To improve the possibility of a safe firefighting operation in ro-ro spaces, it is important to know how to assess the risks with alternative fuel vehicles.

This quick guide is intended to increase the knowledge of risks related to fires in alternative fuel vehicles (AFVs) on board ro-ro ships. AFVs include gas vehicles such as biogas/CNG, LNG, H, or LH, and electric vehicles (EVs). The information is based on the results from the research project BREND 2.0, which focused on risks with gas vehicles and EVs in relation to firefighting operations.

Alternative fuel vehicles

Available statistics today suggests that the likelihood of fires in AFVs is lower than for conventional vehicles. Both battery and gas vehicles are equipped with a range of safety systems, intended to protect them from fires.

Toxic gases are found in combustion products for all type of vehicle fires. EV fires result in higher emission of hydrogen fluoride (HF), compared to internal combustion engine vehicles on fire. HF is very dangerous to inhale, but studies outside BREND 2.0 have shown that the risk for a potential skin uptake of HF is low. It is unlikely that adverse health effects are caused during smoke diving from HF for firefighters wearing standard personal protection equipment.

Gas tanks containing compressed biogas or hydrogen are equipped with a temperature-activated pressure relief device (TPRD) that should release the gas in case of fire. Based on experiments it is concluded that a local fire exposure for more than 15 min, on the gas tank, can result in a pressure vessel explosion. But such situations are rare since a vehicle fire normally develops in a way that activates the TPRD. It is also found that application with water further lowers the risk of a pressure vessel explosion since the tank then is cooled, and thus protected.

Protective equipment and training

Research on the possible consequences of fires in electric and gas vehicles indicate that fire suits, approved according to EN 469 level 2 (together with gloves, boots, flash hood, long-sleeved undergarments, and BA), provide a good protection against heat flux, temperature, and fire gases.

For a fast and efficient response, ambitious training routines are necessary. Not only the manual intervention needs to be trained, also the activation of fixed firefighting systems (FFFS) can be an issue causing concern by the crew. A combination of both announced and unannounced drills are useful. If the crew is often waiting by their assigned mustering location when the fire drill start, occasionally unannounced drills can be a useful addition to the training routines. Consider the crew’s maturity when deciding if and how to carry out this type of drill.
FIRES IN AFVs – TACTICAL RECOMMENDATIONS

Cooling of energy storage and quick extinguishment of vehicle fires lowers the risk of pressure vessel explosion, jet flames, and thermal runaway. However, different ships mean different preconditions: Is there a fixed firefighting system available? What is the size of the fire team? What personal protection equipment (PPE) is available? How well-trained and confident is the crew? These are questions to consider when training and structuring the fire intervention. Depending on the preconditions for manual intervention and continuous risk assessment of the situation a defensive or offensive tactic can be taken.

1. INITIAL FIRE STAGE

Stay out of the smoke plume and, if possible to do so safely, try to extinguish the fire while it is small, for example with hand-held fire extinguishers. Most likely there is no battery fire and no risk for pressure vessel explosion at this stage.

2. ACTIVATE FIREFIGHTING SYSTEM

If the initial fire cannot be extinguished, a deluge system should be activated (if available). This could be part of a defensive tactic where the fire is controlled using the deluge system. Then the crew can stay out of the ro-ro space until the fire burns out and any high-pressure compressed gas tanks have time to cool down. Monitor temperature evolution (e.g., at deck above fire or with temperature sensors) to verify that the fire is being controlled or extinguished.

3. FIRE TEAM INTERVENTION

With an offensive tactic, initially, the AFV fire can be extinguished as a standard vehicle fire. Traction battery will take long time to become involved and gas tanks are designed with a margin of safety in case of a fire. If possible, cool the energy storage (including traction battery and gas tanks).

As soon as compressed gas tanks are being cooled or not affected by any fire, they regain a margin of safety against a pressure vessel explosion.

If there are jet flames from the traction battery (below vehicle) or jet flames from gas tank’s TPRDs the focus should be to cool the surrounding, prevent fire spread and try to extinguish seat of the fire. If possible and safe to do so, let the jet flame burn out.

4. POST EXTINGUISHMENT

EVs: Monitor the temperature and possible gas development for traction batteries that have been exposed to fire. Preventive suppression equipment should be ready to swiftly control a re-ignition.

Gas: Allow fire exposed gas tanks to cool down before the vehicle is approached. Gas tanks will regain their strength, but composite material may leak – smell, listen or use a gas detector to verify. Monitor cryogenic gas storages (LNG, LH₂) in case insulation is lost (boil-off risk). However minor gas leakage should not be an issue in large or well-ventilated ro-ro spaces.

USEFUL LINKS

- BREND 2.0 report
- Safe and Suitable Firefighting report & quick guide
- International Association of Fire and Rescue Services
- MSB: Healthy firefighters: the Skellefteå Model
- MSB: Literature about Lithium batteries (Swedish)