



2023 Firefighter Safety Stand Down FAQs – Lithium-Ion Batteries

1. How do lithium-ion batteries work?

A lithium-ion battery is made up of an anode, cathode, separator, electrolyte, and two current collectors (positive and negative). The anode and cathode store the lithium. The electrolyte carries positively charged lithium ions from the anode to the cathode and vice versa through the separator. The movement of the lithium ions creates free electrons in the anode, which creates a charge at the positive current collector. The electrical current then flows from the current collector through a device being powered (cell phone, computer, etc.) to the negative current collector. The separator blocks the flow of electrons inside the battery.

2. Are all lithium-ion batteries the same?

Not all lithium-ion cells are the same; there exist different variations of anodes, cathodes, storage configurations, and chemistries. All of these variables affect a battery's strength, with different designs being more optimal for different applications.

3. What is “stranded energy”?

Stranded energy is any scenario where electrical energy remains in a battery without an effective means to remove it. This typically happens when the battery is damaged – by force, a coolant leakage, heat, or water intrusion – and normal function ceases. This can also lead to thermal runaway.

4. What is “thermal runaway”?

Thermal runaway describes a process in an energy storage system that is accelerated by increased temperature, in turn releasing additional energy that further increases temperature. Thermal runaway occurs in situations where an increase in temperature changes the conditions in a way that causes a further uncontrolled increase in temperature, often leading to a destructive result.

5. What are the key hazards with incidents involving lithium-ion batteries?

Incidents involving lithium-ion batteries range from thermal events up to and including fire, to motor vehicle accidents and battery submersions. The key hazards that should be considered are, but are not limited to: the risk of high voltage discharge, arcing, and/or shock; rapid heat build-up and/or “thermal runaway” inside the battery(ies); fires involving high temperatures (may be >1500°F); venting and/or flaring of the battery cell or compartment; the production and release of toxic gases including HF and POF₃; the ejection of battery components and/or shrapnel; the need for sufficient water for handling fires (3,000 to 8,000 gallons minimum for an EV fire); and the need for monitoring post-incident for up to 30 to 45 minutes.

6. How much water does it take to put out an electric vehicle (EV) fire?

Most passenger vehicle Emergency Response Guides (ERGs) state that it takes between 3,000 and 8,000 gallons of water to extinguish an EV fire. The water must be applied to the battery cell or compartment. Once extinguished, the EV should be monitored for 30-45 minutes with a thermal imaging device for signs of potential reignition.

7. How effective is foam on a lithium-ion battery fire?

The use of foams and/or encapsulating agents is a tactical decision and has many variables that need to be considered including, but not limited to: (a) the type(s) of foam to be used; (b) can the foam be applied to the battery cell or compartment?; (c) can the foam application be maintained or sustained?, and; (d) what are the type(s) and/or conditions of the battery(ies) involved, i.e. EV versus home energy storage system, etc.?

8. What are the key safety strategies for dealing with an incident involving lithium-ion batteries?

- a. **IDENTIFY** – what type of battery(ies) or system(s) you are dealing with, i.e. personal mobility device versus EV versus ESS/BESS versus commercial energy system. Conducting a risk assessment for your jurisdiction pre-incident can help you and your department identify the number and type(s) of system you are potentially facing.
- b. Establish an **Incident Action Plan (IAP)** – set incident objectives; wear the proper PPE; approach from **UPHILL** and **UPWIND** if possible; minimize time in the “hot” or exclusion zone(s).
- c. If an EV or mobility device is involved, **IMMOBILIZE** the EV/device so it will not move while handling the incident. **ISOLATE** key fobs or remote start devices.
- d. **DE-ENERGIZE** the system(s) if it can be done safely.
- e. **MONITOR** the battery(ies) for 30-45 minutes post-incident with thermal imaging technology to ensure that they are stable and there is little to no chance of a thermal event or of re-ignition.
- f. **COMMUNICATE** the situation to dispatch and post-incident response partners, i.e. towing and recovery, industrial clean-up companies, environmental authorities, etc.

9. How should lithium-ion batteries be disposed of?

Lithium-ion batteries and devices containing these types of batteries should not go in household garbage or recycling bins. They can cause fires during transport or at landfills and recyclers. Instead, Li-ion batteries should be taken to separate recycling or household hazardous waste collection points.

10. Where can I get more information on dealing with incidents involving lithium-ion batteries?

There are many vetted resources available for additional information and free training on how to deal with an incident involving lithium-ion batteries. A few are listed below, and you can find more resources on the [2023 Safety Stand Down web site](#).

- [NVFC Virtual Classroom: Electric Vehicle Safety – An Awareness Level Training](#)
- [IAFC Fire Department Response to Electric Vehicle Fires Bulletin](#)
- [IAFC Tips from Training: Lithium-Ion Battery Mobility Device Fires](#)
- [USFA Emergency Response Guides for Electric Vehicles and Lithium-ion Batteries](#)
- [USFA Lithium-ion Batteries](#)
- [NFPA Alternative Fuel Vehicles Training Program for Emergency Responders](#)
- [NFPA Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results](#)
- [NFPA Energy Storage Systems Safety Fact Sheet](#)
- [NFSA Lithium-ion Battery Fires and Fire Protection](#)
- [FDNY Lithium-ion Battery Safety](#)
- [FDNY Lithium-ion Battery Mobility Device Fires](#)
- [FDNY Lithium-ion Battery Safety Tips](#)