correspondence Group on Casualty Analysis, National Transportation Safety Board 2012
- Fire Aboard Vehicle Carrier M/V Alliance Norfolk 2012
- Fire aboard Victoria Seaways 2013
- Marine accident report Britannia Seaways 2013
- Fire on Corona Seaways 2013
- Marine accident report Urd 2014
- Marine Accident Brief Fire onboard Vehicle Carrier Courage 2015
- Fire aboard Ro-PAX ferry Stena Spirit 2016
- Fire aboard Vehicle Carrier Honor 2017

3.2 Interview study

A total of 15 qualitative, semi-structured interviews were conducted to gather informants' insights regarding the conditions and functions for and practices around manual fire confirmation and localization. The interview guide comprised the following topics (see Annex F for the original interview guide):

- Background knowledge of fire prevention/monitoring:
- Routines in case of alarm/fire
- Communication bridge/machine/runners
- Procedures, rules and legislation (local, shipping company, national, international)
- Potential for improvements (human/technology)

In total, the interviewees comprised insights from four runners (one of the AB working night shift), three officers, two chief officer, one designated person, one shipping company's contact person, one researcher and representatives of other industries (hotel, aviation, and oil and gas). The interviews were carried out in English and Scandinavian between January 2020 and April 2021. The original interview guide can be consulted in Annex F. Interviews were conducted in compliance with current European Data protection legislation (the informed consent for interview participation templated used can be consulted in Annex F).

Interviews were mostly conducted via telephone and were recorded. Researchers took notes during the interviews and completed the transcription (intelligent verbatim transcription) in the aftermath of each interview. The transcriptions were coded and analysed following an abductive approach. Furthermore, a total of seven interviews from WP7 were also consulted to triangulate our findings (including one with a representative of oil and gas industry).

3.3 Onboard trial

The initial plan was to design and perform in close collaboration with vessel crews several trials focused on manual fire confirmation and localization. Yet, the Covid-19 pandemic forced us to find alternative ways to carry the trials out. A major collaboration between the LASH FIRE shipping companies and the researchers in WP6 and WP7, resulted in what could be called remote trial. Informed by remote ethnography methods (Postill, 2016), the trial was designed and executed by the shipping company contact and ship officers, with digital participation of researchers. The trial was performed as a common fire drill onboard Stena Jutlandica, with some extra efforts. The researchers developed the general approach, while the crews refined it. RISE researchers gave the crews instructions of procedures and technology, while the s personnel adapted it to their activities. Stena's

contact person and the crew at Stena Jutlandica organized video recordings of different activities included in the fire drill.

The scenario was well prepared by the Stena personnel. A ship company contact followed the bridge personnel closely. Three bridge officers and the company contact had a chest camera that recorded the drill from their perspective. One earlier explored option was that the researchers could participate in the drill through a video meeting at the company contact's phone, and thus be able to ask questions through him, but this proved difficult. However, the four cameras gave a good overview, and the video recordings were made securely available to the involved researchers, four from the different cameras and one were alle four video recordings were put together. After this trial there were conducted a debrief interview with the captain and chief engineer (the interview guide prepared for the debrief can be consulted in Annex F).

At the debrief interview, the chiefs described that they and the crew had positive experiences with the remote ethnography and preferred this over being subjects to traditional empirical data gathering. Instead of being observed by a group of researchers, they had to wear cameras. The cameras were easier to forget than researchers would have been. In addition, they reckoned that they would be able to watch the videos themselves and use this material to learn and improve their drills. Even if they said it was a relief not having researchers "on their shoulders", they emphasized the importance of carrying out these recorded drills to be more aware of their own actions.

In result, the empirical (video) material of the remote ethnography is different, but maybe as rich, as traditionally gathered qualitative data. For Action 6-B, this implied another type of data gathering process with less trials and scenarios than planned. Still, the trial provided knowledge about identify requirements for manual fire confirmation and localization to improve fire detention. Thus, the method was appropriate to achieve the study aims.

3.4 Theoretical approach – Relevant organizational perspectives for manual fire confirmation and localization

During manual fire confirmation and localization, the *runner* and the bridge/engine room personnel needs to react rapidly and make the right decisions that depends on their awareness and information about the context. Informed decision making can be essential for early detection and localization of a fire.

3.4.1 The context of the manual fire confirmation and localization

Decision making always depend on the context and activity (Rasmussen, 1997; Rosness, 2009). In organizations, the context is shaped by culture, structure, interactions and relations, and technology (Schiefloe, 2017; Schiefloe & Vikland, 2006). The *culture* is comprised of norms, values, and competences that constitute conventions for behavior, interaction, and communication (Antonsen, 2009). *Structure* includes elements like rules and tasks. *Interactional* dynamics are differently expressed in different situations and activities (Halvorsen, 2015, p. 50), while *technology* includes for example vessel and work equipment. As we can see, competence, training, ergonomics, safety management, and other human factors are intertwined in this context. The organizational factors are influenced by the environment and society as a whole, and all these aspects influence and are influenced by one another, making it vital to take into account the complexities and indeterminacies of the context when studying decision making at work (Halvorsen, 2015; March, 1994; Rasmussen, 1997; Rosness, 2009). Reason (1990) discusses actions with or without prior intentions, such as hostile actions, slips, lapses, and mistakes, but this is not further examined here.

In practice, others' decisions affect each actor's ability to make a decision. Some decisions are more critical for one actor than for others. Decisions about procedures, responsibility, time required to complete a task, questions, parallel or competing operations, or other intervening elements will affect any actor's decision making. Antonsen (2009, p. 1120) describes the various aspects that contribute to an accident, concluding that all "these contributing factors are *decisions* that involve the evaluation of risk, the sorting of information, and a trade-off between different interests."

An organization includes several levels, groups and professions, that all have their views and roles, often contradictory, but that still are essential in the collaborative actions. For example, it is common that the crews and office personnel have different opinions and criteria about how the safety management should be (i.e. Størkersen, Thorvaldsen, Kongsvik, & Dekker, 2020).

Work on a ship is a complex system, resting on a high level of experience, skill and collaboration, involving the use of specialized equipment, tools and procedures (Sandhåland, Oltedal, Hystad, & Eid, 2015). A rapidly evolving fire scenario will often mean a sharp increase in many of the factors that are known to undermine decision-making, such as workload and noise. This will place high demands on the system, ranging from the individual crewmember to all the different aspects of the immediate environment, to the interplay within the extended system on-board (e.g. between the bridge and ro-ro spaces), to outer layers of the system such as the land organization, nearby ships and other relevant parties (e.g. Vessel Traffic Service).

3.4.2 Situation awareness

Situation awareness is the perception and understanding of the elements in the environment, the comprehension of their meaning, and the projection of their status in the near future (Endsley, 1995). It depends on stable cognitive properties and on experience, preconceptions, and goals. Situation awareness is often created jointly among actors involved in a work process, and relies on communication, sharing of information and the creation of shared interpretations (Leroux & Mindykowski, 2017, p. 37). Distractions in the environment such as noise, communications or movement can put a strain on the decision-maker's attention. Stress, bad weather, sleep disruption and fatigue also impede the situational awareness. Even though the decision-maker is competent, rested and calm, the situational awareness depends on how information is gathered, integrated, presented and shared can still introduce errors (Endsley, 2017). Coordination within a team is important for situational awareness, but different roles and understandings are important since different professions may need to interpret and use information differently.

3.4.3 Definition of a decision

Most workplaces are organized around decisions, which can also be viewed as commitments to action (Halvorsen, 2015; Lipshitz, Klein, Orasanu, & Salas, 2001). A decision has different characteristics depending on the setting in which it is made.

In strategic meetings, decisions are *clear* and documented; they usually occur at the company and management levels. Reason (1990) uses the term *decisions* primarily for high-level judgments, which can be precursors for safe or unsafe acts at the lower levels of an organization. For high-level decisions, Kongsvik et al. (2015, p. 88) distinguish between *strategic, long-term decisions*, with months and years elapsing between decision and action, and *operational decisions* that involve coordination and planning for the next few days and weeks.

During normal dynamic work, decisions can be more difficult to spot. Kongsvik et al. (2015) define *instantaneous decisions* as those made by sharp-end personnel during the performance of tasks. In these settings, an actor or group of actors might not deliberately make a conscious decision or even

agree that a decision was made at all (March, 1994; Rasmussen, 1997; Rosness, 2009). However, an observer can identify a point in time at which a decision must have been made, because that observer can think of alternative choices that the actor(s) could have made. To become aware of which decisions have led to action and to understand what has occurred, observers seek to find the moments at which an actor could have acted out other alternatives. In such situations, it is often difficult to separate the decision from the decision-making process. Therefore, researchers are advised against trying to isolate the decision or the decision-making process; rather, they are encouraged to determine what aspects were important for the actors during the decision-making process (Rosness, 2009, pp. 807-808).

Decision making at work is often a collective activity that can develop over shorter or longer periods of time, be more or less intentional, and be constrained and shaped by both context and individual qualities (Rosness, 2009, p. 807). Decision making can even be seen as action adapted to situational constraints.

In crisis handling, the first decision criterion is to avert catastrophic outcomes. This may be constrained by stress and time to obtain information (thus, the situation awareness) (Rosness, 2009). In addition, actors in an operational setting may be prone to miss warnings in their environment, because their performance of routine tasks gets automated, i.e., with limited conscious control (Reason, 1990). Warnings from the environment may lose their effectiveness because even the handling of warnings tends to get automated. One function of decision aids in such settings may be to make warnings more effective. In some settings, this may be done by reducing the frequency of unnecessary warnings. Reducing the number of unnecessary alarms may make the remaining alarms more salient (Rosness, 2009, p. 810).

3.4.4 Realistic/naturalistic decision-making

Since the nineteenth century, theories on decision making have been anchored in rational choice theory, which holds that decision makers have all relevant information and the time to categorize data, foresee outcomes, and make the optimal decision based on a consideration of all relevant aspects (Dekker, 2017; Lipshitz et al., 2001): “Errors were attributed either to irrationality or to unawareness” (Reason, 1990, pp. 36-37).

Bounded decision theory gained popularity in the second half of the twentieth century; it holds that most decision making is part of complex social processes and includes more aspects than any one actor can be aware of (March, 1994). Many things happen at once, situations are ambiguous, and the actors must interpret all these inputs based on their own values and the information available to them (March, 1994). When the problem of limited time is added to such a complex environment, the decision-making process is far from the ideal suggested by rational choice theory. Agents tend to act upon beliefs or rituals, change meanings, or appear to say one thing and do another (March, 1994). Still, decisions are locally rational and make sense when one knows the actor’s values, information, and awareness at the time of decision making (Dekker, 2017). Sociologist Max Weber (1864–1920) had already underlined the importance of every actor’s meaning, understanding, and values in social action. Weber held that actors always make decisions that make sense to them in their situation and with the information and values they have.

Numerous studies in recent decades have demonstrated that decisions are commonly made even though “not all alternatives are known, not all consequences are considered and not all preferences are taken into consideration” (Kongsvik et al., 2015, p. 87). Reason (1990, p. 38) notes that “human beings, even when engaged in important decisions, do not work out detailed future scenarios”; rather, the decision maker is likely to contemplate only a few alternatives and neglect seemingly obvious ones.

Herbert A. Simon coined the term *satisficing* to describe such decision making, in which actors try to find a solution that meets certain criteria and is good enough (March, 1994).

Often decisions must be reached under complex conditions with time pressures and ill-defined goals (Lipshitz et al., 2001). Klein (1993) uses the term *naturalistic decision making* to describe his studies of firefighters' work performance. He called experienced personnel's decisions *recognition-primed decision making*. Their collective decisions are not separated from the rest of their work, and they have no or at best limited time to discuss and debate criteria, alternatives, constraints, and pros and cons. Rather, their decisions are made through a silent understanding of the situation, comparisons with other situations, and relying on decisions that have worked earlier under similar conditions. If problems are foreseen, then a given option might be modified or rejected and another typical reaction tacitly explored. Recognition-primed decision making corresponds with a mix of Rasmussen's (1986, pp. 100-103; 1997) skill-based, rule-based, and sometimes knowledge-based problem solving. In the skill-based mode, the actor decides according to patterns of preprogrammed instructions, while in the rule-based mode the actor solves familiar problems with rules of thumb. It can save time to use predictable reactions rather than considering all alternatives. Rasmussen stresses that:

> *Actors are immersed in the work context for extended periods; they know by heart the normal flow of activities and the action alternatives available. During familiar situations, therefore, knowledge-based, analytical reasoning and planning is replaced by a simple skill- and rule-based choice among familiar action alternatives, that is, on practice and know-how. When, in such situations, operational decisions are taken, they will not be based on rational situation analysis, only on the information which, in the running context, is necessary to distinguish among the perceived alternatives for action. (Rasmussen, 1997, pp. 187-188)*

When there is a need for more thorough consideration of alternatives, the actor employs the analytic and conscious knowledge-based decision-mode. However, this may not fall under the task of manual confirmation and localization of a fire.

4 State of the art regarding manual fire confirmation and localization

Authors of the chapter: Kristine Størkersen and Gudveig Gjøsund, NSR

This section presents the result from the document study (see table in section four)., We describe the existing knowledge about manual fire confirmation and localization at ro-ro vessels. This includes overviews of reviews about regulations, company procedures, and accident investigation reports, as well as earlier research results about vessel fires. We have a special interest in the regulations, procedures and operations of the personnel on board used for manual confirmation and localization – the so-called *runners* (watchmen, assistant, security on watch, AB, responsible person or deckhand among others).

4.1 International regulations addressing manual detection and localization of fire

The task of manual fire confirmation and localization is scarcely regulated.

SOLAS is the abbreviation for "The International Convention for the Safety of Life at Sea," which was concluded in 1974. It is regarded as the most important of all international maritime treaty concerning

the safety of merchant ships, and which sets minimum safety standards in the construction, equipment and operation. Manual localization/confirmation is not treated directly in the SOLAS convention, but it addresses training, manual firefighting and the crews' preparedness, competence and actions in case of a fire.

Regarding organizational aspects of confirmation and identification of the fire, SOLAS has some requirements. Crewmembers shall be trained to be familiar with the ship and its fire-fighting systems. Otherwise, training requirements focus on firefighting, not confirmation and localization of fire. All ships must have a fire safety operational booklet, describing the crews' responsibilities. The ISM Code requires a safety management system where safety-related and emergency tasks are risk assessed and described (procedures) and where persons performing them are identified. This system must include description of fire patrols and crew organization for fire-extinguishing (as required by SOLAS II-2). Fire patrols should be familiar with the ship and carry a radiotelephone apparatus.

Regarding technology and vessel design influencing the confirmation and localization of fires, SOLAS has some requirements about the central control station/safety center and alarms, as well as call points and construction of ceiling and bulkheads. MSC recommends some additional measures to facilitate proper identification of the location of a fire: video monitoring of the ro-ro spaces; zoning coherence between fire detection and firefighting system; and clear marking of the zones in ro-ro spaces.

4.2 Company procedures and practices

Company procedures may have more detailed descriptions than the regulations of the confirmation and localization of vessel fire, and company actors also have additional practical solutions.

The manual confirmation and localization is briefly and irregularly addressed. Here, the person sent out to manually confirm and localize the fire, is called "responsible person", "AB/Security on watch" and "deckhand". In general, the task of confirmation and localization is described with few words, and in multiple ways:

- In the procedures of two of the vessels, a first step after alarm is that the Officer of the Watch must
    - make the fire area be "physically investigated by a responsible person and confirmed"
    - "send out AB/Security on watch to investigate area"
- Another vessel has as a third step to "Send a deckhand from the watch, equipped with a walkie-talkie, to the alarm area to check the area".
- The last vessel procedure sample do not include the identification of fire in the initial actions but has as a ship specific consideration/action: that the "team "should "confirm fire exists" (if at sea) or that the "alpha team" should "confirm the location and extend of fire" as part of the drencher activity (if in port).

Not included in the formal procedures, but emphasized at the vessels, is that training, communication, and situational awareness is essential for the fire patrol (potential *runner)*. The shipping company actors stress that confirmation and localization of a fire will be faster (and safer for the *runner*) if the *runner* has knowledge about the situation at the suspected fire localization: cargo, technology, fire prevention systems, possible scenarios and counter measures, etc. Earlier fires have shown that technology can fail during fire, but in many cases technology may be helpful.

According to the industry descriptions, the *runner* does not always have, but would benefit of:

- Smooth and continuous collaboration with bridge team
  - trust
  - mutual understanding of the situation, routines and what is important information for decision making
  - clear communication (two-way channel, common language, predictable messages, and standardized phrases)
- knowledge and training
  - familiarity of the vessel and technology
  - understanding of safe approach to different spaces and fires, depending on situation
  - confidence of own knowledge
  - awareness of possible fire related scenarios
- situational awareness and access due to good vessel design and technology
  - runners' personal equipment (UHF radio, DEC telephone, portable IR camera, flashlight, check point scanner, keys/codes for locks, and in the future: positioning, livestream video, light breathing masks, etc.?)
  - easily readable position descriptions (drencher zones, frame markings, decks, etc.)
  - that cargo is arranged so it will be possible to visually identify and confirm a fire
  - radio coverage
  - bridge crew's redundancy/overview by information from detectors, drencher zones, CCTV and potentially other technology

4.3 Accident investigation reports

In this chapter we will identify which personnel on board that operate as "runners", look at how they are referred to and also review how "runners" appear in the investigation reports when it comes to the description of the event, the analysis on what happened, and the measures proposed.

4.3.1 The runners

Current praxis to localize and confirm a fire on board is usually to send a person to manually identify and confirm the fire. In this report they are called *runners,* but what they are called in the different company procedures and regulations varies a lot. In some of the investigation reports, the runners are mentioned when it comes to describing the event and in the analyses of the event. Sometimes they are mentioned in the measures suggested for improvement. The various investigation reports refer to the *runner* in very different terms. In addition, there are differences between the various vessels/shipping companies in who holds the role of a *runner*. Below we list the different names and actors mentioned as the *runner*. As the list shows, it is only a few of the investigation reports that mentions this role at all. The reason for this is most often that there were no need for a runner to manual confirm and localize the fire since the fire already was detected (and thereby confirmed and localized) by nearby personnel.

Naming of the *runner*:

- Watchkeeping crew member (Und Adriyatik)
- On-watch AB (Corona Seaways)
- Fire patrol (Queen of Scandinavia)
- Watchman and Person sent (Stena Spirit)
- VDW (Vehicle Deck Watchman) (Joseph and Clara Smallwood)
- The lookout (Commodore Clipper and Pearl of Scandinavia)

Different positions that have taken the role of the *runner*:

- The AB (Carrier Courage)
- The third officer and The Master (Carrier Pyxis)
- Ship's assistant (Pearl of Scandinavia)

4.3.2 How investigation reports deal with manual localization and confirmation

As the previous section shows, this phase is usually addressed only on the description of events. Many of the reports do not properly describe this phase in any of their sections. In very limited cases, manual localization and confirmation is included in the analysis, evaluation or recommendations. Below we summarize how manual localization and confirmation is addressed in the different investigation reports.

4.3.2.1 In the description of the event

- Watchkeeping crew member was sent to the alarm scene and he noticed the fire on the trucks, which were parked inside the main deck. (Und Adriyatik)
- The AB opened the main deck port aft door but did not enter the space because of the tightly packed vehicles. He reported to the OOW on his Very High Frequency (VHF) radio that he could not see any evidence of a fire, and he then closed the door. (Corona Seaways)
- The fire patrol who performed the nightly fire rounds was on the bridge on his lap, and the navigator immediately sent him down into the engine room to check the fire alarms. (Queen of Scandinavia)
- The watchman reported to the bridge by phone that he had located smoke above and around a refrigerator truck parked in front of the stern ramp (door), on the port side next to the central bulkhead (…) . when the ship was entering breakwater heads of the port of), the watchman noticed flames on the truck roof (photograph No. 7). He tried to call the bridge on the VHF operating channel, but failed (...) The watchman, not being able to contact the bridge via radio (VHF), started to extinguish the fire with a 50 kg transportable powder extinguisher. (Stena Spirit)
- The third mate instructed the AB to investigate the alarm. The AB departed the bridge after obtaining a radio and conducting a radio check. He travelled from the bridge down to the weather deck and went to the access trunk aft on the starboard side of the vessel (…) The AB told investigators that as he got to the entrance of the ladderways he began to smell smoke. He passed the elevator, went down a ladderway one deck to Deck 12, and saw heavy smoke coming up from below. He immediately radioed up to the bridge, informed the mate about the smoke, and told him to sound the alarm. He then exited the space and returned to the bridge. (Carrier Courage)
- The master rushed into the wheelhouse, confirmed the location of the fire on the fire detection system and instructed the third officer to identify the site of the fire. The third officer (…..) went down to Deck No. 10, opened the fire door at the entrance of DK 10, saw a bright yellow light and reported to the master with transceiver. (Carrier Pyxis)
- At 0243, the second officer instructed the lookout to take a portable very high frequency (VHF) radio and go and check the main vehicle deck to confirm if there was a fire. (...) The lookout knew that the portable radio that he was assigned was not reliable and was concerned that he might become injured or trapped near the fire and not be able to summon help. (…) .They could smell smoke in the area, and the lookout returned to the bridge. (…) The lookout reported to the second officer that he had smelled smoke in the accommodation area, but that he had only been as far as the restaurant. The second officer told him to go to the main vehicle deck. (Commodore Clipper)

- A ship's assistant who was the look out on the bridge was immediately sent to the car deck to make observations. She opened a door to section 5 on the car deck and observed heavy smoke and flames. She saw a trailer on fire close to the flooding control door. At 06.00 she informed the bridge that there was a fire in a trailer on the car deck in section 5. (Pearl of Scandinavia)

4.3.2.2 In the analysis of the event

- An additional visual check caused a delay, which ended up with an uncontrollable fire. (Und Adriyatik)
- The OOW's decision to send the on-watch AB to check the status of the main deck after the first fire alarm was reasonable and appropriate. He had no indication of a fire on the CCTV monitor, and he needed to clarify the situation. The AB also reasonably opted to check the main deck from the door. (Corona Seaways)
- Lack of detailed procedures for the crew in the event of a refrigerator truck fire resulted in a situation that crew activities to detect the source of the smoke was carried out at discretion of person sent for this purpose to the car deck and was inadequate to the hazard existing upon detection of the smoke from the refrigerator unit in the truck. (Stena Spirit)
- The master, upon receiving the report from the third officer of the fire breakout, decided to confirm the situation of the fire himself and control the fire in the initial stage. (Carrier Pyxis)
- In the event of an anomaly, the VDW (Vehicle deck watchman) was to report it immediately to the bridge. Communications between the VDW and the bridge were conducted using fixed telephones connected to the vessel's internal communications system. On each vehicle deck, there were two such telephones, one forward and one aft. VDWs were not equipped with a portable means of communication, nor were they required to be by regulation. (…..) The absence of feedback at the pull station, coupled with the VDW's lack of understanding of the fire detection system, had the potential to generate confusion leading to an inappropriate response or a delay in commencing a response, thereby placing passengers and crew at risk. (Joseph and Clara Smallwood)
- The second officer on the bridge made the correct response in sending the lookout to investigate the first response in sending the lookout to investigate the first fire alarm. (……) The second officer's and the third engineer's mistaken opinions could have been changed by either a report from the lookout or by the second officer looking at the CCTV picture of the main vehicle deck. (…..) The lookout had smelled smoke in the restaurant, but when he returned to the bridge, the second officer was in conversation with the third engineer, and he waited before making his report rather than interrupt. The lookout's report started to challenge the second officer's perception of the problem but lacked urgency, an as the lookout had not actually seen a fire, this was not enough to persuade the second officer to start alerting the rest of the crew. (….) He sent to lookout away again to check if there was a fire and decided to take no further action until he had a definite report. The lookout's faulty radio meant that confirmation was further delayed. (Commodore Clipper)

4.3.2.3 In the measures proposed

- The company made an agreement with professional support and training organization in order to improve fire response abilities of the crew. (Und Adriyatik)
- All crew must be vigilant when on duty, if fire is detected raise the alarm and then fight the fire after help arrives. (Carrier Pyxis)
- To avoid delays in raising the alarm in a real fire situation, fire patrol should have an efficient direct Radio communication with the bridge and all crew members must have familiarization training with the alarm system on board their vessel and for alternate communication

arrangements. Manual pull stations with a time delayed alarm should be appropriately labelled. (Joseph and Clara Smallwood)

4.3.2.4 Examples where "runners" are not used (but should have been):

- The fire alarm detected at the panel was reset before the response teams were in place, perhaps because the crew members on watch in the bridge assumed it was part of the trouble stemming from auto-pilot dysfunction, or perhaps to avoid sounding the alarm. (Al Salam Boccaccio)

4.3.3 Lessons learned from accident investigation reports

One of the most striking findings from the analysis of the accident investigation reports is the diversity in the practices around manually localizing and confirming of fire. There are major differences in which person/position onboard that is sent – also the master – and how the localization and confirmation is performed. It is also worth noticing that even in the investigation reports where the *runner* is described as having a significant role, the measures proposed to prevent these kinds of events happening again are seldom directed towards the role of the runner. To sum up, analysis of the different reports provides us with valuable insights on:

- Quality and thoroughness of incident investigation reports vary to great extent
- Different terms to refer to the 'runners'
- Great heterogeneity regarding practices as well
- Communication issues are common
- Combination of manual detection with the use of existing technology for localization and confirmation of fire
- Great degree of improvisation (lack of detailed procedures and training)
- This phase is black boxed in the reports: Manual detection, localization and confirmation activities are rarely properly addressed/described/problematized, nor analyzed/evaluated in the reports.
- Reports rarely include recommendations to improve the phase of manual detection and confirmation.

For ship procedures and emergency task lists, it is important to include the fire related tasks of individual crew members fire while the ship is in different situations such as sailing or port preparation. It is also a need for alignment when it comes to a unified term for the *runner* and describing the phase of manual localization and confirmation.

4.4 Earlier empirical research about manual confirmation and localization of ro-ro fires

The topic of manual fire confirmation and localization is rarely mentioned in the research literature about firefighting, fire systems, false alarms, or crisis handling. However, some earlier fire research projects have identified and discussed the relevance of the confirmation and localization activities.

4.4.1 FIRESAFE

The first FIRESAFE project created a distinction between early and late detection of fire, as early detection is imperative to succeed with fire extinguishment and detention (Leroux & Mindykowski, 2017). Their criterion for *early detection* is that the available time for safe first response (the time available until conditions become untenable around the fire, disallowing first response) is longer than the required time for that safe first response (to detect the fire and to set up all actions for first response). Otherwise, the detection will be too late to safely extinguish the fire at its initial stage (for example with a hand-held fire extinguisher). These terms and the understanding from the original FIRESAFE project were continued in FIRESAFE II.

4.4.2 FIRESAFE II

The FIRESAFE II project studied fire-related decision making to provide immediate, precise and accessible information to identify and confirm a fire.

> *"A lack of relevant and immediately accessible information can cause severe delays in decision-making, allowing the fire to expand, thereby creating an even more difficult operative situation." (Leroux & Mindykowski, 2017) Page 7.*

FIRESAFE II produced a list of hazards relevant to detection (Leroux & Mindykowski, 2017) p 4-5:

- Technical detection system:
  - commonly deactivated during loading, discharging and maintenance operations
  - not required for weather deck
  - Detectors often are clogged due to dirt, salt, exhaust fumes, etc.
- Early detection is difficult if the fire develops inside cargo or a vehicle
- The detection system alarm panel can be illogical and cause confusion (detection frame number, detection section, drencher section, CCTV numbering, etc.) which can delay first response and extinguishing system activation
- The frequency of fire patrols is undefined and generally quite low
- The accessibility within ro-ro spaces is very limited, which makes manual detection and fire localisation difficult
- Many false alarms reduce the motivation of crew to quickly attend to alarms.

To ensure early detection, one need to receive and interpret an alarm rapidly, and thereafter fast confirm the existence and exact location of the fire. Information collected in FIRESAFE II suggests that the most common practice is to deploy a *runner* to the detector point (limited by the precision of the indication) whom will then report to the bridge (and, if a limited fire, use with a hand-held extinguisher). For some situations or shipping companies this stage is not employed, i.e. if the alarm system information is taken as confirmation enough to deploy the fixed suppression system and employ the fire organization. However, FIRESAFE II showed that experts saw the need of a direct assessment from a person at the fire scene at some point. This point should be early, to avoid that the person making assessment is injured by smoke and in worst case passes out in the area close to the fire. In a scenario of "late detection" the role of the *runner* is still relevant, but with even higher demands for fast deployment of runner and short travel time to detection point. The environment will be even more difficult because of increased smoke and heat. Failure of communication increases because of increased duress and information. In any case, when a fire has been located, the bridge personnel need the observations for the next phase of decision-making.

For decisions leading to activation of extinguishing systems, the hazards identified in FIRESAFE II were:

- Manual confirmation and localization of fire:
  - Runner deployment (e.g., speed)
  - Way finding, localisation and relevant support (e.g., familiarity, markings, signage)
  - Communication issues (between bridge, fire scene, drencher station, engine room).
- When fire is confirmed:
  - Assembly of key decision-makers (e.g., availability)
  - Drencher activation mandate (including hierarchy, blame culture). The field works showed a reluctance towards drencher activation among the crew, either because of a lack of decision mandate, unfamiliarity with the drencher system and drencher room environment, or fear of any negative consequences that could be the result of faulty activation. A large portion of the crew should have the knowledge and mandate for

drencher activation, without fear of negative consequences for the individual crewmember
    - Assessment of fire characteristics, environment, and fire spread
    - Ventilation management (smoke removal vs. supply of more oxygen to the fire)
- Important for both identification of fire and fire extinguishment:
    - Resource management on the bridge (e.g., competing goals/processes, fire management in relation to regular operations);
    - Alarm system management (e.g., information presentation, coherence, noise levels)
    - Maintenance of knowledge and competence (e.g., realism in training)

Leroux and Mindykowski (2017) presents a sub-tree that illustrates reasons for a potential delayed confirmation of fire (see Figure below). Beside faults by the technological confirmation devices, late confirmation can be a result of three different aspects of the manual part of the confirmation routines:

1. Late arrival at detector point
    - If there is no decision maker at the bridge to command the runner, if the alarm information is wrongly interpreted, or if it is difficult to get ahold of a runner
    - If the route to the detector point is complex due to ship design and markings, the runner is not familiar with the routes on the ship, receives poor guidance, or if the runner is situated far away from the detector point.
2. Late identification due to
    - the runner's experience, familiarization, training and handling of stress. Low motivation in the event of a ro-ro space fire alarm is deemed unlikely, but motivation may suffer if the crew member perceives him/herself to be poorly equipped for the task (e.g., sent to the location dressed in regular, flammable clothes)
    - Ventilation: it can be difficult for the runner to localize the fires point of origin.
    - cargo makes it hard to move around or obstructs visibility on deck
    - poor support from decision maker on bridge because of lack of procedures or weaknesses in the technical tools used in these situations
3. Failure in communication because of
    - Lack of communication equipment
    - Poor coverage of communication equipment
    - Misunderstandings because of unclear section numberings. In these stressful situations, *runners* sometimes have difficulties in determining their exact location, which is important information to the bridge e.g., for drencher activation.
    - Misunderstandings because of language barriers.

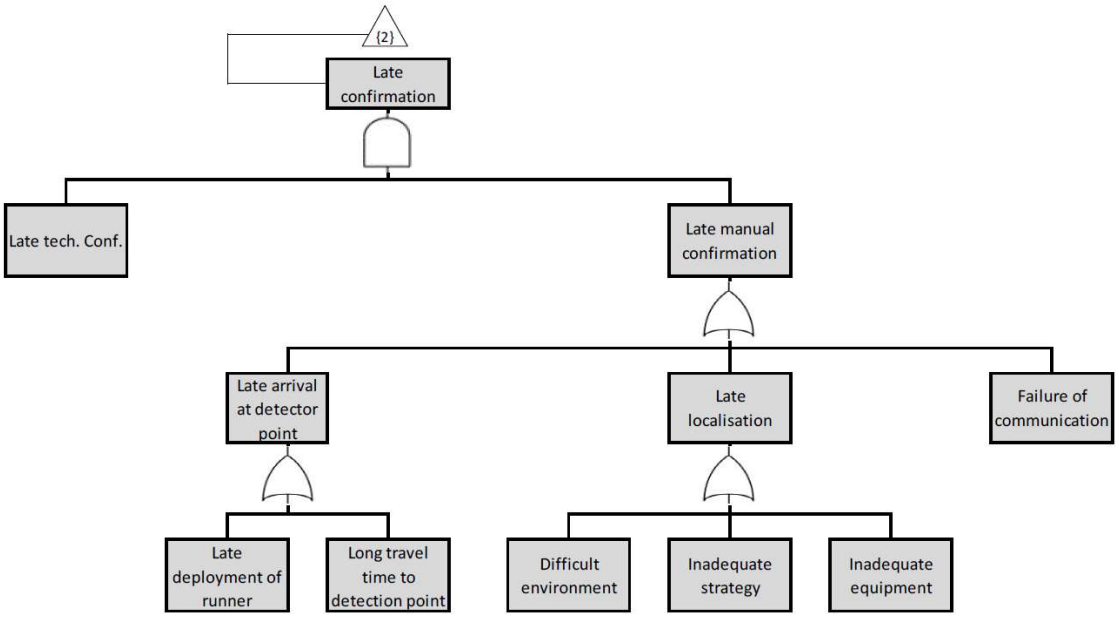


Figure 1: Sub-tree for late confirmation of fire, from FIRESAFE II project

Related to the manual identification of fire, FIRESAFE II found weighing needs to improve (Leroux & Mindykowski, 2017):

- Markings/signage for the *runner's* wayfinding and orientation.
- Crew familiarization
- Tightly packed ro-ro spaces

4.4.3 SEBRA

SEBRA, a recent system study of fire safety organization and usability on Swedish Ro-pax ships confirmed and elaborated on findings from the FIRESAFE projects (Bram, Millgård & Degermann, 2019).

As a basis for the fire safety work, SEBRA found that the safety organization on ro-ro vessels often has limited resources. Ship crews are decreasing in size due to technology and economy, each person has more tasks and roles, but also potential to get to know all onboard. Safety management is centered around compliance with procedures and documentation, and focus on auditable and quantifiable measures.

Vessel construction and modifications often complicate fire confirmation and localization. Observations resulted in several findings of poor design that could undermine performance in the case of a real fire, exemplifying why human factors should be included in all newbuilding and retrofitting:

- Several different alarm sounds and difficult user interfaces on technical monitors
- Difficult design, blind alleys, confusing marking and sections. Negative pressure on some doors, making them permanently closed
- Radio shadows
- Heavy fire equipment, long distances, and several passages too narrow to use
- The technology is not uniformly designed, leading to a difficult identification of the fire through technology systems. New alarm systems are more precise than older. Paper documentation (in addition to alarm system) are needed to guide the runner in the right direction

- Poor design is often compensated for by the crew, with adaptations of signs or professional competence about the vessel

In SEBRA, success factors for rapid response to a fire alarm also were discussed, such as:

- Rapid activation of the technical system and rapid setting of the fire organization.
- Rapid wayfinding for a sufficiently familiarized *runner*
- That all crew members have competence about the vessel, the organization, the technology, firefighting and clear communication
- A fire organization optimally have qualities described as resilient (Dekker, 2003; Woods, 2010), and these qualities require a recognition of the practical work (perhaps in opposite to the formal procedures).
- Good working conditions and effective training: systems, organizations and routines that fit the needs of the crew.

Competence is imperative. The formal requirements for familiarization and trials are not sufficient. "*A fire demands not only competence that crews get through rehearsals and education. The crews' skills are made of operative experience, technical knowledge, local familiarity, handling of stress, and relations to all actors aboard. The company's formal systems to comply with rehearsals seem, however, only to cover a part of these qualities*", (Bram, Millgård, & Degerman, 2019, p. 32) (our translation).

- Fire rehearsals are often repeating and theoretical, but should be surprising and practical, and involve all crewmembers.
- The trials are to establish a "knee jerk reaction" (automatic reaction) to be able to read the alarm situation and make rapid decisions.

Most of the found success factors can be linked to resilient performance in critical operations i.e. properties that allow people to deal with problems that are surprising and do not fully match existing routines (Bram, Millgård, & Degermann, 2019). However, the present study shows that a holistic approach is rarely applied to fire safety. Safety management has a reactive bias, a clear focus on compliance and not on usability. To improve safety at sea, shipping companies should aim for:

- Crew members that knows each other and the vessel. Especially engine personnel need to hold local information about the technical system, ship and organization, and these should thus work at one vessel over time (with proper working conditions, including time off). A real fire aboard requires creativity and adaptation skills, qualities that partly can be coupled with long professional experience, but that today is difficult to systematically reinforce (Bram et al., 2019, p. 32).
- A fire team with special professional and ship-related competences from both deck and engine to be able to identify and confirm fires rapidly, to be able to make decisions beyond the minimalistic procedures.
- Safety management that can promote organizational qualities of resilience (adaption, collaboration and creativity).

5 Empirical results regarding manual fire confirmation and localization

Main author of the chapter Lucía Liste, Kristine Størkersen and Gudveig Gjøsund, NSR

This section presents findings from the interview study and remote trial.

5.1 Results from the interviews

The data from the interviews reveal a great variation in terms of regulations, practices, and routines. Different types of vessels have different regulations, including different routines during night shifts. Shipping companies use not only distinct names to design the person carrying the task of the runner, but also different positions on board for the performance of the tasks. This is in line with findings from the document study. Furthermore, there is also large variations in terms of technology and design. While some vessels have a state-of-the-art technology which can assist on the performance of the task, others have older equipment and serious radio coverage challenges. Some vessels have mismatches between the fire system interfaces and the signage and marking systems on board. Safety cultures on board and organizational practices differ to a great extent as well. Some vessels have steady and experienced crews, while others have a great degree of turnovers. Making sense of the task is rather difficult due to existing large variations, which add complexity to the elaboration of guidelines that support quick manual fire confirmation and localization.

The informants provide insights regarding several themes highlighted as relevant for manual fire confirmation and localization activities, as well as, for the overall fire safety on board. One of these themes is **fire drills and other familiarization issues.**

> *The drills are very important to have the crew well trained. That everyone knows exactly what to do. The more people involved the more chaos* (Informant 4).
>
> *The procedures are well in place and effective as long as we keep up the drills. Trained crew is key so that the procedures work* (Informant 3).

All our informants stress the importance of drills for fire safety on board, however, our informants point out several challenges. The first one is that **manual confirmation and localization is not sufficiently trained in current fire drills**. Current fire drills do not focus on fire confirmation and localization but rather on firefighting activities and equipment. Therefore, familiarization with the task seems to take place when a new member joins the crew, rather than in drills. One of our informants described how important it was to walk together with an experienced crew member for learning what it is normal and being able to use his or her senses (vision, hearing and smelling) to identify suspicious lights, smells and sounds.

> *Familiarization happens during the induction phase, when a new crew join in, so they get familiar with the procedures and actions* (Informant 5).

A second challenge is the **lack of realistic scenarios in drills**. According to several informants, the design and execution of drills which include relevant and realistic scenarios is difficult since there are many different activities that need to be trained and the time for drills is limited. Furthermore, large variations in terms of previous knowledge and experience with fire; tight and overload shifts; and high degree of turnovers certainly challenge crew's motivation and engagement during drills.

> *If we have an experienced crew, we can make fire in places which are more difficult to reach. With a new crew we make other kind of drills* (Informant 7).

Drills can also be an **instrument to select suitable candidates as runner** and an **arena for competence building**. However, the lack of realistic drills is limiting their potential as learning arenas where to share experiences and knowledge that could eventually be translated into new routines.

> *By means of training and trials I find the right watchman. If they apply to this position and they speak English, we can train them*. (Informant 4).

Indeed, the **requirements for the runner position** is also one of the themes often discussed in the interviews. To be able to quickly confirm and localize fire, the runner should have an acceptable **physical condition** and a **decent level of English** (in case English is the working language). Furthermore, the runner must have the **right attitude** which means, for instance, being a confident energetic person, always available and ready, and treat every alarm (no matter fault or not) as a potential real fire. Finally, the runner should have some previous **working experience** and be **familiarized with the task and the vessel**.

> *We see if a person is not ready to work on board if they have not been a long time on the ship. I only want people who have worked several contracts. I need confident people who knows the ships. Sometimes there are old persons in that position, but you have to choose according to the physical conditions of the person, because that have to move fast and carry heavy things and climb fast* (Informant 8).

> *The watchman must speak English, have the marine test, a fire fighter certificate. It is important that the person is familiar with the different equipment and knows the ship well. He must make a few rounds when he comes. The English and how to fight a fire, must be there. But the knowledge about the ship he can learn on board* (Informant 5).

In the same vein, the familiarization with the vessel seems to be a key condition for the officer in charge. Some vessels have mismatches between the information provided in the fire system interfaces and the name of the sensors and/or different signages and markings on the boat. Not being familiar with these would considerably delay the confirmation and localization of a potential fire.

> *You need to be familiarized with the system. You need where all these places are. The cabins are numbered. The public spaces have names.*
> *(…)*
> *Every sensor has a number. You can consult the list, but you are losing time. It is important to be familiar with the system* (Informant 5).

A **good communication between the runner and the bridge** has been pointed as a key subject for a quick and effective manual fire confirmation and localization. Yet, informants discuss a series of issues that make communication difficult. First, **widespread technical issues**: several informants have described the poor radio coverage and blind spots in some parts of vessels and how this can delay the fire confirmation and localization. **Poor English skills** among runners and **too much noise** have been also mentioned as a challenge. The interviews show how good communication should comprise also other elements as **trust and shared understanding of the task**. Informants point to the importance of building a good relationship between the runner and the officer in charge. It is important that they both trust each other and share a common understanding of what it is involved in the performance of the task, for instance, what kind of information that should be provided to each other and how much risk the runner should assume.

> *When a new person starts as a watchman, I make a list of all the list the watchman have to check. This is not compulsory, but I make it. You have to write everything that the watchman shall report. Another important thing: you must trust the person that makes the round. We have checking points on board, on very important places, and then we know if the watchman has been there and when. But we do not have them for all the places on the ships, so by the end, you have to trust the person. And we also know if they have used enough time on the cargo deck. It is not possible to check everything in 2 minutes. With new people I check with*

> *the cameras, and we have detectors in doors that become green when the person has gone true the doors. That I do if I am not sure about the person* (Informant 7).

> *The watchmen have been told to be careful and not risk their lives when going to check the fire, So, they have to close doors and escape since they do not have breathing apparatus nor proper clothes* (Informant 3).

Therefore, it seems important to allocate **resources** and develop **arenas** in which to build such a relationship. How communication is organized on board may also have consequences on manual fire confirmation and localization. In this regard, several informants have pointed to that having **common radio channel** facilitates task coordination leading to a more effective and quicker fire confirmation and localization.

> *In the machinery space, I will call the engine personnel, in any other space will call the clock man. Anybody who is awake, and working is on the same radio channel, except those in the engine room. Everybody listens, and sometimes when you ask the clock man to go and check a location, someone else says I'm there and I will check* (Informant 7).

A **positive and open safety culture on board** and **good working conditions** will positively affect the performance of the task as well. People may have unexpected reactions in real fire events, and it is important to be able to talk about it during drills. Honesty and openness are also important when discussing previous accidents.

> *The behavior of the people in real fire situations is very different. People can act so differently. It is difficult to have concrete procedures, when it is so individual, people act different. Common sense is important* (Interview 5).

Cost saving mindsets, minimum requirements focus and compliance culture can have negative consequences and limit the availability of necessary resources for familiarization and training activities, thus on the overall safety culture on board. For instance, some companies try to reduce both crew and training to the minimum according to regulation.

> *There are lots of temporary staff coming. Some companies tend to employ eastern European, often on short monthly contract. They can be on a ship only one week or two. Here the crew changes every Wednesday. There is a high degree of turnover on ferries. It is frustrating, you spend all week familiarizing a person and then, you never see that person again. It's frustrating. (…) And yeah, also, the working conditions of the vessel do help. If you have a good working atmosphere, then people enjoy working* (Informant 11).

Finally, the **potential for improvements in the conditions for the performance of manual fire localization and confirmation** is a recurrent topic in several interviews. Informants have suggested improvements in two areas: technical and organizational. The first set of improvements focus on the **affordances that the deployment of new technology** could bring for fire confirmation and localization. One of the informants discuss how heat camaras have allowed the runner to be able to get more information of the fire. A next step would be to be able to send images captured by the camera directly to the bridge and the fire team leader, such information would support more informed and better decision-making.

> *Recently, or not recently, we have handheld heat cameras, one is big, and the other is infrared mobile phone size, so the watchman can get a better understanding of the fire and identify the area under the truck. He can communicate taht to the bridge through telling of the radio. It would be amazing to get the pictures on the bridge. It is tricky with*

> *communication, also with radio, especially on the lower decks. But who knows, maybe with 5 G. Wi-Fi spots would work* (Informant 3).

The second group of improvements are concerned with current **organizational aspects**. During a discussion on the current routines and cultures onboard, one of the informants suggest promoting the interchange of ideas and practices and fostering crew members' motivation for learning and innovation by limiting the length that crew members work in the same vessel up to two-three years.

> *Crews are staying very long on the same vessels, for example 8 years. If you stay for such a long time in a vessel you come to a point where you do not see errors, you are blind and you think that everything is correct. If you stay too long you are not motivated, it is difficult to come with new ideas because you do not see how this is done differently in other places.*
>
> *(…)*
>
> *In the report I have suggested to stay no longer 2-3 years in the same vessels because it is good to see other types of vessels, work with different people, get inspired and learn from them etc.* (Informant 2).

Two informants argued that fire localization and confirmation would be quicklier if the number of crew members taking part in fire rounds could increase, as well as their frequency. However, as the same informant points out, the cost-saving focus in shipping companies would make such measures difficult to implement.

> *One way would be to have more people doing the fire round more often. That means more employees. Maybe it is economically unfeasible then?* (Informant 4).
>
> *The only thing I can suggest is to put more people to take the safety round. I am not afraid of fire on the restaurant because it is always people there. I am more afraid on places where there are seldom people. I am worried about these places and we could have more people. But more people means more cost for the company* (Informant 5).

Finally, during a discussion about procedures for manual fire confirmation and localization, an informant argued that the problem is not the lack nor the malfunctioning of current procedures for manual fire localization and confirmation, but the poor English skills of some crew members, which are not able to carry out the task good enough. He believes that strengthening language requirements during recruitment could lead to more effective fire localization and confirmation practices.

To conclude, the interviews have presented a more nuanced insights of the complexity of the task. Despite the task is often oversimplified and overlooked, the analysis of informant's descriptions of the conditions for manual fire confirmation and localization show that the performance of the task mobilizes a complex combination of formal regulations and procedures, use of different technologies, planning interventions, team building efforts, familiarization activities, communication performances, improvisation skills, common sense, trust, and formal, experience-based and tacit knowledge. In particular, four different issues have been highlighted as by informants as conditions giving a quick manual fire confirmation and localization:

- sufficient and realistic drills and familiarization activities that include the training of the task;
- the runner should have good physical condition, good English level, right attitude and previous working experience, as well as be familiarized with the vessel and the task;

- a good communication between the bridge and the runner comprising not only good technical solutions and language skills, but also depicted by trust and shared understanding of the task;
- a positive and open safety culture and good working conditions on board, which goes beyond limiting cost-saving mindsets, minimum requirements focus and compliance culture.

Finally, the informants have pointed four conditions that can be improved for quick manual fire confirmation and localization:

- the deployment of new technology;
- rotation of crews after 2-3 years in the same vessel for promoting learning and innovation;
- more personnel involved in the fire rounds;
- strengthening language requirements in recruitment.

5.2 Results from the onboard trial

5.2.1 Observations

A thorough description of the development process as well as the performance of the onboard trial can be consulted in section 4.3.

NB! In this observation table the runner is referred to as "WAB". The trial was performed in Swedish and all the observations presented are translations from the original to English.

Table 3: Observations from trial

Time	Action (in trial videos)	Radio communication during trial	Comments from chief in debrief interview
0:08	Alarm. Panels indicating fire/smoke		At this vessel there are unnecessary alarms every day or every second day.
0:30	Sending runner	OOW: WAB, it's the bridge WAB: WAB answers OOW: I have several indications on deck 3 fore WAB: Indications on deck 3 fore, I'll check. OOW: Yes, thanks.	OOW coordinates everything until a fire is confirmed, and has always a WAB on watch. The bridge is always manned, while the ECR can be unmanned. The watch AB goes fire inspections and is more familiar with the vessel. If the watch engine man is available, we often send him/her too, particularly when there are fire indications in cargo spaces.
0:50	Camera confirmation from/coordination with ECR	ECR: Engine, it's [name]. OOW: Hi there, [name]. ECR: Hello you. OOW: I've sent the watch AB since I see several indications. Can you check the CCTVs, how it looks? It's all along the fore part of deck 3. ECR: Yes, mm, absolutely, I can see it. [silence for some seconds, talking internally at ECR saying that watch AB is sent] OOW: Can you see anything at the cameras, or? ECR: Yes, very much smoke development on the cameras.	

		OOW: Is it much smoke. Ok. Yes, I will come back to you. Thanks. ECR: Okey.	
1:45	Localization of fire	OOW to WAB: Yes, we can see much smoke on the cameras, so be careful when you enter. WAB: Absolutely. I'm on deck 4 now, in the staircase. I'll be careful.	Optimally, the panel indications will show the location of the fire, and it will be the same indications all along, but just in case we still depend on the WAB giving first hand information about the localization of the fire. He/she has been down there and seen "this is zone 9", and we can confirm that this is the same as our screens. This is one of the most important tasks of the runner, to report about the localization. The markings on deck and on the bulkheads are clear, read, and numbered.
2:00	Silence		OOW and ECR personnel watch their screens.
2:16	Confirmation of fire	WAB: Bridge, this is WAB. OOW: Yes, come on. WAB: Yes, I opened the door a tiny tiny bit, and it is very much smoke one deck 3. So I will not open that door and walk further in at deck 3. One cannot see anything. OOW: Ok.	The smoke may trigger sensors away from the fire, or between two zones, so we rely on the first descriptions from the runner when we start the fire fighting. The fire team members are my eyes and ears outside. The panels and the CCTV are not reliable.
2:46	Activation of firefighting	OOW: The smoke development on deck 3 is total, and several indications are active. I will start the general alarm. Ok, great. Absolutely.	
3:04	General alarm sounds		
9:00	Extended use of runner	OOW: Can Martin/Mats bring a crew and feel the sides and the bulkheads?	You need eyes where it happens. We send a runner if we suspect temperature increase. The runner can check over and under the area, since this is a steel ship. So we work a lot with the runners, running around.
11:23		Chief to ECR: Everything looks ok.	

5.2.2 Analysis

In the conditions extrapolated from accident investigations and literature, some topics come forward as important to quick manual identification of fire. These topics are particularly important for decision-making and can be categorized as overview/sensemaking, communication; procedures; and equipment and system design.

Table 4: Important topics and insights for quick manual fire confirmation and localization from the trial and following debrief

Topic	Insights
Overview/sensemaking	The runner found the location of the fire quickly, but the cargo space was filled with smoke, so the runner could not give a precise confirmation or description of the fire or location.

	Runner is essential to provide information about the fire and the concrete localization. Technology is not good enough. It cannot be trusted since CCTV and sensors can fall out during fire. Runner will be also used later during the fire to check the temperature of the bulkhead to see if the fire has spread or if the origin of the fire was somewhere else than they thought.
Communication	Clear communication on UHF. Communication was smoothly in the drill From debrief: Communication is a skill that really is trained for in drills like this. Communication was smoothly but it is not always as clear. Sometimes radio shadow make communication challenging and several attempts are needed in other to communicate the information requested. It is important to learn how to communicate via radio because it is open for all. It is important that it is not a monologue, that the phrases are short and concise. This is an important aspect that needs to be trained. Sometimes difficult to hear radio communication due to captain's instructions to passengers on PA
Procedures	Going straight to the place suggested by the chief (indicated on the panel)
Equipment and system design	Chief: Information mainly from fire panel, as well as information from runner and ECR's CCTV screens.

Earlier research indicate that the manual confirmation and identification of fire is rarely talked about on the vessels – but that they completely rely on this task being carried out quickly and with vigor (Bram et al., 2019; Leroux & Mindykowski, 2017; Størkersen et al., 2020; Wikman et al., 2017).

The on-board trial went smoothly and showed the optimal manual confirmation and fire management. In addition, we know that the manual fire confirmation and localization is rarely systematized and trained for. Following, the results also contribute to the understanding that it is important to prepare and train for several scenarios where the confirmation is not going that smoothly. Furthermore, the insights confirm the importance of often overlooked sociotechnical factors that need to be in place to ensure a successful performance of the task.

5.2.2.1 Conditions giving quick manual confirmation and localization of fire

The runner is a key person for fire management, setting the scene for the firefighting and being a capacity for the fire team during the trial. Conditions that led to quick manual confirmation in the trial was:

- Clear communication between chief and runner
- Wayfinding goes fast – runner is familiar with the vessel
- Markings and signage are clear
- Technology works – experienced crew knowing what they have and need and how to use it
- Good physical condition to walk around up and downstairs under a stressed situation
- Routines and formal procedures fit with the situation

Special findings from the trial that is not described in prior research are that the runner's information about the fire's detailed localization is vital for the firefighting (since technology cannot be fully trusted), and that the runner is sent several times during the trial to observe temperatures and

status around the vessel to detect whether the fire has spread to new places that are difficult to detect in other ways.

5.2.2.2 Conditions that can be improved for quick confirmation

This current trial has shown that the activity of confirmation is not treated specifically or as a separate activity in the preparations for and descriptions of the drill scenario. One can say that the activity of confirmation is *oversimplified or underspecified* since it is not seen as complex, although a quick confirmation relies on procedures, experience, communication, common sense and improvisation. It is not in focus, but rather black-boxed and in the background. Yet, we observe that this is an essential activity in the drill, yet only (indirectly) discussed in the debrief after being asked by the researchers about it.

The lack of focus on this task is not a problem if operations, drills or real confirmation of fire go according to plans, but since earlier accidents show many problems and vulnerabilities with the confirmation, some measures are needed. Measures can be grouped into three sociotechnical factors: procedures for operation including familiarization efforts, communication measures (findings on communication are informed as well by data gathered by T.6.7, see Annex 1), and technology and vessel design.

5.2.3 Conclusion

The current trial has confirmed the importance of the factors for quick manual confirmation and localization previously identified in our analysis of existing research, procedures, regulation, and accident investigation reports (Størkersen et al., 2020). Such sociotechnical factors are critical for the improvement of decision-making and situation awareness and can be grouped into procedures for operation including familiarization efforts, communication measures, and technology-related aspects. Furthermore, the findings also point to the potential implications of such factors on other fire prevention activities.

The on-board trial provided information that can improve the manual confirmation of fire. Key actors are the officer responsible for fire management (the chief engineer) and the person sent to manually confirm. Important topics are the conditions relevant for their decision-making and situation awareness (such as their technology and procedures for operation, communication, training, familiarization, and drills). Special findings from the trial that are not described in prior research are that the runner's information about the fire's detailed localization is vital for the firefighting (since technology cannot be fully trusted).

6 Development of guidelines for quick manual fire confirmation and localization

Main author of the chapter: Lucía Liste, NSR

6.1 Discussion of potential guidelines in the light of the empirical and theoretical material

The objective of Action 6-B in the LASH FIRE project is to set a standard for quick manual fire confirmation, localization and assessment. Action 6-B has reviewed existing information finding that even if the technical fire detection is quick, the manual fire confirmation and localization is generally time consuming. This is reported by several accident investigations and a few research projects (Bram et al., 2019). Interviews and the remote trial also have shown how current praxis of sending a runner to manually confirm and localize the fire takes significant time due to human, organizational and technical factors. Overall, our findings highlight the following challenges:

- Lack of easily readable position descriptions (drencher zones, frame markings, decks, etc)
- Common mismatches between naming/framing of vertical zones in the cargo space and the information gathered at the bridge
- Runner's lack of familiarization with the vessel
- Very scarce scientific literature on the manual fire confirmation that happens in this time gap between a fire alarm goes off and the fire fighting
- Manual fire confirmation and localization is rarely systematized and trained for: lack of standards, company procedures and/or description of routines regarding the manual fire confirmation and localization
- Poor communication with bridge (radio shadows, lack of a common language, etc)

Action 6-B proposes two different solutions to address these challenges. The lack of easily readable position descriptions (drencher zones, frame markings, decks, etc) and common mismatches between naming/framing of vertical zones in the cargo space and the information gathered at the bridge may cause serious delays in the performance of the task. The runner might experience difficulties in determining his or her exact location, especially when signs and marking areas be obscured by cargo, smoke, dirt, or darkness. To support a quicker manual fire confirmation and localization, Action 6-B proposes to **improve the current signage and marking standards/conditions** by adopting the following measures: (1) the identification and alignment of signage and markings mismatches between bridge and vessel; (2) the replacement of challenging readable position descriptions for easily identifiable and interpretable ones that support effective wayfinding and localization.

The data gathered indicates as well that the manual confirmation and identification of fire is rarely talked about or trained for on the vessels, but it is an important part of the fire management. Accident investigation reports, company procedures, regulations, and earlier research, show that the runner role is underspecified. Indeed, this activity is scarcely mentioned in research, regulations or company procedures - nor in comparable industries such as hotel, aviation, and gas and oil. The interviews show that the role includes a variety of tasks, is employed by a line of professions, and is supported by diverse procedures, equipment, and training. In accidents, the manual confirmation and localization of fire has been delayed because of problems in deploying a runner; inadequate vessel design and equipment for fast wayfinding or situation awareness; runner's lacks familiarity with the vessel and the fire emergency event; poor communication with the bridge control centre also due to radio shadow, etc. Current familiarization practices seem to be insufficient when the runners need to perform the task in a tightly packed ro-ro environment, and/or in very stressful situations. To support quick manual fire confirmation and localization, Action 6-B proposes **guidelines to improve the condition, training, and performance of the task**. The guidelines should be included in companies' procedures and comprises: (1) **a description of the role, the activity and the conditions for performance**; (2) **a description of the practical measures to ensure a clear communication between bridge and runner**; and (3) **a description of the practical measures to ensure familiarization with the task**.

7 Guidelines for quick manual fire confirmation and localization

7.1 Introduction

The purpose of these guidelines is to support quick manual fire localization and confirmation on ro-ro ships by setting a standard for manual fire confirmation, localization and assessment. The LASH FIRE project has studied the conditions for and performance of manual fire confirmation and localization. Findings show that rapid confirmation and localization of a fire is extremely important, since even seconds of delayed fire extinction can be fatal. Yet, fire confirmation and localization are generally time consuming. Furthermore, even if the technical fire detection is quick, ccurrent praxis of sending a runner to manually confirm and localize the fire takes significant time due to human, organizational and technical factors. Three main set of challenges were identified: the lack of attention paid to the task (in drills, company procedures, previous research, etc.); wayfinding difficulties (due to runner's lack of familiarization with the ship and signage and markings mismatches) and communication issues (due to coverage limitations such as radio shadows and blind spots; and problems associated with the use of English as working language, such as misunderstandings caused by the lack of standardized language and/or poor English level). The following guidelines are developed as solutions to these challenges and are an extraction from LASH FIRE report D06.1 "Development of and guidelines for quick manual fire confirmation and localization" in which the background analysis and development work are presented.

This guideline is developed in the project LASH FIRE.

The project has received founding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 81497.

The Agency (CINEA) and the members of the consortium of LASH FIRE are not responsible for any use that may be made of the information in this guideline.

7.2 Application

The standards for manual fire confirmation provided in these guidelines should inform industry actors and regulators on how to enhance management and containment of fire. Guidelines can be used as a reference resource by:

- Ship operators and crews
- Shipyards
- Ship equipment and component suppliers
- Service providers
- Regulatory and standardisation bodies

The guidelines are targeted towards – both, newbuilt and existing - ro-ro cargo, ro-pax and vehicle carriers. These three types of ships have been selected to represent most of the ro-ro ships in the world fleet.

7.3 Definition

AB	Able Seaman
First response	The set of actions comprised during the first minutes after fire alarm aiming to detect, confirm, put out the fire or fire risk in early stage and report the situation
HSE	Health, Safety and Environment
IMO	International Maritime Organization
ISO	International Organization for Standarization
IR	Infra Red
LED	Light Emitting Diode
Ro-pax	Ro-ro passenger ship. The term is used to refer to passenger ship with ro-ro spaces or special category spaces
Ro-ro	Roll-on/roll-off
Runner	Crew member, normally one of the able seamen on duty, sent to the point of fire detection with the task of confirming or disconfirming the existence of a fire.
SOLAS	International Convention for the Safety of Life at Sea
UHF radio	Ultra High Frequency radio
VHF radio	Very High Frequency radio

7.4 The improvement of current signage and marking standards/conditions to support effective wayfinding and localization

In order to support a quicker manual fire confirmation and localization, the guideline proposes to improve the current signage and marking standards/conditions by adopting the following requirements for all types of vessels:

7.4.1 Consistency between signage and marking onboard systems and information displayed in the ship's fire management system interfaces

Signage and marking of drencher zones and deck number shall be consistent with information displayed in in the ship's fire management system interface.

All printed information sources on board shall have consistent drencher zone and deck references, aligned with signage and alarm system.

Ambiguous deck names shall be avoided, as well as mixing reference to deck numbers with reference to names, such as "lower hold".

Suggestions to implement requirements:

Existing ships can conduct a mapping study to identify actual mismatches between the different marking and signage systems on the ship and various fire management system interfaces. The study should consist of a comparison of the information/numbering provided by ships' different fire management system interfaces (such as alarm panel, integrated fire management system, video monitoring system, any fire suppression system, any other documentation and printed instruction, verbal terminology, etc.) and relevant marking/signs numbering (such as painted markings on deck/bulkhead, sections, zones and localities, fire suppression system's valves/pipes, sensors, etc.). All the mismatches shall be registered and addressed with solutions. Annex E includes a template that can be used to conduct the mismatches mapping study.

Solutions based on ship's specific characteristics and needs should be developed and implemented to align the identified mismatches between current marking and signage systems onboard and fire management system interfaces.

Solutions may encompass: the reprinting of printed instructions; reprograming of fire management systems; the replacement of markings and signs; the use of colour coding, etc. Note, in case colour coding is used, colour schemes shall not conflict with colour-coding of access stairways from ro-ro spaces to accommodation in ro-pax vessels. For instance, making corresponding drencher zone information available on the fire panel can be done by reprogramming the fire panel or by adding an extra column with corresponding drencher zones in the existing list of sensors and ship locations. Furthermore, location of CCTV cameras and their visibility angles can be included in the ship drawings displayed on the bridge.

Note, wayfinding and orientation for safety reasons shall come above normal customer access wayfinding in the signage hierarchy in ro-pax vessels.

7.4.2 Easily readable signage and marks standard

Signs and marks shall be easily identifiable and interpretable

Drencher zones and decks shall be marked in such a way that fire patrol always, in fully loaded deck condition, shall be able to visually confirm location from any position along the patrol route, allowing for movement of maximum +/-3 m along path.

CCTV system shall allow for instant identification of which drencher zones are visible from each camera.

Suggestions to implement requirements:

Signs and marks shall be easily identifiable and interpretable (see Annex A for examples) in compliance with established vocabularies and symbols described in ISO 24409-01:2020: Ships and marine technology — Design, location and use of shipboard safety signs, fire control plan signs, safety notices and safety markings — Part 1: Design principles. The following shall be considered:

- Size: Markings and signs shall have a minimum size of 500 x 500 mm for deck numbers and drencher zones. Frame numbers should correspond with the width of the frame.
- Colour: The use of red, or a combination of red/white is recommended.

- Font: The use of Bold Sans Serif for signage is recommended since it is one of the most readable fonts for signage.
- Material:
  - The use of both painted and prefabricated sings and markings are permitted
  - Requirement: Section number signs shall be of photoluminescent material complying with ISO 15370:2021Ships and marine technology — Low-location lighting (LLL) on passenger ships — Arrangement.
- Maintenance:
  - Signage and markings shall be resistant to wear and tear.
  - Signage and markings shall be included in maintenance schemes.
- Location: Placing shall be decided by performing an in-situ analysis based on typical patterns of crew movement and real use cases. The following shall be considered:
  - Sign and markings shall not be obstructed by cargo or fixed installations
  - Signs and markings shall be always visible: crew member shall be able, by means of signage and boundary marking only, to determine the exact location in the ship by walking +/- 3 meters along walking route. For instance: drencher zones information can be painted with a wear and tear resistant material on the “no parking yellow line” in the middle of the cargo deck. Each drencher zone number should be painted at three different locations along the line, at both ends of the drencher zone, and in the middle. Drencher zone numbering shall be inscribed in CCTV images by adding drencher zone number in the location information displayed in CCTV images
  - Deck and vertical boundaries shall be marked to easily identify the sections of the fixed fire-extinguishing system in closed vehicle, ro-ro spaces and special category spaces with water-spraying systems (see Annex A for examples)

7.5 Guidelines for the standardization and formalization of manual fire confirmation and localization

7.5.1 Description of the role, the task and the conditions for performance

Company and/or ship specific procedures shall include concise, simple, and useful descriptions of the role of the runner, the task and its conditions for the performance.

The runner shall be an experienced crew member and shall be familiarized with manual fire confirmation and localization related activities and the ship. The runner shall wear equipment that allows to keep his/her both hands free and ready to act if firefighting first response is needed.

Suggestion to implement requirements:

The following descriptions of role and task are suggested, but it is up to the administration to suggest other that are more suitable for the specific ship, if preferred.

- Role: The runner is a crew member, normally one of the able seamen on duty, sent to the point of fire detection with the task of confirming or disconfirming the existence of a fire.
- Task: Manual fire confirmation and localization is a first response in the event of a fire alarm, consisting of sending a runner to the point of detection with the task of confirming or disconfirming the existence of fire and its location.

The description of the conditions for the performance shall include the following points:

- The runner shall be familiarized with manual fire confirmation and localization related activities and the ship by completing company's familiarization routines and participating in several fire drills that include manual confirmation and localization related events.
- The runner shall be an experienced crew member that report him/herself confident to perform the task and is assessed as capable by the person sending him/her.
- The runner shall wear equipment that allows to keep his/her both hands free and ready to act if firefighting first response is needed. The equipment needed is the same as the one required for the fire patrol and shall encompass:
    - Cotton (rather than polyester) and long-sleeve clothing to protect from fire
    - Light and robust safety torch that can be magnetic attached to the helmet with enough LED intensity (around 100 lumens) to detect leaks or smoke under low visibility condition spaces. A flashlight is useful during night patrolling, specially to inspect unprotected areas, like weather decks.
    - A thermal imaging device such as an IR light handheld camera that can be hanged around the neck for hot spots detection. Desired Specs: Dimensions (like a smart-phone, light around 250g, temperature range from bellow cero up to 150ºC). The IR camera shall be used when the runner may suspect the presence of an ignition source like a suspicious noise or smell, smoke, or sparks.
    - A communication device such as portableUHF radios with press to talk bottoms

7.5.2 Clear communication between bridge and runner during the performance of the task

Ships with English as working language shall standardize language and terminology used by adopting the use of IMO Standard Marine Communication Phrases.

Communication equipment with sufficient coverage shall be used by crews. Not less than the 85% of the cargo deck area shall have radio coverage with full cargo.

Suggestions to implement requirements:

Most relevant IMO Standard Marine Communication Phrases are comprised under section B2/3 FIRE PROTECTION AND FIRE FIGHTING; - Annex G includes a selection of the document's most relevant content.

Potential blind spots for communication and radio shadows should be identified. A study of wave propagation limits and coverage of radio signal in metal structures shall be performed on board (Annex E includes a template for the study questionnaire).

Solutions to eliminate radio blind sports and shadows shall be adopted. Solutions may comprise repeaters, a user-friendly combination of different technologies, use of UHF radio transmitters, radio signal amplifiers, etc. Alternative means of communication shall be deployed in case of few remaining radio blind spots and shadows in non-significant locations.

7.5.3 Familiarization with the task

Manual fire confirmation and localization activities shall be trained in realistic fire drills. The performance of manual fire confirmation and localization related drill's activities shall be assessed and discussed in drill debriefs. Potential challenges and concerns related with the task shall be discussed in HSE meetings.

The use of IMO Standard Marine Communication Phrases shall be practiced during drills and by fire patrols during non-emergency situations.

Suggestions to implement requirements:

Realistic fire drills shall include sub-events in which concerned crew get familiarized with potential scenarios and challenges during fire confirmation, such as typical signs of an incident, typical personal safety risks and default actions depending on situation.

7.6 Reference list

IMO Standard Marine Communication Phrases

ISO 24409-01:2020: Ships and marine technology — Design, location and use of shipboard safety signs, fire control plan signs, safety notices and safety markings — Part 1: Design principles.

ISO 15370:2021: Ships and marine technology — Low-location lighting (LLL) on passenger ships — Arrangement

8 Conclusion

Main author of the chapter: Lucía Liste, NSR

When a fire signal, e.g., heat or smoke, is detected by technical equipment and alarmed, the vessel crew will confirm or disconfirm fire. If fire signals are detected by several sensors, in several areas, or if a fire is seen on CCTV, the fire is confirmed, and the firefighting team will be mustered. However, in many cases, only one sensor alarm is activated. Then, the fire must be manually confirmed or dismissed by a crew member. Current practice is that the officer on watch ask an able seaman (AB) (often bridge watch or fire patrol) to manually confirm and identify the fire. This person can thus be called the runner.

Previous experiences from fires and fire research show that rapid confirmation and localization of a fire is extremely important, since even seconds of delayed fire extinction can be fatal. Yet, fire confirmation and localization is generally time consuming. The objective of Action 6-B in the LASH FIRE project was to set a standard for quick manual fire confirmation, localization and assessment. To do so, we have conducted a qualitative document study of existing regulations, ship company procedures and operations, accident investigation reports, prior empirical research results, and theoretical perspectives about organizational conditions. Later, action 6-B has performed interviews and observation of crewmembers online and onboard. As a step to gather more knowledge to develop guidelines, we have also performed an onboard trial to raise the alarm and confirm the reality and position of fire by crew. The data gathered confirm the need for guidelines for effective

manual fire confirmation, localization and assessment; and point to three main set of challenges to be addressed: the lack of attention paid to the task (in drills, company procedures, previous research, etc); wayfinding difficulties (due to runner's lack of familiarization with the vessel and signage and markings mismatches) and communication issues (due to coverage limitations and use of English as working language).

Therefore, building on the results of the document and interview studies and the remote trial, this report presents guidelines for quick manual fire confirmation and localization. The guidelines comprise requirements regarding two main concerns: (1) To support a quicker manual fire confirmation and localization, Action 6-B proposes to improve the current signage and marking standards/conditions by adopting the following measures: the identification and alignment of signage and markings mismatches between bridge and vessel; the replacement of challenging readable position descriptions for easily identifiable and interpretable ones that support effective wayfinding and localization. (2) To support quick manual fire confirmation and localization, Action 6-B proposes guidelines to improve the condition, training and performance of the task. The guidelines should be included in companies' procedures and comprises: a description of the role, the activity and the conditions for performance; a description of the practical measures to ensure a clear communication between bridge and runner; and a description of the practical measures to ensure familiarization with the task.

Action 6-B's findings and resulting guidelines are valuable due to their overall positive impact on safety on board. Arguably, Action 6-B's results increase awareness about the importance of this task, set new standards for the conditions of performance, and address widespread communication and wayfinding challenges. These contributions support quicker manual fire confirmation and localization, leading to improved information and conditions for first response and fire containment; thus, contributing to the realization of LASH FIRE Specific objective 1: strengthening the independent fire protection of ro-ro ships by developing and validating effective operative and design solutions addressing current and future challenges in all stages of a fire.

9 References

Antonsen, S. (2009). The relationship between culture and safety on offshore supply vessels. *Safety science, 47*(8), 1118-1128.

Bram, S., Millgård, U., & Degerman, H. (2019). Systemperspektiv på brandsäkerhet till sjöss-en studie av organisering och användbarhet i brandskyddetpå Ro-pax-fartyg.

Dekker, S. (2003). Failure to adapt or adaptations that fail: contrasting models on procedures and safety. *Applied ergonomics, 34*(3), 233-238. doi:http://dx.doi.org/10.1016/S0003-6870(03)00031-0

Dekker, S. (2017). *The safety anarchist: Relying on human expertise and innovation, reducing bureaucracy and compliance*. London, United Kingdom: Routledge.

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Human factors, 37*(1), 32-64.

Endsley, M. R. (2017). From here to autonomy: lessons learned from human–automation research. *Human factors, 59*(1), 5-27.

Halvorsen, K. (2015). *Interactional dynamics of team decision making: A discourse analytic study of operational planning meetings in the petroleum industry.* (Doctoral dissertation), Norwegian University of Science and Technology, Trondheim, Norway.

Klein, G. A. (1993). A recognition-primed decision (RPD) model of rapid decision making. In G. A. Klein, J. Orasanu, R. Calderwod, & C. E. Zsampok (Eds.), *Decision making in action: Models and methods* (pp. 138-147). Norwood: Ablex Publishing Corporation.

Kongsvik, T. Ø., Almklov, P. G., Haavik, T., Haugen, S., Vinnem, J. E., & Schiefloe, P. M. (2015). Decisions and decision support for major accident prevention in the process industries. *Journal of Loss Prevention in the process Industries, 35*, 85-94.

Leroux, J., & Mindykowski, P. (2017). FIRESAFE II Detection and Decision.

Lipshitz, R., Klein, G., Orasanu, J., & Salas, E. (2001). Taking stock of naturalistic decision making. *Journal of behavioral decision making, 14*(5), 331-352.

March, J. G. (1994). *Primer on decision making: How decisions happen*. New York: Simon and Schuster.

Postill J. 2016. "Doing remote ethnography" Draft chapter to the Routledge Companion to Digital Ethnography Eds. Larissa Hjorth, Heather Horst, Anne Galloway & Genevieve Bell

Rasmussen, J. (1986). Information processing and human-machine interaction. An Approach to cognitive engineering. *North-Holland Series in system science and engineering, 12*.

Rasmussen, J. (1997). Risk management in a dynamic society: A modelling problem. *Safety science, 27*(2), 183-213.

Reason, J. (1990). *Human error*: Cambridge university press.

Rosness, R. (2009). A Contingency model of decision-making involving risk of accidental loss. *Safety science, 47*(6), 807-812.

Sandhåland, H., Oltedal, H. A., Hystad, S. W., & Eid, J. (2015). Distributed situation awareness in complex collaborative systems: A field study of bridge operations on platform supply vessels. *Journal of Occupational and Organizational Psychology, 88*(2), 273-294.

Schiefloe, P. M. (2017). Pentagonanalyse: En helhetlig modell for sikkerhet i organisasjoner. In S. Antonsen, F. Heldal, & S. Kvalheim (Eds.), *Sikkerhet og ledelse*. Oslo, Norway: Gyldendal Akademisk.

Schiefloe, P. M., & Vikland, K. M. (2006). Formal and informal safety barriers: The Snorre A incident. In C. G. Soares & E. Zio (Eds.), *Safety and Reliability for Managing Risk* (pp. 419-425). London, United Kingdom: Taylor & Francis.

Størkersen, K. V., Thorvaldsen, T., Kongsvik, T., & Dekker, S. (2020). How deregulation can become overregulation: An empirical study into the growth of internal bureaucracy when governments take a step back. *Safety science, 128*, 104772. doi:https://doi.org/10.1016/j.ssci.2020.104772

Størkersen, K. V., Gjøsund, G., & Liste, L. M. (2020). Definition of conditions for manual fire confirmation and localization. Retrieved from LASH FIRE (Legislative Assessment for Safety Hazard of Fire and Innovations in Ro-ro ship Environment). Confidential.Wikman, J., Evegren, F., Rahm, M., Leroux, J., Breuillard, A., Kjellberg, M., . . . Efraimsson, F. (2017). Study investigating cost effective measures for reducing the risk from fires on ro-ro passenger ships (FIRESAFE): European Maritime Safety Agency.

Woods, D. D. (2010). *Behind human error*. Farnham, United Kingdom: Ashgate.

10 Indexes

10.1 Index of tables

10.2 Index of figures

11 ANNEXES

11.1 ANNEX A - Visual confirmation of location on cargo deck

Examples of existing markings and signs

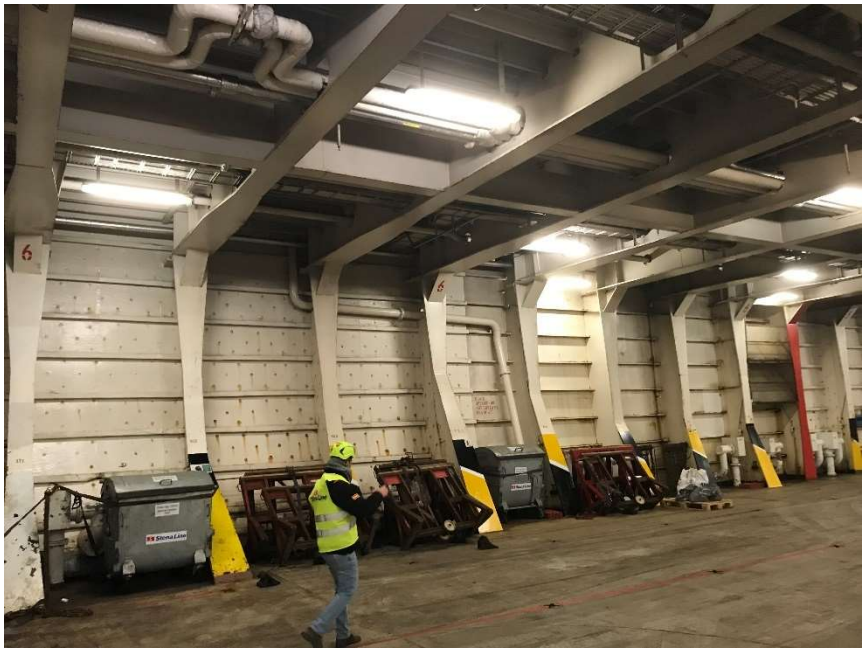


Figure 2. Drencher zone and frame numbering on bulkhead

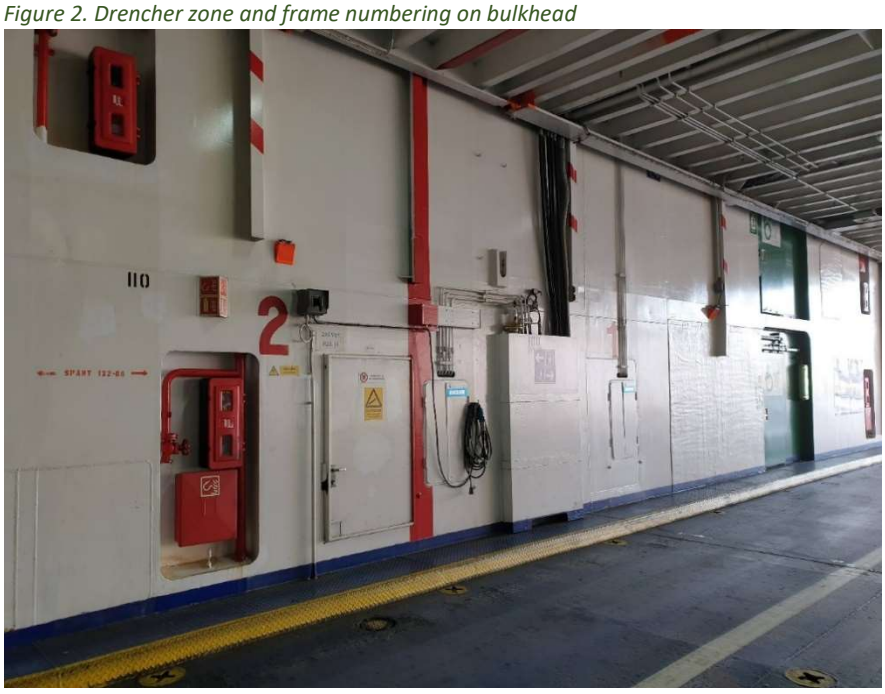


Figure 3. Drencher zone and frame numbering on bulkhead

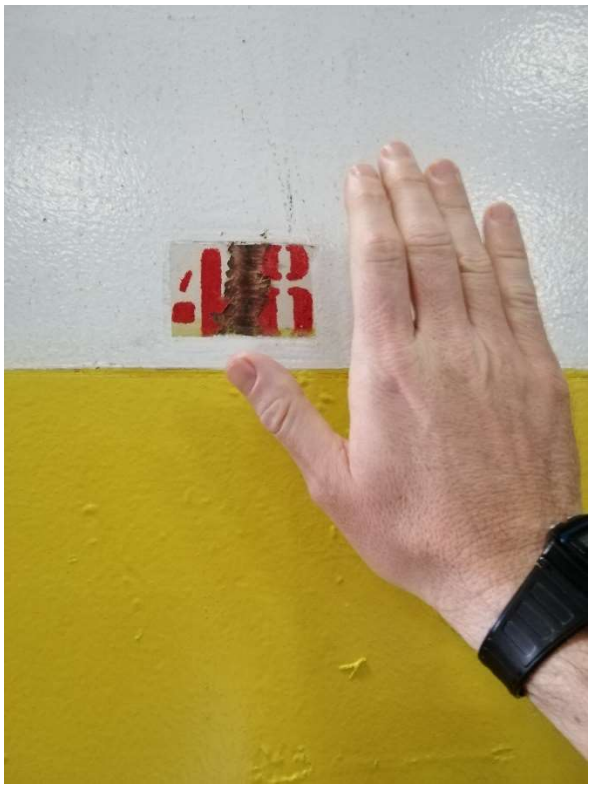


Figure 4. Frame marking

Figure 5. Frame and drencher zone marking

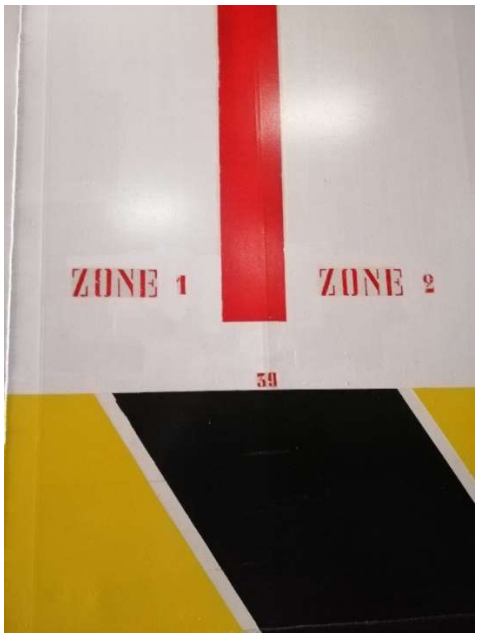


Figure 6. Drencher zone marking

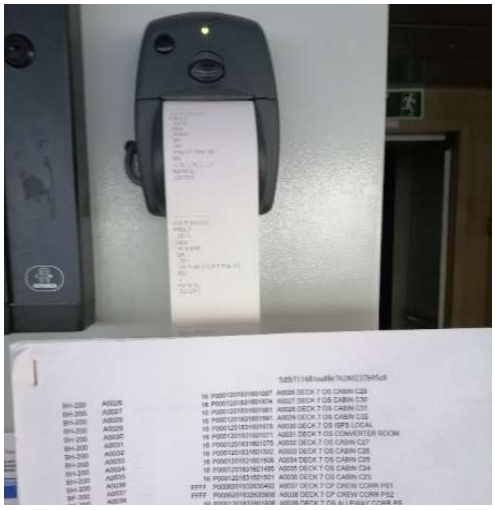


Figure 7. An exemple of a list of current mismatches in dencher systemas and ro-ro spaces

Figure 8. An example of a list of fire detectors positions and of information provided by the fire alarm panel

Examples of easily identifiable and interpretable markings and signs

Examples of easily readable markings onboard existing ships are illustrated in the following figures.

Figure 9. Drencher zone and frame markings on Stena Saga, realized with prefabricated "paint patterns" from supplier.

Colour: Combination of read and white (red square, number in white) or red.
Localization: On Stena Saga there is one set of markings on high level for visibility in CCTV system and on low level 0,75 m above deck for best visibility for patrol of fire team. Low level markings need be visible below trailers but above cars.

Figure 10. Drencher zone markings on Stena Scandica

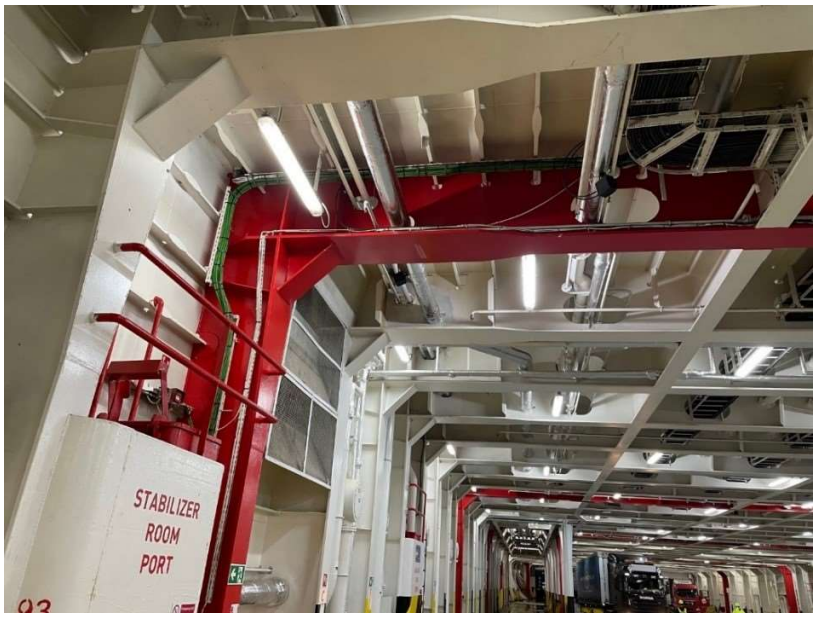


Figure 11. Drencher zone boundaries on Stena Scandica.

Font: According to some sources **Bold Sans Serif** is the most readable font for signage such as in this case.

DZ 14

Figure 12. Example of Bold Sans Serif drencher zone marking

11.2 ANNEX B – Sample procedures

Fire Alarms - Responsibility & Procedure			
Version No. 1	Revision Date. 2018-11-19	Document ID. SOM-1334	Page. 1

SOM chapter: 7

Validity: Stena Britannica

Fire Alarms

Every Fire alarm shall be physically investigated by a responsible person and confirmed as a false alarm before being reset.

The main fire alarm panel is on the bridge with a slave in the ECR and light pillar alarms throughout the ER. Whenever a Fire alarm is activated it shows the location of the fire and sounds an audible alarm at each panel and display, if the panel alarm is not muted from the bridge or ECR within 2 minutes the General Alarm will sound throughout the ship.

Responsibility

It shall remain the responsibility of the **Deck OOW** (Officer Of the Watch) for all fire alarms, regardless of the location of the alarm. A fire alarm will take precedent over any other part of the ship's routine operation including loading or discharging cargo and passengers.
The Deck OOW cannot delegate this task to any other person other than another Deck Officer.

Procedure

If the bridge is manned the OOW will mute the alarm and then request a crew member to investigate. Once the alarm is confirmed as false the alarm can be reset.

When the ship is in port the duty Deck Officer may be elsewhere. It is then up to the engine room OOW to inform him that there is a fire alarm and give him the location of the fire.

The Deck OOW will then request a responsible person to investigate the fire. Engine OOW can mute the alarm while the alarm is investigated.

If the General Alarm sounds when passengers are aboard – after the alarm has been investigated a PA will be made in the passenger accommodation only to inform them of a false alarm.

Comment: On some vessels, in addition to above, alarm is sounded in Master and Chief Engineer cabins after 60 seconds.

Fire (Stena Germanica)			
Version No. 1	Revision Date. 2017-06-10	Document ID. DS-0911	Page. 1

Fire

Actions:	**Checked:**
1. Send out AB/Security on watch to investigate area. And inform Engine department.	
2. If fire broke out press the General alarm button.	
3. Advise the AB/security to make an initial effort if possible.	
4. If the fire is on car deck, switch of power supply to plugin hoses and start sprinkler from Valmet system.	
5. Note the time and position.	
6. Contact Stena Security Center.	
7. Manoeuvring the ship to suit the circumstances	
8. Inform passengers and other crewmembers (continuous info).	
9. Switch on all deck light and if necessary car deck lights.	
10. Light up NUC if necessary.	
11. Send out a DSC call regarding fire.	

Fire (Stena Vinga)			
Version No.	Revision Date.	Document ID.	Page.
1	2019-01-29	SOM-1607	1

SOM chapter: 8 **SMM reference:**

Validity: Stena Vinga

Immediate and simultaneous actions

On board the ship

1. Stop the alarm by pressing the "ALARM MUTE" button on the port side fire alarm panel.
2. Check the alarm code to find out which sensor in which zone has been triggered. Look at the drawing next to the panel to find out where in the ship the concerned sensor is situated.
3. Send a deckhand from the watch, equipped with a walkie-talkie, to the alarm area to check the area.
4. Contact and consult the ECR.
5. If a fire has broken out, set the alarm selector in position 1 or 2, depending on who the alarm is intended for. Then press the green "GENERAL ALARM" button to activate the sounding of the alarm. Inform the ECR.

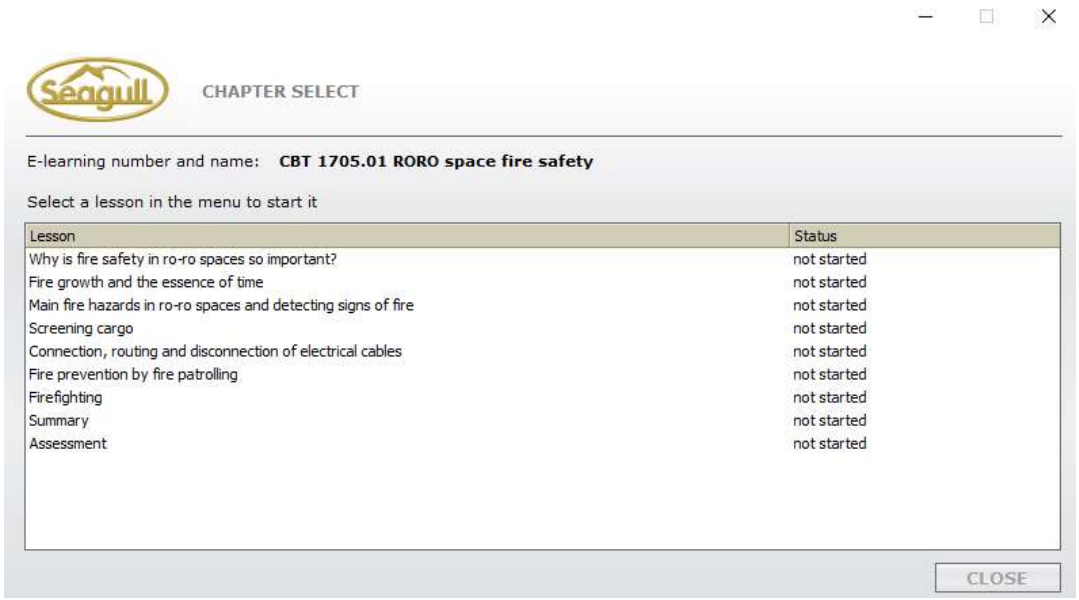
   Position 1: "ALL SHIP"
   Position 2: "CREW ONLY"
6. Check which fans and dampers need to be closed and close these. (MER UTFÖRLIGT BEHÖVS, FÅR TA REDA PÅ)
7. Close the fire doors by pressing the green button "Fire Doors Closed" on the aft port side bridge panel. Make an announcement in the PA before doing so.
8. Make sure that the watertight doors are shut.
9. Manoeuvre the ship considering the art of the fire - e.g. find a lee, stop, steer downwind or into the wind.
10. The safety team starts operating. The crew is mustered at the appropriate muster points, and waits on further orders from the bridge.
11. The Chief Engineer will be in command of the fire group when fighting the fire.
12. Radio stations are manned.
13. Inform passengers and crew (continuous information).
14. ISB signal to be displayed/given.
15. Switch on all deck lights.
16. Make a proper estimate of time and position (e.g. enter the position as a way-point in the GPS)

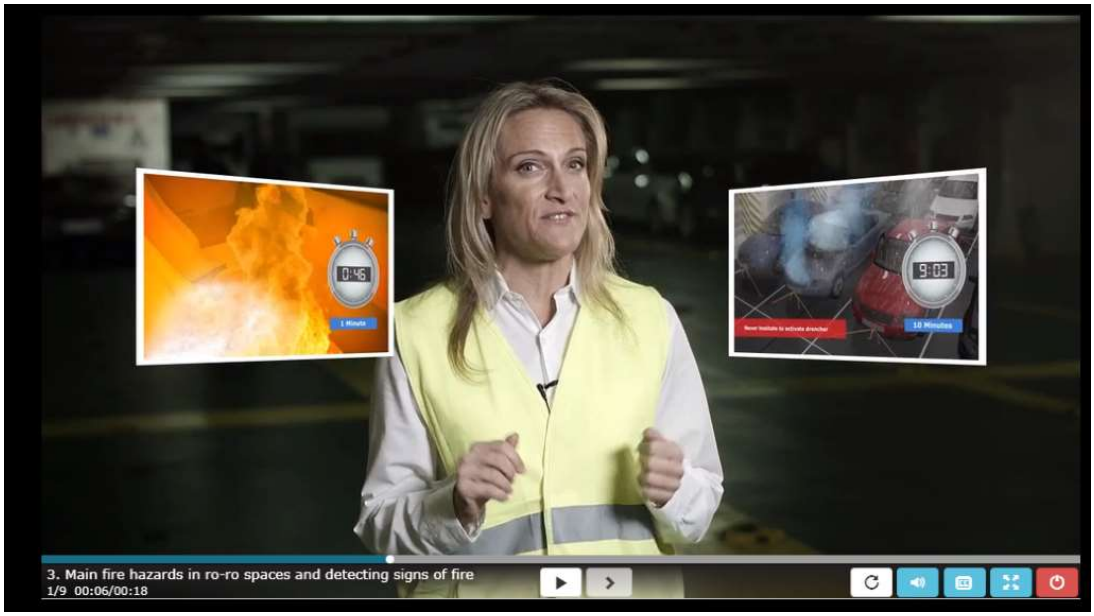
8. Fire on Vehicle Decks (Stena Nordica)				Stena Line
Version No. 1	Revision Date. 2018-08-14	Document ID. DS-1130	Page. 1	

INITIAL ACTIONS - WHEN -FIRE OR SMOKE IS CONFIRMED			
SOUND FIRE/CREW ALARM			
CLOSE APPROPRIATE VENTILATION SYSTEMS, FIRE DAMPERS AND FIRE DOORS			
VERIFY THAT FIRE PUMPS ARE RUNNING			
MAN DRENCHER STATION/ACTIVATE DRENCHERS*			
IF SERIOUS, CONSIDER TO ACTIVATE GENERAL ALARM			
SUBSEQUENT ACTIONS/CONSIDERATIONS			
SEE DS FIRE – GENERAL ACTIONS			
ACTIONS - FIRE IN PORT		ACTIONS - FIRE AT SEA	
INFORM THE LOCAL FIRE BRIGADE IMMEDIATELY		CONTACT JRCC	
VERIFY NO VICTIMS OR MISSING CREWMEMBERS		VERIFY NO VICTIMS OR MISSING CREWMEMBERS	
EVACUATE PASSENGERS AND NON-ESSENTIAL PERSONNEL		CONSIDER DESIRABILITY OF COURSE ALTERATION	
INFORM HARBOUR AUTHORITIES			
SHIP SPECIFIC CONSIDERATIONS/ ACTIONS			
INFORM MASTER		INVESTIGATE, SEND RR TEAM, COMMUNICATE VIA RADIO, CONFIRM FIRE EXISTS	
MANOEUVRE SHIP'S BOW TO WIND/SEA AND REDUCE SPEED, 4 STEERING MOTORS		IDENTIFY CARGO, LOCATE AND TACKLE THE FIRE ASAP. D/G CARGO PLAN + FIRE SCHEDULE	
ESTABLISH POSITION OF FIRE AND THE NEAREST ENTRIES		DRENCHERS CAN BE ACTIVATED FROM THE DRENCHER STATION, OR EMERGENCY STATION IN ENGINE ROOM	
E.R. TO ISOLATE ALL ELECTRICAL REEFER SOCKETS ON DECK		ENSURE THE LOWER HOLD BILGE PUMP IS READY AND START IT WHEN BILGE ALARMS SOUNDS. MIND THE FREE SURFACE EFFECT AND STABILITY IF DRAINING NOT SUFFICIENT	
ALPHA TEAM SHOULD BE READY TO ENTER THE HOLD TO ESTABLISHED THAT DRENCHER SYSTEM IS WORKING, TO CONFIRM THE LOCATION AND EXTEND OF FIRE AND TO MONITOR THE WATER LEVEL FROM DRENCHER SYSTEM		IN THE EVENT OF A DRENCHER SYSTEM FAILURE, SEVERAL TEAMS WILL BE REQUIRED TO ENTER	
BOUNDARY COOLING MAY BE REQUIRED ON ABOVE DECK		INFORM COMPANY DPA AND COASTGUARD ("PAN PAN" OR "MAYDAY")	
QUICK-CLOSING VALVES ON FUEL/LUB OIL LINES TO BE SHUT DOWN IN AFFECTED AREA			

*Activation of the drencher system must be prioritized

11.3 ANNEX C – Stena E-learning for fire patrol crew or similar





11.4 ANNEX D – Fire localization and confirmation experience from historic incidents

Fire safe I

Based on 28 accident reports, the probability of early decision was estimated to 67.9%. 4 accidents did not provide the information regarding early or late decision.

Lisco Gloria Oct 8th 2010

Instant confirmation since by coincidence an AB was on location of fire ignition as part of fire patrol at the same time as the fire alarm was activated.

Norman Atlantic Dec 28th 2014

The interviews carried out with the deck staff and in general with the staff who participated to the initial emergency phases, as well as the evidence gathered during the investigation, show that a first fire alarm was activated approximately at 04:15.

In that moment, the second mate and a seaman were on duty. In addition, considered the difficult conditions of the navigation, after departing from Igoumenitsa, the Captain decided to remain here and keep on monitoring (see. par. 4.1.8). The deck officer on the bridge, applying the correct procedure, immediately sent the seaman to the area concerned by the alarm to check its conditions, but the seaman said that in the signaled position there was only a refrigerated truck, whose combustion generator for the cooling system was working and there was no incipient fire. After about 15 minutes a fire pre-alarm was heard again and a *Fire Alarm* followed.

Thereafter, the Captain, who already was on the navigation bridge, after seeing the flames on the starboard flying bridge deck coming out of the windows (the great side openings) of deck 4, ascertained that a fire was developing on board, ordered to transmit the fire alarm (serious gravity) and to issue the *"crew call"*. In the immediately following minutes, he ordered the first mate to go on the spot (deck 4 frame 156) to check the situation and the deck officer on the navigation bridge to immediately activate the Drencher (04:30) system. Based on the evidence gathered, following our

Stena Spirit Vehicle deck fire Aug 31st 2016

At 06:38:54 an alarm was triggered in the fire alarm control panel on the bridge as a result of activation of a smoke detector in zone 110 located on the car deck No. 3 in the aft part of the ship.

The officer of the navigational watch instructed the seaman (watchman) responsible for waking up the crew before manoeuvers via the radio (UHF) to go to a car deck No. 3 and to check the situation in the aft part of the ship.

At 06:41:00 the engineer on watch from the engine control room reported to the bridge via telephone that a fire detector was activated on the car deck. In response, the watch officer informed him that a watchman had already been sent to check the car deck No. 3 at the ship's stern.

At 06:43:10 the watchman reported to the bridge by phone that he had located smoke above and around a refrigerator truck parked in front of the stern ramp (door), on the port side next to the central bulkhead (drawing No. 2 and photograph No. 4).

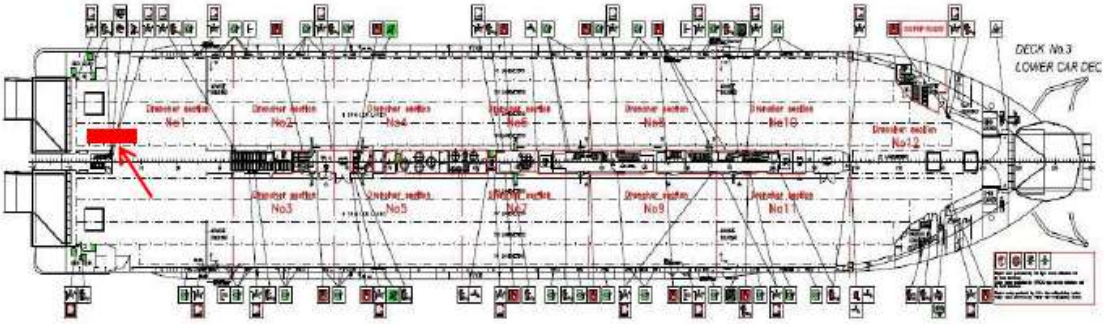


Figure 2. Refrigerator truck position on car deck no. 3

Instructed by the officer of the watch, the watchman disconnected power supply of the truck's refrigerator unit from the ship's electrical system in the distribution cubicle located on the wall of the companionway to the steering room.

Photograph No. 4. Watchman next to the refrigerator truck in smoke fumes

The officer of the watch informed the ship's electrical engineer by phone to come to the car deck to check the cause of the smoke coming from the refrigerator truck.

After passing the "GD" buoy at 06:47:34, the master came to the bridge. The chief officer and the officer of the watch reported to the master on the activation of the fire detector and presence of smoke on the car deck No. 3.

The master ordered another, detailed inspection of the area from which the smoke originated to check for any smouldering fire. Additionally, he instructed that the inspection be assisted also by the ship's safety officer who, by then, had also come to the bridge.

At 06:48:09 the officer of the watch managed to separate the fire zone 110 in the fire alarm control panel on the bridge and, thus, to deactivate the fire alarm (photograph No. 5).

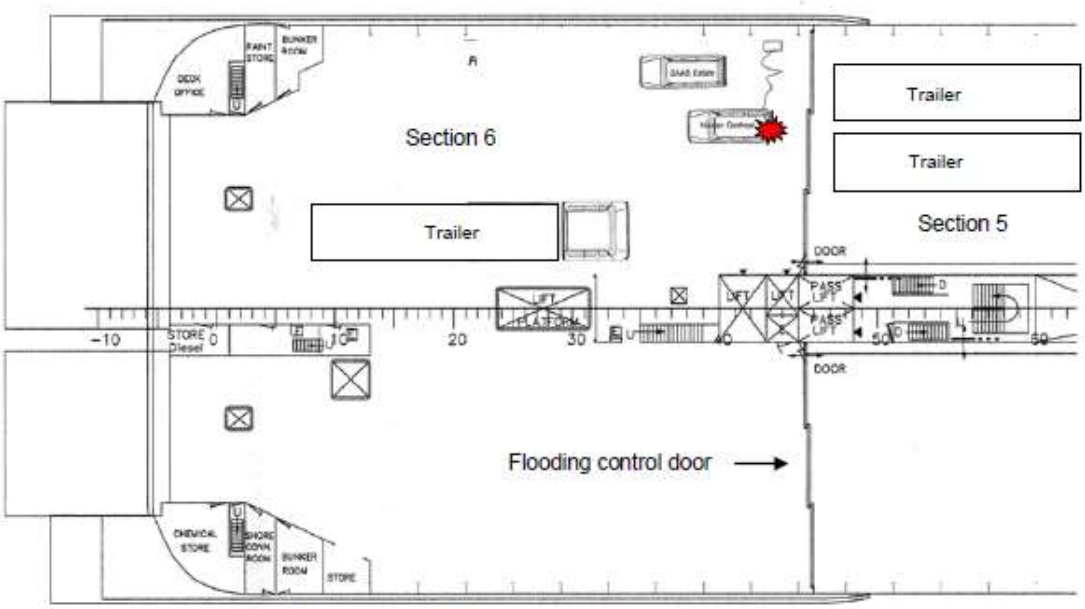
Next, the watchman present on the car deck, together with the officer of the watch on the bridge, attempted to switch on the ventilation in the cargo hold to remove the smoke that was present there. The captain stopped these activities and instructed them to wait until the ship safety officer completes the inspection ordered by the captain.

At 06:50 the electrical engineer arrived at the scene on deck no. 3 next to the refrigerator truck; the safety officer arrived soon after. Neither of them found any signs of fire, except for presence of smoke. After several minutes, they reported to the bridge that the smoke originated from the refrigerator unit, more specifically its drive's v-belts and that burnt rubber can be smelled, as well as that there was no fire hazard on the car deck.

When the crew members were checking the deck in the area of the refrigerator truck, the smoke grew thicker and flames could be seen on the image recorded by CCTV camera No. 07 which were reflected by the ceiling on the right side of the truck (photograph No. 6).

Meanwhile, the officer of the watch and the senior officer attempted to switch on the ventilation on deck no. 3. Furthermore, the officer of the watch tried for almost 2 minutes to contact the watchman in the cargo hold, but he did not succeed. The fire developed considerably and covered the entire width of the truck's roof (photograph No. 9).

Pearl of Scandinavia Nov 17th 2010



The car deck aft showing where the electric car was parked

7.7 The location of the fire and initial measures

At 05:58 on 17 November 2010, an alarm sounded due to an electrical leak caused by a current-carrying wire leaking to the ship's metal construction. A few seconds later, a smoke alarm sounded indicating a fire on deck 3. A smoke detector indicated that the fire was on the car deck in section 5 close to the flooding control door. Shortly after, numerous smoke detectors indicated fire all over the car deck. When the fire alarm first sounded, the ship was at a position 6 nm west of the peninsula of Kullen in Sweden.

A ship's assistant who was the look out on the bridge was immediately sent to the car deck to make observations. She opened a door to section 5 on the car deck and observed heavy smoke and flames. She saw a trailer on fire close to the flooding control door. At 06:00 she informed the bridge that there was a fire in a trailer on the car deck in section 5. The seat of the fire was therefore believed to be in this section in front of the flooding control door.

Position where the fire broke out Google Earth

Shortly after the first fire alarm at 05:58, the master was called to the bridge. Immediately after the chief officer sounded the fire alarm in the crew's quarters The master arrived at the bridge at 06:03 and took over navigational command.

Stena Britannica lower hold fire Jan 17th 2018

At 0239 on 17th January 2018, the Fire Alarm activated on the Bridge. The duty bridge OOW sent Able Seaman to investigate. He (fire patrol AB) quickly located the vehicle on fire and let off one fire extinguisher onto fire. He found that he could only receive Radio comm with bridge but could not transmit a clear call to bridge. So he ran up to deck 3 to get a clear radio signal to confirm the fire. NB he could have activated a manual call point but he knew the bridge was already aware of the location of the fire. He would still have needed to run up to deck 3 to make the call to the wheelhouse to give important information on the fire. Radio comms between wheelhouse and car deck 3 was poor and only one way for the whole of the emergency. It was also poor between BA Parties and BA control on deck 1. Recommend to IMPROVE RADIO COMMUNICATIONS IN THE LOWER HOLD. Note: we have since tested radios in the EMPTY lower hold and found comms very good. This issue appears to be when we have a full ship. As an interim measure, recommend more use should be made of the DECT phone system.¶

11.5 ANNEX E – Templates: Questionnaires for the study of consistency and wave propagation limits

STUDY OF THE CONSISTENCY BETWEEN SIGNAGE AND MARKING AND FIRE MANAGEMENT SYSTEM INTERFACES

Aim: To find mismatches between information/numbering provided by ships' different fire management system interfaces and related marking/signs numbering

Process:

(1) prepare a detailed and exhaustive list of all different signs/markings on board as well as every ship's fire management interface
(2) compare the information/numbering provided in every fire management interface with the related onboard signs and markings.
(3) Fill in the table selecting the relevant answers:
- **n/a:** if the interface does not provide information about such sign/marking
- **C** (consistency): if the information/numbering in the interface does coincide with the related sign/marking.
- **M** (mismatch): if the information/numbering in the interface does not coincide with the related sign/marking. Please, register the information/numbering provided in the interface.

	Alarm panel	**Integrated fire management system**	**Video monitoring system**	**Fire suppression system**	**Printed instructions**	**Verbal terminology**	**Fire plan**
Painted marking on deck/bulkhead							
Sections							
Zones							
Localities							
Fire suppression valves							
Sensors							

NOTES:

NAME OF PERSON (S) INVOLVED (voluntary):

NAME OF THE SHIP/LOCATION:

DATE AND SIGN:

MEANS OF COMMUNICATION FOR FIRE CONFIRMATION

Study of the wave propagation limits and coverage of radio signal in metal structures.

Aim: To find blind spots for communication with the bridge during the process of confirming or dismissing the presence of a fire

Do you have any radio blind spots on your ship? Please specify below.

NUMBER	LOCATION	VHF SIGNAL (Y/N)	UHF SIGNAL (Y/N)	IS AVAILABLE OTHER MEANS OF COMMUNICATION LIKE INTERNAL TELEPHONE (SPECIFY)
1	EMERGENCY GENERATOR			
2	BATTERY LOCKER (GMDSS)			
3	PAINT LOCKER			
4	FIRE PUMP			
5	LAUNDRY			
6	PAX CABIN CORRIDOR			
7	GALLEY			
8	COMPRESSOR ROOM			
9	ENGINE CONTROL ROOM			
10	SOPEP			
11	DRENCHER ROOM			
12	HYDRAULIC ROOM			
13	RAMP. ACCESS CONTROL			
14	CAR DECK			
15	MAIN CARGO DECK			
16	WEATHER DECK			
17	LOWER HOLD			
18	UPPER DECK			

Please, note that a complete list of ship locations should be made for each ship

NOTES:

NAME OF PERSON (S) INVOLVED (voluntary):

NAME OF THE SHIP/LOCATION:

DATE AND SIGN:

Our findings regarding communication are informed as well by the insights gathered through two studies of the wave propagation limits and coverage requirements of radio signal in metal structures carried out by *task 6.7 Means of Communication for Fire Confirmation*. The aim of these studies has

been to find blind sports for communication with the bridge during the process of confirming or dismissing the presence of fire. The studies have been carried out during July 2021 in two different vessels: Bahama Mama (Balearia) and Stena Flavia. The studies have consisted in a questionnaire to be filled in with information on whether there is radio signal and other available means of communication in different locations in the vessel.

11.6 ANNEX F – Interview guides and informed consent for interview participation

This is the interview guide for Action 6-B.

- Background knowledge of fire prevention / monitoring:
    - Who does what? How does this work?
        - (Fire rounds)
        - Drills
        - Control panels, machine, bridge
        - Other
- In case of alarm / fire:
    - Who does what? How is it going today?
        - Bridge
        - Machine
        - Runners / what are these called? / Deck guard (the area managers?)
- Communication bridge / machine / runners
- How is it done here vs. elsewhere?
- What would be the best way to do it?
- What do the rules say about how to handle the manual part of fire detection?
    - Timeline - how do the rules say this should be done? How is this done in practice?
    - What equipment do you have with you?
    - What takes the longest time?
- What is important to be vigilant?
- Check guidelines first - and feel free to have an interview with the shipping company before talking to those on board (telephone interview?)
- Common to add procedures, in addition to international regulations?
- After you have found the fire or clarified that there is no fire - what happens then?
- How is area responsibility organized - are there always deck personnel?
- Do you want any equipment that could make fire identification easier?
- What procedures do you follow? Who made these?
- How to create procedures, how to know what is it covered by regulations?
- How is area responsibility organized?
- Where do the routines come from (regulations, the same on the boats in the shipping company, etc.)?
- (Fire round: What do you look for, how often?)
- For those who have experience from several boats: Difference in routines in passenger / cargo?
- Technology - how much are the cameras used?
- What is it flexible, boat-specific, shipping company-specific, national and international regulations?
- Human / technology interaction - alarm panel operation, after the alarm has gone off
- What happens automatically, what do you have to decide for yourself and when? Is it possible to switch off automatic features, such as alarms, sprinkler systems, etc.

Is this always done the same - regardless of shift / officer?

Remember to look for technology, organization and regulations that are desired, used or not used, and informal adaptations.

Timeline - draft, discuss with those we interview

This is the interview guide prepared by Action 6-B researchers for the debrief.

Why debrief?

- Get input from practitioners on this specific drill
- Get insight into different perspectives to the same situation (runner/bridge)
- Get input from practitioners to guidelines

What do we want to hear about?

- On drill:
    - Was this a realistic scenario/drill?
    - Take us through the drill – what happened from the alarm went off
    - What part of your actions were determined by
        - Written guidelines
        - Common sense
        - Collaboration
        - Technical aids and equipment
    - Is this the best way of response? If not – how would you prefer it?
    - Can you describe the contact with the "runner", person to manually confirm the fire? How did you decide who to contact? How did you explain to him/her where you wanted the runner to go?
    - What part of the runner's actions were determined by procedures and/or common sense?
    - Would you be confident in this situation if it was a real incident, or: Would other (less experienced/not as familiarized, in other physical condition), be confident in this situation if it was a real incident?
    - If no; What would make them/you more confident/suited for the situation?
    - What did you learn from this drill? What do you think other learned from this drill?

- On guidelines:
    - Are there any differences between the procedures and how the drill was conducted?
    - Are there any lacks in the procedures when it comes to this kind of drill/incidents?
    - Think of other types of incidents where the runner/AB has to act; do you see any weaknesses in the procedures/guidelines?
    - Overall: Are the guidelines/procedures sufficient?
    - What kind of improvements would be helpful when it comes to
        - Guidelines/procedures
        - *Familiarization*
        - *Communication*
        - *Collaboration between actors*
        - *Technical equipment*

Information about the project and the interview about manual fire localization

The LASH FIRE project works to find solutions that can prevent and combat fires on RoRo and RoPax ships (ships that carry both passengers and rolling cargo). The project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814975. This particular study is organized by NTNU Social research in Norway.

The interview where you will participate is meant to examine how you perform your fire localization and confirmation (after a fire alarm).

- Purpose: to understand how fire localization is carried out and potentially how this routine can be improved, to save time and be able to extinguish a potential fire.

We will interview ship personnel on several vessels, and see patterns from the interviews together with information from earlier studies. Participants for the interviews are chosen based on work position and vessel type. In the end, the data we collect will be used to understand where improvements can be made.

Our interview will be like a conversation around topics you are familiar with: Your job in general, what you do when a fire alarm is activated at the bridge, the communication with other personnel, equipment you wear, procedures you are supposed to follow, and how you go about to locate and confirm a potential fire. We estimate that the interview will take an hour of your time.

We are committed to protecting your privacy and your data will be treated confidentially. References to you as a person (name, workplace, organization, contact information) will be removed. During the analysis, all individual utterances are grouped together. When data is presented in project reports or articles there will be no way of determining the source of information. Only project researchers with legitimate reasons will have access to the data. Because we may want to contact you on a later occasion with additional questions or clarifications, contact information will be kept in a separate file which will be stored safely. Anonymous results from our research will be shared within the project group, on our project website www.lashfire.eu, on conferences and in scientific journals.

Your participation in this interview is voluntary. You have the right to withdraw from its activities at any time without stating a reason, and without any consequences.

We want to **thank you** for taking the time to participate in this interview. If you have any further questions afterwards, please do not hesitate to contact us.

Kristine Vedal Størkersen, kristine.storkersen@samforsk.no, phone: + 47 99 26 58 96

Researcher, NTNU Social research, Norway

Informed consent of interview participation

The LASH FIRE project investigates fire safety on RoRo and RoPax ships, ships that carry both passengers and rolling cargo. The project is funded by the European Union's Horizon 2020 research and innovation programme, grant agreement 814975.

The interview where you will participate is meant to examine manual fire localization and confirmation.

You will participate as an interviewee.

Consent

- ❑ I have been fully informed about the purpose of this interview, how information is gathered and treated
- ❑ I have been given opportunity to ask questions about the interview before it begins and know who to contact with further questions
- ❑ I have been informed that my participation is voluntary and anonymous and that I, whenever I feel the need, may cancel my participation without stating a reason
- ❑ I hereby consent to participating in this interview which is part of the LASH FIRE project.

Place/Date/Year

_____

Signature of the participant

_____

Printed name

_____

11.7 ANNEX G – A selection of Relevant Marine Communication Phrases for manual fire confirmation and localization

INTERNATIONAL MARITIME ORGANIZATION

IMO **E**

ASSEMBLY
22nd session
Agenda item 9

A 22/Res.918
25 January 2002
Original: ENGLISH

Resolution A.918(22)

Adopted on 29 November 2001
(Agenda item 9)

IMO STANDARD MARINE COMMUNICATION PHRASES

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

RECALLING ALSO resolution A.380(X) by which it adopted the Standard Marine Navigational Vocabulary,

RECALLING FURTHER the provisions of regulation V/14.4 of the International Convention for the Safety of Life at Sea, 1974, requiring that on all ships to which chapter I thereof applies, English shall be used on the bridge as the working language for bridge-to-bridge and bridge-to-shore safety communications as well as for communications on board between the pilot and bridge watchkeeping personnel unless those directly involved in the communications speak a common language other than English,

RECOGNIZING that the standardization of language and terminology used in such communications would assist the safe operation of ships and contribute to greater safety of navigation,

RECOGNIZING ALSO the wide use of the English language for international navigational communications and the need to assist maritime training institutions to meet the objectives of safe operations of ships and enhanced navigational safety through, *inter alia*, the standardization of language and terminology used,

HAVING CONSIDERED the recommendations of the Maritime Safety Committee at its sixty-eighth and seventy-fourth sessions,

1. ADOPTS the IMO Standard Marine Communication Phrases set out in Annex 1 to the present resolution;

2. AUTHORIZES the Maritime Safety Committee to keep the IMO Standard Marine Communication Phrases under review and to amend them when necessary in accordance with the procedure set out in Annex 2 to the present resolution;

3. RECOMMENDS Governments to give the IMO Standard Marine Communication Phrases a wide circulation to all prospective users and all maritime education authorities, in order to support compliance with the standards of competence as required by table A-II/1 of the STCW Code;

4. REVOKES resolution A.380(X).

FOREWORD

As navigational and safety communications from ship to shore and vice versa, from ship to ship, and on board ship must be precise, simple and unambiguous so as to avoid confusion and error, there is a need to standardize the language used. This is of particular importance in the light of the increasing number of internationally trading vessels with crews speaking many different languages, since problems of communication may cause misunderstandings leading to dangers to the vessel, the people on board and the environment.

In 1973, the Maritime Safety Committee agreed, at its twenty-seventh session that where language difficulties arise a common language should be used for navigational purposes, and that language should be English. In consequence the Standard Marine Navigational Vocabulary (SMNV) was developed, adopted in 1977 and amended in 1985.

In 1992, the Maritime Safety Committee, at its sixtieth session, instructed the Sub-Committee on Safety of Navigation to develop a more comprehensive standardized safety language than SMNV 1985, taking into account the changing conditions in modern seafaring and covering all major safety-related verbal communications.

At its sixty-eighth session in 1997, the Maritime Safety Committee adopted the Draft IMO Standard Marine Communication Phrases (SMCP) developed by the Sub-Committee on Safety of Navigation. The draft IMO SMCP, following international trials, was amended at the forty-sixth session of this Sub-Committee, and was given final consideration by the Maritime Safety Committee at its seventy-fourth session in the light of remarks received by the Organization. The IMO SMCP was adopted by the Assembly in November 2001 as resolution A.918(22).

Under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as revised 1995, the ability to use and understand the IMO SMCP is required for the certification of officers in charge of a navigational watch on ships of 500 gross tonnage or more.

INTRODUCTION

1 Position of the IMO SMCP in maritime practice

The IMO Standard Marine Communication Phrases (SMCP) has been compiled:

- to assist in the greater safety of navigation and of the conduct of the ship,

- to standardize the language used in communication for navigation at sea, in port approaches, waterways and harbours, and on board vessels with multilingual crews, and
- to assist maritime training institutions in meeting the objectives mentioned above.

These phrases are not intended to supplant or contradict the International Regulations for Preventing Collisions at Sea, 1972 or special local rules or recommendations made by IMO concerning ships' routeing, neither are they intended to supersede the International Code of Signals, and their use in ship's external communications has to be in strict compliance with the relevant radiotelephone procedures as set out in the ITU Radio Regulations. Furthermore, the IMO SMCP, as a collection of individual phrases, should not be regarded as any kind of technical manual providing operational instructions.

The IMO SMCP meets the requirements of the STCW Convention, 1978, as revised, and of the SOLAS Convention, 1974, as revised, regarding verbal communications; moreover, the phrases cover the relevant communication safety aspects laid down in these Conventions.

Use of the IMO SMCP should be made as often as possible in preference to other wording of similar meaning; as a minimum requirement, users should adhere as closely as possible to them in relevant situations. In this way they are intended to become an acceptable safety language, using English for the verbal interchange of intelligence among individuals of all maritime nations on the many and varied occasions when precise meanings and translations are in doubt, as is increasingly evident under modern conditions at sea.

The accompanying CD/Cassette is designed to familiarize users with the pronunciation of the phrases.

2 Organization of the IMO SMCP

The IMO SMCP is divided into External Communication Phrases and On-board Communication Phrases as far as its application is concerned, and into Part A and Part B as to its status within the framework of STCW 1978 as revised.
Part A covers phrases applicable in external communications, and may be regarded as the replacement of the Standard Marine Navigational Vocabulary 1985, which is required to be used and understood under the STCW Code, 1995, Table A-II/I. This part is enriched by essential phrases concerning ship handling and safety of navigation to be used in on-board communications, particularly when the Pilot is on the bridge, as required by Regulation 14(4), Chapter V, SOLAS 1974, as revised.

Part B calls attention to other on-board standard safety-related phrases which, supplementary to Part A may also be regarded as useful for maritime English instruction.

3 Position of the IMO SMCP in Maritime Education and Training

The IMO SMCP is not intended to provide a comprehensive maritime English syllabus, which is expected to cover a far wider range of language skills to be achieved in the fields of vocabulary, grammar, discourse abilities, etc., than the IMO SMCP could ever manage. However, Part A in particular should be an indispensable part of any curriculum which is designed to meet the corresponding requirements of the STCW Convention 1978 as revised. In addition, Part B offers a rich choice of situations covered by phrases well suited to meet the communication requirements of the STCW Convention 1978 as revised, which mariners are implicitly expected to satisfy.

The IMO SMCP should be taught and learned selectively according to users' specific needs, rather than in its entirety. The respective instruction should be based on practice in the maritime environment, and should be implemented through appropriate modern language teaching methods.

4 Basic communicative features

The IMO SMCP builds on a basic knowledge of the English language. It was drafted intentionally in a simplified version of maritime English in order to reduce grammatical, lexical and idiomatic varieties to a tolerable minimum, using standardized structures for the sake of its function aspects, i.e. reducing misunderstanding in safety-related verbal communications, thereby endeavouring to reflect present maritime English language usage on board vessels and in ship-to-shore/ship-to-ship communications.

This means that in phrases offered for use in emergency and other situations developing under considerable pressure of time or psychological stress, as well as in navigational warnings, a block language is applied which uses sparingly or omits the function words *the, a/an, is/are,* as done in seafaring practice. Users, however, may be flexible in this respect.

Further communicative features may be summarized as follows:

- avoiding synonyms
- avoiding contracted forms
- providing fully worded answers to "yes/no"-questions and basic alternative answers to sentence questions
- providing *one* phrase for *one* event, and
- structuring the corresponding phrases according to the principle: *identical invariable plus variable.*

5 Typographical conventions

( ) brackets indicate that the part of the message enclosed within the brackets may be added where relevant;

/ oblique strokes indicate that the items on either side of the stroke are alternatives;

... dots indicate that the relevant information is to be filled in where the dots occur;

(*italic letters)* indicate the kind of information requested;

~ tildes precede possible words or phrases which can be used after/in association with the given standard phrase.

GENERAL

1 Procedure

When it is necessary to indicate that the IMO SMCP are to be used, the following message may be sent:

"Please use IMO Standard Marine Communication Phrases."

"I will use IMO Standard Marine Communication Phrases."

2 Spelling

2.1 Spelling of letters

When spelling is necessary, only the following spelling table should be used:

Letter	Code	Letter	Code
A	Alfa	N	November
B	Bravo	O	Oscar
C	Charlie	P	Papa
D	Delta	Q	Quebec
E	Echo	R	Romeo
F	Foxtrot	S	Sierra
G	Golf	T	Tango
H	Hotel	U	Uniform
I	India	V	Victor
J	Juliet	W	Whisky
K	Kilo	X	X-ray
L	Lima	Y	Yankee
M	Mike	Z	Zulu

2.2 Spelling of digits and numbers

A few digits and numbers have a **modified** pronunciation compared to general English:

Number	Spelling	Pronunciation
0	zero	ZEERO
1	one	WUN
2	two	**TOO**
3	three	**TREE**
4	four	**FOWER**
5	five	**FIFE**
6	six	SIX
7	seven	SEVEN
8	eight	AIT
9	nine	**NINER**
1000	thousand	**TOUSAND**

3 Message Markers

In shore-to-ship and ship-to-shore communication or radio communication in general, the following eight Message Markers may be used (also see "**Application of Message Markers**" given in PART A1/6 "Vessel Traffic Service (VTS) Standard Phrases"):

(i) Instruction
(ii) Advice
(iii) Warning
(iv) Information
(v) Question
(vi) Answer
(vii) Request
(viii) Intention

4 Responses

4.1 When the answer to a question is in the affirmative, say:
"Yes .... " followed by the appropriate phrase in full.

4.2 When the answer to a question is in the negative, say:
"No ..." followed by the appropriate phrase in full.

4.3 When the information requested is not immediately available, say:
"Stand by …" followed by the time interval within which the information will be
available.

4.4 When the information requested cannot be obtained, say:
"No information."

4.5 When an INSTRUCTION (e.g. by a VTS Station, naval vessel or other fully authorized personnel) or an ADVICE is given, respond if in the affirmative:
"I will/can ... " - followed by the instruction or advice in full; and,
if in the negative, respond:
"I will not/cannot ... " - followed by the instruction or advice in full.

Example: "ADVICE. Do not overtake the vessel to the North of you."
Respond: "I will not overtake the vessel to the North of me."

4.6 Responses to orders and answers to questions of special importance both in external and on-board communication are given in wording in the phrases concerned.

5 Distress, urgency and safety signals

5.1	MAYDAY	to be used to announce a distress message
5.2	PAN PAN	to be used to announce an urgency message
5.3	SECURITE	to be used to announce a safety message

6 Standard organizational phrases

6.1 "How do you read (me)?"

6.1.1 "I read you ...

bad/one	with signal strength one	(i.e. barely perceptible)
poor/two	with signal strength two	(i.e. weak)
fair/three	with signal strength three	(i.e. fairly good)
good/four	with signal strength four	(i.e. good)
excellent/five	with signal strength five	(i.e. very good)

6.2 When it is advisable to remain on a VHF Channel / frequency, say:
"Stand by on VHF Channel ... / frequency ... ."

6.2.1 When it is accepted to remain on the VHF channel / frequency indicated, say:
"Standing by on VHF Channel ... / frequency ... ."

6.3 When it is advisable to change to another VHF Channel / frequency, say:
"Advise (you) change to VHF Channel ... / frequency ... ."
"Advise(you) try VHF Channel .. / frequency... ."

6.3.1 When the changing of a VHF Channel / frequency is accepted, say:
"Changing to VHF Channel ... / frequency ... ."

7 Corrections

When a mistake is made in a message, say:
"Mistake ..." followed by the word:
"Correction ... " plus the corrected part of the message.

Example: "My present speed is 14 knots - mistake.
Correction, my present speed is 12, one-two, knots."

8 Readiness

"I am/I am not ready to receive your message."

9 Repetition

9.1 If any part of the message is considered sufficiently important to need safeguarding, say: "Repeat ... " - followed by the corresponding part of the message.

Example: "My draft is 12.6 repeat one-two decimal 6 metres."
"Do not overtake - repeat - do not overtake."

9.2 When a message is not properly heard, say:
"Say again (please)."

10 Numbers

Numbers are to be spoken in separate digits:

"One-five-zero" for 150
"Two decimal five" or
"Two point five" for 2.5

Note: Attention! When rudder angles, e.g. in wheel orders, are given, say:

"Fifteen" for 15 or
"Twenty" for 20, etc.

11 Positions

11.1 When latitude and longitude are used, these shall be expressed in degrees and minutes (and decimals of a minute if necessary), North or South of the Equator and East or West of Greenwich.

Example: "WARNING. Dangerous wreck in position 15 degrees 34 minutes North 061 degrees 29 minutes West."

11.2 When the position is related to a mark, the mark shall be a well-defined charted object. The bearing shall be in the 360 degrees notation from true north and shall be that of the position FROM the mark.

Example: "Your position bearing 137 degrees from Big Head lighthouse distance 2.4 nautical miles."

12 Bearings

The bearing of the mark or vessel concerned is the bearing in the 360 degree notation from north (true north unless otherwise stated), except in the case of relative bearings. Bearings may be either FROM the mark or FROM the vessel.

Example: "Pilot boat is bearing 215 degrees from you."

Note: Vessels reporting their position should always quote their bearing FROM the mark, as described in paragraph 11.2 of this section.

12.1 Relative bearings

Relative bearings can be expressed in degrees relative to the vessel's head. More frequently this is in relation to the port or starboard bow.

Example: "Buoy 030 degrees on your port bow."
(Relative D/F bearings are more commonly expressed in the 360 degree notation.)

13 Courses

Always to be expressed in 360 degree notation from north (true north unless otherwise stated). Whether this is to TO or FROM a mark can be stated.

14 Distances

To be expressed in nautical miles or cables (tenths of a mile), the unit always to be stated.

15 Speed

To be expressed in knots:

15.1 without further notation, meaning speed through the water; or,

15.2. "ground speed", meaning speed over the ground.

16 Times

Times should be expressed in the 24 hour hours hours UTC notation; if local time will be used in ports or harbours it should clearly be stated.

17 Geographical names

Place names used should be those on the chart or in Sailing Directions in use. Should these not be understood, latitude and longitude should be given.

18 Ambiguous words

Some words in English have meanings depending on the context in which they appear. Misunderstandings frequently occur, especially in VTS communications, and have produced accidents. Such words are:
The conditionals "may", "might", "should" and "could"

May
Do not say: "May I enter the fairway?"
Say: "QUESTION. Do I have permission to enter the fairway?"
Do not say: "You may enter the fairway."
Say: "ANSWER. You have permission to enter the fairway."
Might
Do not say: "I might enter the fairway."
Say: "INTENTION. I will enter the fairway."
Should
Do not say: "You should anchor in anchorage B 3."
Say: "ADVICE. Anchor in anchorage B 3."
Could
Do not say: "You could be running into danger."
Say: "WARNING. You are running into danger."

18.2 The word "can"

The word "can" describes either the possibility or the capability of doing something. In the IMO SMCP the situations where phrases using the word "can" appear make it clear whether a possibility is referred to. In an ambiguous context, however, say, for example: "QUESTION. Do I have permission to use the shallow draft fairway at this time?" Do not say: "Can I use the shallow draft fairway at this time?" if you are asking for a permission. (The same applies to the word "may").

Note: In all cases the radiotelephone procedures as set out in the ITU Radio Regulations have to be observed.

B2 Safety on board

B2/1 General activities

The phrases of this section apply to most of the emergencies covered in this chapter.

B2/1.1 Raising alarm

.1 Operate the general emergency alarm.
.2 Inform the Master / Chief Engineer /... .
.3 Inform the ... coast radio station / vessels in vicinity (on radio).
.4 Request assistance (on radio) from ... and report.
.4.1 Assistance was
~ requested from ... .
~ offered by ... .
~ accepted from ... .
.5 Transmit a SÉCURITÉ / PAN-PAN / distress alert / MAYDAY and report.
.5.1 A SÉCURITÉ / PAN-PAN / distress alert / MAYDAY was transmitted.
.6 Was the distress alert / MAYDAY acknowledged?

.6.1 Yes, the distress alert / MAYDAY was acknowledged
by ... coast radio station / MRCC / vessel(s) in vicinity.
.6.2 No, distress alert not acknowledged (yet).
.6.3 Repeat the distress alert.

B2/2 Occupational safety

B2/2.1 Instruction

.1 Prepare a training plan for occupational safety.
.2 When was the last training session on occupational safety?
.2.1 The last training session was on ... *(date)*.
.3 When is the next training session on occupational safety?
.3.1 The next training session is on ... *(date)*.
.4 Are new crew members / passengers instructed on occupational safety?
.4.1 Yes, new crew members / passengers are instructed.
.4.2 No, new crew members / passengers are not instructed (yet).
.4.3 Instruct new crew members / passengers by ...*(time)* / on ...*(date)*.
.5 Participation in training sessions on occupational safety is mandatory.

B2/2.2 Practical occupational safety

.1 Instruct crew on occupational safety before departure.
.2 Have special instruction on dangerous goods / heavy lifts/cargo securing / illumination / ventilation / ... .
.3 Where are dangerous goods carried on board?
.3.1 Dangerous goods of IMO Class ... are carried
~ on deck (in roped-off areas).
~ in no. ... hold(s).
~ in ... /on... .
.4 Prepare an emergency plan.
.5 Brief all crew members / passengers on the symptoms caused by dangerous substances.
.6 What signals / communications are used in case of emergency ?
.6.1 The following signals / communications are used in case of emergency: ... .
.7 Brief all crew members / passengers
~ about restricted areas.
~ how to report in / out (when entering / leaving bridge / engine room / ...).
.8 Do not enter the unmanned (engine) room /... space without permission.
.8.1 Report on telephone / radio / ... while in the (engine) room /... space every ... minutes.
.9 Brief all crew members / passengers on the storm.
.9.1 Attention! Entering the forecastle / main deck / weather side / ... of the vessel is prohibited / dangerous (due to storm).
.9.2 Attention! Make use of hand rails and lifelines in corridors and on deck.
.9.3 Attention! Close all dead lights and storm doors.
.9.4 Attention! Secure all loose objects in your cabins / on deck / in ... .
.10 Brief all crew members / passengers on winter conditions / tropical conditions.
.11 Check the completeness and availability of the occupational safety equipment and report.
.11.1 Occupational safety equipment is complete and available.
.11.2 Following occupational safety equipment is not complete / available: ...
.11.3 Occupational safety equipment will be complete and available in ... hour(s).

.12 Appoint an officer / a crew member in charge of safety before working.
.13 Take additional safety measures for the
~ work on masts.
~ work outboard.
~ work in hold(s) / tank(s).
~ work in extreme weather conditions / ... .

B2/3 Fire protection and fire fighting

B2/3.2 Fire fighting and drills

.1 Reporting fire

.1 Fire on board!
.1.1 Smoke / fumes / fire / explosion
~ in engine room.
~ in no. ... hold(s) / tank(s).
~ in superstructure / accommodation.
~ in ... space.
~ on deck / ... .
.1.2 Smoke / fumes from ventilator(s).
.1.3 Burnt smell / fumes in .../ from... .
.2 Report injured persons / casualties:
.2.1 No person injured.
.2.2 Number of injured persons / casualties is: ... .
.3 What is on fire?
.3.1 Fuel / cargo / car(s) / truck(s) / wagon(s) / containers (with dangerous goods) / ... on fire.
.3.6 No information (yet).
.4 Is smoke toxic?
.4.1 No, smoke not toxic.
.4.2 Yes, smoke toxic
.5 Is fire under control?
.5.1 Yes, fire (in ...) under control.
.5.2 No, fire (in ...) not under control (yet).
.5.2.1 Fire spreading (to ...).
.5.2.2 Fire (in ...) not accessible.
.6 Report damage.
.6.1 No damage.
.6.2 Minor / major damage in .../ to ... .
.6.3 No power supply (in ...).
.6.4 Making water in ... .
.7 Pressure on fire mains!
.8 Shut down main engine(s) / auxiliary engine(s) / ... and report.
.8.1 Main engine(s) / auxiliary engine(s) / ... shut down.
.9 Stop fuel and report.
.9.1 Fuel stopped.
.10 Close all openings (in ... / in all rooms) and report.
.10.1 All openings (in ... / in all rooms) closed.
.10.1.1 Openings in ... not accessible.
.11 Switch off ventilator(s) (in ...) and report.
.11.1 Ventilator(s) (in ...) switched off.
.12 Turn bow / stern to windward.
.13 Turn port side / starboard side to windward.

.14 Alter course to ... .

.4 Cancellation of alarm

.1 Is the fire extinguished?
.1.1 Yes, fire (in ...) extinguished.
.1.2 No, fire (in ...) not extinguished (yet).
.1.3 Fire restricted to ... space / area.
.2 Post a fire watch and report.
.2.1 Fire watch posted (in ...space / area).
.3 Fire extinguishing systems / means remain on stand-by.
.4 Fire fighting team / ... team remain on stand-by.
.5 Rope off the fire area and report.
.5.1 Fire area roped off.
.6 Check the fire area every ... minutes / hour(s) for re-ignition and report.
.6.1 Fire area checked, no re-ignition.
.6.2 Fire area checked, re-ignition in ... space / area.
.6.2.1 Re-ignition extinguished.
.7 The fire alarm is cancelled (with following restrictions: ... .)

B2/4 Damage Control

See also B2/1 "General Activities".

B2/4.1 Checking equipment status and drills

.1 Check the openings in all spaces / in ... and report
.1.1 All openings in ... are closed.
.1.2 Openings in ... are not closed (yet).
.1.3 Openings in ... are not accessible.
.2 Check the watertight door control and report
.2.1 Watertight door control
~ is operational.
~ (in ...) is not operational (yet).
~ (in ...) will be operational in ... minutes.
.2.2 Watertight door(s) (in ...) is / are not accessible.
.3 Check the pumps / emergency generator and report
.3.1 (Bilge) pump(s) in ... / emergency generator
~ is / are operational.
~ is / are not operational (yet).
~ will be operational in ... minutes.
.4 Check the power supply and report
.4.1 Power (in / at ...)
~ is available.
~ is not available (yet).
~ will be available in ... minutes.
.5 Check the damage control equipment and report.
.5.1 All damage control equipment is complete and available.
.5.2 Damage control equipment is not complete.
.5.2.1 Complete the damage control equipment.

11.8 ANNEX H: Application of Guidelines for quick manual fire confirmation and localization on example case

Place and date: Norvik, 04.04.2022

Example ship: Stena Baltica

Action 6-B proposed solutions were applied on Stena Baltica during an onboard visit in Norvik, on April 4th, 2022. The visit was arranged by the Stena Project Manager Fire Safety, which provided support onboard to the NTNU Social Research team. The visit started with the observation of the visibility conditions of fully loaded cargo deck during ship arrival. It continued with a comprehensive ship familiarization round with a safety focus carried out by the Safety Officer. The weekly "Fire and Abandon Ship" drill was observed, both, from the bridge and the affected deck. Finally, the application of guidelines and suitable solutions were discussed with several crew members, namely, the captain, Watch Officer, two watchmen and the Safety Officer.

The improvement of current signage and marking standards/conditions to support effective wayfinding and localization

-

A. Consistency between signage and marking onboard systems and information displayed in the ship's fire management system interfaces

A.1 Signage and marking of drencher zones and deck number should be consistent with information displayed in in the ship's fire management system interface.

A.2. All printed information sources on board must have consistent drencher zone and deck references, aligned with signage and alarm system.

A.3 Ambiguous deck names should be avoided, as well as mixing reference to deck numbers with reference to names, such as "lower hold".

Application to example case: Stena Baltica has recently gone through an extension process in which sensor numbering, signage/marking systems and fire management system interfaces have been subject to changes and revised by an external company. The level of consistency is satisfactory and not extra actions are required.

Stena Baltica is encouraged to adopt the following recommendations:

- to make corresponding drencher zone information available on the fire panel. This can be done by reprogramming the fire panel or by adding an extra column with corresponding drencher zones in the existing list of sensors and ship locations.
- to include location of CCTV cameras and their visibility angles in the ship drawings displayed on the bridge.

-

B. Easily readable signage and marks standard

B.1 Signs and marks shall be easily identifiable and interpretable

B.2 Drencher zones and decks should be marked in such a way that fire patrol always, in fully loaded deck condition, should be able to visually confirm location from any position along the patrol route, allowing for movement of maximum +/-3 m along path.

B.3 CCTV system should allow for instant identification of which drencher zones are visible from each camera.

The following shall be considered:

- Size: Markings and signs shall have a minimum size of 500 x 500 mm for deck numbers and drencher zones. Frame numbers should correspond with the width of the frame.
- Colour: The use of red, or a combination of red/white is recommended.
- Font: The use of Bold Sans Serif for signage is recommended since it is one of the most readable fonts for signage.
- Material:
  - The use of both painted and prefabricated sings and markings are permitted
  - Requirement: Section number signs shall be of photoluminescent material complying with ISO 15370:2021Ships and marine technology — Low-location lighting (LLL) on passenger ships — Arrangement.
- Maintenance:
  - Signage and markings shall be resistant to wear and tear.
  - Signage and markings shall be included in maintenance schemes.
- Location: Placing shall be decided by performing an in-situ analysis based on typical patterns of crew movement and real use cases. The following shall be considered:
  - Sign and markings shall not be obstructed by cargo or fixed installations and shall be visible through video monitoring systems.
  - Signs and markings shall be always visible: crew member shall be able, by means of signage and boundary marking only, to determine the exact location in the ship by walking +/- 3 meters along walking route.
  - Deck and vertical boundaries shall be marked to easily identify the sections of the fixed fire-extinguishing system in closed vehicle, ro-ro spaces and special category spaces with water-spraying systems

Application to example case: Stena Baltica has well maintained, and easily identifiable and readable signs and markings, including vertical boundaries of drencher system. The size, colour and fonts used in Stena Baltica are in line with guidelines requirements and no extra actions are required. Signage/marking is not visible from some of the CCTV cameras.

Required actions for Stena Baltica:

- Material: Drencher zone number signs shall be of photoluminescent material complying with ISO 15370:2021Ships and marine technology — Low-location lighting (LLL) on passenger ships — Arrangement.
- Location:
  - drencher zones information should be painted with a wear and tear resistant material on the “no parking yellow line” in the middle of the cargo deck. Each drencher zone number should be painted at three different locations along the line, at both ends of the drencher zone, and in the middle. The markings should be maintained in line with current maintenance practices on board.
  - Drencher zone numbering shall be inscribed in CCTV images. This can be done by adding drencher zone number in the location information displayed in CCTV images.

Guidelines for the standardization and formalization of manual fire confirmation and localization

A. Description of the role, the task and the conditions for performance

A.1 Company and/or ship specific procedures shall include concise, simple, and useful descriptions of the role of the runner, the task and its conditions for the performance.

A.2 The runner shall be an experienced crew member and shall be familiarized with manual fire confirmation and localization related activities and the ship. The runner shall wear equipment that allows to keep his/her both hands free and ready to act if firefighting first response is needed.

Application to example case: Descriptions of the role, task and conditions of performance are not formally described in company nor ship procedures. Crew members get sufficiently familiar with the role of the watchman and the manual fire confirmation and localization during ship familiarization activities and by applying common sense. The watchman's role and tasks are only carried out by experienced crew members. The equipment used by the watchman in the performance of the task comprises a torch and radio device.

Required actions for Stena Baltica: A written description of the role, the task and the conditions of performance shall be included in the ship procedures to be accessible for consultation (for instance, for new crew members joining the ship). The following descriptions of role and task are suggested, but it is up to the administration to suggest other that are more suitable for this specific ship, if preferred.

- Role: Runner: Crew member, normally one of the able seamen on duty, sent to the point of fire detection with the task of confirming or disconfirming the existence of a fire.
- Task: Manual fire confirmation and localization is a first response in the event of a fire alarm, consisting of sending a runner to the point of detection with the task of confirming or disconfirming the existence of fire and its location.

The description of the conditions for the performance shall include the following points:

- The runner shall be familiarized with manual fire confirmation and localization related activities and the ship by completing company's familiarization routines and participating in several fire drills thatinclude manual confirmation and localization related events..
- The runner shall be an experienced crew member that report him/herself confident to perform the task and is assessed as capable by the person sending him/her.

The runner shall wear equipment that allows to keep his/her both hands free and ready to act if firefighting first response is needed. The equipment needed is the same as the one required for the fire patrol and shall encompass:

- Cotton (rather than polyester) and long-sleeve clothing to protect from fire
- Light and robust safety torch that can be magnetic attached to the helmet with enough LED intensity (around 100 lumens) to detect leaks or smoke under low visibility condition spaces. A flashlight is useful during night patrolling, specially to inspect unprotected areas, like weather decks.
- A thermal imaging device such as an IR light handheld camera that can be hanged around the neck for hot spots detection. Desired Specs: Dimensions (like a smart-phone, light

around 250g, temperature range from bellow cero up to 150ºC). The IR camera shall be used when the runner may suspect the presence of an ignition source like a suspicious noise or smell, smoke, or sparks.

- A communication device such as portable VHF/UHF radios with press to talk bottoms

B. Clear communication between bridge and runner during the performance of the task

-

B.1 Ships with English as working language shall standardize language and terminology used by adopting the use of IMO Standard Marine Communication Phrases.

B.2 Communication equipment with sufficient coverage shall be used by crews. Not less than the 85% of the cargo deck area shall have radio coverage with full cargo.

Application to example case: Insights from the visit show that crew members are familiar and use IMO Standard Marine Communication Phrases in their communication and in manual fire confirmation and localization related activities. Crew members use VHF radio transmitters and are aware of the radio blind spots in the ship. The mapping of propagation limits and coverage of radio signal shows blind spots in the following locations: fire pump, compressor room, engine control room, drencher room, car deck and lower hold. Fixed telephones are available as alternative means of communication in all the above locations, but not in lower hold. The preferred solution for blind spots would consist of the installation of a radio signal amplifier.

Required actions for Stena Baltica: The installation of a radio signal amplifier to eliminate identified radio shadows.

Stena Baltica crew members are encouraged to continue using IMO Standard Marine Communication.

C. Familiarization with the task

C.1 Manual fire confirmation and localization activities shall be trained in realistic fire drills. The performance of manual fire confirmation and localization related drill's activities shall be assessed and discussed in drill debriefs. Potential challenges and concerns related with the task shall be discussed in HSE meetings.

C.2 The use of IMO Standard Marine Communication Phrases shall be practiced during drills and by fire patrols during non-emergency situations.

Application in example case: Insights gathered on the onboard visit show that task familiarization activities are trained in fire drills and discussed in debriefs and HSE meetings if relevant. IMO Standard Marine Communication Phrases are known and used by crew members during drills and by fire patrol in non-emergency activities. Therefore, task familiarization activities are satisfactory and no extra actions are required.

Safety Officer and the rest of Stena Baltica crew members are encouraged to continue meeting requirements by:

- conducting realistic fire drills that include sub-events in which potential scenarios and challenges during fire confirmation are trained.

- assessing and discussing the performance of manual fire confirmation and localization related drill's activities in drill debriefs and HSE meetings when relevant.

- practicing the use of IMO Standard Marine Communication Phrases during fire drills and by fire patrols during non-emergency situations.