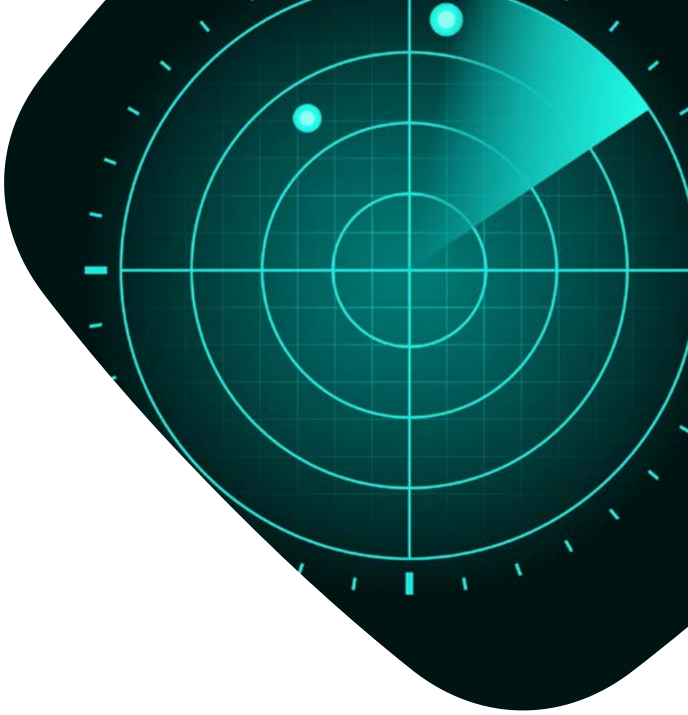
Circular

Lithium batteries; yet another wake up call

In recent years, we've observed a notable rise in fires stemming from lithium-based batteries. Recent incidents have underscored the potentially devastating consequences of these fires. As a response to this growing concern, we're issuing an updated version of our November 2020 circular on the risks associated with lithium-based batteries.

MSIG SPECIALTY MARINE

September 2023



Using lithium-based batteries is associated with significant fire-related hazards and safety risks. While protective systems and tools are available to mitigate these risks, understanding the operational mechanisms of these tools is crucial. This understanding ensures that protective systems are appropriately tailored to address the potential failure modes of specific battery systems. As insurers, we advocate for heightened awareness and more comprehensive regulations on lithium-based batteries.

Based on our current understanding, managing or extinguishing fires originating from large battery packs containing lithium-based batteries is a challenging and costly task. At the time of writing, there were few suitable rules and legislation on the use of lithium-based batteries in a marine environment. Through this circular, MS Amlin Marine aims to increase awareness of the dangers and risks related to lithium-based batteries by providing information and practical recommendations to help further highlight this issue.

Lithium Fires

Lithium, like all alkali metals, is highly reactive and inflammable. A lithium fire is identifiable by its brilliant silver flame. Moreover, lithium has the potential to spontaneously ignite and become explosive when exposed to air and water.

The nucleus of a lithium-based fire resides within the cell itself. This is a highly challenging area to access and even more difficult to extinguish due to its multifaceted nature, encompassing various forms of fire (metallic, chemical, etc.). Additionally, it radiates energy into its surroundings, potentially generating its own oxygen.

While a fire within a single cell can be contained, the situation dramatically escalates in a battery composed of tens of thousands of cells. Such an incident can rapidly become an uncontrollable event, as the fire effortlessly propagates to adjacent cells.

Following a fire, the site of the accident is likely to be saturated with toxic gases, such as carbon monoxide, nitrogen dioxide, hydrogen chloride, hydrogen fluoride, hydrogen cyanide, benzene, and toluene, which have all been detected following a fire. For this reason, it's imperative that all protocols for entering enclosed spaces are strictly observed.

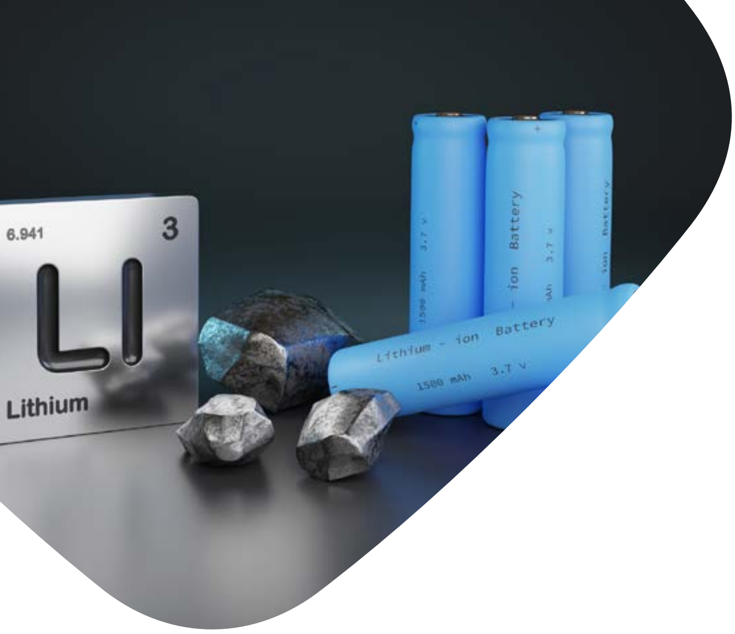
Thermal Runaway

Another risk is the phenomenon known as thermal runaway. Lithium-based batteries can explode or melt when internal electrical components short-circuit. This can occur due to mechanical issues, accidents, or incorrect installation of the electrical components or lithium-based batteries. Such failures are often triggered when a section of the battery becomes excessively hot and fails to cool down swiftly, initiating a chain reaction that generates escalating heat. This cascading effect is referred to as thermal runaway.

Thermal runaway arises from a failure within a battery cell. This failure leads to a temperature surge, triggering a chain reaction that releases more energy. This reaction causes the electrolyte to decompose into flammable gases, which subsequently saturate the fire with oxygen and can escalate into an uncontrollable scenario with destructive results. Once initiated, the process causes temperatures to surge rapidly (within milliseconds), reaching temperatures of approximately 400 °C.

Safety

Lithium technology has been around for over 115 years, but with battery demand surging 5-fold between 2016 and 2022 the number of incidents has increased. In response, safety standards have been drawn up and various safety



features have been integrated into battery cells in recent years. The most commonly employed safety measures are outlined below:

- Battery Management System (BMS)

The BMS safeguards cells by disconnecting power and regulating cell charging. It can identify short circuits within components and address other potential hazards that might lead to thermal runaway or self-ignition.

- Software

Employing specialized software to mitigate battery failure risk enables timely real-time alerts. However, it's crucial that any software must be simultaneously tested with hardware to assess the potential risks of complete system failures.

- Liquid Cooling and Air Cooling

Currently, liquid cooling and air cooling are the sole safety systems proven to effectively prevent thermal runaway. These active cooling systems prevent batteries from entering thermal runaway by dissipating more heat than the cells generate.

- Early Detection System

Fire suppression, detection, and release systems must remain fully operational even in the event of a single failure in another subsystem, such as the BMS. A well-implemented early detection system triggers an alarm at a stage where appropriate measures can be taken to prevent the loss of an entire system, and the associated consequences.

- Injection of Foam

When compared with other tested methods, direct foam injection yields the most effective heat mitigation results. This technique boasts the highest potential for module-to-module fire mitigation, especially when engineered to inundate modules/racks over extended time intervals. This approach is particularly valuable for maintaining elevated safety levels when exploring alternative ship integration concepts, such as installing batteries without a dedicated battery room.

- High-Pressure Water Mist Protection

High-pressure water mist protection offers robust heat mitigation at the module level and comprehensively safeguards the battery compartment against external fires. Furthermore, it exhibits useful gas absorption and gas temperature-reduction capabilities.

- Chemical Fire Suppression Agent

A Chemical Fire Suppression agent is dispersed as a mist onto lithium battery fires. This method requires full sealing of the battery room. Room ventilation must be suspended for the suppression process to be operational. It's important to be aware that this suppression method could elevate toxic and explosive battery gas concentrations within the room until ventilation is reinstated.

- Sprinklers

Sprinklers do not extinguish visible flames; rather, they mitigate heat by releasing a high-pressure water mist. A drawback of this method is that water dispersion may drive gas into pockets with elevated concentrations, potentially heightening the risk of explosion.

- Total Flooding

Incorporating flooding systems for the battery pack is only feasible during the vessel's design phase. This ensures that bulkheads and stability have been accurately calculated. It is imperative to emphasize that no other essential components may be situated within these compartments. Looking ahead, naval architects should contemplate incorporating dedicated fully floodable spaces for lithium-based batteries into the design of new vessels. Additionally, for car carriers, dedicated decks for electric vehicles should be positioned preferably in the lower regions of the ship to facilitate flooding.

Conclusions and recommendations

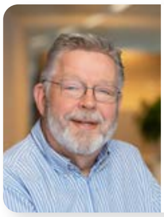
Lithium-based batteries are expected to have an important role to play, even if alternative options emerge. In the normal circumstances for which they were designed, these batteries have demonstrated reliability and safety across nearly all environments and applications. However, in dynamic situations like transportation, maritime or vehicle usage, special attention must be directed toward both battery design and installation, as well as safety measures such as packaging, emergency protocols, and storage procedures.

Nonetheless, it's vital that lithium-based batteries are carefully handled and properly understood, especially when they are used in large quantities, such as battery packs or storage units. While the likelihood of malfunctions is not significantly higher than that of other batteries or energy sources, the potential impact on personnel, assets, and the environment could be catastrophic.

Individuals involved with lithium-based batteries, regardless of their role or capacity, must be aware of the inherent risks throughout the lifecycle of these batteries; from manufacturing to eventual disposal. To serve this purpose, comprehensive regulatory frameworks exist at the international, national, and local levels, particularly in the domains of handling, transportation, and storage. These regulations are continuously amended to meet the changing landscape.

If you require further information or assistance, please don't hesitate to contact our Loss Prevention Services department: LPS@msigspecialtymarine.com

Peter van der Kroft
Technical Loss Prevention Consultant
+31 10 799 5800
peter.vanderkroft@msigspecialtymarine.com



Ferry Elzinga
Technical Loss Prevention Consultant
+31 10 799 5800
Ferry.Elzinga@msigspecialtymarine.com

MSIG Europe offices

Antwerp, Hamburg, London, Paris, Rotterdam and Singapore

MSIG SPECIALTY MARINE

msigspecialtymarine.com