Electric Vehicles on Dedicated Shipping Vessels

Risk Analysis:

Vehicles are usually shipped on vessels dedicated to carrying vehicles, e.g. roll-on/roll-off (RO/RO) vessels, pure car carriers (PCCs) or pure car/truck carriers (PC/TCs). The operation of these vessels relies on relatively quick loading/unloading operations. Thousands of vehicles with minimal space between them can line multiple enclosed low-ceiling decks. While this stowage arrangement facilitates economies of scale for the operator, it presents significant challenges in detecting, accessing, fighting, and controlling the spread of a vehicle fire at sea. This is particularly true when considering the typical rudimentary fire detection and fighting options available to a crew of such vessels. The growing amount of plastic and the introduction of electric vehicles (EVs) and their lithium batteries has become an increased firefighting challenge. As a result, experience shows that such fires can lead to huge physical, financial, and environmental damage. For example, the "Felicity Ace" vessel carrying 3965 Volkswagens, Porsches, Bentleys and Lamborghinis recently caught fire while crossing the Atlantic Ocean and ultimately sank. It is unclear where the fire originated however, lithium batteries in the electric vehicles (EVs) are thought to have contributed to fire perpetuation. The complexity of the fire required special fire-fighting authorities.[1] Total value of contents lost has been estimated at over USD $425M. [2]

In recent years, there has been a rapid increase in the demand for EV's and so a greater number are now being shipped around the world on vessels as captioned above. The majority of these modern EVs are powered by lithium ion (Li-ion) battery technology. The United Nations has developed guidance on the transportation of Dangerous Goods (DG) (see our MLCE bulletin: *Containerized Lithium Battery Shipments*). Li-ion EVs are categorized as Class 9 '*miscellaneous dangerous substances and articles*' with various special provisions.[3] These provisions cover testing, proper securing, protection, and what to do when there are signs of battery leakage or damage. However, the regulation has been outpaced by the advancements in technology and does not account for variations in Li-Ion EV design. There can be a divergence between manufacturers of Li-ion cells that are aggregated to form the EV batteries, including variation in quality of the cells, the protective casing, power control software and connectors. The implication is one of increased safety risk during transport.

Transporting EVs can be risky for other reasons too.

- Voltage and temperature are two factors controlling the battery reactions. The external environment (which controls the temperature, voltage, and electrochemical reactions) is the leading cause of internal disturbances in batteries. Thus, the environment in which the battery operates plays a significant role in battery safety.[4]
- The EV batteries can short-circuit if damaged, overheat and create a chain reaction known as "thermal runaway," a cascading effect in which they reach very high temperatures and emit smoke and toxic gasses that can further fuel fire and explosion, especially when stored closely with other lithium batteries (e.g. tightly packed EVs)
- Large amounts of plastic used in the EV design increases the combustible load of the vehicle (contributes to a more intense fire)
- Should a fire occur, EVs can contribute up to 2 times more energy than internal combustion engine (ICE) vehicles and spread much faster across EVs

This is a particular risk if the batteries are improperly packaged, poorly manufactured, untested, defective, contaminated, or subjected to shock/impact or physical damage. The degree of risk is also inherent to the state of charge (SoC), since this determines the overall available initial energy within the battery. Moreover, thermal runaway may occur more quickly at higher SoCs giving even less time for the crew to attempt to manage a fire on board. This is a new technology introduced into the logistic supply chain, as such it presents new challenges for ship staff. These battery fires have become more prevalent and extreme, but vessel design and firefighting standards have not yet been adapted to address the new exposures, which puts the crew of (ocean) vessels in difficult situations when there is a fire.

Considerations for safe transportation:

1. Ensure cargo is certified safe for transport in accordance with the UN Manual of Tests and Criteria and appropriately declared under the correct UN carrier number. This is the responsibility of the shipper[2]. Failure to do so could create a significant liability if a major loss is determined to have been caused by their product.

2. Ensure an organization Dangerous Goods (DG) Specialist has been nominated who has completed the required training and qualifications with responsibility for correct declaration of the EVs being shipped.

3. Verify accompanying shipment documentation and request evidence of appropriate UN testing for battery technology with evidence that all have passed manufacturers quality assurance criteria.

4. Conduct pre-shipment surveys to verify visible condition and SoC's of EVs being shipped.

5. Prior to shipment, measure battery temperatures, e.g. with infra-red thermometers, comparing and confirming the temperature remains similar to ambient conditions. Although installed batteries may be inaccessible, indicative temperatures may be taken from the immediate area surrounding the battery. If recorded temperatures are +5°C greater than ambient, ensure the vehicle is not loaded on to the carrier.

6. If a battery has been found to be heating, visibly damaged, mis-handled, impacted, or dropped, a quality control evaluation should be made before approval for reloading. Note, these products may now present an increased safety risk and must meet any special requirements for defective, damaged, waste or recycling.

7. Ship Li-ion EVs with a maximum 50% SoC where possible. Many new EVs are presented for shipment with 75-100% SoC's. In such instances, notify your broker or AIG underwriter.

8. Pay greater attention if shipping EVs with batteries of on older standing. Older batteries may have reached their end of life due to many charging cycles, potentially exposure to heat and shocks. Hence potentially consider that same can be unfit for transport in confined spaces such as on vessel car decks, trains and trucks.

9. Do not charge Li-ion EVs on board a vessel at any time.

10. Stow all EVs away from external heat sources, external moisture sources, and other hazardous cargo and properly secured to minimize the risk of shifting or movement during the voyage.

11. Focus vessel selection on modern dedicated vehicle carriers with no recent deficiencies relating to firefighting equipment, fire drills and/or emergency procedures. Ideally selected vessels should be equipped with a functioning early detection or air sampling type fire monitoring system in cargo spaces.

12. Work with cargo handling personnel and logistics partners to educate them on the Li-ion safety risks and the importance of careful EV handling during staging and loading/unloading.

For further information, please contact your local Marine Loss Control Engineer.

1. Felicity Ace Fire is Out But Why Do Car Carriers Have So Much Trouble? https://www.autoweek.com/news/industry-news/a39181217/felicity-ace-ship-fire-is-out-but-why-do-car-carriers-have-such-trouble/
2. Multiple reports on the values can be found at https://gcaptain.com/around-400-million-worth-of-cars-could-be-lost-in-felicity-ace-fire/ and https://www.reinsurancene.ws/burning-car-carrier-felicity-ace-could-be-500m-cargo-loss-says-skytek/ and https://www.autoweek.com/news/industry-news/a39652509/felicity-ace-manifest-list/
3. https://unece.org/transport/dangerous-goods
4. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1027876/Draft_MGN_653_Electric_Vehicles_Onboard_Passenger_Ro-Ro_Ferries.docx.pdf
5. https://www.sciencedirect.com/science/article/pii/S2095495620307075 A review of lithium-ion battery safety concerns: The issues, strategies, and testing standards, August 2021

MLCE 05/17/2022