4 ELBAS – WP4: Fire Drills and Training

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4.1 Introduction

The objective of this work effort was to examine current fire drills and training methods specifically related to fires on vehicle decks, identify future training needs, and help develop and perform specialized and realistic training for effective firefighting of vehicle deck fires.

4.2 Onboard Fire Drills & Training

The regulations and requirements related to onboard fire drills and for training of crew serving on passenger ships are contained in the International Maritime Organization (IMO)'s Safety of Life at Sea (SOLAS) Convention and in the Seafarers' Training, Certification and Watchkeeping (STCW) Code. SOLAS specifies the requirements for fire drills while the fire training certification requirements are set in the STCW Code.

Figure 4.1: Onboard Fire Drill, including use of special cooling tool and smoke machine

4.2.1 Fire Drills

The SOLAS Convention states the requirements for Fire Drills in *Chapter III – Regulation 19.3.5 Fire Drills* which primarily focuses on checking and testing the readiness of onboard fire response and the firefighting equipment, to develop and maintain the crew's skills as preparation for a real situation.

While the SOLAS regulation specifies that "*Drills shall, as far as practicable, be conducted as if there were an actual emergency*" there are no detailed requirements in SOLAS for how drills shall be set-up. This is left to the responsibility of the individual shipping company to define a drill's contents and set-up through their Safety Management System (SMS) procedure.

In SOLAS, it is only specified that, "*Fire drills should be planned in such a way that due consideration is given to regular practice in the various emergencies that may occur depending on the type of ships and the cargo.*" (SOLAS Ch. III Reg. 19.3.5.1)

4.2.2 Training Requirements

The STCW convention specifies the required training and level of competence in fire prevention and fire fighting for maritime personnel as detained in Chp. 6 Section A-VI/1 -- ***Specification of minimum standard of competence in fire prevention and fire fighting*** and Section A-VI/3 ***Mandatory minimum training in advanced fire fighting***. Specifically, the STCW requirement states the following: - *The type and scale of the fire is promptly identified, and initial actions conform with the emergency procedure and contingency plans for the ship* (STCW section A-VI/3)

Additionally, STCW states requirements to be able to "Prevent*, control and fight fire on board - Ability to organize fire drills, Knowledge of classes and chemistry of fire, Knowledge of fire-fighting systems, Action to be taken in the event of fire, including fires involving oil systems.* "(STCW section A-VI/3)

Through the field work conducted in WP1 of the ELBAS project, several different onboard fire drills were observed. The drills included Emergency Mustering of crew dressed in SCBA firefighters' outfits, which was carried out as per the ship's Emergency Muster List, with a fire scenario of a simulated EV fire on a vehicle deck. The fire drill included the use of a smoke machine to provide the effect of impaired visibility and the seat of the simulated fires were inside of a luggage wagon. In both cases, firefighting teams in full bunker gear entered the vehicle deck to actively fight the simulated fire with charged fire hoses and other equipment. In addition, where practicable reduced lighting and obstacles were used, to simulate realistic conditions during an actual fire (see Figure 4.2.)

Figure 4.2: View during an onboard fire drill using (a) a thermal image camera and (b) regular field of view

The STCW requirement for live firefighting training includes demonstrating the ability to "*fight fire in smoke-filled enclosed spaces wearing self-contained breathing apparatus*". (STCW Table A-VI/1-2) This general training requirement applies to all ship types, including both cargo and passenger ships.

All seafarers are required to complete such regular mandatory fire training courses on shore, including "smoke diving", as well as Fire Team Leader courses for officers. However, there is currently no specific IMO / STCW requirement for specific training related to tackling vehicle deck fires onboard a ferry.

4.2.3 Realism of Shipboard Fire Drills

Shipboard fire drills are generally conducted on an empty deck, without vehicles, due to operational costs and constraints. These training simulations, as seen in Figure 4.3, provide vital response criteria such as firefighter response times, firefighter equipment readiness, fire protection system functionality, detection network responsiveness, and smoke/obscuration conditions during a fire event.

Figure 4.3: Fire drill onboard ship, with the use of smoke machines and charged fire hose lines

These fire drills are of course simulated and only mimic a fire scenario, to limit any hazardous exposure to firefighters, the ship, and the environment. This is accomplished by using a smoke machine rather than an open fire. In a realistic fire scenario, the responding firefighters will be exposed to additional obstacles such as excessive heat and smoke production from the fire, along with a maze of stowed vehicles. The stowed vehicles, shown in Figure 4.4, form narrow aisles of travel through the vehicle deck and present pinch points for the movement of a charged firehose lines.

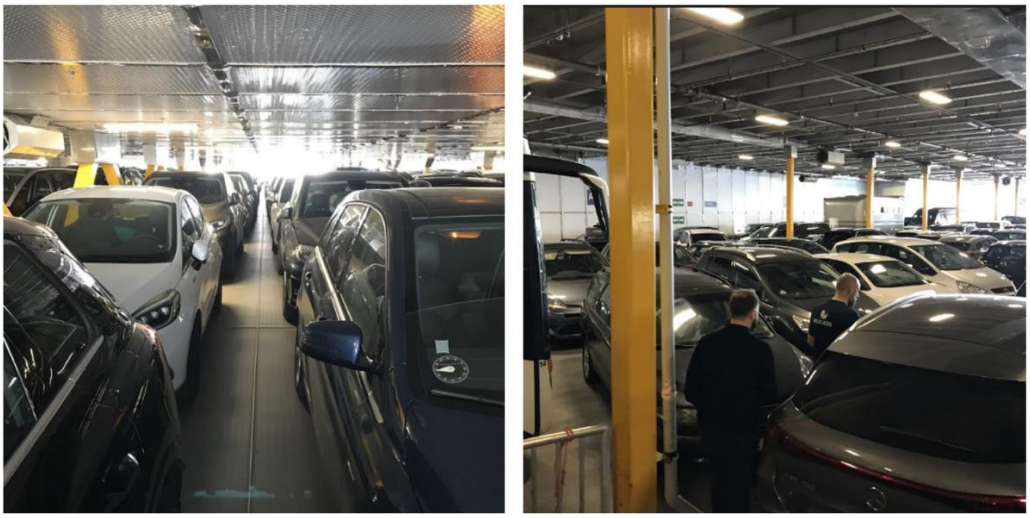

Figure 4.4: Examples of the tightly stowed vehicles on a fully loaded vehicle deck to highlight reduced mobility

4.3 Realistic Fire Training – Simulated Vehicle Deck with Real Cars

Modern vehicles pose newer risks and hazards in case of fire, including airbags exploding, greater use of integrated electronics, and increased use of plastics and fiberglass. This results in an increased formation of HF gases and generally a higher fire load than previous generations of vehicles. While fires in modern cars are rarer, the consequences can be more severe when they occur onboard a ferry, where both space and firefighting resources are limited.

To better address these obstacles, experiments were conducted through the ELBAS Project to simulate a realistic fire scenario aboard a fully loaded vehicle deck. The experimental set-up, shown in Figure 4.5, consisted of nine cars (8 conventional cars surrounding a single electric vehicle) placed within a structure built from ISO 40 ft shipping containers to simulate a vehicle deck. This type of fire testing, detailed in section [31] (WP3: Live Fire Testing), helped to test the applicability of various firefighting tools. Such an experience is not practicable to conduct during the onboard Fire Drills, nor is part of the mandatory STCW shipboard fire training.

Figure 4.5: Specialized Test and Training Set-up simulating a Vehicle Deck

4.3.1 Realistic Fire-training Set-up of a Vehicle Deck

Vehicle decks on ferries are often rather compact with vehicles usually stowed near each other. Furthermore, the ceiling height clearance on vehicle decks can be as low as just over 2 m. Therefore, the use of large fire extinguishing devices, navigation and maneuvering around in between the stowed vehicles can be an additional challenge for this unique environment. Therefore, the usability of these different firefighting techniques within such a confined space must be considered when conducting training and fire drills.

Considering the above challenges, a series of large-scale experiments with live fire performed under the ELBAS project described earlier in WP 3, where different firefighting devices and technologies were then put to test against an EV fire. During the final two days of testing, selected shipboard firefighters were given the opportunity to try out several of these devices and techniques in the experimental set-up, which was designed to represent the conditions and challenges when fighting a fire on a vehicle deck in a ferry at sea.

4.3.2 Simulated Vehicle Deck Set-up

The ELBAS test set-up was constructed at RESC in Slagelse, Denmark, and was designed to simulate the enclosed and compact nature of the vehicle deck. The ELBAS set-up provides simulated and realistic

conditions of a ferry vehicle deck, with the capability to train firefighting on real fires using real cars and inside a similar geometry to that normally found on a full vehicle deck with cars stowed tightly close to each other.

The main structure of the vehicle deck set-up consisted of combining two standard 40-ft ISO shipping containers, connected with steel plating with stowed vehicles inside, see Figure 4.6 and Figure 4.7.

Figure 4.6: Inside the Specialized Test and Training Set-up Simulating a Vehicle Deck

Figure 4.7: Initial Vehicle Fire in the Specialized Test and Training Set-up

4.3.3 Live Fire Training Course – Modern Vehicle Fires on a Vehicle Deck

Based on the experience gained in the ELBAS project a new training course, with focus on crew training of how to extinguish a fire in a modern vehicle on board a ship, has been developed, see Figure 4.8.

Figure 4.8: Realistic Live Fire Training of a Vehicle Deck Fire

This course provides shipboard firefighters with a more realistic training scenario for tackling a modern vehicle fire, such as in an EV, onboard a ship, in a shore-side test set-up resembling a ferry's vehicle deck with live fire using real cars.

Having a specialized fire training course for vehicle deck fires provides both theoretical knowledge and the practical skills, to assess and handle risks and dilemmas associated with extinguishing such fires.

In addition, protective equipment as well as the safe decontamination of emergency personnel is covered, to address the issue of toxic soot and residue on the fireman's outfit, specifically resulting from HF gases which could be released.

A pilot training course was conducted using the specialized test and training set-up, involving representatives from shipboard firefighting organizations including firefighters, see Figure 4.9.

Figure 4.9: Fully developed vehicle fire(s) in the specialized test and training set-up

Feedback received from the ship-based participants of the pilot course held during the ELBAS project, was very positive. The experience gained from training on real burning vehicles in a set-up, which resembles a vehicle deck, was unique and realistic of what might be encountered in a real situation onboard.

4.4 Joint Exercises – Shipboard & Shore Coordinated Response

The criteria listed in STCW (Section A-VI/3 Mandatory minimum training in advanced firefighting, 6.1.1.8) includes the requirement of "*procedures for coordination with shore-based fire fighters*." These procedures typically consist of Point-of-Contact lists and details on available shore-side support, contained in the company's SMS.

However, it is not always the case that full scale joint exercises are regularly held between the ship and shore-side emergency response services, and that in some cases land-based professional firefighters are not fully aware of the specific firefight procedures, training and equipment existing onboard.

In the case of an EV fire onboard, which may be challenging for the ship's officers and crew to tackle alone onboard, an integral planning of a combined response with the assistance of shore-based fire fighters is highly recommended.

Traditionally, perhaps due to political reasons, various agencies have not engaged in such dialog, due to different laws and regulations applicable to each area (maritime vs. shore-based emergency response). Benefit can be had by developing cooperation agreements with external authorities, to ensure holistic contingency planning and coordinate cross-disciplinary exercises with the local emergency services.

Figure 4.10: Onboard Fire drill with use of a smoke machine and charged hose lines

By engaging with local shore-side emergency services, challenges can be identified and addressed, and contingency plans developed to be best prepared for an EV or other fire incident onboard. It would be advisable to invite for knowledge sharing and a preparedness exercise with emergency managers, to help increase awareness of specific shipboard installations, available firefighting equipment and SMS procedures in use onboard. The advantages of involving the local shore-side emergency services in the planning of shipboard emergency response procedures helps ensure the best congruencies when dealing with an EV fire situation, which potentially may develop into a larger incident requiring assistance from shore.

4.5 Conclusions and Recommendations

Fire Drills provide the opportunity to test response times and for the checking of readiness of firefighting equipment and functioning of fire systems onboard. However, such drills may only be of limited value to prepare for a real-life situation of an EV Fire onboard. It is important to perform as realistic training exercises as possible, as this may help to reveal any issues in how specialized firefighting equipment is used.

It is recommended to work with local emergency services and first responders, to transfer and develop existing knowledge of EV-specific firefighting from ashore over to the maritime sector.

Realistic firefighting training of maritime personnel is essential. In general, it is recommended that, based on the observations and experiences from ELBAS project, crew members would benefit from more live fire training or realistic drills involving a fire on a vehicle deck – to experience the difference between a conventional car fire and EV fire, for instance.

Effective drills shall incorporate socio-technical elements combining both human and technical aspects, in order to effectively manage a fire onboard.

When a fire occurs on a vehicle deck, the location of the fire's origin is less critical in the early stage of firefighting. It can be assumed that any fire on the vehicle deck is a battery fire and therefore appropriate precautions shall be taken for such a type of fire.

The following elements are recommended to include in fire training for vehicle deck fires:

- Training on use of **CCTV** as a fire detection and verification of a fire, thus potentially improving response timing to the fire,
- Use of **Sprinkler/ Drencher/ water-mist system** – Training on effect and use strategy during a fire incident
- Proactive use of Smoke management strategy, including active use of ventilation, as part of the decision support tools (CFD).
- Shipboard firefighting theory related to topics such as: smoke toxicity, sprinkler and ventilation zones, ship stability, etc.
- Better understanding of the benefits of using water to dilute toxic smoke and gases.
- Importance of post fire drill **Debrief,** which can be used to address facts surrounding battery fire, toxic gasses, and smoke movement,

EV fires on ferries are not to be feared more than any other fire at sea. They can typically be dealt with using the correct technology, education, and training of shipboard personnel, as well as with coordinated cooperation between the ship and shore-side emergency services.