LITHIUM-ION SAFETY TIPS FOR FIRST RESPONDERS

Lithium-ion batteries have emerged as the power source of choice for many modern devices and are also used in energy storage systems. From toothbrushes to smartphones, power tools to medical devices, scooters to cars, these rechargeable power sources have transformed how we power our toys, devices, vehicles, homes, cities… just about everything.

However, there are **RISKS** associated with lithium-ion batteries, and **FIRST RESPONDERS** must be aware of the **CHALLENGES** and how to mitigate these dangers using various **RESPONSE STRATEGIES**.

UNDERSTANDING THE RISKS

Conditions that can lead to a potentially dangerous incident

Lithium-ion batteries contain volatile metal electrolytes. When exposed to excessive heat or physical damage or if an incompatible or malfunctioning charger is used, this can create a chemical reaction inside a battery cell/battery pack and cause one or all these conditions:
Swelling/Bulging – an increase in size. It may burn hot, but no gas is released.
Heat – hot, but no gas released. Temperatures can exceed well over 1,000 degrees Fahrenheit.
Venting/Popping/Hissing – gas is released, including lots of hydrogen, which is extremely flammable, hydrogen fluoride, and hydrogen cyanide, which are highly toxic. The fumes also contain various metal particles which are toxic to human health, i.e., lithium, nickel, cobalt, copper, and iron depending on the metals used to make the batteries.
Fire – gases are released (hydrogen, carbon monoxide, etc.) and ignited, fire will spread to other battery cells, fire will spread to other exposures.
Explosion – gases that were vented sometimes do not ignite immediately and accumulate; they find an ignition source which causes a loud sounds and increased pressure – an **EXPLOSION**. This delay in ignition endangers occupants and first responders!
Thermal Runaway – triggering a chain reaction of an uncontrolled release of heat, can cascade to adjoining battery cells causing multiple battery cells to catch fire and/or explode. Lithium-ion batteries contain chemicals that are classified as fuel and an oxidizer. If heated or damaged, they can catch on fire and continue to burn until the fuel is consumed. Large quantities of water can be used to cool the batteries and stop progression to adjoining cells, provided the water can reach the cells to have the desired cooling effect. Lithium-ion batteries can be ejected from the battery packs, spreading the fire or creating a cascading incident.

UNDERSTANDING THE CHALLENGES

State of Charge (SOC) / Stranded Energy

Lithium-ion batteries with a high SOC release more heat/fire/explosion and produce, or vent toxic gases, while batteries with a low SOC release less heat/fire/explosion but will vent more toxic gases. Fire Responders do not have the tools to measure Stranded Energy in batteries.

Chemical Exposure

First Responders should be cautious of potential chemical exposure during a Lithium-ion battery incident. **TREAT** - **the incident like a Hazardous Materials scene**. **STAGE** - **Upwind and Uphill to avoid the fumes and runoff. Always wear Personal Protective Equipment (PPE) and Respiratory Protection—Self-Contained Breathing Apparatus (SCBA)**.

Battery Pack Construction

Lithium-ion battery cells are produced in various sizes and shapes, such as flat, cylindrical, and rectangular cubes. The battery cells are installed in Battery Packs to protect them from physical damage. The Battery Packs used in most Electric Vehicles (EV)'s are designed to prevent penetrations and are vented. First Responders should always consult the Emergency Response Guide developed by the Original Equipment Manufacturer (OEM), i.e., Tesla, BMW, Hyundai, Ford, Toyota, etc., when accessing a Battery Pack on a specific vehicle.

Reignition Risks

Even after extinguishing a lithium-ion battery fire, there is a risk of reignition due to Stranded Energy- minutes, hours, days, or even months later. First Responders should implement thorough post-fire assessments and continued monitoring, moving the device/EV can create new damage leading back into thermal runaway. A minimum 50-foot radius of non-combustible materials for storage/quarantine is recommended.

Source: https://batteryguy.com/kb/knowledge-base/what-are-lithium-ion-batteries

RESPONSE STRATEGIES – DEFENSIVE / OFFENSIVE / NON-INTERVENTION

Establishing Safety Zones

Establish Safe Zones to protect from potential hazards and minimize the risk of contamination. Use the Emergency Response Guidebook **(ERG Guide #147)**, Safety Precautions, and Protective Distances. Structural Firefighter's Protective Clothing, including an SCBA, shall be required for firefighting activities. When entering the Hazard Zone, **PPE MUST always be worn**, including after extinguishing the fire. Contact with the metal electrolytes can cause **severe medical burns to the skin and respiratory systems**. Implement the appropriate **Decontamination Procedures** for all personnel and equipment used at the incident.

Assessment of Incident Priorities

1. Life Safety/Rescue	2. Incident Stabilization	3. Property/Environment Conservation

Perform Size-up

1. What have I got? - Battery Cells / Battery Pack / Electric Hybrid Vehicle / Energy Storage Device / Electric Vehicle (EV) Charging Station
2. Where is it going? - Exposures, Open/Flaming Combustion, or Confined/Explosive Combustion
3. What do I need to control it? - (Resources) Water / EV Blanket / EV Turtle Nozzle / Lift / Jack Stands / **Electric Vehicle Containment Unit**

Select the Strategic Mode – Defensive or Offensive or Non-Intervention

Confining Techniques

Move lithium-ion power source to a safe location or move exposures away from the thermal runaway. EV's will need to be towed, no neutral.

EV Blanket, following procedures established by the manufacturer and department SOP. These blankets will confine the fire, heat, and smoke released; however, they will affect the free burning process and will prolong the incident. Consequently, remove the blanket as soon as possible.

Cooling Techniques

Firefighters may try to establish a cooling method to manage these incidents; however, this will require a lot of water and could prolong the incident. Using a Thermal Imaging Camera **find the heat**. Implement and use multiple fire hoses to cool the heat generated by lithium-ion batteries. On EV's the batteries are in Battery Packs; so, the water being applied is not able to reach the source of the heat; the battery cells in thermal runaway; therefore, the cooling effect will be limited. Where will the run-off go? The water is full of metals!

Take No Action

Let the fire consume the lithium-ion power source. **THIS IS THE BEST STRATEGY at PRESENT TIME – 01/2025**

INCIDENT COMMAND SYSTEM (ICS) and ASSISTANCE

How is this incident going to impact the community? Political and economic concerns due to the smoke and fumes and road closure(s) for an extended period of time. Evacuations and or Shelter-In-Place needs.

Establish Unified Command and develop an Incident Action Plan (IAP). It may require multiple Operation Periods.

Fire/Hazmat Agencies, Law Enforcement, Emergency Management, Safety and Environmental Enforcement Agencies, Hazmat Contractors, Tow Truck Companies, Public Works, Crane Company

Energy Security Agency (ESA) 855-372-7233

ESA provides recommendations for safe battery handling to manufacturers, public/private organizations, first responder communities, and end users.