

Ro-Ro Fires

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Background

Over a 15 year period there were 38 incidents involving fires on vehicle decks of ro-ro ferries reported to the United Kingdom Maritime Accident Investigation Branch (UK MAIB). North has also seen a rise in the number of serious incidents associated with fires that started in the vehicle decks of a vessel.

Vehicle deck fires can escalate quickly and develop to a point where it is difficult to contain or extinguish.

In accordance with Safety of Life at Sea (SOLAS) regulations, defined areas are protected by A60 class bulkheads. The intensity of a vehicle deck fire, however, may evolve rapidly to a state where it can potentially overcome these A60 class bulkheads.

In past incidents, where the fires were able to catch hold quickly or were not successfully tackled, passengers and crew members have been forced to abandon ship. In one particular incident the intensity and location of the fire blocked access to the survival craft. The 31 persons on board, who had mustered in the bridge area, were forced to escape to the forecabin by climbing down fire hoses and lanyards before abandoning ship onto a single 6 man life raft.

Classification of Fires

An analysis of the 38 cases reported to and investigated by the MAIB revealed that the most frequent classification/location of fires on vehicle decks was:

Classification of Fire	Number of reports
Fire in vehicle cab	6
Electrical fire on vehicle	9
Electrical fire on reefer	12
Fire on reefer (other cause)	2
Vehicle engine fire	5
Other cause	4

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Carriage of Vehicles

New vehicles

It is not only used vehicles that have been known to be the source of fires. New vehicles also have the potential to start a fire if shipped in an unsatisfactory or unsafe condition.

New vehicles are usually shipped with their batteries connected and keys in their ignition – potentially allowing electrical circuits to be energised. This coupled with fuel sources such as petrol or debris on decks or in engine bays may provide the conditions for a fire to develop.

Many new vehicles are fitted with a transportation mode which is activated prior to the vehicle's shipment. This mode results in a large number of the internal vehicle's circuits being shut down reducing the likelihood of any unwanted electrical faults.

While there are processes in place for the vehicles to be put into transport mode, it is not uncommon that it does not occur and therefore the vehicles are shipped in a live condition.

It is worth noting, however, that if the battery is connected then the starter motor is permanently live even in the transport mode or with the ignition off.

Used vehicles

There are a number of risks with shipping used vehicles and plant. These risks are increased when they do not have a valid road worthiness certificate or whose history and condition cannot be checked.

Problems are not uncommon with used vehicles when they have spent an extended period of time awaiting shipment in a port area.

The internal electrical connections may suffer significant deterioration as a result of the salt air corrosion. This may affect the electrical systems but also may result in electrical faults such as shorting across electric circuits or the battery.

Parts may seize and seals on fuel/oil systems may perish to the point they allow hazardous fluids to leak.

The insulation of electrical cables in vehicles that have been lying idle for a long time may become brittle, weak and break down. Electrical systems that have been idle and have been reconnected to a charged battery are

more prone to failure. Leaving a key in the stop/park position may offer little defence as many of the circuits may still be live.

There have been numerous cases reported where vehicles contain personal possessions. Subsequent post fire investigations have revealed the contents of the vehicles to include gas canisters, jerry cans, welding equipment or other unusual items which could all be additional fuel or sources of ignition.

Disconnecting the battery and removing the key fully may assist in isolating the circuit and preventing any sparks that may ignite residual flammable material remaining in the vehicle.

Following loading operation, as well as an electrical spark, there may be other ignition sources such as engine heat transfer, discarded cigarette ends or cab heating systems.

Hybrid and electric vehicles

Depending on the make and model of a hybrid or electric vehicle a battery isolation switch may be fitted within the cabin of the vehicle. If fitted then this should only be activated once the vehicle is parked and secured.

Safe stowage and securing

Before being accepted for shipment, every vehicle should be inspected externally by a competent and responsible person or persons to check that it is in satisfactory condition for shipment.

Consideration should also be given to the fact that many second hand vehicles may be transported on top of or within other second hand vehicles. These vehicles, carried as cargo, should be subject to the same rigorous checks as other vehicles being shipped.

All vehicles should be suitable for securing to the ship in accordance with the ship's approved Cargo Securing Manual.

Any labels, placards and marks that would indicate the carriage of dangerous goods should be properly displayed. Crew members should be aware of the hazardous units as detailed on the stowage plan and should be vigilant against the carriage of undeclared dangerous goods.

Any vehicle, whether of new or used, should be secured to prevent movement. Contact between vehicles during a voyage may damage them to the extent of rupturing fuel tanks or damaging electrical systems.

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Fig 1: Vehicles securely lashed



Fig 2: Lashing should be suitable for vehicle type and weight

Vehicles should, so far as possible, be aligned in a fore and aft direction. They should not be parked on permanent walkways or in such a way as to obstruct fire-fighting equipment or scuppers.

If water spray fire curtains are installed then vehicles should not be parked across them.

The parking brake of each vehicle or each element of a vehicle, where provided should be applied and the vehicle should, where possible, be left in gear.

If the vehicle is equipped with a battery disconnection switch, it has to be activated once the vehicle has been parked in position on board of the vessel.

When the vehicle is fitted with an electronic holding device then this should be applied prior to disconnection of battery.

If there is any doubt as to the suitability of the parking brake then the vehicle should be secured with the assumption that the parking brake may fail or not engaged fully.



Fig 3: Well maintained and organised lashing equipment

Pre-departure checks for the carriage of vehicles

A well-documented pre-loading/acceptance procedure should cover basic checks for the carriage of new and used vehicles. This may include, but not be limited to:

- Ignition switched off and the key removed to an agreed location. Consideration should be given to keeping the keys inside the vehicle in a visible place to avoid the potential of delays resulting from the loss of key
- Disconnection of all battery cables

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- Isolation of battery terminals
- Inspection of battery for visible signs of damage
- Prohibiting the carriage of spare/excess fuels or flammable liquids
- Checking the integrity of seals and pipelines in order to ensure there are no visible leaks - are there visible signs of leaking oils or fuels? Is the engine bay lagging oil soaked? Is the engine bay relatively clean?
- Checking interior to ensure that flammable material such as oily rags spare fuel, undeclared chemicals etc. aren't stored inside a vehicle.

Fire-Detection and Fire-Fighting

Reaction

As in every incident where fires are involved, early detection and extinction is key. Modern day fire-detection systems are capable of identifying the location of smoke/fire to a reasonable degree of accuracy.

It is not uncommon however, where the OOW has not accepted the credibility of an alarm, for the system to be re-set or silenced. In one particular case an MAIB report revealed that during a 7 minute period 16 different sensors went into alarm, activating a combined total of 81 times. The system was silenced 11 times and reset 7 times by both the duty engineer in the engine control room and the duty officer on the bridge. Although both officers had a basic understanding of the fire-detection system from their familiarisation training, the system was not routinely used as part of the fire drills, and the alarm was normally activated only during maintenance or testing. Failure to act quickly and effectively can often allow time for a fire to take hold to an extent where it becomes increasingly difficult to tackle.

A fire-detection system is a critical item of equipment on board all vessels. It is important that it is maintained in a reliable condition. The use of it should be incorporated into drills so that crew members can become familiar with its operation and become confident in interpreting the alarms.

It is vitally important that alarms are treated seriously and the appropriate action taken to establish the current condition of the space where the alarms have been activated. This may involve the use of CCTV equipment or

sending someone to go to the area to investigate further. Whilst the use of a lookout offers a valuable first hand onsite appraisal it has a number of limitations that should be understood, amongst those are:

- The time taken to get onsite, especially on large vessels, may add considerable time to a first response for fighting any potential fire
- You may be placing the lookout in a potentially dangerous situation where they may be overcome by smoke or heat
- It is essential that if using a lookout then they are briefed about the situation and equipped with functioning two way communications with the OOW.

Activation of numerous detectors heads, unexplained electrical faults or a smell of smoke in the accommodation should be enough to convince the OOW that a problem may exist that warrants the vessel's emergency response plans to be initiated. **If in doubt – act.**



Fig 4: CCTV remote monitoring

Confinement and ventilation

The ability to contain/confine a fire and close down the ventilation system of a vessel's vehicle deck is an important initial step in fighting any fire. Ensuring a compartment is fully closed prior to introducing your fire-fighting medium will prevent any flow of fresh air into the space and ensure, if available and used, any charge of CO₂ remains within the space intended. Although CO₂ is heavier than air, over time it will dissipate through any open ventilators. In general the more effectively a cargo space can be sealed the better chance the vessel will have of containing and extinguishing a fire.

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A recent MAIB report revealed that there was some confusion amongst a vessel's crew on how to fully lock the ventilation housing louvres into a "closed" position. Not all crew were aware of the exact procedure to lock these louvres closed or that the task required a minimum of two people.

Failure to correctly lock the louvers closed resulted in a small 1.5cm gap between the louvre and the housing face, which initially may not seem like a significant opening. However, the combined consequence of all the ventilation housings having this clearance was equivalent to an open area of 5m² - which is a significant area for CO₂ to escape or fresh air to be drawn in.

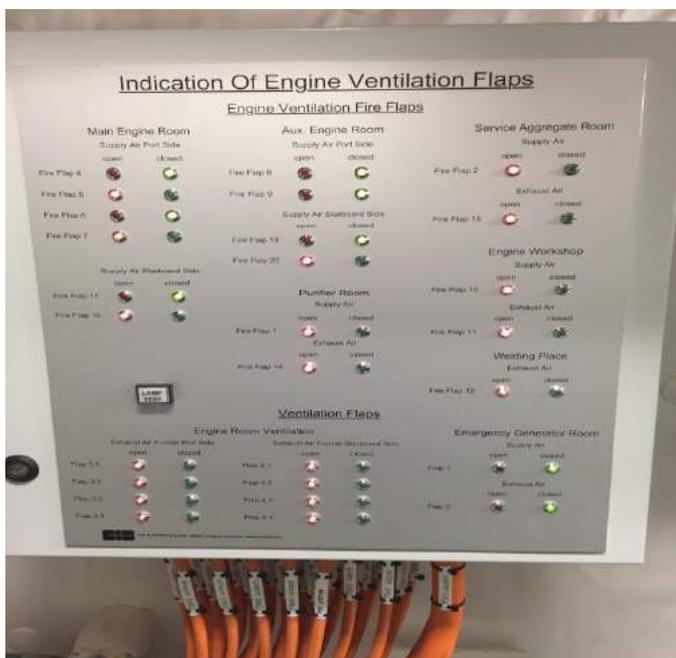


Fig 5: Remote ventilation flap indicators

Some interesting points that may be worth considering and incorporating into drills on board your vessel are:

- Does the vessel's training manual highlight how to close ventilation houses fully?
- Are ventilator housings marked as to which space they serve?
- Do the crew know which ventilators are automatic and which require a manual intervention?
- Are adequate personnel assigned to closing ventilators during a drill?
- Is there a positive check made on all ventilators to ensure a good seal is made?
- Is the operation of the ventilators regularly checked and confirmed?

Boundary cooling

Boundary cooling plays a key part in controlling the spread of a fire to any adjoining spaces and forms a vital part of the overall effort to ensure there is no re-ignition after initial fire-fighting efforts.

Bulkhead and deck temperatures should be monitored and boundary cooling should be maintained until such time as there is a notable decrease in temperatures. Regular checks should also be carried out after this to monitor for any potential re-ignition.



Fig 6: Fire drill - boundary cooling

Problems Associated with Fighting a Fire

In order to remain commercially viable it is not uncommon for ships to carry as many cargo units as possible. At the time of writing there is no legal minimum distance required between vehicles or trailers which may be parked as little as 150mm apart.

This close stowage of cargo units, coupled with the large open areas involved due to lack of subdivision, may lead to a rapid growth of fire and can reduce the effectiveness of a vessel using a water drenching system.

An additional obstacle associated with such tightly packed units is the difficulty in fighting a fire manually. It can be difficult enough to move between units in normal work PPE but the addition of a bulky fire protection suit and SCBA may make moving through a vehicle deck space and tackling the fire manually almost impossible. Reduced

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visibility due to smoke and the presence of lashing or obstacles at low level pose a real tripping danger to those attempting to fight the fire.

If a vessel's water drenching system is operated effectively at an early stage, then the quantity of water being deployed should be sufficient to prevent significant spread between units over the width of the deck.

As vessels use sea water in their drenching systems, problems may develop if the pipes and heads have not been rinsed out, with fresh water, after testing. Heads and pipes may become blocked and the system may not work as planned in the event of an emergency.

This breakdown in an essential system coupled with the proximity of vehicles can then lead to a situation where a fire can spread rapidly from trailer to trailer through an undivided space such as a vehicle deck.

CO₂ systems may be considered as a more effective fire-fighting medium but are not suitable for special category spaces or open vehicle spaces and have limited effectiveness in boundary cooling.

It is unlikely that sufficient CO₂ will be available for every vehicle deck space on board. It is also unlikely that there will be sufficient CO₂ to allow for multiple attempts to extinguish a fire following an initial release and subsequent re-ignition. In light of this careful assessment must be made before entry is considered or ventilation resumed after any fire.

It is not uncommon for a space to be opened or ventilated when it is believed the fire is extinguished. However, opening or ventilating a space before the space and fuel contained within it has cooled sufficiently, can allow the CO₂ to escape and oxygen to get into the space. This can allow the fire to redevelop with no CO₂ remaining to deal with subsequent redevelopment.

After the initial fire there may be a great deal of damage to both the ship structure and cargo units. There may also be flammable fluids, electrical connections and other sources of ignition present along with fuel that may have leaked from tanks. Therefore the chances of a secondary fire occurring is significantly higher.



Fig 7: Drenching system flushing valve

Vessel stability

A very serious secondary danger exists when fighting a vehicle deck fire by means of a water drenching system. The consequence may be as serious as the initial fire - loss of stability due to a free surface effect caused by a build-up of water over a large area.

There have been a number of documented incidents where the vessel's stability had been adversely affected by the introduction of free water on an open deck, such as a vehicle deck. This has been exacerbated when water is unable to drain through deck drains due to items that have been flushed out of cargo units.

SOLAS highlights the potential serious loss of stability which could arise due to large quantities of water accumulating on the vehicle decks during the operation of the water spraying system.

For closed vehicle and ro-ro spaces and special category spaces, where fixed water-spraying systems are fitted, effective measures should be in place to ensure floating debris does not block drains in spaces: An IMO circular ([MSC.1/Circ.1320](#)) recommended that an easily removable screen or grating may be installed over each

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drain, raised above the deck or installed at an angle to prevent large objects from blocking the drain.

If the vessel's water drenching system is activated, a close check must be made on the over side discharge and the angle of list of the vessel. If a noticeable decline in the amount of water being discharged through the overboard drains is noticed in combination with the listing of the vessel then consideration should be given to stopping the drenching system until the vessel is brought upright.



Fig 8: Vehicle deck drain

If the drenching system is stopped for any length of time then careful checks should be made on surrounding decks and bulkheads for any rise in temperature.

What Can Be Done?

Housekeeping

Ensure vehicle decks are free from clutter or items that may block drainage system if a drenching system is activated. If movable screens are fitted then check regularly that they are all in place and that they are fit for purpose i.e. to prevent drains being blocked by floating debris.

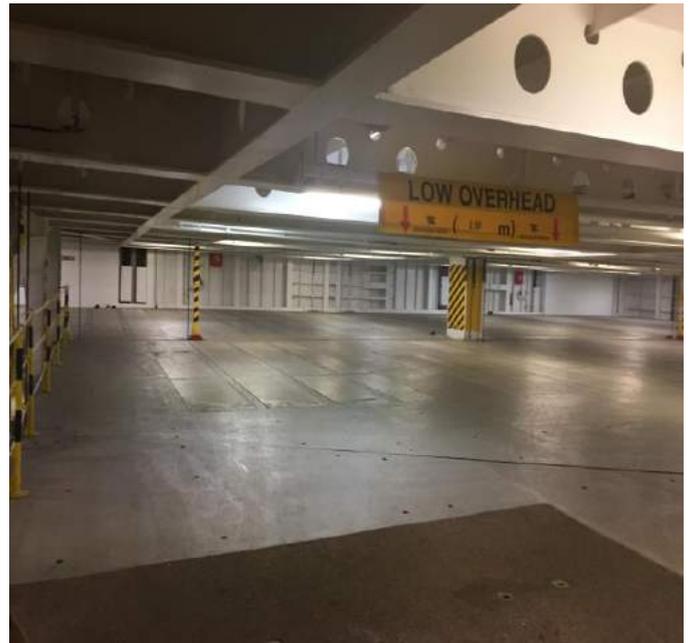


Fig 9: Clear deck

Smoking and naked flames should not be permitted on any vehicle decks. Conspicuous "no smoking" or "no smoking/naked lights" signs should be displayed.



Fig 10: Car deck one separation with no smoking signs

There should be no unauthorised persons on the vehicle decks at any time, and there should be no entry to vehicle decks when the vessel is at sea, unless specifically permitted.

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Familiarity

All personnel should be familiar with the vessels fire-detection system and all alarms should be treated seriously and assumed to be real until they are verified as false.

The crew should also be familiar with the operation of the fixed fire-fighting system. The time to find out how the system is operated correctly is not in an emergency situation.



Fig 11: Drencher system valve labelling (colour coded)

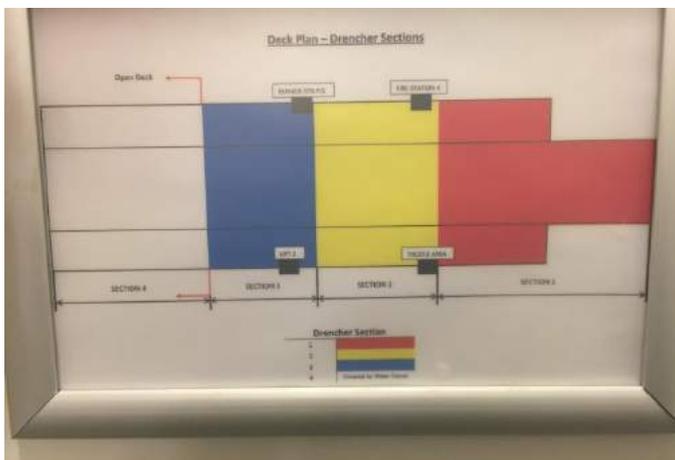


Fig 12: Colour coded car deck drencher sections

Training

Early detection and an appropriate response are vital to a successful outcome. Well planned drills and training exercises that cover a full range of scenarios and situations are valuable in ensuring crew members are

aware of their responsibilities and will ensure familiarity with all equipment on board.

Drills should be as realistic as possible and various scenarios should be allowed to play out from detection onwards and cover both successful outcomes and non-successful scenarios.

A debrief at the end of the exercise is a very useful tool to gauge feedback not only from the officer in charge but those crew members who actually took part. Learning points from these drills/debriefs should be documented and incorporated into the next scheduled drill.

In order to be best prepared for any emergency situation it is important that crew members are fully aware of the location and use of all critical safety equipment on board the vessel.



Fig 13: Portable fire-fighting equipment

This should not be limited to familiarity with Self Contained Breathing Apparatus (SCBA) but should also include training in items such as:

- Type and location of emergency ventilation shut down
- Location of and operation of quick closing valves pump stops and electrical isolation boards
- The operation and the location of portable fire-fighting equipment both in and near the vehicle deck areas
- Escape routes and emergency exits
- Re-entry procedures and checks

Crew members should be trained and confident in the use of fixed fire-fighting equipment such as CO₂ or water

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drenching systems. Training should incorporate items such as:

- Particular zone characteristics, such as volume of spaces and time taken to flood each space if using CO₂
- Location of drain valves on the vehicle decks and the location of their overboard discharge
- Location and use of emergency ventilation stops
- Valve operation, including sequence of operation in order to isolate a particular zone
- Alarms and mustering procedures

The importance of boundary cooling cannot be ignored and in order for boundary cooling to be effective, the crew must fully understand the layout of the vessel and where boundary cooling should be applied to prevent the fire spreading to adjoining spaces.



Fig 14: Fire drill - boundary cooling

Planned maintenance

A planned maintenance system should cover all items that are associated with cargo units and fire protection including power leads, plugs, connectors and fire-detection and extinguishing systems.

In one particular example highlighted by the MAIB, a fire started because of overheating in a reefer cable plug connected to a trailer. This was due to an insulation breakdown fault. Sustained heating, over a period of at least 7 hours, led to a temperature rise to over 900°C - sufficient to melt the cable core and start a fire. A robust planned maintenance system should help in identifying faults in equipment such as this.

Ensure any power cables or leads are suitable for the task they are being used for – the rating of the power supply lead for a reefer unit should be as required by manufacturer's recommendations.

Check the condition of electrical protection devices to ensure they activate at an appropriate level.

Carry out regular checks of refrigerated trailers powered by ship's electrical systems to provide early warning of any overheating, these checks should include:

- Identification of loose connections
- Is there any visible wire or cracks/cuts in the cables?
- Looking for any cable/connectors that are hot, consideration may be given to using a hand held infrared heat detector to look for hotspots
- Investigation of any earth faults – any earth fault alarms should be treated as seriously as any other alarm
- Are there any suspicious smells? Burning plastics and fuels have a very distinct smell.

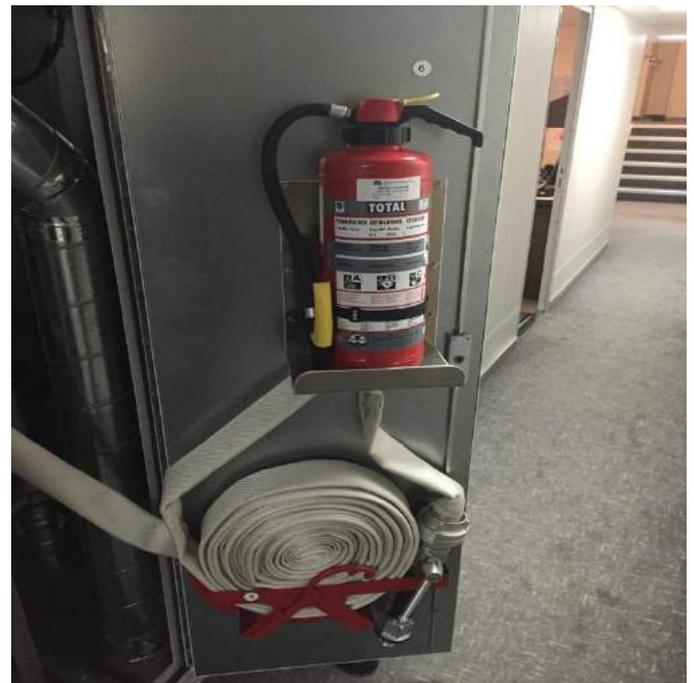


Fig 15: Planned maintenance should include both fixed and portable equipment

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Summary

Training

- Be familiar with location and operation of all fire-fighting equipment – both fixed and portable.
- Ensure crew are familiar with layout of vessel, where deck boundaries are and where fire zones extend too.
- Practice regular realistic drills – learn from incidents experienced in drills.

Maintenance

- Check all fire-fighting systems regularly including both fixed and portable.
- Regular testing of any drencher systems where fitted and cleaning of system pipes and heads following any tests.
- Check ventilation systems – ensure system operates effectively and closes correctly.

Vigilance

- Ensure crew are vigilant at all times. This includes during loading operations and during routine rounds of cargo spaces.
- Be on the lookout for loose debris on deck and inside vehicles.

Reaction

- React to any suspicious burning smells and oil leaks.
- Treat alarms as real until proven otherwise.
- Early detection and extinction is vital.

Procedures

- Have systems in place for isolating batteries and removing keys.