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LASH FIRE

Deliverable D10.2

Onboard demonstration of weather deck fire-extinguishing solutions

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Abstract

This report summarizes the findings and outcomes of an onboard demonstration conducted by Unifire AB (UNF) to test the effectiveness of an autonomous fire monitor system in detecting and suppressing fires on the weather deck of the Stena Scandinavica ro-ro vessel.

The demonstration validated the results of the development and of previous testing conducted in Borås, Sweden (in 2022), and Trondheim, Norway (in 2022), which established the system's ability to detect and guide water onto fires as well as suppress large-scale fires. The demonstration on the Stena Scandinavica vessel was successful, showcasing the capabilities of the system in a real-world scenario.

The autonomous fire monitor system used on the vessel consisted of an actuated valve, a UNIFIRE Force 80 remote control fire monitor, Unifire's X-TARGA PLC with FlameRanger software, and IR3 Array Flame detectors. Twelve fire tests were conducted, each with a different fire location on the weather deck. In all tests, the fire monitor system extinguished the fires within 15 seconds from ignition without any human intervention. These results were consistent with previous testing, demonstrating the system's rapid and accurate fire detection and suppression capabilities.

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Content

1 Executive summary

This report summarizes the findings and outcomes of an onboard demonstration conducted by Unifire AB (UNF) to validate the effectiveness of an autonomous fire monitor system in detecting and suppressing fires on a ro-ro weather deck (Task T10.8). The demonstration was conducted onboard the Stena Scandinavica vessel in the Harbor of Gothenburg on May 23, 2023.

Problem definition

The objective of action 10-B is to develop and demonstrate feasible and effective system solutions. While doing this, several aspects need to be considered, such as the weather and other environmental conditions, the fire hazards, specific requirements, and other challenges that influence the installation and operation of the systems.

The project description states that “Quick system activation, safe controlling, high coverage and fast fire suppression are fundamental criteria for the systems, which also need to sustain the harsh environmental conditions.” The development work should additionally be based on the most recent technological advances in the field, in other words a state-of-the art review is required, identifying the newest technology, ideas, and features.

Task T10.8, the subject of this report, is to demonstrate the developed solutions by means of live, onboard fire tests.

Method

The performance of the autonomous fire monitor system was demonstrated in a series of onboard fire tests conducted on the open weather deck of the Stena Scandinavica ro-ro vessel. The vessel was equipped with an autonomous fire monitor system positioned to detect and suppress fires on the weather deck as described in Deliverable D10.3 (Description of the development of weather deck fire-extinguishing systems and selected solutions).

Two small propane gas burners were used to generate flames on the open weather deck (Figure 8). Each produced flames with approximate dimensions of 60 cm × 60 cm at the base and a height of 60 cm.

A total of twelve (12) separate fire tests were conducted. For each of the twelve tests, the fire was positioned in a different location on the weather deck. Prior to the ignition of the propane gas burners, the autonomous fire monitor system had no information about whether, when or where a fire would be ignited.

Results and achievements

The results of the demonstration were highly successful. The autonomous fire monitor system demonstrated its ability to rapidly and accurately detect fires, determine their locations, and aim the water stream for effective fire suppression, initiating suppression in under 15 seconds of fire ignition. Moreover, the system extinguished all twelve fires in under 15 seconds from ignition, without any human intervention.

Contribution to LASH FIRE objectives

The overall objective of WP10 is to provide for efficient, effective, and safe fire extinguishment in ro-ro spaces, regardless of the type or size of the space and with less crew dependence. The objective of Action 10-B is to develop and demonstrate feasible and effective fixed fire-extinguishment solutions for ro-ro weather decks.

Report D10.3 documents the results of Tasks 10.5-10.7, as follows:

- definition of conditions for use of weather deck fire extinguishing systems, including a consolidation of regulatory, environmental, operational and shipyard requirements and establishment of necessary functions of weather deck fire extinguishing systems (Task 10.5);
- development of the three solutions: an autonomous and remote-controlled fire monitor system and a compressed air foam monitor system, including installation costs and environmental impact assessment (Task 10.6); and
- large-scale fire performance validation of the system solutions and sharing of results with WP04 (Task 10.7).

This report documents the results of Task T10.8, the onboard demonstration and testing of the selected system solutions by real installations onboard a ro-ro passenger ship on a relevant weather deck.

Exploitation

The overall results of Task T10.8 was to demonstrate the developed solutions by means of live, onboard fire tests. The purpose of the onboard demonstration was to assess the effectiveness of an autonomous fire monitor system in rapidly detecting and suppressing fires on a real weather deck, thereby improving fire safety measures. By showcasing the system's capabilities, the demonstration aimed to build confidence among stakeholders, highlighting its autonomous functionality and its successful integration as an example for ship installations.

2 List of symbols and abbreviations

CE	Conformité Européenne. Note: CE marking is a mandatory administrative marking asserting conformity with relevant standards, applied to certain products offered for sale within the European Economic Area
DoA	Description of Actions
DC	Direct Current
EMC	Electromagnetic Compatibility
EU	European Union
F4M	FiFi4Marine B.V. (partner in the LASH FIRE project)
FLOW	FLOW Ship Design d.o.o. (partner in the LASH FIRE project)
GUI	Graphical User Interface
IMO	International Maritime Organization
IR	Infrared
LAN	Local Area Network
PLC	Programmable Logic Controller
RISE	RISE Research Institutes of Sweden
UNF	Unifire AB (partner in the LASH FIRE project)
WAN	Wide Area Network

3 Introduction

Main authors of the chapter: Magnus Arvidson, RISE and Roger James, UNF.

Fire monitor systems are not currently required to be installed for the protection of ro-ro weather decks on ships, although the fire load is substantial and manual firefighting operations are both difficult and hazardous. Recently, the International Maritime Organization (IMO) has recognized the use of “fixed fire-extinguishing measures on weather decks” in the Interim guidelines of MSC.1/Circ.1615 [1]. Member States are invited to bring the Interim guidelines to the attention of all parties concerned and to recount their experience gained using the guidelines to the IMO. The guidelines use the term “fire monitors” to describe the system technology. Although the term is not defined in the document, it is recognized as a fixed, remote-controlled device that can deliver a large water or foam stream and is mounted on a stationary support that is elevated above the deck flooring (refer to Figures 1 and 6). The nozzle tip can also be adjusted to control the spray angle from jet to spray. Fire monitors are widely known to be a highly effective means of suppressing fire, particularly when intervention is rapid.

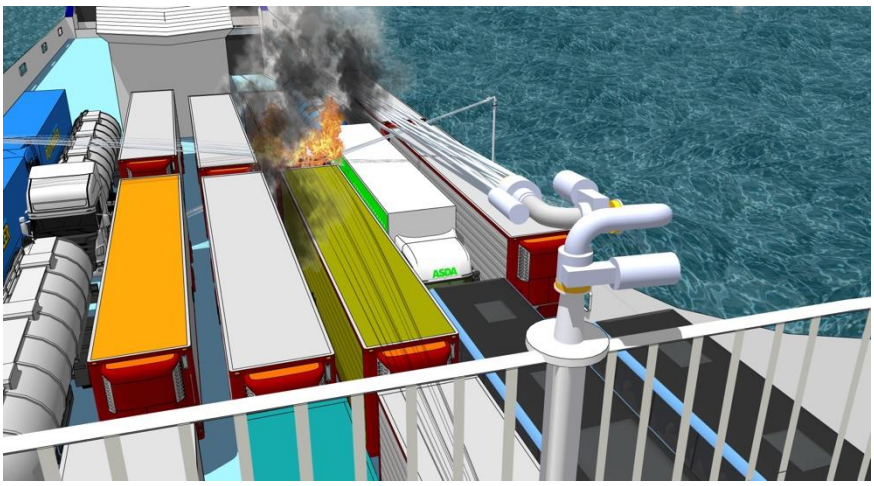

Figure 1. Example layout of remote control, semi-autonomous or fully autonomous fire monitors for weather deck fire protection.

The objective of WP10, Action 10-B, is to develop and demonstrate feasible and effective fixed fire-extinguishment solutions for weather decks. The Description of Actions (DoA) states that “Quick system activation, safe controlling, high coverage and fast fire suppression are fundamental criteria for the systems, which also need to sustain the harsh environmental conditions.”

The system solution developed by project partner Unifire AB (UNF), , who independently developed the novel technologies, comprised an autonomous and remote-controlled fire monitor system for weather deck protection. The development included theoretical evaluations and system development testing. The task also included installation and maintenance cost assessments.

Task T10.8 of WP10 calls for the onboard demonstration and testing of the selected system solutions by real installations onboard a ro-ro passenger ship on a relevant weather deck. This report describes the onboard demonstration and testing of the Unifire autonomous and remote-controlled fire monitor system.

4 Description of the developed fire monitor system solutions

Main authors of the chapter: Roger James, UNF, Mattias Eggert, UNF, and Magnus Arvidson, RISE.

4.1 Autonomous fire monitor system

4.1.1 Overview of system parameters and installation

A remote control and fully autonomous fire monitor system developed by UNF and design and installation criteria in terms of fire detector and fire monitor placement and flow rate demand was developed (see Report D10.3, Description of the development of weather deck fire-extinguishing systems and selected solutions). For best performance, the detectors should be installed as high up as practically possible. This provides better viewing angles that allow more precise positioning of a fire. For a similar reason, the fire monitors should also be elevated. One autonomous system (one fire monitor and two detectors) has been confirmed to cover an area of 30 meters (W) by 50 meters (L) using 1200 liters/min at 5 bar inlet pressure. The width is representative t of weather decks.

A minimum of two systems must cover the same area from opposing angles. A fire will then be effectively suppressed from opposing angles, and under windy conditions, it is expected that the effect of the wind will be balanced out. It should be emphasized that the two systems operate simultaneously and completely independently of each other. The autonomous fire monitor system that was developed is considered a viable and realistic solution to provide effective autonomous fire protection on weather deck. The assumption is that ships in the future will be operating increasingly autonomously, and the crew will be small.

4.1.2 Description of the developed remote control and fully autonomous fire monitor system

The fully autonomous fire monitor system developed by Unifire is capable of rapid and accurate fire detection and targeted fire suppression by means of a two-inch (2”) fire monitor[1], without any human intervention required. The autonomous fire monitor system is also capable of being remote controlled by a human operator at any time, regardless of whether autonomous suppression has been initiated.

The fire monitor can also be installed without detectors and be remote controlled by crew members by means of a variety of remote control devices. It can also record an operator’s use of the remote control device, store it to memory, and play it back in a continuous loop; which recording can be initiated by pressing the “play” button on the remote control device, or can be activated by means of an input from an external detector alarm signal or other input signal. In the case of both the autonomous fire monitor system and the remote control fire monitor system, each fire monitor can be controlled by multiple remote control devices, which can be a tethered joystick and/or can operate wirelessly by radio remote control and/or by a computer over a WAN or LAN. Furthermore, the remote control devices can be placed in any location (or locations) on the ship, allowing for safe control access in the event of a fire.

[1] A two-inch (2”) monitor was determined to provide sufficient flow and reach for the effective fire suppression on weather decks, while also minimizing weight, the necessity for larger pumps and piping, and thereby keeping costs to a minimum. See Report D10.3. The demonstration discussed in this document used a three-inch (3”) Force 80 fire monitor identical to the developer’s (Unifire’s) Force 50 two-inch (2”) fire monitor in every way except for the pipe diameter—it was used because it had previously been outfitted on the Stena Scandinavica and was identically suited for the demonstration tests and allowed for lower costs of the demonstration without affecting the validity of the tests in any way.

4.1.3 Components of the developed remote control fire monitor

The remote control fire monitor developed by Unifire (refer to Figures 2 and 3) comprises the following primary components:

- Unifire Force 50 remote control fire monitor with: a two inch (2”) internal pipe diameter; made of stainless steel 316L (EN1.4404) with fully integrated and enclosed stainless steel worm gears and Bronze (CuSn12) gear wheels; fully enclosed 24V DC brushless (BLDC) motors for high torque and extremely precise, long-lasting position feedback; and designed for the harsh conditions of marine environments; and

Figure 2. Unifire Force 50 2" remote control fire monitor made of stainless steel 316L.

- an Integ 50 steplessly-adjustable jet/spray water or foam firefighting nozzle tip that controls the spray angle, also made of stainless steel 316L and Bronze and with a fully enclosed 24V DC brushless (BLDC) motor; and
- an X-TARGA PLC that contains a proprietary PLC designed and manufactured by Unifire, a built-in power converter from 110-230V AC (50/60Hz) to the PLC’s native 24VDC/20Amp requirements. The PLC is CE marked and EMC tested and is housed in an IP66 cabinet designed for the harsh marine environment; and
- quick-connect, highly sealed motor power and control cables; and
- one or more remote control devices.

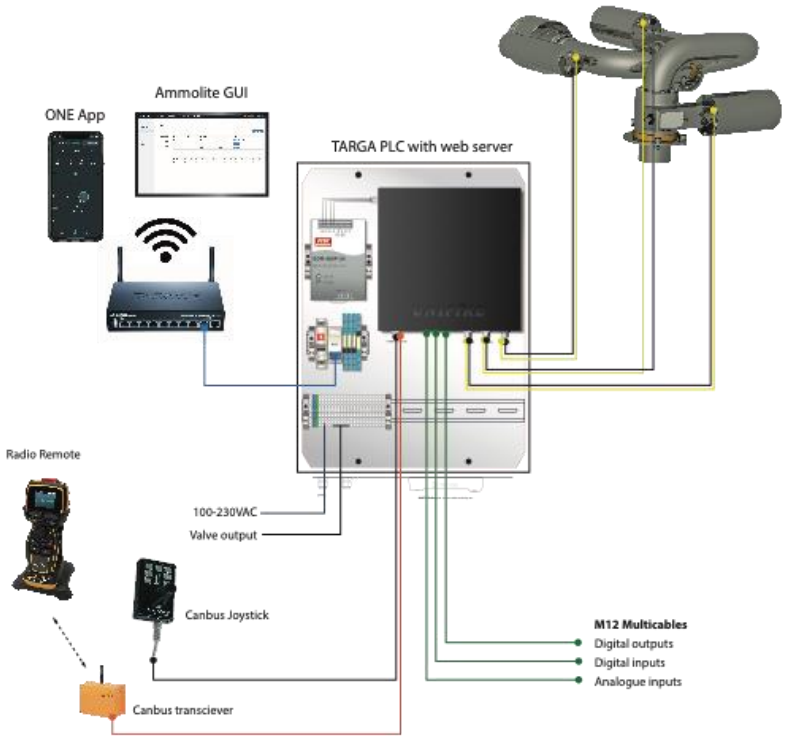

Figure 3. Schematic layout of a Unifire remote control fire monitor system.

4.1.4 Components of the developed autonomous fire monitor system

The autonomous fire monitor system developed by Unifire (refer to Figure 4), called FlameRanger, comprises the remote control fire monitor system described in 4.1.3 above, and two Tyco FV311 IR3 flame detectors[2]. Additionally, the autonomous system's X-TARGA PLC has inputs for the flame detectors and specialized electronic hardware and software that process signals from the flame detectors.

The flame detectors must be carefully and precisely positioned during system setup so that their respective viewing angles allow for accurate and precise triangulation of a fire's (or fires') position(s) by the system's software.

[2] The Tyco FV311 is not the only available fire detection technology for autonomous fire monitor systems. Unifire has also developed autonomous fire monitor systems that utilize other fire detection technologies, including other makes of flame detectors, thermal imaging cameras, and hybrid detectors, and others.

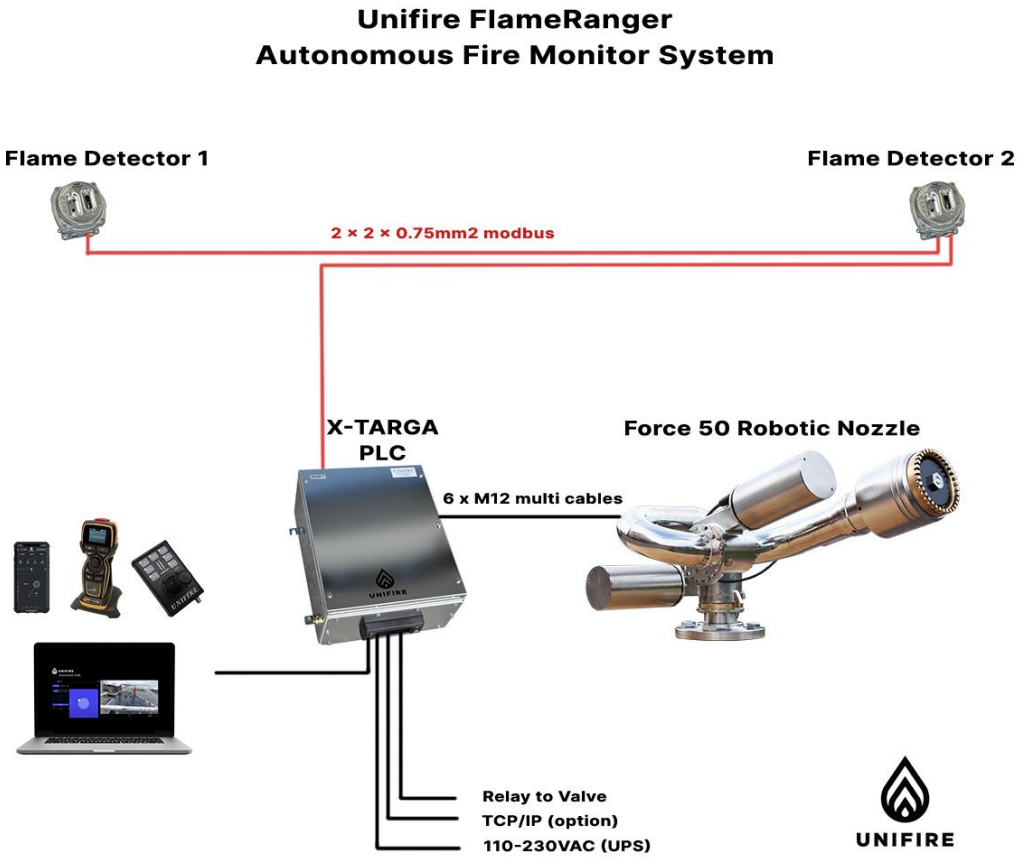

Figure 4. Schematic diagram of Unifire FlameRanger autonomous fire monitor system.

5 The ship chosen for the installation and demonstration

Main author of the chapter: Roger James, UNF

The ship selected for the onboard demonstration of the remote controlled and autonomous fire monitor system was the Stena Scandinavica (refer to Figure 5).

Figure 5. Stena Scandinavica (Stena Line).

In addition to having a typical weather deck for the carriage of vehicles, the Stena Scandinavica had previously been outfitted with a Unifire Force 80 (3”) remote control fire monitor with an Integ jet/spray nozzle tip that protects the weather deck and which was suitable for the demonstration of the system (see footnotes 1 and 2, above). This fact reduced the required installation of the fire monitor and, accordingly, saved time and cost of the of the demonstrated system.

The Stena Scandinavica had also previously been outfitted with two Tyco FV311 IR3 flame detectors, as part of Work Package 9, for gathering long-term data, determine possible susceptibility to false alarms and to determine whether the detectors were suited for long-term used in the harsh conditions of a weather deck. It should be noted that the detectors remained in perfect working condition throughout the study and recorded no false alarms.

The open weather deck of the Stena Scandinavica measures approximately 70 m (L) by 28 m (W).

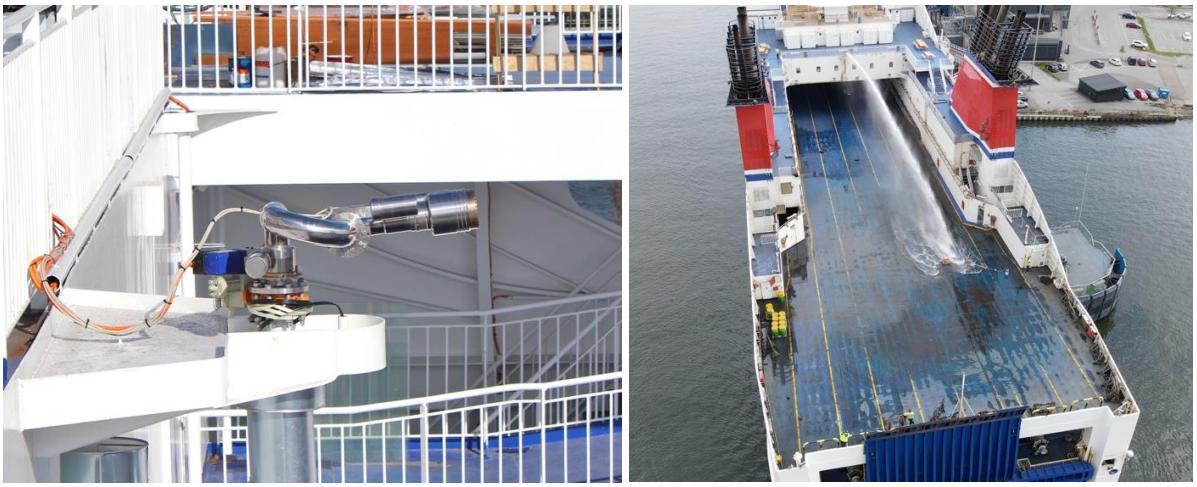

Figure 6. Unifire Force 80 remote control fire monitor protecting the weather deck of Stena Scandinavia (left) and a photo taken (right) during of one of the twelve demonstrations in which the autonomous fire monitor detected, located, and extinguished a propane burner fire onboard the Stena Scandinavica.

6 The installations and their objectives

Main author of the chapter: Roger James, UNF.

In a series of tests conducted in Borås, Sweden, in May 2020, it was established that the developed autonomous fire monitor system was able to rapidly detect fires in multiple locations, accurately determine their locations in three-dimensional space, and accurately and effectively aim the fire monitors water stream to suppress the fire at and around its source.

In a second series of large-scale fire tests conducted in Trondheim, Norway, in September 2022, it was established that the developed fire monitor system could effectively suppress and contain fires simulating a burning freight truck trailer fire.

The objective of the installation of the system that is the subject of this document was to achieve a real-life demonstration of the effectiveness of an autonomous fire monitor system to suppress fires on an actual ro-ro weather deck.

To achieve this aim, the autonomous fire monitor system was installed to protect the weather deck of the Stena Scandinavica (refer to Figure 7). Propane gas burner fires were ignited in twelve different positions on the weather deck of the to determine whether and how the autonomous fire monitor system would perform.

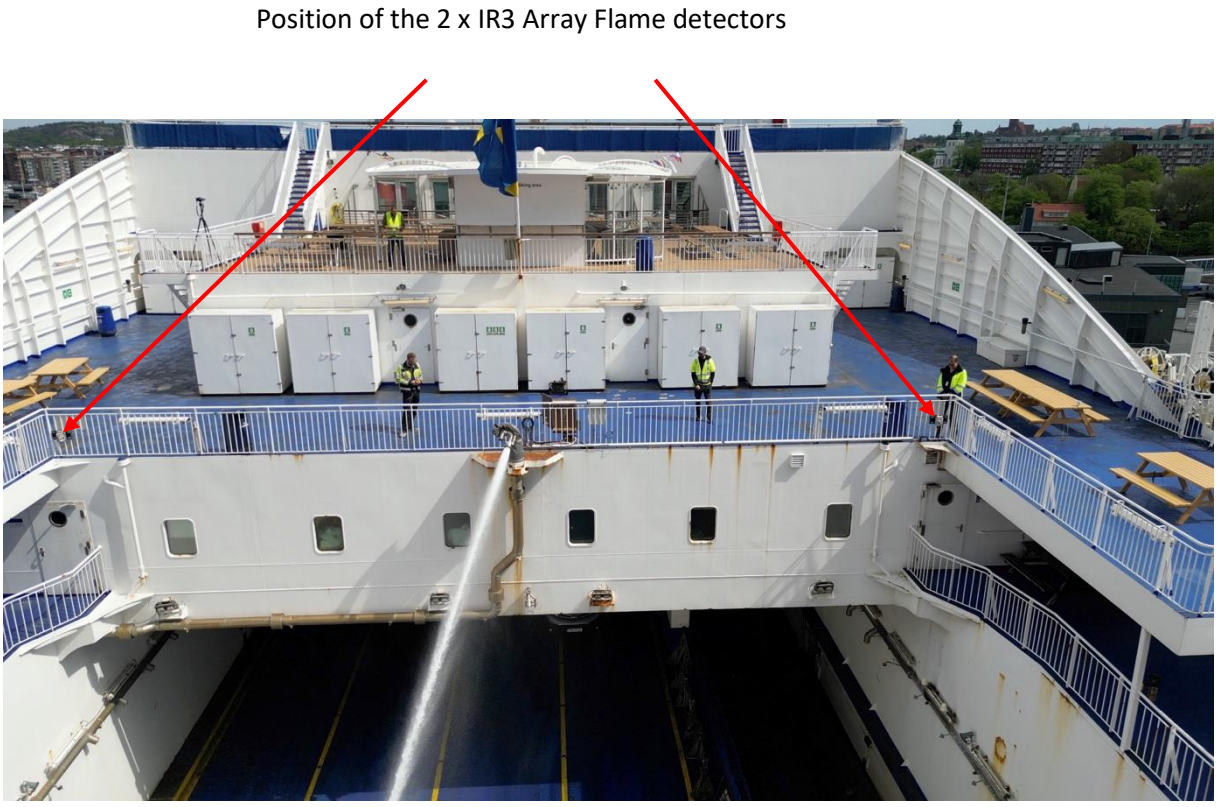

Figure 7. *Autonomous fire monitor suppressing a weather deck fire and showing the position of the system's Force 80 fire monitor and its two IR3 flame detectors.*

Two small propane gas burners were used to generate flames on the open weather deck (refer to Figure 8). Each produced flames with approximate dimensions of 60 cm × 60 cm at the base and a height of 60 cm. A total of twelve (12) separate fire tests were conducted.

In each of the twelve tests, the propane gas burners were placed at separate random positions on the weather deck (refer to Figures 9 and 10), ranging from 15 meters away from the fire monitors, up to 60 meters, which is further than the design recommendations established in the project. The monitor was supplied with a flow of water of 3000 l/min at 6 bars. With a higher flow and pressure, a larger area can be protected by each fire monitor.

Prior to the ignition of the propane gas burners, the autonomous fire monitor system had no information about whether, when or where a fire would be ignited.

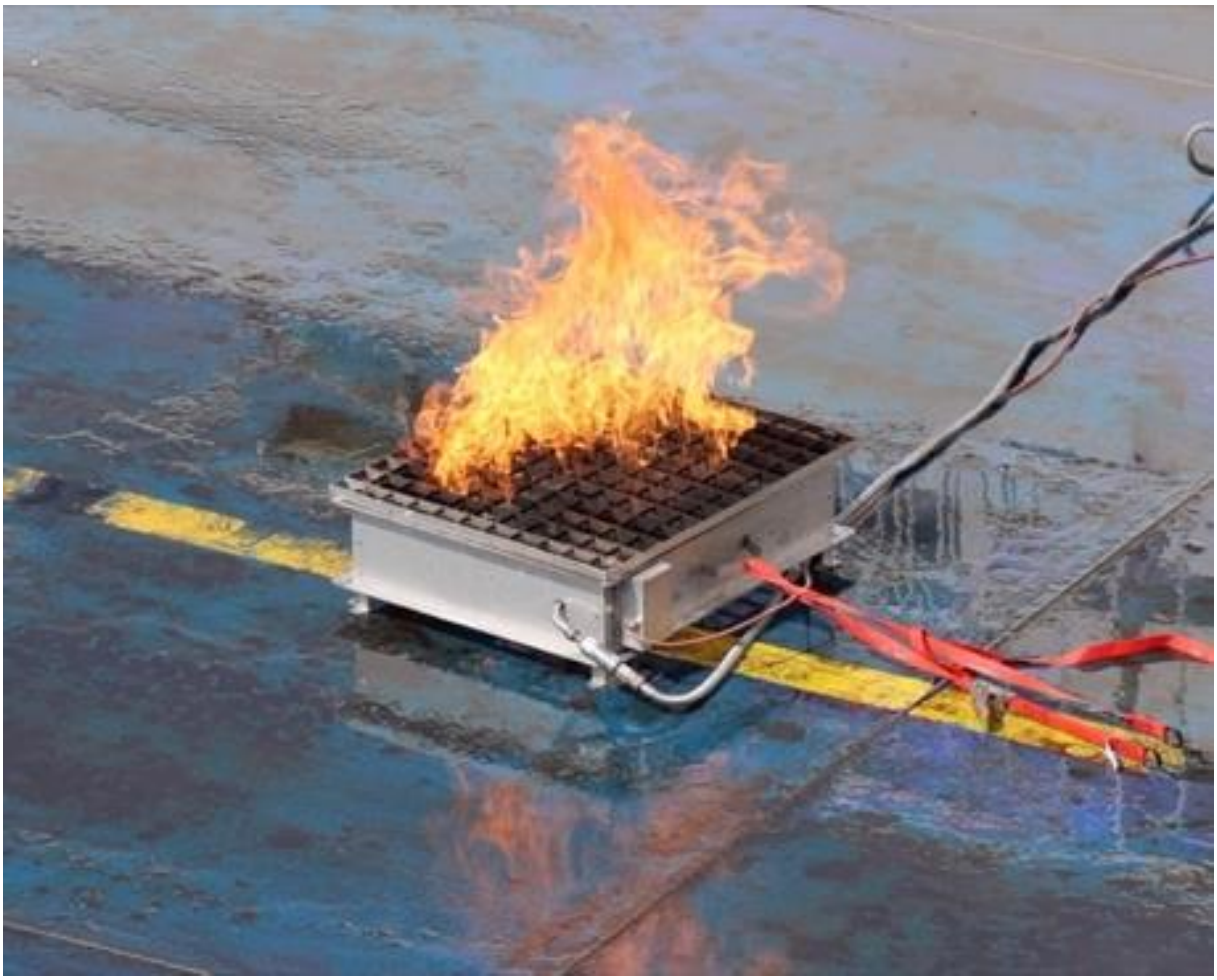

Figure 8. *A close-up photo of one of the two identical propane gas burners used in the demonstration to generate flames on the weather deck.*

Figure 9. *Photo from the perspective of the autonomous fire monitor suppressing one of twelve fires located in twelve random positions on the weather deck during the demonstration onboard the Stena Scandinavica.*

7 Results and observations

Main author of the chapter: Roger James, UNF.

7.1 Fire test results

In each of the twelve demonstration fire tests conducted, the autonomous fire monitor system rapidly and successfully detected the fire and aimed the water stream directly at and around the fire. Moreover, the system extinguished each of the twelve weather deck fires in under 15 seconds from ignition, without any human intervention.

Figure 10. Photo taken during of one of the twelve demonstrations in which the autonomous fire monitor detected, located, and extinguished a propane burner fire onboard the Stena Scandinavica.

7.2 Observations

It was observed that in each of the twelve demonstration fires placed in separate locations onboard the Stena Scandinavica:

- that the autonomous fire monitor system was able to rapidly detect the fire; and
- accurately determine the three-dimensional coordinates of the fire; and
- accurately guide the fire monitor's stream of water to suppress the fire by oscillating over and around the fire; and
- the autonomous fire monitor extinguished each of the fires in less than 15 seconds from the ignition of the propane burners.

8 Discussion

Main author of the chapter: Roger James, UNF.

This document describes the demonstration and testing of a remote controlled and autonomous fire monitor system for the protection of weather decks, as part WP10-B, Task T10.8.

The objectives of Task T10.8 were met, and the demonstration clearly established the effectiveness of the system to rapidly detect fires on a ro-ro weather deck, accurately determine the fires' three-dimensional positions and autonomously and effectively suppress the fires—all without any human intervention, yet with the ability of a human operator to remotely control the fire monitor at any time.

9 Conclusion

Main author of the chapter: Roger James, UNF.

The objectives of the demonstration were to confirm, onboard the Stena Scandinavica, the ability of an autonomous fire monitor system to rapidly detect fires on a ro-ro weather deck, accurately determine the fire's position and autonomously and effectively suppress the fire—all without any human intervention. The findings of this demonstration confirmed that the developed autonomous fire monitor system achieved each of these capabilities in a real-world installation. Furthermore, because the system can also be remote controlled by a human operator, the demonstration also confirms that a remote control fire monitor can also be effective, particularly if the system is rapidly commenced.

The demonstration also confirmed the viability of autonomous fire monitor technology to significantly enhance fire safety on ro-ro weather decks and in other industrial applications. The system's rapid and effective fire detection and suppression capabilities—with all twelve separate, randomly-placed weather deck fires having been extinguished autonomously in less than 15 seconds—clearly establishes the potential to dramatically improve overall fire safety and substantially minimize the risk of fire-related incidents on ro-ro vessel weather decks.

The onboard demonstration of the autonomous fire monitor system was successful and validated the objectives of Action 10-B and Task T10.8. The system's ability to rapidly detect fires, accurately determine their locations, and promptly initiate suppression without human intervention provides a valuable solution for improving fire safety and prevention.

10 Indexes

10.1 Index of figures