



# Lithium-Ion Battery Fires



## Overview:

Lithium-Ion (Li-ion) batteries are becoming more prevalent in consumer products ranging in size from smaller products such as mobility devices up to and including use in large-scale power grid support. These smaller devices are being used in everyday applications by the public and are consequently being stored, charged, sold or repaired inside residential and commercial occupancies.

Fires involving lithium-ion batteries have been increasing at an alarming rate and have resulted in fatalities. Even when the initial cause of a fire was not the lithium-ion device, the involvement of lithium-ion batteries in a fire can increase the intensity of the fire.

Lithium-Ion batteries are commonly used in many devices which include:

- Electric bikes
- Electric scooters
- Hoverboards
- Wheelchairs
- Drones
- Power tools
- Laptops
- Cell phones
- E-cigarettes



## Hazards and Considerations:

Batteries may rupture and vent toxic flammable gases and/or explode violently when the gases ignite, when subject to the following:

- Thermal – Hot or Cold temperatures.
- Physical – Impacted, crushed, or pierced.
- Electrical – Over-charging or forced discharge, including internal manufacturing defects or internal short circuiting.
- Drying after being wet.



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It may be difficult to discern if a Lithium-Ion battery pack or cell is compromised; the resulting heat signatures may not be picked up by a Thermal Imaging Camera (TIC).

***Note: A thermal imaging camera shall not be relied upon to determine if a Lithium-Ion battery pack or cell is compromised.***

***Thermal Runaway.*** When the stable state of batteries/cells rapidly fails due to increased heat from charging or external conditions such as fire, the cell transitions from a stable state to an unstable state and then to catastrophic failure of the cell. Once thermal runaway begins it will propagate (spread, domino effect) to the adjacent battery cells. It may only take seconds for this dangerous event to take place. Usually there is a “pop” or rupture sound heard proceeding Thermal Runaway with pressurized white smoke (flammable / toxic gases) venting moments prior to ignition. Water may not prevent a battery from entering thermal runaway. If able to penetrate the battery case, water may provide a cooling effect on the adjacent battery cells. This cooling may reduce propagation to other cells.

***Dry Chemical and Foam Extinguishers are ineffective for any type of Lithium-Ion related extinguishment.***

***Flammable and Toxic Gases.*** Lithium-Ion batteries in thermal runaway produce many different gases. These gases combine to form a flammable, explosive and toxic atmosphere. Toxicity and flammability levels vary depending on specific battery technology and manufacturer. ***Refer to ERG/DOT Guides 147 & 125.***

***Unexpected Re-ignition.*** Lithium-Ion batteries are known to unexpectedly re-ignite (with no warning) minutes, hours or even days after all visible fire has been extinguished.

***Explosive Force.*** There are documented cases where Lithium-Ion batteries ruptured and ignited with such force that walls were blown down resulting in structural damage and extensive fire spread.





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## Actions:

- All personnel shall operate at Lithium-Ion battery fires in full personal protective equipment and SCBA, properly donned. This includes outdoor Li-Ion battery fires.
- The discovery of Lithium-Ion Batteries while operating at a structure fire, or during overhaul operations shall be immediately communicated to the IC via radio. If it is determined that Li-Ion Batteries are involved in fire, have been exposed to elevated temperatures, or are showing signs of battery failure, it should be communicated to the IC as an "URGENT" emergency radio message.
- Use a handline to extinguish the fire; flames from a Lithium-Ion battery should be knocked down with copious amounts of water. Water application should continue until conditions are dormant-that is when no more flame, gas or smoke is being released from the battery or mobility device.
- Li-Ion Batteries or mobility devices which are involved in fire, found within a fire area, or subjected to elevated temperatures **MUST** be moved from the area in which members will be operating. This should be accomplished before overhaul operations begin.
- When possible, prior to overhaul in the area of the Lithium-Ion battery or mobility device, members should conduct a diligent search for stray battery cells. These individual cells may have become dislodged from the battery pack during the fire or by the hose stream during extinguishment.
- Firefighters must not place the Lithium-Ion battery pack or cells in the pocket of their bunker coat or pants.
- When possible, members should move the Lithium-Ion batteries by use of a nonconductive tool, a shovel with a wooden handle or other method that doesn't require members to carry in their hands.





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- The batteries or mobility device should be moved to the following location in order of preference until it can be appropriately over packed/mitigated by a HAZMAT Company
  1. Bathroom tub in fire apartment, with all cells fully submerged in water.
  2. Sink large enough that all cells can be fully submerged in water.
  3. Garbage pail or bucket large enough that all cells are capable of being fully submerged in water.
- When the above options are not practical, the Incident Commander may order the removal of the batteries or mobility device via a fire apartment window.
- When the battery or mobility device is in a location that makes removal via fire apartment window not practical, such as in an upper story apartment in a high-rise building, the Incident Commander may order the batteries or mobility device moved to a different location on the fire floor while ensuring that the batteries are protected by a charged hoseline. The charged hoseline will remain in place until overpacking/mitigation procedures have been completed by a HAZMAT Company.
- A Lithium-Ion battery or mobility device shall NOT be moved in an elevator or via stairs unless overpacked (mitigated) by HAZMAT and approved by the IC.
- Removal and Overpack Procedures for Lithium-Ion batteries shall be conducted in the following manner while wearing full PPE and SCBA donned, and under the protection of a charged hoseline:
  - a. A 5 or 18-gallon CellBlock Transportation Pail, along with CellBlock Fire Suppression Loose-Fill media will be utilized for overpacking.
  - b. Start with an open pail, and line the bottom of the pail with approximately 2 inches of CellBlock Loose-Fill.
  - c. Using a non-conductive shovel, place battery/batteries inside of pail. Do not layer batteries on top of each other.
  - d. Once batteries are placed inside of pail, add approximately another 2 inches of CellBlock Loose-Fill, ensuring to fully cover all batteries.



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- e. If necessary, repeat steps C and D to add more batteries until pail is full. There must be approximately 3 inches of CellBlock Loose-Fill between the last layer of batteries and the top of the pail.
- f. For battery packs attached to E-Bikes or Scooters, the frame containing the battery will have to be cut in order to remove battery. ***DO NOT CUT OR FURTHER DAMAGE THE BATTERY.***
- g. Pail must be secured with supplied metal lid and locking clamp.
- h. After 24-48 hours, the entire contents of the pail will be transferred to the 55-gal CellBlock Drum.
- i. Li-Ion Containment systems shall be located in a secure area away from structures vehicles, etc.
- j. Full PPE with SCBA donned shall be worn during this procedure.
- k. Upon transfer from 5 or 18-gal pail, to 55-gal drum, the pail will be returned to HAZMAT to be placed back in-service.
- l. Coordinate with fire investigators to preserve evidence for Origin and Cause Investigation Reports.
- m. Li-Ion batteries shall be disposed of according to DOT and EPA/DEP regulations.



### Safety Considerations:

- Full PPE with a donned facepiece must be worn at all times with Lithium-Ion batteries or mobility devices that have been involved in fire or subjected to elevated temperatures.
- Due to the rapid re-ignition danger when involved in fire or subjected to elevated temperatures, full PPE with a donned facepiece must also be worn at all times during the following:
  - a. Whenever members are operating in the immediate area / same room.
  - b. When handling or removing from an area to the bathtub, sink or bucket.
  - c. When securing a mobility device with a rope for removal via window.
  - d. Physical damage (impacted, crushed or pierced) to the Mobility Device or Battery.
- Anyone exposed to gasses or smoke produced by Li-Ion batteries shall be decontaminated by HAZMAT and examined by EMS. This includes fire personnel, additional first responders, and civilians.