What we have learned about the dangers of lithium-ion batteries and fires

By **Mike Schwarz**

The biggest topic for discussion in the marine world during 2023 has surely been the challenges associated with lithium-ion batteries and specifically dealing with the aftermath of fires that have made media news headlines around the world; and not just in the marine sector either. More column inches have been devoted to this technology than almost anything else it seems as the marine world continues its race to decarbonise. It appears we know far more now than we did a year ago, such as the use of metal boxes to contain a burning object and cooling the item as fast as possible to lower the temperature. These activities come with inherent risks of course. And once fire takes hold, as we have seen the result can be utterly devastating.

IIMS has written many words and published several associated articles on the subject and will continue to do so as more information comes to light in 2024, especially as official accident reports start to appear. The aim of this in-depth feature article is to reprise some of that content in scaled down format from the sheer volume of published material and to put it altogether in one place for the benefit of the surveying profession.

This story surfaced in July 2023 and caused some raised eyebrows when it was first published.

Safety Advisory Notice: Transportation of electric vehicles containing lithium batteries damaged by extreme weather events

The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) has issued this safety advisory notice to inform the public and raise awareness of the risks involved in the transportation of electric vehicles (EVs) powered by installed lithium batteries that may have been damaged due to submersion in waters during extreme weather events. When transported in commerce, EVs containing these damaged batteries may present particularly significant hazards to the public, including property damage, injury, and even death.

PHMSA wishes to remind potential shippers of EVs - including vehicle owners, salvage companies, and vehicle transport companies - that they have a responsibility to assess EVs for potential damage to their installed lithium batteries and to observe the specific requirements in the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) for both the transportation of EVs containing lithium batteries, and for the transportation of damaged and/or defective lithium batteries in commerce.

Federal hazardous materials law authorizes the Secretary of Transportation (the Secretary) to "prescribe regulations for the safe transportation, including security, of hazardous materials in intrastate, interstate, and foreign commerce" 49 U.S.C. 5103(b)(1). The Secretary has delegated this authority to PHMSA in 49 CFR 1.97(b). PHMSA's regulations (i.e., the HMR) are designed to achieve three primary goals:

1. Ensure that hazardous materials are packaged and handled safely and securely during transportation. This document contains guidance provided to help the regulated community understand how to comply with regulations, but its contents are not substantive rules themselves and do not create legally enforceable rights, assign duties, or impose new obligations not otherwise contained in the existing regulations and standards.

2. Effectively communicate the hazards of the materials being transported to transportation workers and emergency responders.

3. Minimize the consequences of an accident or incident should one occur.

As part of its safety mission, PHMSA regulates the transportation of lithium batteries, including those that are installed in or are intended for use in EVs. Lithium batteries pose a risk in transportation, and the HMR contains provisions intended to address the risk in transport and ensure safety of the public whether the lithium batteries are installed in an EV being transported or are transported separately. Damaged or defective lithium batteries pose a unique risk because they are more likely to experience thermal runaway and ignite during transportation. Consequently, shipments of damaged or defective lithium batteries have additional restrictions – see 49 CFR 173.185(f) – compared to newly manufactured, used, or undamaged/properly functioning batteries. It should also be noted that damaged, defective, or recalled lithium batteries must be prepared for shipment in accordance with the relevant provisions of the HMR and may be shipped only by highway, rail, or vessel transportation and are strictly forbidden for commercial transportation by aircraft.

There have been fires associated with lithium batteries installed in EVs that were submerged in floodwaters following extreme weather events. Saltwater is especially harmful to lithium batteries as residual salt within the battery or battery components can form conductive bridges that can lead to short circuit and self-heating of the battery, resulting in fires. The time frame in which a damaged battery can ignite varies, from days to weeks, and EV battery fires can be extremely time – and resource-intensive for responders. In addition, responders face safety risks related to the emission of toxic and flammable gases from damaged lithium batteries, and the unpredictability of thermal runaway and reignition. As such, lithium batteries from EVs that have experienced flooding or other exposure to the elements in a manner other than designed are at significant risk of damage, resulting in elevated potential for producing a dangerous evolution of heat, fire, or short circuit.

PHMSA understands that assessing whether a battery is damaged may require input from the manufacturer and recommends that shippers consult with the manufacturer of the battery to assist in such a determination. However, it is ultimately the shipper's responsibility to determine when a battery is damaged and therefore requires additional consideration for packaging and transportation. Specifically, in accordance with 49 CFR 173.22(a), the shipper must properly class and describe the hazardous material being offered for transportation and determine whether the packaging or container is an authorized packaging. In addition, shippers are forbidden from offering for transportation or transporting electrical devices, such as batteries and battery powered devices—including EVs—that are likely to create sparks or generate a dangerous evolution of heat, unless packaged in a manner which precludes such an occurrence.

Lastly, when movement of an EV with a damaged lithium battery on a motor vehicle is necessary to protect life or property in an emergency, certain requirements of the HMR are waived. See 49 CFR 177.823(a)(3). Additionally, the National Highway Traffic Safety Administration has published guidance on their website for towing and recovery operators and vehicle storage facilities that describes how to properly handle EVs in the event of damage, fire, or flooding.

What are the packaging and marking requirements to transport damaged, defective, and recalled lithium batteries? See 49 CFR 173.185(f):

- Place the battery in an individual, non-metallic inner packaging that completely encloses the battery.
- Surround the inner packaging with non-combustible, electrically non-conductive, and absorbent cushioning material.
- Place each inner packaging into its own specification outer packaging rated to the Packing Group I performance level. This means only one damaged, defective, or recalled battery per inner packaging, and only one inner packaging per outer packaging.
- Mark the outer packaging as "Damaged/defective" and identify the battery type. The marking—reading "Damaged/defective lithium-ion battery" or "Damaged/defective lithium metal battery"—must be in characters at least 12 mm (0.47 inches) high.

What are the packaging requirements to transport EVs powered by lithium batteries that have not been damaged? See 49 CFR 173.220(d):

- EVs with their batteries installed are forbidden for transport aboard passenger-carrying aircraft.
- Lithium batteries contained in vehicles, engines, or mechanical equipment must be securely fastened in the battery holder of the vehicle, engine, or mechanical equipment, and be protected in such a manner as to

prevent damage and short circuits (e.g., by using non-conductive caps that cover the terminals entirely).

- Except for vehicles, engines, or machinery transported by highway, rail, or vessel with prototype or low production lithium batteries securely installed, each lithium battery must be of a type that has successfully passed each test in the United Nations (UN) Manual of Tests and Criteria, as specified in 49 CFR 173.185, unless approved by PHMSA's Associate Administrator.
- Where a vehicle could possibly be handled in other than an upright position, the vehicle must be secured in a strong, rigid outer packaging. The vehicle must be secured by means capable of restraining the vehicle in the outer packaging to prevent any shifting during transport that would change the orientation or cause the vehicle to be damaged.
- Where the lithium battery is removed from the vehicle and is packed separate from the vehicle in the same outer packaging, the package must be classified as "UN3481, Lithium-ion batteries packed with equipment" or "UN3091, Lithium metal batteries.

What are the additional stowage requirements to transport EV's powered by lithium batteries when carried on a vessel? See 49 CFR 176.905(a):

- For vehicles with batteries installed, the batteries shall be protected from damage, short circuit, and accidental activation during transport.
- Each lithium battery must be of a type that has successfully passed each test in the UN Manual of Tests and Criteria unless approved by PHMSA's Associate Administrator.
- A vehicle showing any signs of leakage or electrical fault—such as inability to start or move under its own power—or signs of prolonged exposure to water, is forbidden for transportation onboard a vessel.
- Where a lithium battery installed in a vehicle is damaged or defective, the battery must be removed and transported according to 49 CFR 173.185(f), unless otherwise approved by PHMSA's Associate Administrator.

Earlier in the year, the TT Club issued this press release.

Fire not the only danger with lithium-ion batteries

Devastating consequences of rapidly spreading, and often challenging to extinguish fires involving the batteries particularly in electric vehicles (EV) on board ships, and other parts of the supply chain have been well-documented in recent months. There is however less awareness of the highly toxic combustion products that are released and their respective impact to the health and wellbeing of those exposed to the gases.

Based on the evidence of past fires the time between the initiation of a failed battery igniting to a discharge of toxic vapour can be measured in seconds rather than minutes. This is due to a process known as thermal runaway. The rapid sequence of events typically occurs where an internal electrical short within one of the battery cells generates heat; this breaks down the internal structure of the battery, increasing the rate of the reaction in an ever-increasing cycle. There is often a dramatic release of energy in the form of heat and a significant emission of toxic gases.

Neil Dalus of TT endeavours to paint a picture of the dangers. "During a lithium battery thermal runaway event, research has shown that significant amounts of vapour can be produced per kWh (kilowatt hour). In many common supply chain scenarios, including ships' holds and warehouses, the reality is that such vapour clouds are likely to accumulate. Even when the clouds are able to disperse, the potential toxic effects may occur at lower concentrations."

Drivers, stevedores, ships' crews and first responders attempting to control the blazes encounter what might appear to be smoke but is in fact a mix of toxic gases, generated quickly and in large volumes. These gases once in the atmosphere behave differently to smoke, often pooling at floor level due to their density. "Traditionally where fires and smoke are concerned one would stay low to avoid inhalation, doing so where lithium battery fires are concerned is likely to prove problematic," observes Dalus.

The toxicity of gases given off from any given lithium-ion battery differ from that of a typical fire and can themselves vary but all remain either poisonous or combustible, or both. They can feature high percentages of hydrogen, and compounds of hydrogen, including hydrogen fluoride, hydrogen chloride and hydrogen cyanide, as well as carbon monoxide, sulphur dioxide and methane among other dangerous chemicals.

Early detection of such an incident can also be pivotal in managing the response, camera and thermal imaging could enable an expedient response. Such equipment might have already become commonplace for some modes, however conducting a thorough risk assessment for example when cargo is stored in warehouses would be prudent. As Dalus comments however, "Given the hazardous nature of this vapour, if any of these measures are not in place then the best course of action is to evacuate the area and leave the incident response to the emergency services, ensuring that the known risks are appropriately communicated."

The article in full can be read at
https://bit.ly/3ZPpFPw
Or scan the QR code.

Chubb launches Lloyd's consortium to address lithium battery risk

Lithium-ion batteries have certainly been exercising the finest minds in the marine insurance sector and here is the response from Chubb which is leading a new Lloyd's of London consortium to tackle this issue. This article first aired in September 2023.

A new initiative was rolled out and launched by Chubb. A new Lloyd's of London consortium has been created (which Chubb will lead) that is designed to provide insurance coverage for risks associated with the transit and storage of lithium batteries.

The consortium was created to address a lack of capacity in the marine cargo market for providing lithium battery transit and stock insurance. It provides a one-stop solution with limits up to $50 million for risk types associated with lithium batteries including transit, stock throughput, standalone stock and warehouse legal liability, and will include excess stock and part orders.

As mentioned, the consortium is being led by Chubb Global Markets (CGM), including its Lloyd's platform, and supported by 11 other Lloyd's syndicates. Chubb Global Markets will also draw on the capabilities of Chubb Climate+, the company's global climate business unit launched early in 2023.

Rob Wilson, Chief Underwriting Officer for Chubb Global Markets said that the work involved in managing lithium battery risks is extensive and brokers can now use this facility to gain access to capacity in this new risk area.

He added, "The consortium provides brokers and insureds with a single port of call to bind these risks, helping to shore up the lithium battery supply chain as demand continues to grow."

"The lithium battery industry is growing at a rapid rate and many businesses involved in moving and storing these batteries are increasingly in need of an experienced and reliable insurance partner and solution to support the ramp-up in production," said Matt Hardy, Leader of Chubb Climate+ for Chubb Overseas General.

He further commented, "The creation of a consortium dedicated to underwriting these risks aligns firmly with our commitment to harnessing our underwriting and risk engineering capabilities to support the transition to a low-carbon economy."

NCB launches second container inspection initiative to battle the dangers of misdeclared cargo

In September, the National Cargo Bureau released information about their second container initiative, which partially covers the issue of lithium-ion batteries.

National Cargo Bureau (NCB) has launched a second container inspection initiative to combat the persistent threat posed by misdeclared cargo. In a determined response to these sobering revelations and escalating concerns around ship fires, particularly those stemming from lithium-ion batteries, NCB is enhancing its inspection initiative. Several major shipping lines including Hapag Lloyd, Maersk and MSC have committed to the initiative, and container inspections have already commenced in various locations around the world.

Five years prior, NCB had again joined forces with industry leaders, Maersk, Hapag Lloyd, and MSC, in a trailblazing effort that laid bare the disconcerting realities within container transport safety.

Key findings from the analysis:

– 55% of inspected containers were non-compliant
– 43% of containers failed due to poorly secured dangerous goods
– 6.5% were found to be carrying mis declared dangerous cargoes.

Subsequent inspections, performed by NCB, have continued to reveal poorly stowed containers as well as undeclared and mis declared shipments of dangerous goods such as charcoal, flammable liquids, and used lithium-Ion batteries.

NCB expects this second round of inspections to expose further container deficiencies but, hopefully, reveal improvements since the first initiative.

Read the article in full at **https://bit.ly/3PRpVKv**.
Or scan the QR code.

IUMI publishes "Best practice & recommendations for the safe carriage of electric vehicles"

The International Union of Marine Insurance, which represents the cream of marine insurers weighed into the debate in September following the publication of their best practice guidelines, a most useful document.

There are growing concerns within the shipping community, including marine underwriters, about fires breaking out on car carriers and ro-ros with the assertion that many of these fires are attributable to electric vehicles. In response, the International Union of Marine Insurance (IUMI) has researched these claims and published recommendations on the safe carriage of electric vehicles (EVs).

Lars Lange, IUMI Secretary General, explains:

"Our paper draws on a body of scientific research which demonstrates that fires in battery EVs are not more dangerous than fires in conventional vehicles, nor are they more frequent. Although statistics continue to be gathered, they currently estimate that, in general, there are fewer fires from EVs compared with fires from conventional vehicles when driven over the same distance."

Research also proves that there is only a minor difference between total energy released during an EV fire and one that is related to an internal combustion engine vehicle (ICEV). Once established, vehicle fires are largely (approx. 80%) fuelled by the car body and interior parts rather than the propulsion system. However, the potential for thermal runaway (when the battery suffers an unstable chemical reaction) exists for EVs whereas it is not a consideration for ICEVs. Thermal runaway makes fires hard to extinguish, hence mitigation measures such as boundary cooling must be employed rapidly. Moreover, the risk of re-ignition is higher for an extended period of time.

In light of this, IUMI concludes:

- Early fire detection and verification/confirmation is critically important to reduce the time between detection and firefighting response to a minimum. Options, in addition to the conventional systems, could include thermal imaging cameras and AI powered systems.
- Drencher systems are effective for fire-fighting onboard roro and ropax vessels both for EV and ICEV fires and should be installed alongside video monitoring systems.
- CO_2 extinguishing systems, if applied quickly, are successful in fighting PCTC fires and their capacity should be doubled. High-expansion foam fire extinguishing systems have also proved to be effective to prevent heat transfer from one vehicle to another.
- Early detection, confirmation and a short response time are crucial to fight a fire successfully. On board PCTCs, fixed systems should always be applied before manual fire-fighting is employed.
- A clear policy is required on which cargo is accepted or rejected. Vehicles should be screened with used vehicles being checked carefully for hidden damage.
- Charging onboard ropax vessels should be permitted subject to relevant risk assessments and control measures. Safety mechanisms built into EVs are usually activated during charging.

Read the full article at **https://bit.ly/47DUBpa**.

ClassNK releases guidelines on the safe transportation of electric vehicles

A well-known and respected classification society, ClassNK, joined the debate in August 2023. They published a set of guidelines that focuses on the safe transportation of EVs.

In a bid to bolster the safety of maritime transportation of electric vehicles (EV) at a time of major concern for the shipping industry, ClassNK has unveiled a set of new guidelines and measures.

ClassNK has developed the Guidelines for the Safe Transportation of electric vehicles, which describes the characteristics of EV fires and provides guidance on how to respond, built upon dialogue with experts, operators, manufacturers, and other stakeholders.

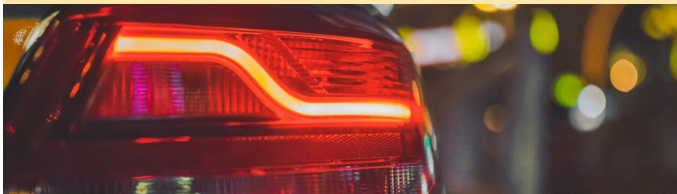
Publishing these guidelines is a sensible move by ClassNK's part given the surge of challenges presented by climate change and global warming, the export of hybrid and EVs powered by lithium-ion (Li-Ion) batteries. There exists a faction of industry insiders who argue that the transport of these vehicles may not be completely safe.

In the case of a thermal runaway, the risks are considerably amplified. This dangerous occurrence involves an uncontrolled escalation in temperature within the battery, resulting in a swift and forceful discharge of energy. The consequences of such an event can be dire, potentially leading to catastrophic explosions or fires.

"Controlling li-ion battery fires are almost impossible, once the fire catches on to nearby vehicles their frames melt and the work to extinguish is extremely challenging", stated Henrik Meyer, senior quality manager, ports, terminals and stevedoring at Wallenius Wilhelmsen.

The aim of the guidelines is to assist in the development of fire safety measures for the maritime transportation of EVs and, thus, enhance the overall safety of such transportation for not only ships themselves but also for their respective crews.

Read the full article at **https://bit.ly/3EVYIQG**.



MGN 653 (M) Amendment 1 electric vehicles onboard passenger roll-on/ roll-off ferries

Maritime regulators are behind the curve and struggling to catch up given the speed of technological change as opinion and facts continue to form on the matter of lithium-ion batteries. But the MCA has issued an amended MGN in August that deals specifically with EVs.

The UK Maritime and Coastguard Agency has issued a Marine Guidance Note (MGN) amending the guidance on the safe carriage of electric vehicles on board passenger ferries. The MGN was released on 7 August 2023.

This MGN provides the UK shipping industry with best practice guidance to facilitate safe carriage, and potential charging of, electric vehicles onboard roll-on roll-off (ro-ro) passenger ferries. The MCA has developed this guidance in conjunction with, and at the request of industry. Amendment 1 includes new guidance in section 4 on the carriage of light electric vehicles such as e-bikes and e-scooters which have become an area of concern following a spate of fires.

This is a lengthy document and can be viewed in full online at **https://bit.ly/3ZLrGMq**.
Or scan the QR code.

Lithium-ion battery fires on vessels remain one of the biggest safety issues

Earlier this year Allianz highlighted that battery fires on vessels remain one of the biggest safety issues facing the shipping industry. There have been a number of serious fire incidents in recent years where Lithium-ion (Li-ion) batteries have been reported as the source of or contributing to fires on vessels. Allianz experts Capt. Rahul Khanna, Captain Randy Lund and Captain Anastasios Leonburg, share their thoughts on how electric vessels may impact safety onboard.

Decarbonization and electrification are increasing the number of shipping goods that contain Li-ion batteries, from electric vehicles (EVs) to a wide range of consumer and electronic goods. The global Li-ion battery market is expected to grow by over 30% annually from 2022 to 2030, according to a report by McKinsey.

Recently, the Fremantle Highway car-carrying vessel caught fire off the Dutch coast with over 3,000 vehicles on-board enroute from Germany to Egypt. A fire on board car carrier Felicity Age in February 2022, led to the vessel sinking in the Atlantic Ocean, along with its cargo of 4,000 vehicles. Li-ion batteries were cited as being a factor in keeping the fire ablaze. The Höegh Xiamen, caught fire in June 2020 in Jacksonville, Florida, resulting in the total loss of the vessel and its cargo of 2,420 used vehicles. An improperly disconnected battery in a used vehicle led to the fire, according to the official investigation.

In light of the growing number of fires on cargo ships, a spokesperson for IMO said that it will announce new safety standards for those transporting electric vehicles in 2024. The guidelines could include specifications on how fully a battery can be charged. The IMO said that chemicals for extinguishing fires, special fire blankets, equipment such as battery-penetrating jet extinguishers and bigger gaps left between electric vehicles on ships could also become mandatory.

Allianz explains that Li-ion batteries can be carried on board ships either as a cargo themselves or as part of the equipment for the electric vehicles (EVs) they provide power for. Many of these batteries are safely transported every day but fire risks are present in both scenarios, especially if the batteries are used or defective, damaged or improperly stored, packaged, handled or labelled.

The main hazards are fire, explosion, and 'thermal runaway', a rapid self-heating fire that can cause an explosion. They can also produce irritating, corrosive or poisonous gases that cause an explosion in a confined space. The main causes of Li-ion fires are substandard manufacturing or damaged battery cells or devices, over-charging, and short circuiting. Li-ion batteries are an important source of energy and do not necessarily burn more frequently than other goods. It is only when they ignite that they are more difficult to extinguish as they can burn more ferociously and are capable of spontaneously reigniting hours or even days after they have been put out.

Most ships lack the suitable fire protection, firefighting capabilities, and detection systems to tackle battery fires at sea, which has been made more difficult by the dramatic increase in ship size – container-carrying capacity has doubled in the last 20 years. We have seen many fires where malfunctioning or damaged batteries have been attributed as a contributing factor in recent years.

Allianz has long warned about the risks associated with Li-ion batteries and EVs in shipping for a number of years, first highlighting this issue in 2017. A recent report highlights a full list of loss prevention measures to consider including:

- All EVs should display clear and precise identification on the windshield detailing the battery type (e.g. Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV).

- EVs with low ground clearance should be clearly labelled as this can present loading and discharging challenges arising from the vessel's ramps, inner slopes, or deck appendages.

- All EVs with a Li-ion battery must have successfully passed pressure, temperature, crush, and impact tests as described in the UN Manual of Tests of Criteria – subsection 38.3 for transport of Li-ion batteries.

- All EVs must be fully functional, self-propelled, safe to drive and contain an undamaged battery system.

- There should be no charging of EVs during the passage.

All EVs must be properly secured to prevent any shifting during transport.

- One potential idea being explored by some car carrier operators, as part of fire-preventative measures, is the use of fire-proof blankets manufactured specifically for EVs.

Allianz experts conclude that the debate about EVs in the shipping industry is ongoing, with conversations about whether there is even a need for dedicated Ro-ro vessels for EVs.

"From an insurance perspective, this is something we would like to see – purpose-built vessels for transporting EVs, designed to substantially reduce the risk of fire. We have already seen shipping companies stop transporting EVs on their ships because of the potential fire risk," says Allianz.

Höegh Autoliners details EV fire mitigation measures aboard its ro-ro fleet

Recent fire incidents aboard electric vehicle (EV) carrying vessels have brought attention to factors such as thermal runaway, saltwater intrusion, and compromised battery cells or components. Industry stakeholders, insurers, and safety experts have underscored the need for vigilance. Höegh Autoliners outlined the measures it is taking to minimise the risks.

"Together with a clear decarbonisation target, safety is our top priority both on our existing fleet and when designing our new Aurora-class vessels. Fire safety has been a focus area and part of the design work from day one," said chief operating officer of Höegh Autoliners, Sebjørn Dahl.

To improve fire detection and the ability to handle a possible fire the carrier has, Höegh Autoliners has implemented an extended number of fire zones, and installed heat and smoke detecting cameras and fire blanket stations on all cargo decks, among other measures. It said that it also has more than the class required amount of CO_2, which serves as a highly efficient fire extinguisher, onboard its vessels. "We've also improved the onboard digital platform. This enables us to include early warning if any loaded unit would send out notification of anomalies such as elevated battery temperatures," said Dahl.

The carrier said it is not transporting second-hand EVs as they may represent a higher risk.

Prior to loading, it has a number of fire risk management procedures, based on the fact that high-voltage batteries in electronic and hybrid cars are charged ideally below 30 percent and not above 50 percent, limiting the energy density on the vessel's deck and thereby reducing the potential severity of fires.

Höegh added that its crew undergo regular refresher training on fire safety and firefighting techniques, and complete regular drills. In cooperation with local training centres, it is focusing on hands-on fire-fighting techniques as well as safety procedures for high temperature fires.

De-risking the carriage of lithium-ion batteries

At the heart of efforts to draw attention to the hazards inherent in transporting lithium-ion batteries, specialist freight insurer TT Club now urges debate leading to a balanced, yet realistic awareness of the dangers, and a united approach to enhancing their safe carriage. Improved regulatory clarity is required and auto manufacturers need to address transport safety issues more thoroughly.

Rapid development of battery technology and the uncertainties created by these developments, particularly concerning safety when the energy packs are being transported require the logistics industry to have a clear understanding of the dangers which can include fire, explosions and toxic gas emissions. Moreover, there needs to be increased efforts to minimise the risks, and if necessary, make sure there is an effective response to any catastrophic event.

Alarmist reports in the media can overstate the number of incidents involving electric vehicles. Indeed Peregrine Storrs-Fox, Risk Management Director at insurance mutual TT Club points out that "Lithium-ion (li-ion) battery fires are not an everyday occurrence. But when thermal runaway does happen, the result is release of toxic gases such as carbon monoxide and hydrogen cyanide, a very high temperature fire and can spread very fast."

The release of toxic fumes may be the first alert, but fire with temperatures higher than 1,000degs centigrade can be reached in a matter of seconds and, as the mix of chemicals and metals ignites, devastation can ensue.

In keeping with its mission to extend awareness and achieve a united front, TT Club was delighted to be part of a forum of interested parties which was held recently in London. Much was revealed by the speakers and valuable debate ensued. "Supply chain players including ship owners, carriers, forwarders, terminal and port operators and insurers are engaged with these debates. Indeed, the maritime regulator IMO (International Maritime Organization) has its guidance for carriage of these batteries under serious review," says Storrs-Fox. "But we need to bring manufacturers of EVs and the batteries that power them actively into the debate. Their ambitions for the development of more powerful, lighter and diverse battery cells must not be allowed to outstrip prioritising safety concerns surrounding their future transportation around the globe."

Such concerns regarding the battery packs within electric vehicles (EVs) have been raised in the US and the National Transportation Safety Board (NTSB) has carried out a study. The forum heard that EVs were reported to have incurred fewer fire incidents than internal combustion engine (ICE) cars. However, there are a few provisos to be highlighted here – not least that there are far fewer electric cars on the road than ICE vehicles.

Secondly it is understood that newer batteries are less likely to ignite or explode than used batteries, effectively the older the li-ion unit, the greater the chance of an incident. As a result, it is not clear how the batteries will perform through the intended life, given that the switch to EV's is only now gathering pace and most battery packs are new.

Regarding the rapid spread of fire, Eva Mckiernan, the technical director at firefighting consultancy Jensen Hughes highlighted the dangers of thermal runaway as the most pressing issue after ignition. She explained that these energy packs are thermo-dynamically unstable. When the batteries are damaged, they can release hot and poisonous gases into containers or onto car decks of ro-ro ships and other vehicle carriers within seconds. When the batteries explode those extraordinary temperatures can be reached.

"Thermal runaway occurs when the heat and chemical reactions reach a certain level, they are effectively self-sustaining and very difficult to extinguish," she added.

Of course, EVs are just one use for li-ion batteries, which can be found in a variety of goods including e-bikes and scooters, as well as computers and mobile phones. All of these goods are transported with batteries in containers. Whilst transported as new, it may be reasonable to expect appropriate packaging, although state of charge is variable, used and damaged batteries present considerable uncertainty for the transport supply chain.

"Currently li-ion batteries are classified as one of four UN numbers, depending on power output or the weight of lithium in them and whether they are contained within devices or shipped separately. All four are Class 9 in the IMDG Code – Miscellaneous dangerous substances and articles," explained Storrs-Fox. "Class 9 is the least hazardous ranking and dates from a change in IMDG Class from 4.3, which was made in the late eighties. Clearly there is a need for a radical review of this classification, as the size and energy capacity of these batteries has altered dramatically since then. As has the volume being carried in container ships."

This raises concern that li-ion batteries are not classified as sufficiently hazardous and the range of potential Special Provisions increases complexity and uncertainty. All this may have serious ramifications when a container is being accepted for shipment or a ship stowage plan is being compiled. Storrs-Fox concludes, "In addressing the commercial opportunity in the answering the agenda to move away from fossil fuels, there needs to be urgent engagement from manufacturers and OEMs to resolve the justifiable concerns of the logistics industry – ahead of regulatory strengthening."

UK Chamber of Shipping to examine risks of lithium-ion batteries

The UK Chamber of Shipping has established an ad hoc working group to gain a comprehensive understanding of the risks associated with lithium-ion batteries (LIBs). The group is to examine various aspects of batteries, including how to guard against such batteries going into thermal runaway and catching fire.

The group has participants from the Chamber membership, the Maritime and Coastguard Agency and expert specialists. It is aiming to develop:

- Proposals for regulations relating to the carriage of LIBs on ships
- Recommendations for training and information for ships' crews
- Procedures for detecting damaged or faulty LIBs
- Equipment that can be used in ports and on ships to help manage the risks effectively.

The carriage, stowage, and safety of electric vehicles is an issue the shipping industry aims to tackle. Lately, in order to reduce greenhouse gas (GHG) emissions and accelerate the energy transition, the marine industry has begun to incorporate batteries onboard ships. However, for marine stakeholders, batteries present both a unique set of opportunities and a challenge.

Batteries can be very dangerous cargo if not handled properly. Some of the reasons include:

- Fire (Li-ion batteries contain electrolyte, an ignitable liquid);
- Explosion (resulting from the release of ignitable vapor/gases in a confined space);
- Thermal runaway (a rapid self-heating fire that can cause an explosion);
- Toxic gases that these hazards can produce.

And what about lithium-ion challenges with superyachts and small craft?

If you have read this article and think it mostly concerns the commercial shipping industry, you are correct; it does. But there are some very real concerns from those operating in the small craft and workboat surveying sectors too. Several inland waterways surveyors in the UK have, for example, raised very real concerns about the configuration of lithium-ion battery installations on narrowboats. In addition, a number of small craft and yachts are being retrofitted with lithium-ion batteries, including in some cases, with batteries designed specifically for houses (which are cheaper) and not boats! The potential for catastrophe in those circumstances is very real. And the superyacht sector is not devoid of these major concerns either. Last year almost 70 superyacht fires were attributed to lithium-ion battery fires. However, in most cases these were caused not by the main superyacht battery installation itself, but by the lithium-ion powered toys and accessories.

This article entitled 'Are lithium-ion batteries safe on yachts – and other vessels?' will give you an insight to this particular issue and can be read at **https://bit.ly/48HUSIr**. Or scan the QR code.