



Carroll County Department of Fire & EMS

Standard Operating Procedure: 4.08	Effective Date: 05/15/2024
Subject: Lithium-Ion Battery Response	Section: Fire Rescue Operations
Authorized: Chief Michael W. Robinson, Director	Revision Date: N/A

I. PURPOSE

This standard operating procedure describes the hazards associated with Lithium-Ion Batteries used to power equipment such as personal electronics, personal mobility devices, electric vehicles, residential and commercial battery energy storage systems. It also addresses size-up along with operational awareness and procedures when responding to these incidents.

- A. Lithium-Ion (Li-ion) batteries are prevalent in consumer products ranging in size from smaller personal 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.
- B. Lithium-Ion batteries can be found as single cells, pouches, or prismatic packs. They can also be combined using multiple cells to make a battery module like found in a handheld tool battery or E-bike. Multiple modules can be combined to form a battery pack like is found in electric vehicles and battery energy storage systems.
- C. 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.
 - 1. Lithium-Ion batteries are commonly used in the following applications:
 - a) Small electronic devices (i.e. cell phones, E-cigarettes, etc.)
 - b) Laptops
 - c) Personal Mobility Devices (PMDs)
 - a. Electric Bikes
 - b. Scooters
 - c. Hoverboards
 - d. Wheelchairs
 - d) Electric and hybrid vehicles
 - e) Battery Energy Storage Systems (BESS/ESS)
 - a. Residential – EV Charging, Photovoltaic

b. Commercial – Stand-alone units, In-building units

D. HAZARDS/SAFETY

1. Batteries may rupture and vent toxic flammable gases and/or explode violently when the gases ignite, when subject to the following:
 - a. Thermal – Hot or Cold temperatures.
 - b. Physical – Impacted, crushed, or pierced.
 - c. Electrical – Over-charging or forced discharge, including internal manufacturing defects or internal short circuiting.
 - d. Drying after being wet.
2. Respiratory protection should always be used by responders in the presence of suspect lithium-ion batteries to prevent unexpected inhalation of toxic gases. Any inhalation of these gases should receive a medical evaluation.
3. Full PPE with a donned facepiece must be worn at all times with lithium-ion batteries that have been involved in fire or subjected to elevated temperatures and are either intact or their status is unknown.
4. Due to the rapid re-ignition danger of batteries involved in fire, subjected to elevated temperatures or physical damaged (impacted, crushed, pierced), 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 (i.e. same room)
 - b. Handling batteries or a Li-Ion powered device (i.e. removing from an area to the bathtub, sink or bucket)
 - c. Whenever removing a Li-Ion battery, equipment or personal mobility device out of structure (i.e. removing through the interior or a rope removal via window.
5. 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) due to the speed in which it can occur or the outer protective housing
6. Thermal Runaway occurs when the stable state of batteries/cells rapidly fails due to increased heat from charging or external conditions such as fire or mechanical damage, the cell transitions from a stable state to an unstable state followed by catastrophic failure of the cell. Once thermal runaway begins it may propagate (spread, domino effect) to the adjacent battery cells. It may only take seconds for this dangerous event to take place and should be expected to occur.
 - a. Usually there is a “pop” or rupture sound heard preceding Thermal Runaway with pressurized white smoke (flammable / toxic gases) venting moments prior to ignition.
7. Water may not prevent a battery from entering thermal runaway. Water may provide a cooling effect when applied directly to adjacent battery cells or conducted through the case surrounding the cells. This cooling may reduce propagation to other cells.
8. Dry Chemical agents and foam are ineffective for any type of lithium-ion related extinguishment.

9. Lithium-Ion batteries in thermal runaway produce many different gases. These gases combine to form a flammable, explosive and toxic atmospheres. Toxicity and flammability levels vary depending on specific battery technology and manufacturer. Elevated carbon monoxide readings on a multi-gas meter absent any fire and smoke may inform responders of thermal runaway occurring.
10. Lithium-Ion Batteries are known to unexpectedly re-ignite (without warning) minutes, hours or even days after all visible fire has been extinguished. Reignition is a common occurrence and can happen with explosive force, especially in a confined area. Li-ion batteries have the ability to rupture and ignite with such force that walls can be blown down resulting in structural damage and extensive fire spread.

F. OPERATIONS

1. Whenever the following procedures take place, a charged handline must be in position for Lithium-ion batteries or mobility devices involved in fire.
2. 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.
3. 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.
4. When a Lithium-Ion Battery or mobility device fire involves a fatality or injured civilian all members operating should be aware of the need for scene preservation prior to the arrival of the Fire Marshals. Life safety always takes precedence and if a device or battery must be moved or overpacked, pictures taken where possible prior to the operation. Fire Marshall's shall be informed of the battery's status and associated hazards.
5. 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 module or pack during a fire or by the hose stream during extinguishment. Special attention should be given to furniture where a cell may have become lodged.
6. Firefighters must not place the lithium-ion battery pack or cells in the pocket of their bunker coat or pants.
7. 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.
8. Li-Ion battery cells, small modules or packs and personal mobility device should be moved to a safe location in order of preference below until it can be appropriately

over packed/mitigated by HazMat, MDE, Hazmat Contractor or other subject matter expert:

- a. If batteries involved in fire or thermal runaway continue to present a life safety hazard, a risk assessment should be made to determine if the batteries can be moved safely to the exterior of a structure with on-scene personnel in full PPE using SCBA and buckets/containers.
- b. Bathroom tub in the fire structure, with all cells fully submerged in water.
- c. A sink large enough that all cells can be fully submerged in water.
- d. A salvage bucket, garbage pail or open container large enough that all cells are capable of being fully submerged in water.
- e. When the above options are not practical, the Incident Commander may remove the batteries or mobility device via a window.
 - a. When the battery or mobility device is in a location that makes removal via window not practical, such as in an upper story apartment in a building, the Incident Commander may move the batteries or mobility device to a different location on the fire floor and ensure 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 unit or MDE.
- f. A lithium-ion battery or device shall NOT be moved in an elevator unless overpacked (mitigated) by Haz Mat and approved by the IC.

9. Residential battery energy storage systems

- a) In addition to a charged hoseline and full PPE while operating near the battery energy storage system, members will ensure that they activate any emergency disconnects if safe to do so and understand that the battery system still poses an electrical hazard because of the stranded energy in the container.
- b) Apparatus will position their equipment at the corners of a structure known to have a battery energy storage system, in case of an explosion.
- c) Members will keep a minimum distance of 50 feet from the battery storage system. The Incident Commander will set up a Hot Zone, at their discretion, working with the HazMat team, utility company, and responsible third-party vendors and contractors.
- d) Incident Commanders shall make every attempt to notify the building owner or occupant(s) that there is a risk associated of a secondary event including fire as a result of continued power generation from the battery energy storage system.
- e) Work with responsible party and manufacturer or contractor for incident handover and final mitigation.

1. Commercial battery energy storage systems

- a. First arriving units will isolate the area and provide direction, over the radio, for other incoming units. Recommended distance is 150 feet.
- b. Do not enter any fenced in area unless there is a savable life or known rescue.
- c. Place apparatus in a safe location away from the battery energy storage system and overhead power lines.
- d. Protect exposures.
- e. Defensive firefighting using water streams or F-500 are the preferred agent for response to lithium-ion battery fires.

- f. If a fire develops, take a defensive stance toward the burning unit and apply water to neighboring battery enclosures and exposures.
 - g. If personnel can identify a remote shut off to the unit or system by operating the visible disconnects.
 - h. Work with responsible party and manufacturer or contractor for incident handover and final mitigation.
2. Electric vehicles
- a. Determine offensive or defensive tactics
 - b. Consult vehicle emergency response guide if applicable (do not delay life safety for this)
 - c. Defensive tactics
 - i. Provide safe area
 - ii. Protect exposures
 - iii. Be aware of sudden vehicle movement
 - iv. Be aware of projectile battery cells
 - d. Offensive tactics
 - i. Provide safe area
 - ii. Safely approach vehicle utilizing normal vehicle fire tactics
 - iii. Chock EV wheels if possible
 - iv. Minimum flow of 150 gpm for visible fire and 60gpm for any battery pack in thermal runaway for cooling effect.
 - e. Continue to cool vehicle and battery pack to reduce chances of additional thermal runaway.
 - f. Use thermal imager to monitor vehicle and battery pack for increase temperatures.
 - g. Towing of vehicle
 - i. Vehicles should show no signs of fire or thermal runaway for 45 minutes prior to towing or police investigation.
 - ii. Vehicles should be towed on a flatbed or with wheel dolly to prevent power build-up.
 - iii. Consideration of fire engine and/or tanker to follow tow truck to storage lot in the event of fire.
 - iv. Tow company should be advised to keep vehicle 50 feet away from all exposures.

G. INCIDENT COMMAND CONSIDERATIONS

1. HazMat and/or MDE shall be consulted or requested to any fire or incident involving a lithium-ion battery or device suspected of being powered by a lithium-ion battery.
2. A charged handline shall remain ready until Haz Mat units have completed over packing and mitigation procedures.
3. The determination by the IC to establish a watch line for the over-packed batteries, while awaiting removal, should be determined at the IC's discretion and the guidance of the Hazmat units and MDE.

II. RECISION

This Standard Operating Procedure rescinds all directives regarding Lithium Ion Battery Response or similar content previously issued for personnel of the Carroll County Department of Fire & EMS.