

SUPERFUND TECHNICAL ASSESSMENT RESPONSE TEAM STANDARD OPERATING PROCEDURE FOR REMOVAL OF LITHIUM-ION AND NICKEL METAL HYDRIDE BATTERIES FROM ELECTRIC VEHICLES 2023 MAUI WILDFIRE RESPONSE

October 27, 2023

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 2023 Maui Wildfires. 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. Numerous chemical and physical hazards are present during vehicle battery recovery. Chemical hazards include acid gases and occasional lead-acid. 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 respirator utilizing acid gas/P100 dual cartridge, flame retardant clothing (FRC), cut resistant gloves, hard hat, and safety glasses. Tyvek suits are only utilized during lead-acid battery removal. 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).

4. PROCEDURE

4.1 Vehicle and Battery Inspection

The EV Battery Removal Team will mobilize to EVs previously identified in the field by the Battery Reconnaissance (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. 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.

4.2 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 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.

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

In addition, support personnel should be performing air monitoring with a multi-gas unit at various points of battery extraction. 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.

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.



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

4.4 Accessing 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.

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. 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.



(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.

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 data point is updated to “Complete” in QuickCapture via Field Maps, and additional information is placed in the database. If the

battery is not able to be removed, the data point will be updated to the appropriate status based on the following definitions:

- Needs Assessment – a burned EV that has been identified but not yet processed by battery removal team
- Complete – An EV that has been processed by the battery removal team
- Deferred – An EV that cannot have its battery removed due to technical issues such as safe access
- Archived – An EV that has been moved or removed (not by EPA) since marked as “Needs Assessment”; vehicle is no longer there
- Follow Up Required – An EV that cannot have its battery removed without EPA leadership approval. Typically, EVs in the burn zone with minimal to no observed fire and/or heat damage.
- Not In Universe – An EV that 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.



Needs Assessment – An electric vehicle that has been identified, but not yet processed by removal team.



Complete – An electric vehicle that has had its battery recovered.



Deferred – An electric vehicle that cannot have its battery removed by EPA due to technical issues, such as the inability to access the vehicle safely.



Archived – An electric vehicle that has been moved since a "Needs Assessment" point was created.



Follow Up Required – An electric vehicle that cannot have its battery recovered without EPA leadership's decision.



Not in Universe – After "Follow Up Required" resolution, an electric vehicle that will not have its battery recovered as decided by EPA leadership; or EV battery not found at location.