Carriage of Electric Vehicles (EVs) in Containers

Introduction

As the world becomes more socially aware of climate change and global warming people are reassessing their approach to a growing number of everyday commodities. One such commodity is the Electric Vehicle which, in many parts of the world, is now being adopted as an eco-friendly alternative to the more traditional, conventionally fuelled vehicle. Throughout the world people are adjusting their purchasing habits in support of this worthy cause.

In evidence of this growing trend to prevent global warming the Club has received a number of enquiries on the carriage of Electric Vehicles (EVs) in containers.

This document is intended to provide guidance on information gathering that should be considered when undertaking due diligence and risk assessment in consideration of carrying EV's in containers on container vessels.

Considerations

The vessel's Master has an obligation to ensure the safety of the vessel, all those onboard, the cargo and the marine environment. Shipowners' obligations extend to the provision of a seaworthy ship and ensuring the safe carriage of cargo through to its delivery at the discharge port.

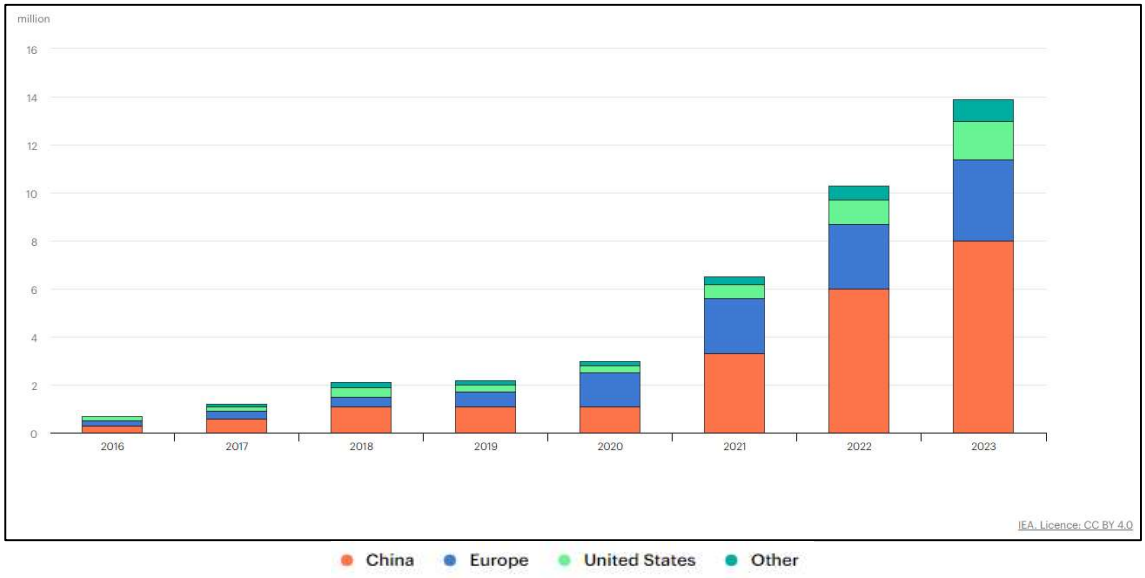
It should be recognised that while the shipowner relies upon the shippers for providing an accurate cargo declaration, shipowners are also expected to undertake their own due diligence in ensuring the safety of their vessels and all those aboard.

New types of cargo and novel ways of carrying these may present new risks. These risks should always be properly identified, evaluated, and mitigated to being as low as reasonably possible. This is particularly important where there are concerns that these risks may not be adequately addressed through existing regulatory standards and industry guidelines. On these occasions it may be necessary for the carriers to consider implementing additional safety measures and checks to mitigate against identified risks until such time as further information, knowledge, experience, statistical data or preventive measures are available to support re-evaluation of these risks.

Increasing Global Demand (increased shipments)

EV markets are seeing exponential growth with sales **exceeding 10 million in 2022** and Market trends and policy efforts in major car markets support a bright outlook for future EVs sales per IEA report.

As demand for EV's grows, so will the requirement for transportation by sea – which will consequently have an impact on the risk exposure of the shipowners.



Source: IEA analysis based on EV Volumes - https://www.iea.org/data-and-statistics/charts/electric-car-sales-2016-2023

Hazards and Carriage Limitations

The International Maritime Dangerous Goods (IMDG) Code classifies an EV under battery powered vehicles or battery powered equipment as UN no. 3171.

Shipping EVs in containers will require particular attention to the inherent risks of Lithium Ion (Li-ion) batteries and those due to the onboard stowage location and proximity of other cargo (including IMDG) or equipment on board.

A fire onboard a container ship can have catastrophic outcomes, endangering safety of life, causing serious environmental pollution and resulting in significant financial losses.

Inherent Risks with Li-ion Batteries

EVs are usually built with a pack of high-capacity Li-ion batteries, usually located in the bottom of the EV, and present some significant risks, many of which are not apparent, or readily identifiable, particularly when shipped in containers. Major risks associated with the EVs are –

1. **Thermal runaway** – is an exothermic reaction which usually originates from a single cell of a damaged Li-ion battery. A chemical reaction is initiated in the damaged cell that results in the production of toxic gases, so-called "**off-gases",** and the generation of "**heat"** inside the cell. The heat produced is more than the amount that can normally be vented and therefore this eventually results in damage to the electrolyte barrier. The battery consequently short-circuits and a thermal propagation result which spreads to adjacent cells, thereby creating a chain reaction that sets off a rapid self-heating fire that can cause an explosion and the release of toxic gases. There is no known solution to stop this thermal runaway process once it has started.

2. **Fire Risk** – EVs batteries may catch fire due to external factors such as **exposure to high temperatures, short-circuits, for example due to getting wet, or mechanical damage**.

3. **Leaks and Chemical Exposure** – damaged batteries could leak **hazardous chemicals** (corrosive or toxic), posing risks to the ship, seafarers and other cargo.

Considerations for Loading and Stowage of EV's in a Shipping Container

1. **Inconsistent Enforcement** – Container shipping is a multi-modal transportation activity which already presents a global challenge due to inconsistencies in the implementation and enforcement of national and international regulatory requirements and safety controls. EVs have been assigned UN No. 3171 under the IMDG Code and, whilst there is regulation and guidance currently available for the carriage of EV's and Li-On batteries in containers, by the time that container arrives on board (loaded on to a ship) it could have passed through multiple jurisdictions.

2. **Know Your Customer (KYC)** – If possible, it would be desirable for carriers to be notified in advance of any intention to ship EVs stowed in containers. Such prior notification would enable Members to perform due diligence prior to accepting such consignments to verify that the shippers involved have the necessary knowledge and experience to ensure that the EVs are in a safe condition for shipment, and they are properly stowed and secured within the containers.

3. **New vs Second Hand EVs** – A key concern with the containerised shipment of EVs is the inability of the ship's crew to verify the condition of the EVs within the containers. This issue arises from the shipper being responsible for loading and securing the EVs in the containers, an activity over which the "carrier" (shipowner) has no control. The ship's crew are also unable to monitor the EV unit itself during the voyage. The carriage of second hand EVs has a potentially higher risk as the quality of the vehicle itself and safety checks on its condition may not be of a standard equivalent to those applied to the shipment of new vehicles. There is a concern that some shippers may not maintain appropriate standards which is why it is very important to undertake KYC checks to provide an increased level of confidence that robust safety checks, securing and stowage procedures are in place before considering the acceptance for shipment of second hand cars in containers. There is also the possibility that even the most robust of checks may not identify historical damage and issues affecting the integrity of the Li-ion batteries and electrical systems in the vehicle.

4. **Pre-Loading Documentation** – All necessary documents and declarations are to be complete and accurate, such as the shippers' declaration, bills of lading, packing list, customs declarations and IMDG documentation, including accurate IMDG Code labelling on the containers for clear identification.

5. **Additional Conditions of Carriage** – The following should also be considered in respect of shipper responsibilities –

    a. **Pre-Loading Inspection** – thorough inspection of EVs to ensure the battery is in an intact, secure, and stable condition.

    b. **State of Charge (SoC)** – the SoC of the battery is important and ideally should be kept to a minimum to mitigate against risks of overheating and short-circuits. Some jurisdictions and some manufacturers may have specific guidelines on SoC. Industry experts suggest that the optimum SoC should be between 20% to 50%, dependent on the duration of the sea voyage.

6. **Container Selection** – Where possible, consider using specialised containers equipped with remote monitoring and fire suppression systems. As a minimum a marine, type-approved container with CSC plate, could be used providing appropriate due diligence and risk assessment are undertaken. The container should have adequate and appropriate approved securing arrangements for safely securing the EVs, having due regard to the weight of the EV and spreading the load evenly across the container floor. EVs are generally heavier than their internal combustion engine counterparts.

7. **Loading Process in a Shipping Container –** Shippers should always use specialised vehicle loading ramps to load an EV into a container. Forklifts should never be used for these operations to avoid the risk of accidentally damaging the EV's battery.

Onboard considerations for the loading and stowage of containers carrying EVs

1. **Stowage and segregation** – As a minimum, stowage and segregation should meet the requirements of the IMDG Code and the vessels Document of Compliance (DoC) for the Carriage of Dangerous Goods. Additionally, where possible, consideration should be given to the following:

    a. Stowing containers carrying EVs away from the accommodation block, so that toxic gasses, if released, do not enter crew accommodation.
    b. EVs are classed as IMDG Class 9 cargo meaning that there is no segregation required between the containers carrying EVs and containers carrying other IMDG classes. This can pose a serious risk if EVs are loaded next to other IMDG cargoes such as IMDG Class 2 "Gases" or IMDG Class 3 "Flammable Liquids" etc. It is recommended that containers carrying EV's should be stowed away from containers carrying other IMDG cargoes.
    c. Stowing on easily accessible lower tiers on deck.
    d. Stowing at easily accessible outboard slots on deck.

    The above considerations are suggested with the intent of avoiding an increase of risk to the crew in the event of a fire, while allowing for the possibility of safe fire-fighting access to the container stowage location, such as for the use of a water mist lance, for boundary cooling, and if possible, to access the seat of a fire - if inside the container.

2. **Battery Management System (BMS)** – Explore the possibility of accessing battery management system reports for the vehicle, ideally from prior to shipment through until discharge from the vessel.

Observations and Recommendations

The current IMO regulations do not specify any additional requirements for the carriage of EVs in containers, treating them as a general IMDG cargo. However, as noted above it is recommended that EVs in containers are not stowed adjacent to other IMDG containers to minimise the risks that could arise from the initiation of thermal runaway and fire.

The following additional measures could include engaging appropriate subject matter experts to provide advice on –

1. **Risk assessment and mitigation –** Prior to committing to any shipment of EVs, the risks should be properly evaluated and considered as a part of a detailed risk assessment and shipboard officers should be consulted at every stage.

2. **Crew training & preparedness** – Ship's crew are trained and qualified in accordance with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW). The risks associated with "Thermal Runaways" are different to the standard STCW fire risk specific crew training and additional training, over and above these minimum requirements should therefore be considered. Developing additional risk specific scenarios for onboard routine training and drills to deal with EV and Li-ion battery related fires should also be considered.

3. **Monitoring & Detection** – Remote monitoring detection and early warning using video feed, heat or gas detection or other appropriate systems, and including access to battery management systems should be considered.

4. **Physical monitoring** – Additional patrols (weather permitting) in the vicinity of containers carrying EVs, with appropriate live communications back to the officer of the watch.

5. **Procedures or policies** – Develop and update policies, procedures, and checklists to cover any new measures to be implemented.

6. **Specialist Equipment** – Additional and specialist equipment such as Hydropen, Thermal Imaging Cameras and Water Lancing equipment can also be considered.

7. **Vessel design and development** – Consider additional design and structural measures for existing and future fleet vessels, over and above minimum statutory requirements, to improve vessels capability to monitor, detect, mitigate and address any potential EV associated hazard.

Conclusion

The current regulations under SOLAS, the IMDG Code and other Conventions do not currently detail any additional equipment or specific vessel requirements to address the shipment of EVs in containers. EVs are considered as IMDG cargo and may be stowed with other IMDG cargoes; therefore, Members are encouraged to assess their own protocols and procedures and proactively implement appropriate additional safety measures intended to best enhance their own vessels' safety and to protect their crew, their vessel, the cargo and the marine environment.

Detailed guidance on the carriage of Li-on batteries within containers is available from the CINS Lithium-Ion Batteries in Containers Guidelines that were published in March 2023.