LITHIUM-ION BATTERY MOBILITY DEVICE FIRES

Effective:	June 10, 2022
Scheduled Review:	June 10, 2025
Approved:	Fire Chief Mike Kennedy

Significant portions of this SOP are based of the Fire Department of New York, Fire Tactics and Procedures, Hazardous Materials 20, April 19, 2022. AAFD is grateful for the FDNY sharing their experiences with lithium-ion mobility device fires.

I. PURPOSE

This procedure describes the hazards associated with lithium-ion batteries in mobility devices and addresses size-up, operational awareness and procedures. Most importantly, the bulletin is intended to help assess the degree of risk present with fires involving lithium-ion batteries.

II. BACKGOUND

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 mobility devices which include:

- Electric Bikes (Figure 1)
- Scooters (Figure 2A and 2B)
- Hoverboards
- Wheelchairs

Figure 1

Figure 2A

Figure 2B

III. CONSTRUCTION

Battery cells - the most common is the 18650 cell which is cylindrical (left) and slightly larger than an AA battery (right). (Figure 3)

Figure 3

Battery Pack (Module) - is a group of battery cells connected together in a series or parallel configuration. (Figure 4A and 4B)

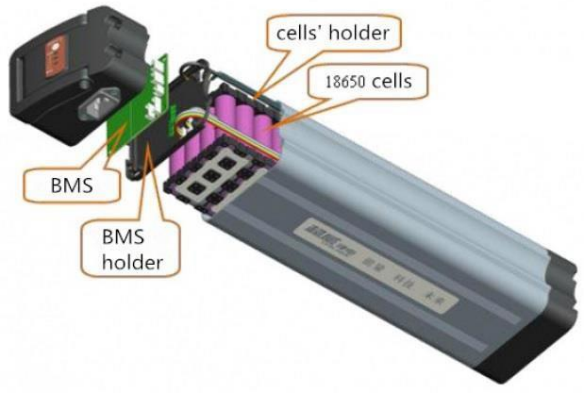

Figure 4A

Figure 4B

Battery packs may be permanently installed or removable from the mobility device. They are located externally on the frame, floorboard (Figure 5A and 5B) or rear rack of the mobility device but can be found internally on some devices. An internal mount is common when the mobility device is foldable (Figure 6). The mobility device in the closed (folded) position may give direct access to the lithium-ion battery pack.

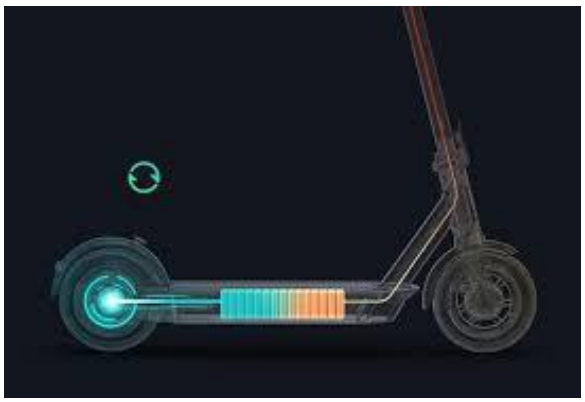

Figure 5A

Figure 5B

Figure 6

IV. HAZARDS

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.

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). 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 is 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.

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 - On more than one occasion in New York City (NYC), lithium-ion batteries ruptured and ignited with such force that walls were blown down resulting in structural damage and extensive fire spread.

V. OPERATIONS

Whenever the following procedures take place, a charged handline must be in position.

When lithium-ion batteries or mobility devices involved in fire, 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.

lithium-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, firefighters should move the lithium-ion batteries by use of a non-conductive tool, a shovel with a wooden handle or other method that does not require members to carry in their hands.

The batteries or mobility device should be moved to the following location in order of preference:

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 remove 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 move the batteries or mobility device to a different location on the fire floor and ensure the batteries are protected by a charged hoseline.

A lithium-ion battery or mobility device shall **not** be moved in an elevator or via stairs unless overpacked (mitigated) as approved by the IC.

VI. SAFETY

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:

- Whenever members are operating in the immediate area / same room.
- When handling or removing from an area to the bathtub, sink or bucket.
- When securing a mobility device with a rope for removal via window.
- Physical damage (impacted, crushed or pierced) to the mobility device or battery.