Spotlight

SHIFTING PERSPECTIVES

Lithium-Ion Fires

A Burning Issue for Urban Centers and Beyond

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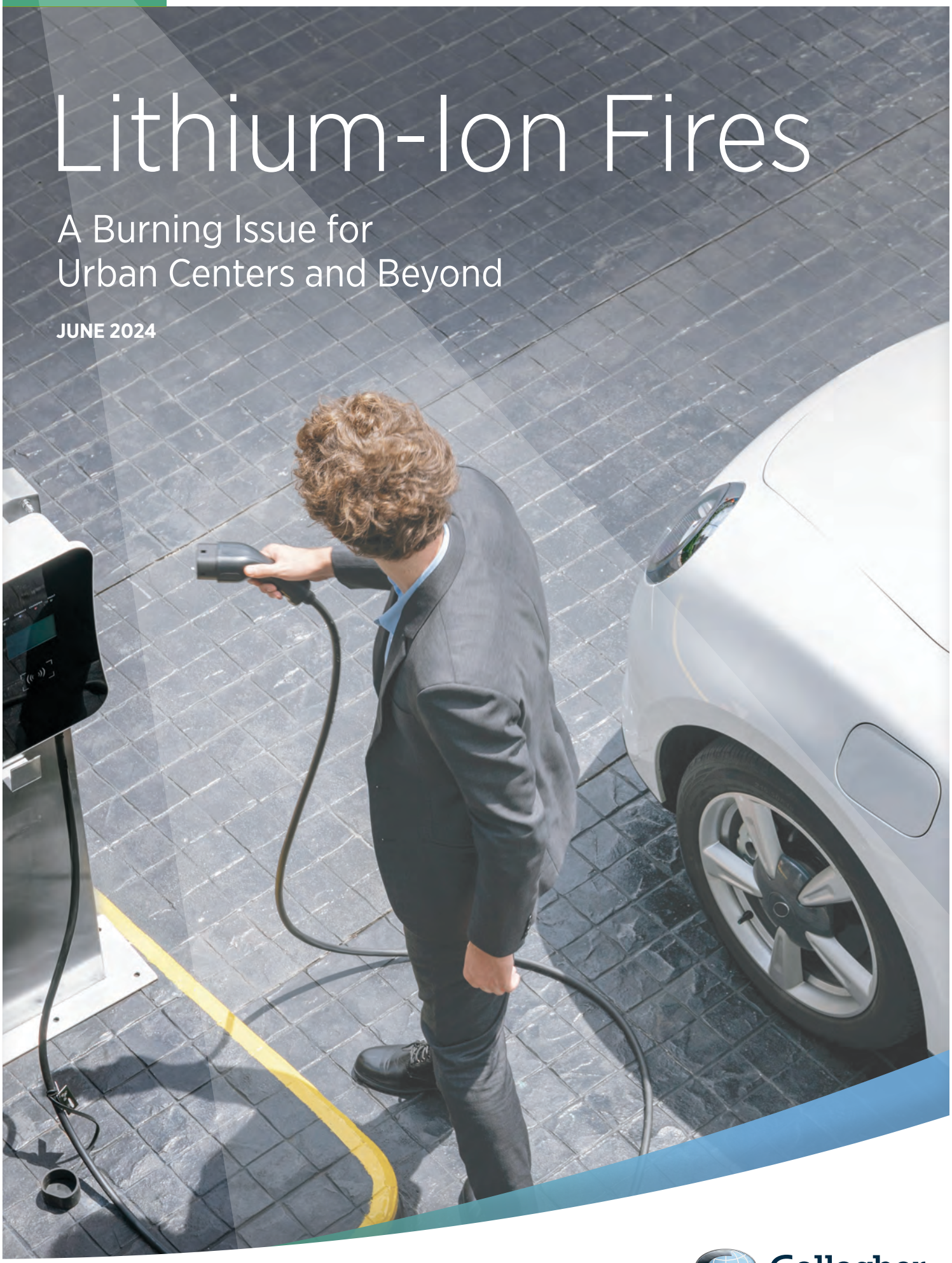


Gallagher

Key Insights

1. Incidents of lithium-ion (Li-ion) battery-related fires are increasing globally, leading to physical damage and personal loss.
2. Globally, demand for Li-ion batteries is expected to surge seven-fold to around 4.7 TWh by 2030, driven in large part by demand for electric vehicles.
3. With large populations and demand for technology, urban areas have a high concentration of risk.
4. Thermal runaway is a self-sustaining chemical reaction that keeps increasing the temperature and pressure inside the cells of a battery, until ignition and/or explosion occurs.
5. The extreme heat generated by Electric Vehicle (EV) battery fires can reach up to 4,900°F (2,700°C).
6. Early detection systems are critical in controlling fires, but they are still in the early stages of development.

Lithium-Ion Fires
A Burning Issue for Urban Centers and Beyond

Incidents of lithium-ion (Li-ion) battery-related fires are increasing globally, leading to physical damage and personal loss. The resulting claims and losses have insurers reevaluating their liabilities as businesses and policymakers attempt to understand the rise in incidents and take steps to mitigate the risk. There are implications for the future of this technology, which is so critical to the Net Zero transition.

In 2023, following 149 recorded cases of e-bike-related fires and three deaths in the city, the London Fire Brigade placed e-bikes and e-scooters as the greatest source of fire risk.[1]

In the US, there were over 25,000 incidents of fire or overheating relating to Li-ion batteries between 2017 and 2022.[2] The impact has been most pronounced in urban areas, where the use of micromobility vehicles such as e-bikes and e-scooters have grown substantially in the past five years and where fires started by Li-ion batteries can more easily spread through multi-occupancy buildings.

In 2023, there were 18 fatalities in New York blamed on exploding Li-ion batteries. This pushed the total death toll from fires in the city to over 100 for the first time in two decades.[3]

NY Mayor Eric Adams has signed five bills into law to regulate further Li-ion batteries sold in New York City and strengthen fire safety related to battery fires.[4]

The severity of fires caused by Li-ion batteries — and a phenomenon known as thermal runaway — has the potential to cause devastating losses. In Illinois, a factory fire in 2021 ignited around 100 tons of lithium-ion batteries, requiring the evacuation of over 4,000 individuals from the vicinity due to the release of toxic fumes and smoke.[5] It took firefighters over 72 hours to bring the fire under control.

Global Li-Ion Battery Figures:

1. The global demand for Li-ion batteries will increase almost seven-fold between 2022 and 2030, reaching 4.7 TWh in 2030.
2. The lithium-ion battery market is expected to reach USD257 billion in 2030, while the battery chain, including mining and recycling, can cross USD400 billion.
3. The automotive sector is the major user of lithium-ion batteries. In the US, 64% of total lightweight vehicles will be EVs by 2030.
4. Electric cars made up 18% of total car sales in 2023, more than four times the market share of 4% in 2020.
5. The EV market is expected to grow at a rate of 17.8% from 2023 to 2030 and reach USD1,580 billion.
6. Nearly 24% of all EV fires are directly caused by lithium battery packs.[6]

Spotlight

Why are we seeing more li-ion battery fires?

Li-ion batteries offer many benefits, and there have been notable advancements to improve their stability and reduce fears of spontaneous fires occurring. However, concerns remain about the potential for battery packs to overheat and/or explode.

Damage to batteries, their improper disposal, and issues with quality during the manufacturing process are factors that increase the risk of combustion.

The escalation in lithium-ion fire incidents can be largely attributed to the increased demand for devices running on such batteries, including laptops, phones, e-scooters and bikers, and smartwatches. Globally, demand for Li-ion batteries is expected to surge seven-fold from 700 GWh in 2022 to around 4.7 TWh by 2030.

EVs and other mobility devices will make up most of this demand, reaching 4,300 GWh by 2030.[7] The Li-ion battery market was valued at USD50.98 billion in 2022 and is expected to grow with a CAGR of 19.3% to 2030.[8]

"Fires caused by lithium-ion batteries are becoming more common as we rely on them to power an increasing number of our daily-use devices. From our wristwatches and cell phones to other household appliances, it is easy to find five to seven items with a lithium-ion battery just by looking around.

Although these batteries are small and have been manufactured by reliable companies for years, they still have their problems, if damaged, for instance."

— Donna Settle, Property Risk Engineering Leader, Gallagher

The Unique Properties of Li-Ion Battery Fires

Unlike traditional fires fueled by burning materials such as wood or gasoline, Li-ion fires are triggered by a chain reaction known as thermal runaway. Once ignited, they eject a range of flammable and toxic gases, which can also spread out and cause explosions. Li-ion battery fires are:

- **Toxicity:** The burning battery releases toxic fumes, such as hydrogen fluoride, that can irritate the respiratory system and even be fatal if inhaled at high concentrations.
- **High temperature:** The intense heat generated can melt or ignite surrounding materials, cause additional property damage, and pose challenges during attempts to escape or extinguish.
- **Reaction with salt water:** EVs that have been flooded in coastal regions are exposed to salt water, which infiltrates the battery pack and corrodes the connections, leading to short-circuit and subsequent thermal runaway.[9]
- **Deep-seated flames:** The heat source is in the battery's core, surrounded by other parts, making it difficult to penetrate and cool the burning components. This is especially true with EVs.
- **Reignition risk:** Even after the initial flames are extinguished, residual chemical energy can cause batteries to reignite days later.

How thermal runaway occurs

Consider this scenario: A minor manufacturing defect leads to a short circuit in a smartphone's lithium-ion battery. The short circuit, in turn, generates localized heat and increases the battery's temperature. This rapid and uncontrollable temperature rise, known as thermal runaway, causes the flammable electrolyte to break down in an exothermic reaction, releasing toxic gases.

The gases increase internal pressure and potentially compromise the battery casing. The escaping gases can catch fire or cause the battery to explode, posing a safety hazard.

Thermal runaway can be triggered by manufacturing defects, physical damage to the battery, improper charging practices, or aging. It is a self-sustaining chemical reaction that keeps increasing the temperature and pressure inside the battery until an ignition and/or explosion occurs. Unless the reaction can be cooled quickly or the battery can be safely contained, such fires are difficult to put out using conventional firefighting methods.

"When an exothermic reaction occurs in one part of the battery, it starts to release heat and deform, leading to uncontrolled heat production that can result in a cascade effect to the next cell and eventually cause a fire. Additionally, it starts releasing flammable gases, which can cause an explosion from the container, making the fire hard to extinguish."

— Peter Simon, Northeast Regional Manager of Loss Control, GB Technical Services

Urban centers: denser spaces, more risk

With large populations and demand for technology, urban areas have a high concentration of lithium-ion batteries. The growing popularity of micromobility vehicles means more batteries are stored and charged within or in close proximity to buildings. Here, a single fire can pose a significant threat to people and property.

Certain types of property are more exposed than others. These include multi-occupancy high rises, public buildings (those providing public charging stations), and student accommodation (where there is typically a high concentration of electronic devices, and micromobility vehicles). Charging stations for EVs often have numerous batteries concentrated in a single location, creating a potential fire hazard should any of them malfunction.

Charging equipment malfunctions, defects in the product, voltage fluctuations, and other electrical faults can also spark battery fires. In Queens, New York, a deadly house fire was caused by an e-bike battery being plugged into an incompatible charger.

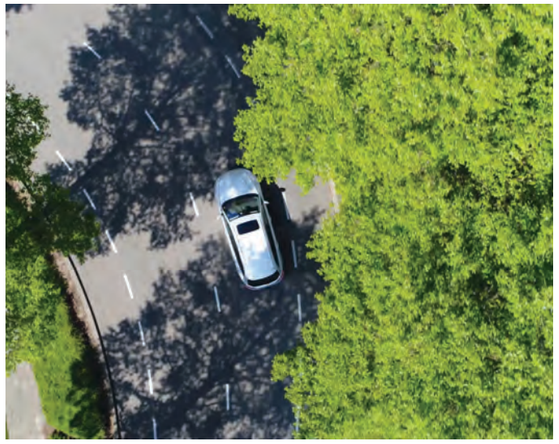
Since EVs take a lot of time to charge, owners tend to leave their vehicles unattended while charging. This increases the likelihood that red flags will go unnoticed, with a concentration of risk in multi-story or basement facilities.

In the UK, the government published interim guidance in 2023 on best practices when and where installing charging points in covered car parks. Developed by Arup for the Department for Transport,[10] the guidance integrates fire safety considerations into such installations. It recognizes that EV battery fires have unique characteristics, including:

- **Re-ignition:** Fires can reignite hours or even days after they have initially burnt out due to thermal runaway, causing adjacent cells to heat up in a cascading effect.
- **Compressed gas venting** can result in flash fires or directional jet flames. If compressed gases accumulate in a confined space in the right proportions, they may even cause a vapor cloud explosion.

"When people need to park their electric vehicles in high-rise buildings, they often do it right next to their unit's front door instead of driving it all the way to the back. However, this creates a safety risk as these vehicles can catch fire and become a hazard for the occupants. Many cities are considering banning them from high-rise structures, but some property owners are still allowing them."

— Donna Settle, Property Risk Engineering Leader, Gallagher



Electric vehicles

EVs are one of the most significant contributors to Li-ion-related fires worldwide, a risk set to increase as the number of vehicles on the road increases. While some evidence suggests that EV fires are less frequent than those in hybrid vehicles and petrol or diesel vehicles, the severity can be much greater.[11]

One of the biggest components of an EV is the battery pack, with fires behaving according to battery size, chemistry, and state of charge, among other factors. The extreme heat generated by EV battery fires can reach up to 4,900°F (2,700°C).

Battery packs store significant amounts of energy but are susceptible to catching fire when damaged or exposed to saltwater intrusion, which corrodes and short circuits traditional Li-ion batteries.[12]

In Florida, several EVs were reported to catch fire after being submerged in storm surge floodwaters following Hurricane Ian in September 2022, a phenomenon that was also witnessed during recent typhoons in Japan.[13]

Nearly 24% of all EV fires are directly caused by lithium battery packs.[14] In March 2024, the main highway of Illinois was closed for nearly three hours due to a single EV burning on the road.[15] It took the combined effort of three fire departments and thousands of liters of water to prevent the blaze from spreading.

EV-related blazes are a growing marine exposure. In 2022, the Felicity Ace cargo ship, carrying around 4,000 luxury vehicles, including electric vehicles, caught fire in the middle of the Atlantic Ocean. Every vehicle on board was consumed, causing the vessel to sink, with one vehicle manufacturer incurring total damages of around USD335 million as a result of the incident.[16]

Commercial property and liability risks

For businesses, Li-ion battery fires can cause substantial disruption, resulting in property damage and business interruption and putting the safety of workers and customers at risk. There are other liabilities to consider, not just product liability for the manufacturer.

These include pollution incidents that may arise from contamination of water and soil during and after a fire-fighting operation. The fire that occurred in Morris, Illinois, in 2021 is one example. Fearing that water or foam could cause the battery packs to explode, firefighters used 28 tons of cement to smother the flames.[17]

After the fire, the Illinois Environmental Protection Agency took legal action against the former paper mill's owner. In a referral to the state attorney general, it called for the owner to retain an environmental contractor to perform both on-site and off-site remediation.[18]

For waste and recycling facilities, the exposure to fires caused by the improper disposal of Li-ion batteries are significant. The batteries often experience mechanical damage when crushed by the transport vehicles and may ignite in transit or during transfer at the recycling facility. The heat generated during anaerobic processes increases the chance of combustion and offers plentiful material to fuel the flames. California's recycling agency says batteries are the top cause of fire at the state's waste facilities, which result in millions of dollars of damage a year.

A 2021 report from the US Environmental Protection Agency (EPA) found that Li-ion batteries from devices such as wireless earbuds and vape pens thrown into waste disposals caused more than 200 fires at different waste facilities.[19] The sector's growing susceptibility to facility fires makes it difficult for companies to access insurance coverage.

Dubai Bans E-Scooters in the City's Metro

Earlier this year, Dubai, UAE, announced a ban on e-scooters inside the Metro and Tram effective from March 1 to enhance passenger safety. The Roads and Transport Authority (RTA) stated that commuters could no longer carry e-scooters inside metro facilities.[20]

It follows an incident in February when smoke detected from an electric scooter led to services being delayed for nearly an hour at one of the city's busiest stations.[21]

Spotlight

Taking the heat off: New fire codes and best practices

Government authorities and regulatory bodies are introducing new safety standards and fire codes to mitigate the risk and ensure the safe use of Li-ion technology. The **EU Battery Regulation 2023/1542**,[22] which came into effect on February 18, 2024, provides new safety requirements for Li-ion batteries, including setting minimum standards for quality assurance.

Underwriters Laboratories (UL) have developed two new standards — **UL 9540 and UL 9540A**,[23] that focus on the safety of Energy Storage Systems (ESS):

- **UL 9540:** System-level listing standard that defines ESS's design, construction, and performance requirements to ensure their overall safety.
- **UL 9540A:** A standardized test method that evaluates how well an ESS design can contain thermal runaway events within a single battery cell and prevent fire from spreading to other cells.

The National Fire Protection Association is considering the development of a Battery Safety Code, to provide uniform, minimum requirements to address fire, electrical, life safety, and property protection from battery hazards. Requirements are anticipated to include fire, explosion, and other dangerous conditions related to battery technologies as experienced through the lifecycle of a battery: raw materials and battery production through storage, use, and end of life.

From a product liability perspective, quality control testing remains important to ensure that metal fragments are not generated during the manufacturing process, which could later cause a short-circuit and subsequent fire.

Industries that are heavily reliant on the use of Li-ion battery storage are investing in early detection, systems to locate and cool overheating batteries before they become dangerous.

A best practice approach includes close adherence to safety standards and careful inspection and disposal of damaged batteries. Staff should be made aware of the threat and given clear guidance on how and where batteries can be stored and safely charged.

"Anecdotally, it appears a disproportionate number of fires are created by low-quality batteries that do not have the appropriate certification or quality control, thus the increased propensity to fail resulting in thermal runaway. These batteries are often favored due to low price point.

The non-certified battery risks have become so problematic that some jurisdictions (NYC, for example) have passed laws prohibiting the buying and selling of batteries that are not UL certified. But even with the new laws, people are still buying and selling these non-certified batteries online."

— Peter Simon, Northeast Regional Manager of Loss Control, GB Technical Services

"Early detection systems are critical in controlling fires, but they are still in their initial stages of development. While progress has been made in developing early detection systems for controlled environments, such as large enclosed battery storage systems, implementing these systems in residential properties is not feasible due to their high cost."

— Donna Settle, Property Risk Engineering Leader

Conclusion: Adapting to Change; Building Resilience

Li-ion batteries are an essential part of the journey to Net Zero and transition to renewable sources of energy. Battery storage units are critical to providing a steadier and more predictable load to the electricity grid, which reduces the inherent volatility in renewable energy sources, such as wind and solar.

In cities and beyond, they are an increasingly important technology, an integral part of digital economies and the next generation of transportation.

Improvements in quality and safety are constantly being made, but exposures will continue to grow as our reliance on Li-ion batteries increases.

As the landscape continues to shift, underwriters are reevaluating how they price and assess the risk, with the potential for stricter wording and exclusions in the future.

Taking proactive steps to mitigate exposure to thermal runaway involves investment in safety controls and quality assurance across the value chain, alongside greater education and awareness on how Li-ion battery fires can be prevented.

"While I am not aware of any Li-ion battery exclusions through ISO and have not seen any carrier-specific Li-ion battery exclusions, it would not surprise me if carriers started pushing for that type of exclusion in the future. The biggest underwriting concerns are thermal runaway situations that cause fires or explosions if the batteries are stored centrally without appropriate controls in place.

One of our automotive industry clients gave us just a few business days' notice that they had full truckloads being delivered for storage. They had specifically had metal casings installed over the multiple Li-ion batteries to prevent fire or explosion.

We had to provide the property and casualty underwriters with detailed information about how the technology worked to get them comfortable with the client storing such a large volume of Li-ion batteries.

One of the property carriers issued a non-renewal when we had them increase the values in New York to reflect the battery storage. We were able to replace them with London capacity, but it was not easy."

— Tom Ryan, Senior Vice President, Casualty Practice Leader, ***Gallagher***

Spotlight

Reduce Your Exposure to Li-Ion Battery Fires

- **Ensure safety standards and compliance:** Implementing and adhering to local and international safety standards, such as UL 9540A, demonstrates a commitment to risk reduction.
- **Acquire specialized insurance coverage:** Explore specialized EV or battery-specific insurance options for better protection.
- **Foster employee training and awareness:** Educate employees on the safe handling, storage, and disposal of lithium batteries to further reduce the risk of accidents. Perform regular inspections to identify damaged batteries quickly.
- **Follow storage and charging best practices:** Avoid charging in extreme heat, keep doorways and passages clear while charging, and keep charging ports away from combustibles. Encourage the use of approved, quality-assured batteries and chargers, and the proper disposal of batteries in a facility capable of handling them. Do not charge devices overnight.

Citations

1 Ungoed-Thomas, Jon. "'Unexploded bombs': call for action after 11 deaths in UK due to e-bike fires." *The Guardian*, 9 March 2024.
2 "What You Need to Know About Home Fire Risks from Lithium Batteries." *Orion180*, 22 November 2023.
3 J.Kelly, Keith. "Lithium Batteries Drive Fire Death Toll to 106 Across City in '23, Highest in 20 years." *Chelsea News*, 30 January 2024.
4 "Mayor Adams Announces Plan to Combat Lithium-Ion Battery Fires, Promote Safe Electric Micromobility Usage." *City of New York*, 20 March 2023.
5 "Nearly 100 Tons of Lithium Batteries Involved in Large Morris Industrial Fire." *NBC Chicago*, 29 June 2021.
6 Linder, Jannik. "Lithium-Ion Battery Fire Statistics: Market Report & Data." *Gitnux*, 27 May 2024.
7 Fleischmann, Jakob et al. "Battery 2030: Resilient, sustainable, and circular." *Mckinsey & Company*, 16 January 2023.
8 Trevisano, Urbano. "Lithium-Ion Battery Market Set to Witness Impressive 19.3% CAGR Growth Over 2023-2030." *LinkedIn*, 14 December 2023.
9 Picon, Andres. "Why 6 flooded EVs burst into flames after Hurricane Ian." *E&E News*, 21 October 2022.
10 Dhanjal, Rav. "Arup develops fire safety guidance for EVs in covered car parks." *Arup*, 17 July 2023.
11 Friswell, Sally. "Guidance issued on EV fire safety in car parks." *RICS*, 3 May 2024.
12 "Extreme fire risk with EV's exposed to salt water - Coast Guard issues alert to not allow on ships." *CTIF International Association of Fire and Rescue Services*, 6 February 2023.
13 "Electric vehicles catching fire after being submerged in salt water during Hurricane Ian." *CTIF International Association of Fire and Rescue Services*, 18 October 2022.
14 Linder, Jannik. "Lithium-Ion Battery Fire Statistics: Market Report & Data." *Gitnux*, 20 December 2023.
15 Wehner, Greg. "Tesla battery catches fire in Illinois, shutting down highway for nearly 3 hours: Report." *FOXBusiness*, 19 March 2024.
16 Valdes-Dapena, Peter. "Burned ship carrying luxury cars has now sunk." *CNN Business*, 2 March 2022.
17 Babwin, Don. "Batteries exploding in burning abandoned Illinois building." *AP News*, 1 July 2021.
18 "Superior Battery Inc." *Illinois Environmental Protection agency*, 8 February 2023.
19 Crespo, Yaima. "Why lithium batteries are a growing problem for trash and recycling services." *NBC Miami*, 11 March 2024.
20 "Dubai: E-scooters banned inside metro, tram." *Khaleej Times*, 29 February 2024.
21 Dhanjal, Meher. "Services restored after Dubai Metro station announces delay due to smoke detection." *Khaleej Times*, 14 February 2024.
22 "Circular economy: New law on more sustainable, circular and safe batteries enters into force." *European Commission*, 17 August 2023.
23 "What You Need to Know Now About Fire Codes Governing Lithium-ion Battery Use." *Vertiv*, 2 July 2021.

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