Fire hazards associated with lithium batteries

The lithium-ion battery market was valued around **$56 B** at the end of 2021 and is poised to reach a market cap of **$280 B** by 2030.

Within the past several years, these batteries have been involved in a group devastating fires. Read on to discover key factors to help mitigate these risks.

Background

The use and presence of lithium-ion batteries have grown tremendously in the past few decades from a new battery chemistry positioned as a rechargeable technology to becoming the predominant energy source of mobile and portable electronic products. First developed to address needs for low weight, long life cycle energy sources for the smart phone, tablet and camera markets, lithium-ion technology has grown rapidly and now provides energy sources for not only consumer electronics, but for:

- Power tools
- Household electronic devices
- Automated storage retrieval robots
- Energy storage systems
- Electric vehicles and micro-mobility devices

The success with Li-ion batteries lies in their high specific capacity, energy density, and power density. These characteristics make the lithium-ion battery the choice for all of these devices today.

Every Hartford insured will have exposure to lithium-ion batteries in one form or another, including the following occupancies:

- Hospitality
- Technology
- Retail
- Healthcare
- Education
- Life sciences
- Manufacturing
- Service businesses

Lithium-ion batteries now make up at least 37% of the consumer market for portable devices and electric vehicle powertrain.

In addition to Electric Vehicles, these batteries are used in consumer devices, defense applications, energy storage systems, data center backup units, eCigarettes, photovoltaic systems, and micro-mobility devices such eBikes and eScooters. The lithium-ion battery market was valued around $56 B at the end of 2021 and is poised to reach a market cap of $280 B by 2030.

Lithium-ion Battery Module

Within the past several years, these batteries have been involved in a group of fires due to a design aspect of the chemistry which makes them more prone to ignition and explosion. The US Consumer Product Safety Commission reported more than 25,000 issues involving fires or over-heating associated with Li-Ion batteries in a 5-year period.

Why are Li-Ion batteries a problem?

Li-Ion batteries utilize an SEI (solid electrolyte interphase) layer which affects the charge and discharge rate and the life of a battery cell. These batteries are also constructed with a separator within the electrolyte, which segregates the anode (negative) and the cathode (positive). The most common electrolyte is a flammable lithium salt solution that allows an electrical charge to pass between the two terminals (anode and cathode), converting stored energy into usable electrical energy.

The electrolyte and separator are less tolerant to increasing temperature than the electrodes or current collectors. When the electrolyte is allowed to leak due to physical damage or puncture, if the separator deteriorates due to a manufacturing defect or short circuit, or if the cell heats up due to overcharging, an ignition can occur, creating excessive heat within the cell.

Thermal Runaway Process

The buildup of heat within the battery cell can expand to adjacent cells, as they are often joined in a battery module, with modules arrayed in a pack, which makes them vulnerable to a phenomenon called thermal runaway. When the temperature of a Li-Ion battery increases to about 300° F, the high-energy materials and organic components are not stable and are capable of producing additional heat.

If the heat is not able to dissipate fast enough, the battery temperature will increase and accelerate the heat-releasing process. This process is known as thermal runaway which releases flammable gases from the battery materials. This includes the organic electrolyte, and will accumulate inside the battery module/pack, allowing the gas to accumulate which can result in the rupture of the battery and a flash fire and explosion.

The loss landscape

Loss data associated with lithium-ion battery fires is sporadic and not well aggregated. The US Consumer Product Safety commission recently reported that they have identified over 25,000 issues involving fires over just a 5-year period. Initially, lithium-ion battery fires were seen in personal computer devices such as laptops and other electronic devices.

Fire involving lithium-ion battery powered eBike

More recently, lithium-ion battery fires have started to occur in electric vehicle (EV) batteries, eBikes, eScooters, hoverboards, and eCigarettes. In 2022 alone, there were 200+ reported fires caused by lithium-ion batteries in micro-mobility devices in New York City. This represents a 50% increase over the 104 fires reported by the FDNY involving this equipment in 2021. A recent fire, traced to a faulty lithium-ion battery, developed on the 20th floor of a high-rise building in Manhattan, causing over 36 injuries. Reportedly, the fire was related to a battery in a micro-mobility device. The 200 fires involving micro-mobility devices in 2022 in New York resulted in multiple millions of dollars of damage with a reported 6 deaths, all from eScooters and eBikes.

Significant fires

Some of the more notable significant fires involving lithium-ion batteries include:

Cardboard Recycling Plant - Jamaica, NY

Five-alarm fire which shut down the Long Island railroad for over ten hours when a fire originating in a lithium-ion battery powered device-ignited trash, paper, and recycled cardboard.

Paper Mill – Morris, IL

An abandoned paper mill was being used to storage over 200,000 lithium-ion batteries. Water leaking from the roof caused a battery to ignite, creating a chain reaction of battery explosions due to thermal runaway. The fire was eventually controlled by pumping in dry cement to cover the burning batteries to a depth of 3 feet.

Underground Parking Lot – Quebec, Canada

A Hyundai Kona EV battery pack ignited while the vehicle was parked in an underground parking garage, requiring the fire department to evacuate the entire 8 floors of the building, ventilate the garage to reduce smoke, and then extract the vehicle from the building.

Cargo Ship – Atlantic Ocean

A cargo ship (Felicity Ace) carrying over 4,000 vehicles sailing from Germany to the US was involved in a fire affecting a significant amount of the vehicles , some of which were EV's with lithium-ion batteries. While the cause has not been formally identified, the existence of lithium-ion battery-powered vehicles created concerns for re-ignition potential once the on-board fires were laced under control.

Grand Concourse Fire – Bronx, New York

A lithium-ion battery in an eBike being charged inside a restaurant ignited a fire which quickly spread to the restaurant and multi-occupant building resulting in a 4-alarm response from FDNY with over 160 firefighters. It was later learned that several workers at the restaurant routinely charged their eBikes in the restaurant overnight.

EV Parking Station – New Delhi, India

A major fire developed and spread in an electric vehicle parking station in 2022, damaging or destroying 93 vehicles (EV's and electric-powered rickshaws). A short circuit in an EV battery was believed to be the source of the fire.

Evidence of overheated Lithium-ion phone battery.

Reducing the Li-Ion risk

The nature and sensitivity to the threat of fire involving Li-ion batteries requires a multi-faceted approach to prevent fires involving this type of equipment and materials, as well as strong fire protection measures. Operations exposed to significant potential threats include: areas of bulk battery recharge or refurbishment; storage of batteries for distribution; storage of electronic devices, including Li-ion battery packs; enclosed parking areas with EVs and EV recharging; habitational storage and recharging of micro-mobility devices; warehouse operations with robot-controlled storage; and retrieval systems and retail shops with eCigarettes, eBikes and eScooters.

The increasing fire threat involving eBikes and eScooters is highly correlated with the practice of consumers purchasing 3rd-party batteries from a variety of sources, most of which are not tested by a recognized testing laboratory to assure preventative devices and safety features are well designed and incorporated into battery packs and re-charging units.

Underwriters Laboratory published the UL 2272 standard in 2016 which addresses and certifies electrical systems in personal electric mobility devices. In 2020, UL published the UL 2849 standard which is specific to eBikes. The latter standard addresses the battery management system (BMS) which is able to monitor and prevent overheating and overcharging issues.

Risk mitigation actions

- Segregated and automatic sprinkler protected storage of lithium-ion battery packs
- Use UL listed Lithium-ion battery charging stations
- Limiting and controlling Li-Ion battery recharging operations in segregated area
- Adequate inspection, testing and maintenance programs for lithium-ion batteries used in automation and robotic systems
- Adequately designed sprinkler system for UPS backup systems in server rooms and data centers

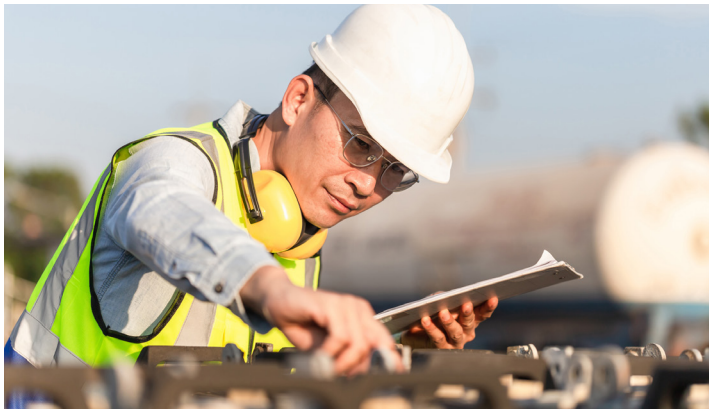
- Safe storage, handling, and recharging of Li-Ion micro-mobility devices
- Safe control and segregation of damaged, returned, or expended Li-Ion batteries
- Fire-resistant construction segregating storage of Li-Ion battery exposures
- Relocating devices powered by Li-ion batteries to detached storage areas where possible
- Limiting the quantity of storage and re-charging of micro-mobility devices to only those devices that show a UL-listed marking

The Hartford REO property services

Your Risk Engineering business partners provide the first line of defense in reducing likelihood and severity of fires and explosions associated with products and devices powered by lithium-ion batteries. As a sponsoring member of the Property Insurance Research Group (PIRG), an arm of the National Fire Protection Association (NFPA), The Hartford REO not only benefits from early fire testing and control methodologies for emerging fire threats, but also actively participates in recommending solutions that will work their way into national codes and standards.

Through comprehensive on-site surveys and service consultations, Risk Engineering delivers the following to our external customers:Identifies and evaluates Emerging Issues, including lithium-ion battery fire risk

- Identifies inadequacies and offers solutions for improvement to minimize lithium-ion battery risk
- Identifies and evaluates Emerging Issues, including lithium-ion battery fire risk



Engineer checking on a battery storage system.

- Consults with insureds to reduce risk posed by lithium-ion battery storage and recharge, battery-powered tools, eMobility products, handling of batteries, electric vehicle charging, and others
- Manages open recommendations follow-up and coaching to drive risk improvement

Resources

Contact Risk Engineering or go to TheHartford.com/risk engineering and enter your current policy number for on-demand solutions focused on the loss trends that most impact your industry. Learn how to prevent product/completed operations incidents by utilizing the following resources:

- Supply Chain Risk
- Contract Management Best Practices Industry specific guidance can be found here:

  CPSC Status Report on High Energy Density Batteries Project (2028)

  NFPA Lithium-ion Battery Safety for Consumers

  NFPA PIRG Lithium-ion Batteries Hazard and Use Assessment

  University of Washington Environmental Health and Safety

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