

# REMOVAL OF LITHIUM-ION AND NICKEL METAL HYDRIDE BATTERIES FROM ELECTRIC VEHICLES

2025 SOCAL WILDFIRE RESPONSE

February 1, 2025

## 1. OBJECTIVE

This standard operating procedure (SOP) describes a set of general guidelines for the removal of batteries from hybrid and electric vehicles (EVs) impacted by the 2025 Southern California Wildfire Response. This SOP also includes safety procedures for the removal and transportation of extracted batteries. The objective is to extract lithium-ion (Li-ion), nickel metal hydride, (NiMH) and other batteries used in EVs and transport them to a secure area where they may be stored and prepared for recycling or disposal. The handling of damaged Li-ion and NiMH batteries from thermally insulted and fire damaged vehicles presents significant hazards to response personnel and should be handled with extreme care. The EV Battery Removal Team generally consists of the following: Federal On-Scene Coordinator (OSC), START personnel, certified electrician, battery subject matter expert, heavy equipment operator, and 2-3 support team members (air monitoring, water hose operation, supply handler). The EV Battery Removal Team is part of the broader EV Task Force.

The purpose of this SOP is to outline field techniques for the safe removal and transportation of fire damaged Li-ion and NiMH batteries identified in the field. This SOP is geared towards the following sources of Li-ion and NiMH batteries: EVs, limited mobility devices, golf carts, all- terrain vehicles, scooters, bikes, mopeds, and larger transportation vessels.

## 2. SUMMARY OF METHOD

Removal and transportation of extracted batteries is done by a team of trained hazmat responders familiar with vehicle manufacturers, models, and mechanical and battery technology. Personnel from the Emergency Response and Removal Services (ERRS) contract will be responsible for the physical removal of the batteries and Superfund Technical Analytical Response Team (START) personnel will be responsible for the documentation of activities in field logbooks and electronic field collection and mapping software. Additional contractors will be responsible for electrical and temperature checks.

## 3. HEALTH AND SAFETY

Qualified personnel should have completed adequate training to enter a disaster area, including HAZWOPER, OSHA, site-specific safety, and cultural training, if necessary. Numerous chemical and physical hazards are present during vehicle battery recovery. Chemical hazards include acid gases, occasional lead-acid, and heavy metals. Physical hazards include heavy lifting of tools, sharp metal, risk of fire or explosion from thermal runaway of a battery, heat stress, ash and chemical exposure, and dehydration. Level C PPE will be used for this operation: half-face or full-face respirator utilizing acid gas/P100 dual cartridge, flame retardant clothing (FRC)<sup>1</sup>, cut resistant or shock resistant gloves (as appropriate), hard hat, protective boots and safety glasses. A Job Hazard Analysis (JHA) has been generated by the Safety Officer for inclusion in the Health and Safety Plan, which is housed on the 2023 Maui Wildfires Teams page, Section 1.6 Safety Officer, managed by the US Environmental Protection Agency (EPA).

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<sup>1</sup> Flame Retardant Clothing: The implications of using disposable vs reusable FRC should be considered in the health and safety plan and field procedures. Appropriate decontamination or disposal of FRC should be implemented in the field prior to entering vehicles so ash and other contaminants do not contaminant vehicles.

## 4. PROCEDURE

### 4.1 Approach and monitoring

Air monitoring with a multi-gas meter should be performed during approach to determine if any off-gassing or release of toxic vapors is occurring.

The area should be monitored prior to any personnel coming upon the vehicle in addition to consistent monitoring for changes in ambient conditions around the battery during the removal process. An appropriate exclusion zone boundary and stand-off distances determined in the field on a case-based scenario to protect public and responder exposure should be implemented at each site. The exclusion zone boundary should initially be designed and consistent with the use of heavy equipment, however, contingencies for the potential for a cascading thermal runaway should be identified prior to operations as such to provide the ability to expand based on real-time conditions. An operational exclusion zone boundary of 75ft should initially be established in consistent with ERG Guide 147 for stable but present batteries on-site. A “fall back” exclusion zone should be identified by the field team and used if a cascading thermal runaway event occurs while operations are occurring on-site. This perimeter is designed for public safety and the off-site migration of contaminants of concern, but for operations engineering controls and PPE should be used during activities. If the public or other adjacent working teams are present, notification of the operation and contingencies that may be required to include shelter-in-place or other appropriate protective distances shall be communicated by the field team leader.

### 4.2 Vehicle and Battery Inspection

The EV Battery Removal Team will mobilize to EVs previously identified in the field by the Household Hazardous Materials Reconnaissance (recon) and/or Battery Recon Team and marked with a painted blue lightning bolt. Vehicle make/model (if known), along with any other identifying features of the vehicle are provided by the Recon Team in QuickCapture via Field Maps (note: EV/ESS that are located on parcels that have been deferred to Phase II will display in Field Maps as pink. Do not address these points in Phase I). The vehicle will be assessed by team supervisors to determine if the condition of the vehicle is a candidate for battery removal. In some circumstances, vehicle batteries may not be impacted enough for removal and may be outside the scope of this SOP. A determination of battery collection opportunity will be performed by the OSC, SME, or other project supervisor.

### 4.3 Vehicle and Battery Identification

Hybrid and EV battery removal personnel should use information available on the National Fire Protection Association website: <https://www.nfpa.org/training-and-events/by-topic/alternative-fuel-vehicle-safety-training/emergency-response-guides> to predict battery location and chemistry if field observations are inconclusive. Possible battery locations include inside the trunk, under the rear seat or underneath the vehicle. Additionally, a lead-acid battery or lithium ion 12V battery may be located either in proximity to the battery pack or under the vehicle hood. Images presented in this SOP are for general information only since the variety of battery configurations are numerous and are dependent on vessel make, model, option and year.

### 4.4 Render Safe Procedure

Batteries may continue to hold a charge or be energized even after being thermally impacted. It is extremely important to ensure that batteries are de-energized prior to removal of any component of the vehicle, particularly the battery. A certified electrician will determine whether any stored energy remains in the battery pack before field personnel proceed to the removal step. If a charge is remaining, additional tactics such as physical separation or sever of the main power cable may be necessary. A review of the technical specifications of the specific make and model of the vehicle prior to such event to ensure appropriate and safe separation is essential. The vehicle should not be touched or disturbed until de-energizing of the battery is performed. An infrared thermometer or thermal imaging should also be used to ensure the temperature of the battery is not elevated or increasing. In addition, support personnel should be performing air monitoring with a multi-gas unit at various points of battery extraction.

Once it has been shown that there is no risk of electrocution, fire, or exposure to gases, the team may proceed with the physical removal of the battery.

Temperature checks should also be performed throughout the battery recovery process. Using a laser temperature

gun or thermal imagery camera, temperature checks should be performed upon initial assessment, during manipulation of the vehicle, extraction of the batteries and within any container used to store batteries for the transportation process. Temperature increases above ambient/surrounding materials should be monitored closely and a rapid rise indicates potential thermal runaway.



*Certified electrician testing Ni-MH battery pack for remaining battery charge prior to removal*

#### 4.5 Accessing and Removing the Battery

Access to the batteries will depend on the type and condition of the vehicle. Most EV battery compartments will be found intact or partially intact. Location of each battery will be dependent on the year, make, and model of the EV. Some battery packs are located on the bottom of the vehicle and will require the EV to be placed on its side or have its roof removed (for stability) and rolled on its top. Others have batteries located under the back seat and may require the roof to be peeled back to access the battery. Each EV will be assessed to determine the most appropriate method to access and recover the battery.

Entry and support personnel don personal protective equipment (PPE) – including fire resistant clothing, half-face or full-face respirator with acid gas cartridges, hard hat, safety goggles, steel toed boots and protective gloves (leather gloves over nitrile). Charge fire hose assembly (a minimum of 1 hose line with 10-40 gallons per minute [GPM] target flow charged) and have fire hose operator stand-ready.

Note: if battery condition indicates the possibility of intact cells, the task force will upgrade to the appropriate level of PPE specified in the Site HASP, including Level B PPE with full-face respirators, SCBAs, and fire-resistant clothing.

A combination of power tools and hand tools will be used to remove batteries from EVs. Fire responder tools (spreader and cutter) are also utilized for accessing damaged vehicles and rendering the vehicle structurally safe for battery access. Doors and/or the roof of the vehicle may be removed for easier battery access or to safely flip the vehicle to access undercarriage batteries. The vehicle will be secured to avoid unintended rollover or movement during repositioning and/or battery harvest. A mini excavator with thumb attachment is also used for repositioning vehicles as well as assisting with access by removing seats or other obstructions. Dust suppression is provided prior to and during vehicle repositioning by a support vehicle with water buffalo trailer, however the batteries are not to be oversaturated with water.

#### **Options for Battery Removal:**

##### **Option 1 – Separation of high voltage battery from EV for transport**

- i. Personnel = EPA OSC, START, ERRS (1 Operator, 1 Truck Driver, 3-4 Laborers, and 1 Electrician).
- ii. PPE = Flame Retardant Clothing and Level B & C
- iii. Tools, Equipment, Supplies = General, Heavy Equipment (Excavator or Telehandler),

Cribbing, Extrication Tools, rigging straps

- iv. Safety Measures = Water Source, Fire Blanket, Tyvek Wrapping, and Fire Appliances
- v. Lift High Voltage Battery In/On Transport Vehicle, Trailer, or Roll-off Container

**Option 2 – Separation of high voltage battery and portion of vehicle chassis for transport**

- i. Personnel = EPA OSC, START, ERRS (1 Operator, 1 Truck Driver, 3-4 Laborers, and 1 Electrician).
- ii. PPE = Flame Retardant Clothing and Level B & C
- iii. Tools, Equipment, Supplies = General, Heavy Equipment (Excavator or Telehandler), Cribbing
- iv. Safety Measures = Water Source, Fire Blanket, Tyvek Wrapping, and Fire
- v. Lift High Voltage Battery and Chassis In/On Transport Vehicle, Trailer, or Roll-off Container

**Option 3– Collection of loose batteries that have separated from case**

- i. Personnel = EPA OSC, START, ERRS (1 Operator, 2 Laborers).
- ii. PPE = Flame Retardant Clothing and Level C
- iii. Tools, Equipment, Supplies = General, Heavy Equipment
- iv. Safety Measures = Water Source
- v. Place Material into Metal Container



*(Left) Rescue spreader and cutter. (Right) Cutting roofing support beams (A, B, C pillars) prior to flipping vehicle for battery pack access on some vehicles.*





*Flipping Tesla Model S to access batteries in undercarriage.*



*(Left) Nissan Leaf li-ion battery pack in undercarriage. (Right) Nissan Leaf battery pack after removal.*

#### 4.6 Packaging the Battery

Prepare collection site for the “Lau Lau” battery wrapping process (see Figure 8):

1. Place a protective tarp on the ground or on the bed of the truck/trailer, as applicable.
2. Place several pieces of mule tape (also referred to as electrical conduit pull tape) with slip knot on the tarp for a tie off, as necessary.
  - a. Place the fire blanket on top of the mule tape.
3. Place a piece of Tyvek house wrap on top of the fire blanket.
4. Place weights to keep the wrap materials from being blown by the wind and in place.

Manipulate the vehicle to expose the battery casing or the batteries themselves. This may require heavy equipment.

Recover the individual batteries or battery casing containing batteries. Using heavy equipment or power tools, attempts to maintain the integrity of the battery casing should be performed. If the battery case can be recovered

without spilling batteries onto the ground, this would be the preferred method. If extraction requires a more aggressive approach, the casing should be handled in a manner as to not lose contents. Using shovels, loose battery cells and prismatics should be collected and containerized in 55-gallon steel drums for transport to the staging area. Poly drums should not be used as steel drums will hold integrity longer in case of a fire.

Move intact battery casing onto a prepared “Lau Lau” collection wrap (see Figure below). Remove mechanical assist rigging. Wrap the battery with Tyvek house wrap and tape to secure. Use tape to label the battery with the Assessor’s Parcel Number (APN) of the battery location along with battery type (li-ion or NiMH) and vehicle type. Wrap with the fire blanket and secure the wrap with the mule tape as needed.

**Note:** if the condition of the battery indicates the possibility of intact cells, label the Tyvek house wrap with **red tape or red paint** to assist with handling at the staging area.

If the battery was wrapped on the ground, use lift straps and 4 personnel to move the wrapped battery onto the transport trailer. If the battery was wrapped on the trailer, use lift straps and 4 personnel to move the wrapped battery to the appropriate position for transport. Alternatively, heavy equipment may be used to move the battery case onto the transport trailer. Secure the wrapped batteries to the trailer.

**Caution: Do not puncture, break, tear, or force open any lithium-ion batteries or battery packs. Doing so can initiate a thermal runaway or violent reaction scenario.**



*“Lau Lau” wrapping process as described above.*

## 5. FIRE CONCERNS AND RESPONSE PLAN

The Battery Removal Team must be prepared to respond to an EV battery fire. A water buffalo with a minimum of 1 hose line with 10-40 gallons per minute (GPM) target flow must be onsite. All personnel should be upwind if possible. In the event of fire, all personnel will egress upwind and emergency services will be called immediately. If safe to do so, the fire hose operator will secure the perimeter of the fire to prevent propagation until emergency services arrive. Should a fire occur while the batteries are in transport to the staging area, the vehicle is to pull over to a safe location, drivers are to evacuate the transport vehicle, keep people a minimum distance of 330 feet and use the water buffalo to protect the area around the vehicle, if safe to perform. The local fire department must be contacted immediately and then incident command. Additional considerations are detailed in the 2023 *Maui Wildfires Damaged Lithium-Ion Battery Management Guide for Electric Vehicles and Mobility Devices*.

## 6. POST REMOVAL

### 6.1 Waste Management

Battery chemistry (Li-ion, NiMH) and condition of the battery determines the method for safe transportation to the staging area for deconstruction. Intact battery packs will be “Lau-Lau wrapped” (see 2023 Maui Wildfires Damaged Lithium-Ion Battery Management Guide) prior to transport. Loose batteries will be containerized on-scene using shovels and placed in 55-gallon steel drums. Batteries will be sorted according to the waste stream and placed into appropriate containers. The sorted batteries will then be placed on a flatbed trailer and labeled with the respective Assessor’s Parcel Number (APN) for tracking at the Staging Area.

### 6.2 Battery Removal Tracking



Once battery removal is complete, a white lightning bolt is painted over the blue lightning bolt and a post removal photo is collected. The EV location point should be selected on the Field Maps and update the status of the point to “Complete.” If the battery is not able to be removed, the data point will be updated to the appropriate status based on the following definitions:

- **EV/ESS/Other Recon Needed:** A burned battery has been identified, but not yet reconned by the battery team.
- **EV/ESS/Other Removed:** The battery has been removed from the burn zone.
- **EV/ESS/Other Damaged:** The battery has minimal to no observed fire and/or heat damage.
- **EV/ESS/Other Destroyed:** The battery has been destroyed by fire and/or heat damage.
- **Not EV/ESS/Other:** The battery was not located, confirmed to not be an EV, or will not have its battery removed per EPA leadership



*White lightning bolt painted over blue lightning bolt indicating that battery has been removed.*

## Electrical Vehicle Status Guide

*The entire universe of this data set is electric vehicles identified by the EV Team.*



**EV/ESS/Other Recon Needed:** A burned battery has been identified, but not yet reconnected by the battery team.



**EV/ESS/Other Damaged:** The battery has minimal to no observed fire and/or heat damage.



**EV/ESS/Other Destroyed:** The battery has been destroyed by fire and/or heat damage.



**Not EV/ESS/Other:** The battery was not located, confirmed to not be an EV, or will not have its battery removed per EPA leadership



**EV/ESS/Other Removed:** The battery has been removed from the burn zone.



## **Appendix: Lithium Ion Battery Wildfire Response Equipment/Personnel List**

### **Equipment – Recovery and transport (Purpose: Separating, packaging, and transporting the batteries)**

- Tow-capable pick-up or other trucks
- Mini excavator with thumb
- Water buffalo
- Tyvec sheeting
- Fire blankets
- Radios
- Duct tape/gorilla tape
- Metal open top drums with bungs
- Ratchet straps for securing loads
- Metal open-top trailer
- Hand tools including, but not limited to:
  - 12-16lb sledge hammer
  - Heavy Duty pry bar or 30” Halligan pro bar
  - heavy duty USAR lifting bar or digging bar with flat edge
  - Mechanics toolset including bits and sockets etc.
  - Non-sparking tools including bung wrench
- Temperature gun/sensor
- Battery tools such as impact driver and Sawzall w/appropriate metal cutting blades
- Steel pipe, chain rigging set-up
- Rope, webbing and load-capable carabiners
- 6’ fiberglass A frame ladder
- Extrication tools

### **Personnel – Recovery and Transport**

- 1 -Equipment operator (mini excavator)
- 1 - Water buffalo tech
- 2 - Tech roustabouts for shoveling batteries, managing drums and other tasks
- 1 – Electrician with PV training/experience

### **Air Monitoring**

- SPM Flex with acid gas tapes
- Particulate monitors such as handheld dusttraks
- 5 Gas – MultiRae
- Viper
  - A fixed array can be set up at the staging area and managed through Viper, while Recovery teams can carry handheld instruments for use as needed.

**Note 1:** this list is dynamic and subject to change based on field team needs.

**Note 2:** Greg’s original list included ERRS Independent Mobile Equipment Cache (per task force): extrication spreader and cutter (Qty 1 set) battery operated); Sawzall with torch blades for metal various sizes (Qty 2 Battery Operated); Heavy Duty pry bar or 30” Halligan pro bar (Qty 1); heavy duty USAR lifting bar or digging bar with flat edge (Qty 1); 12-16 pound sledge (QTY1); Impact Drills HD (Qty 2, Battery operated); HD Equipment Impact Socket Set and Regular mechanics set (Qty Set); Misc. Mechanics tools set (Qty. 1 set); Tyvek/Tape/Blades/Markers (Qty 1 lot); Power wall lifting bar system (Qty 2 sets: pipe, rope/flat web, carabiners); Ratchet Straps (QTY 1 Set or enough); Tractor trailer or

truck and trailer; Containers (Metal Drums, Totes, Dumpsters? (QTY to fit trailer; Bung wrench and ring clamp bolt socket (Qty 1); Brine solution in Totes able to be transferred with trash pump (Qty 1 lot Duke Sauce 5% Sodium Chloride, 5 % Sodium Bicarbonate and water); 6' fiberglass A frame ladder (Qty 1); Truck, trailer, mini excavator or telehandler (QTY 1 each); water buffalo (Qty 1); Utility rope 3/8" 1/2" x 100' or mule tape (QTY 1 Lot).