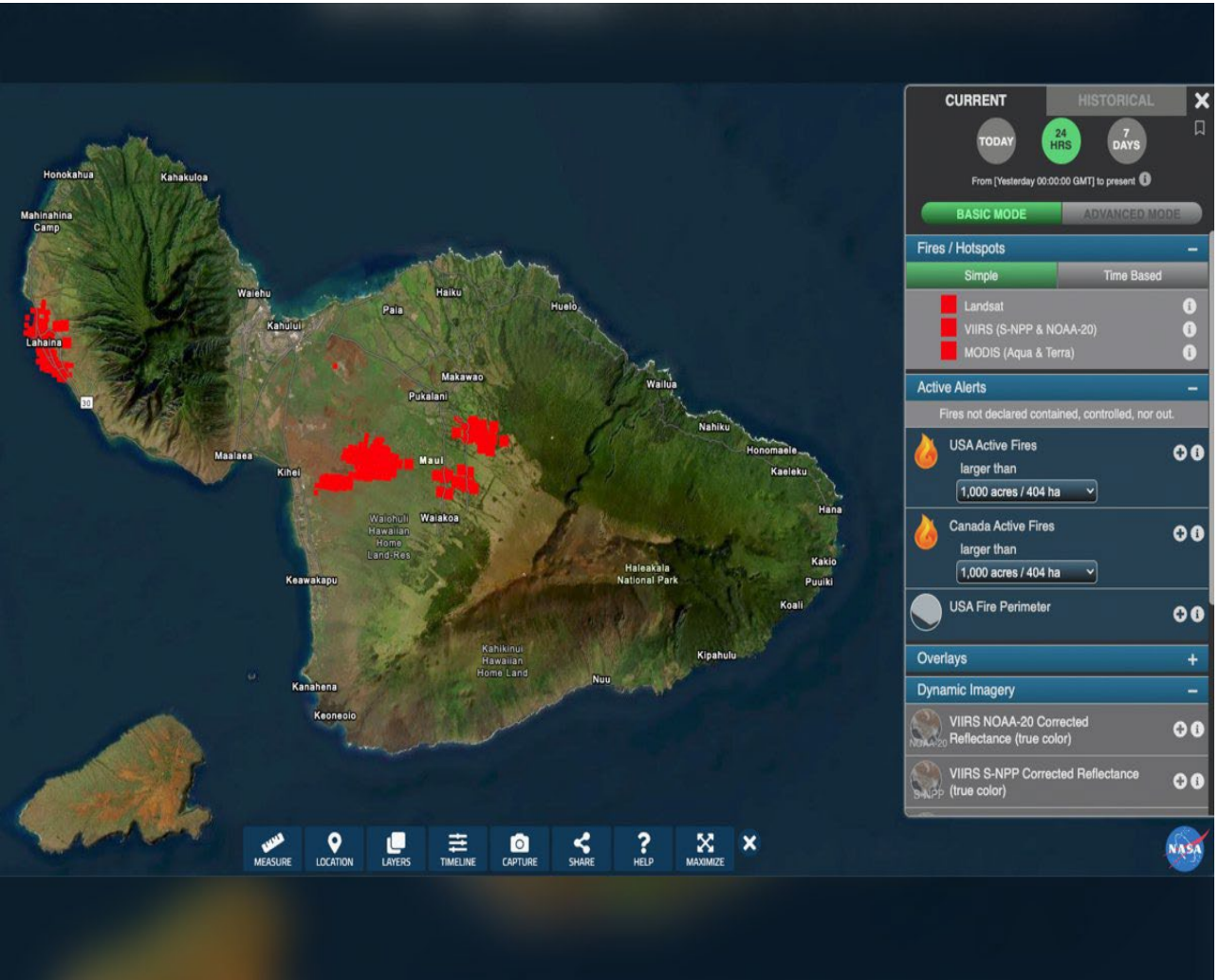
Lithium-ion Batteries in a Fire Disaster Response: Maui Case Study



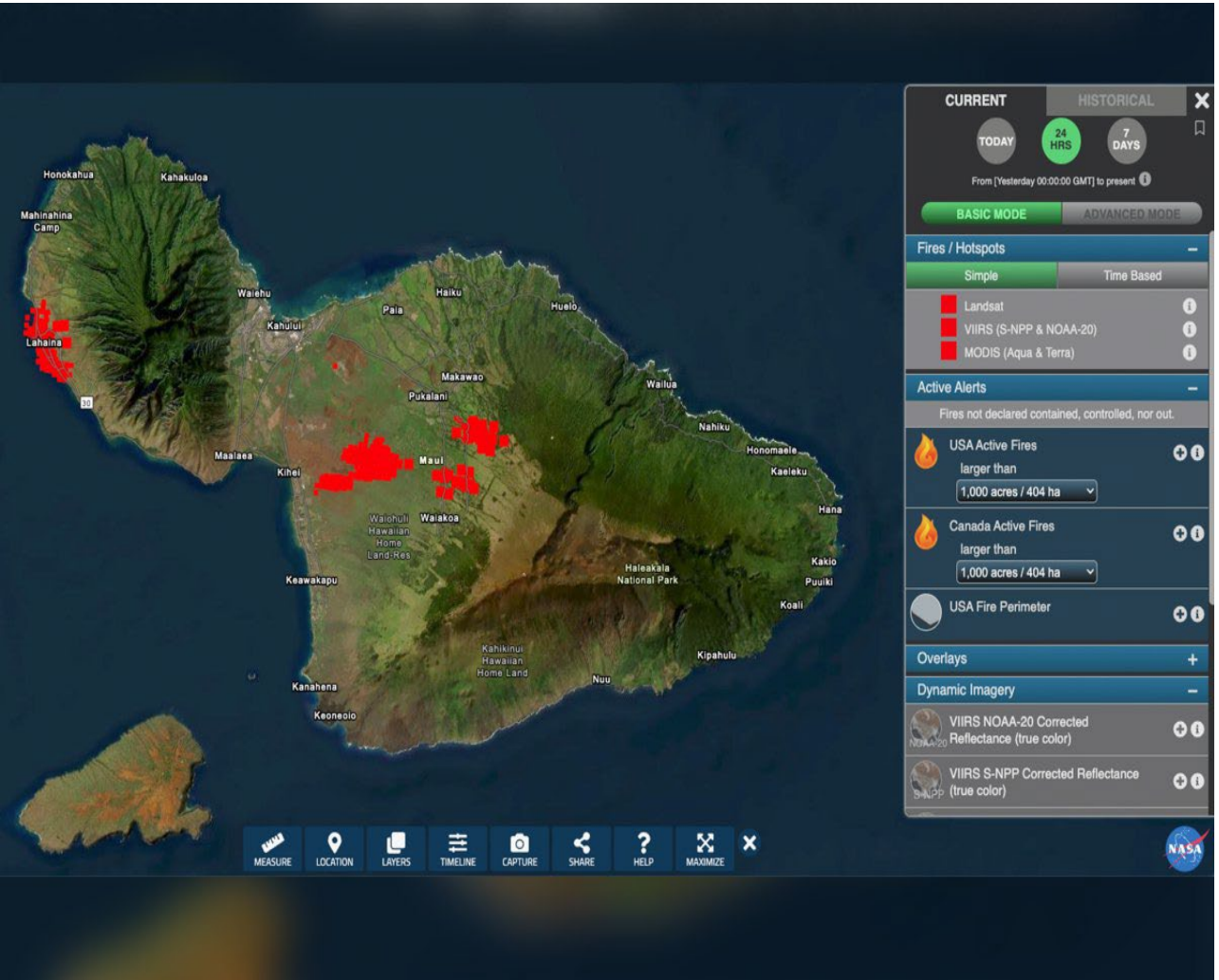
Chris Myers-USEPA Region 9 OSC

Leon Wirschem – SD County DEHQ

Greg Jenkins-USEPA Contractor

Rob Rezende – Da guy! rocks!

Lithium-ion Batteries in a Fire Disaster Response: Maui Case Study



Introductions…

Intro/Background of Incident, Mission Assignment, and Li-ion Batteries

Section 1

Maui Wildfires: Li-ion Battery Operations – The Team

Stephen Ball: USEPA Region 10 On-Scene Coordinator

Keith Glenn: USEPA Region 2 On-Scene Coordinator

Greg Jenkins: Maui Fire Hazmat Captain (ret.), USEPA Contractor

Chris Myers: USEPA Region 9 On-Scene Coordinator

Eric Nuchims: USEPA Region 9 On-Scene Coordinator

Chris Reiner: USEPA Region 9 On-Scene Coordinator

Rob Rezende: San Diego City FD Hazmat Battalion Chief

Bryan Vasser: USEPA Region 4 On-Scene Coordinator

Leon Wirschem: San Diego County DEHQ – Hazmat Division/Emergency Response

USEPA START and ERRS Contract Support

State and Local Resources

Introduction and Background

Mission Assignment Operations conducted under ESF-10

- FEMA Funding
- CERCLA Authority
- MAs: Household Hazardous Waste Removal including Residential BESS; Commercial Hazardous Waste Removal; Electric Vehicles; 505 Front Street Dewatering; Submarine Lead-Acid Batteries.

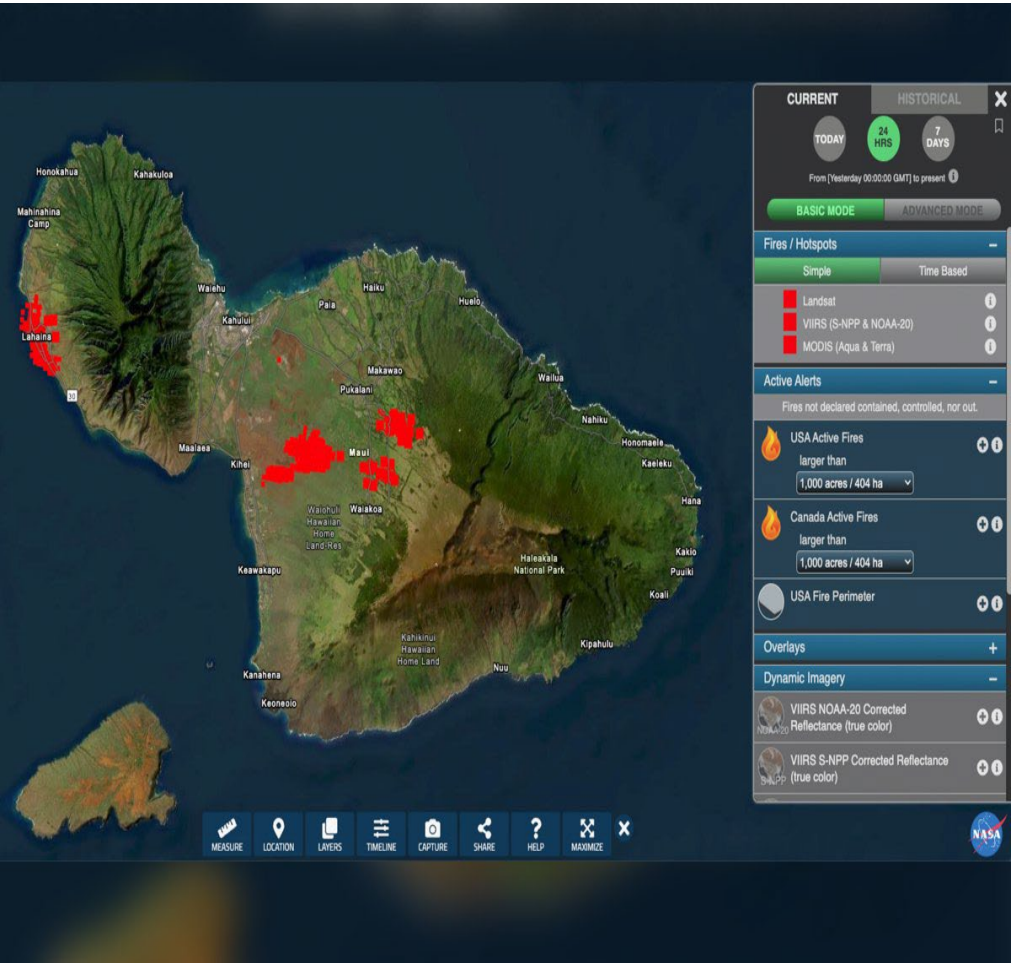
Unique challenge presented by location

- May/June USEPA Hawai'i Training Circuit
- Shipping DDR Batteries
- Processing in the field is the only way to proceed
- Disposal (Recycling)

DDR Batteries to "Not Batteries"

- Multiple sources, developing the process for identification, removal, processing, and shipping.

Maui Wildfires: Incident Demographics



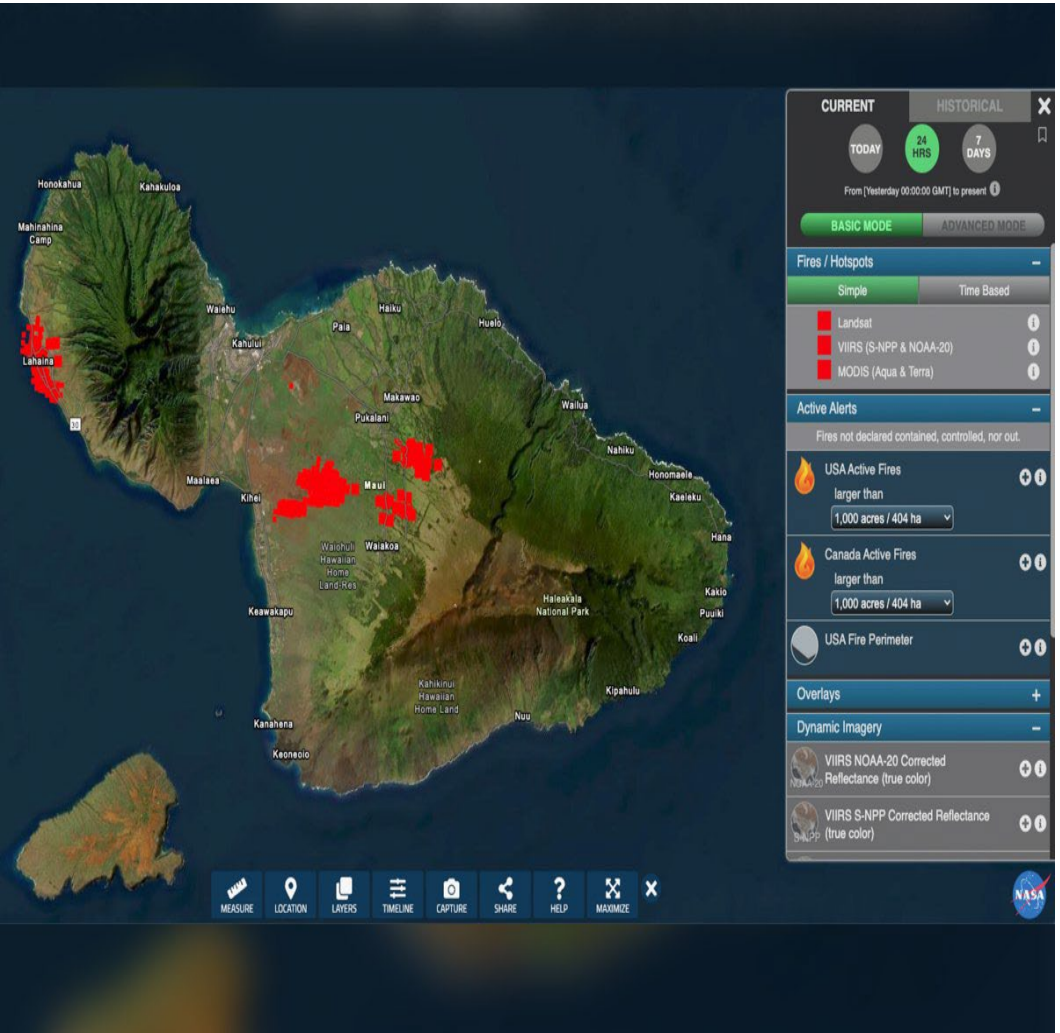
Maui:

- The County of Maui consists of 4 islands; Maui, Moloka‘i, Lanai and Kaho‘olawe (Ancient Land Mas of “Maui Nui”
- Total area of 2,398 square miles of which 1,162 is land and 1,237 is water.
- As of the 2020 Census and prior to fire, Maui County has a total population of 164,754

Kula: 34.54 square miles. Resident population prior to fire of 6,942

Lahaina: 7.78 square miles of which 80% was destroyed by fire on August 8th, 2023; with a death toll as of November 14th , 2023 of 100 souls and 4 people missing; Resident population prior to fire of 12,702.

Maui Wildfires: Li-ion Battery Operations – ESF 10 MA Structures



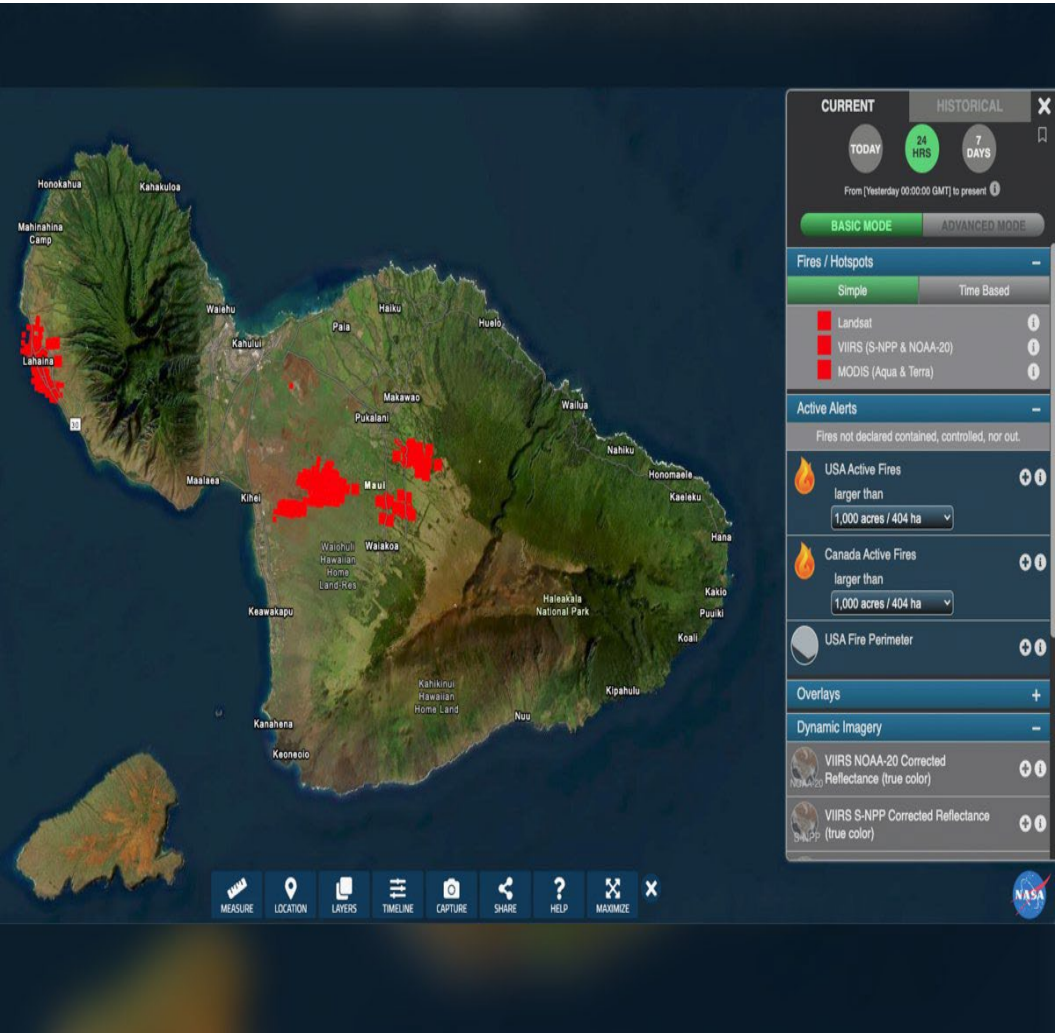
- Total structures damaged/destroyed/deferred within mission assignment universe: **1,621 total** (1,448 Phase One Complete, 173 Deferred to Phase Two).

- **Kula: 26 total** (26 Phase One Complete, 0 Deferred to Phase Two); (Commercial, 2 Phase One Complete, 0 Deferred to Phase Two); (Residential, 24 Phase One Complete, 0 Deferred to Phase Two).

- **Lahaina: 1,595 total** (1,422 Phase One Complete, 173 Deferred to Phase Two); (Commercial, 72 Phase One Complete, 100 Deferred to Phase Two); (Residential, 1,350 Phase One Complete, 73 Deferred to Phase Two).

- **Kula and Lahaina** Residential BESS: **274**

Maui Wildfires: Li-ion Battery Operations – ESF 10 MA Electric Vehicles



- Total Electric Vehicles archived/complete/deferred/denied within mission assignment universe for Kula and Lahaina combined, **99**:
- Archived (Vehicle no longer on site): 1
- Complete: 94
- Deferred: 1
- Denied: 3

Initial Challenges

- Li-ion batteries are unpredictable
- Concerns over safety of personnel and public
- Not a lot of guidance on how to handle them once impacted by fire
- Shipping via DDR is cost prohibitive and limited by shipping co.
- Shipping Co. do not like DDRs
- Little on-island resources for managing DDR/waste
- Few national experts

Presentation of DDR in the Field

Primary Sources:

- Battery Energy Storge Systems
- Electric Vehicles (Cars, go-carts, golf carts)

Secondary Sources:

- Limited mobility devices (bikes, scooters)
- Power tools
- Computers
- Speculative/Creative Accumulation Sites

Residential Li-ion Battery Energy Storage Systems (BESS)

Section 2

Reconnaissance - BESS

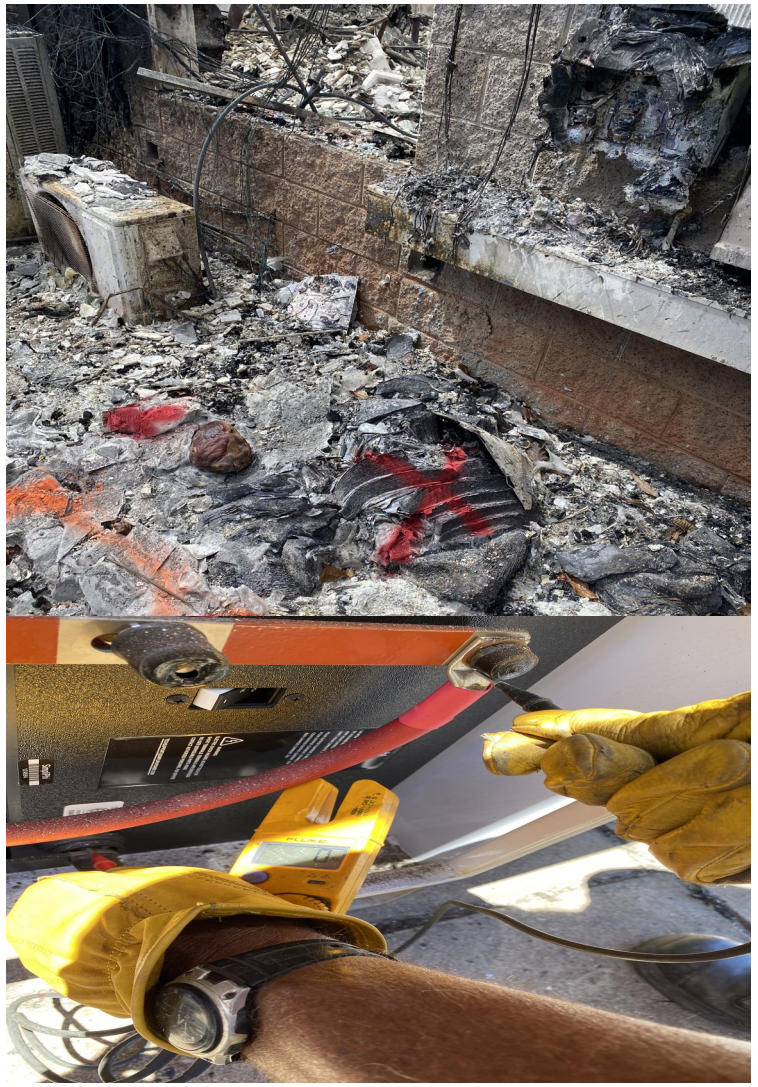
Intel Obtained from:

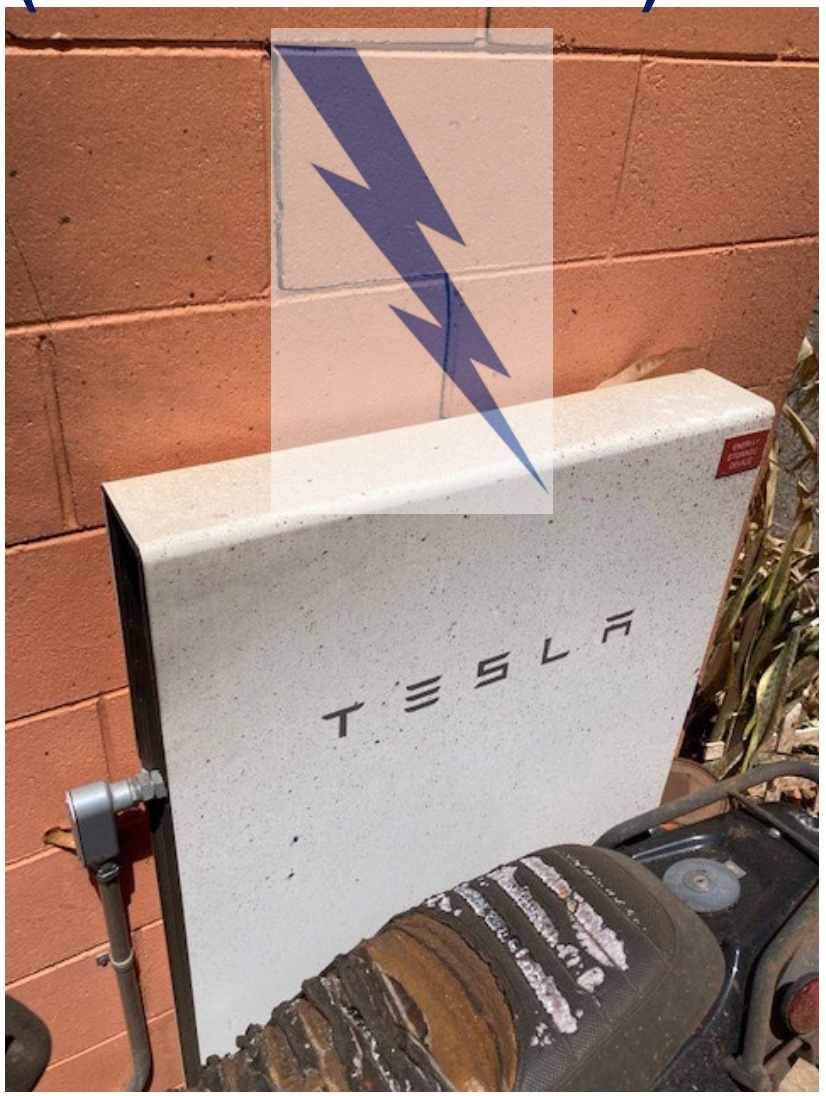
- Tesla Database
- HECO
- Owner Self-Assessment
- Ground Truth – EPA Teams

-Different Brand = Different Battery Chemistry

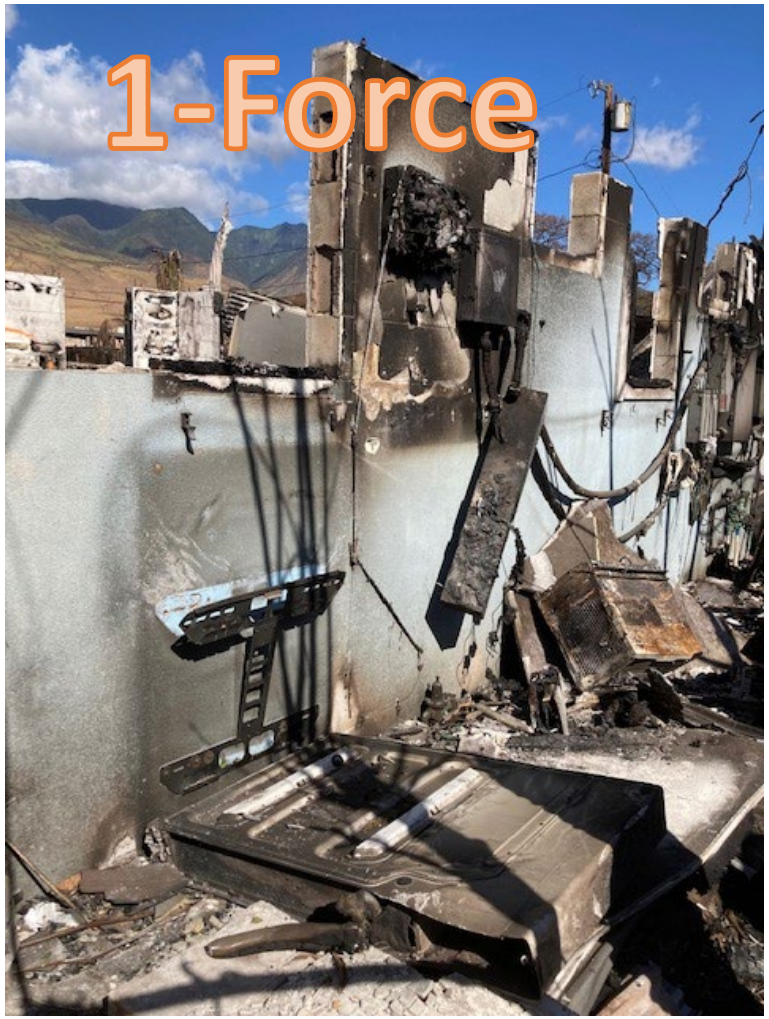
-Limited or No Technical Reference Support From Manufacturers

Reconnaissance of “Powerwalls” (Residential BESS)





Removal/Recovery of “Powerwalls” (Residential BESS)



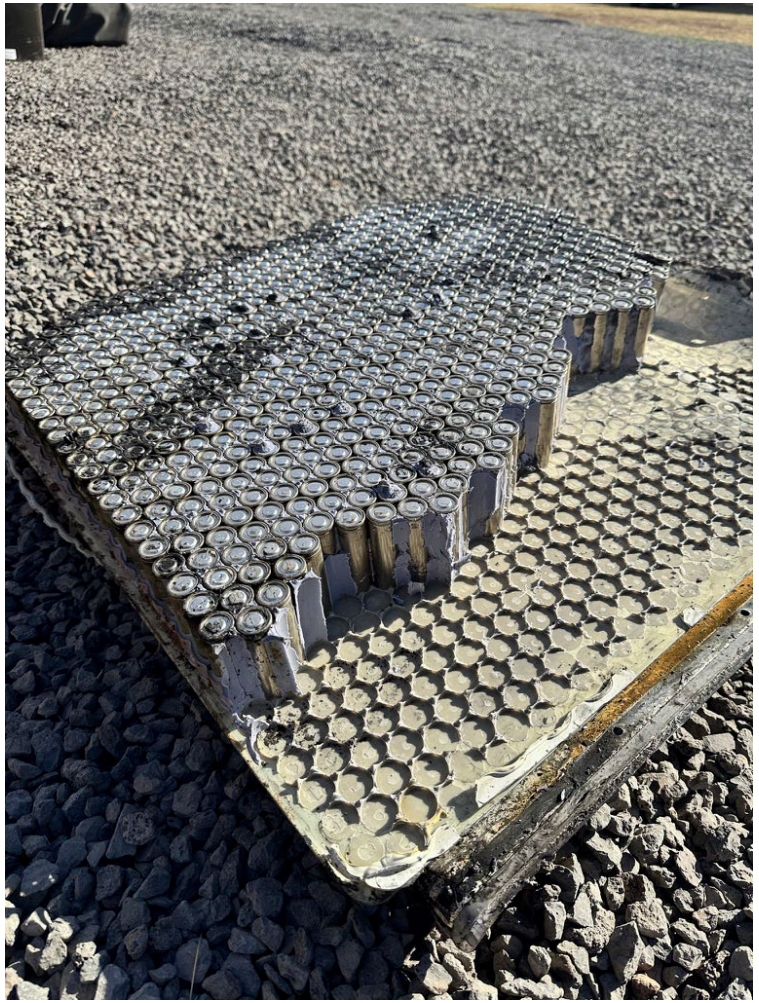
Removal/Recovery of “Powerwalls” (Residential BESS)

3-“Lau Lau”

Tyvek/FB

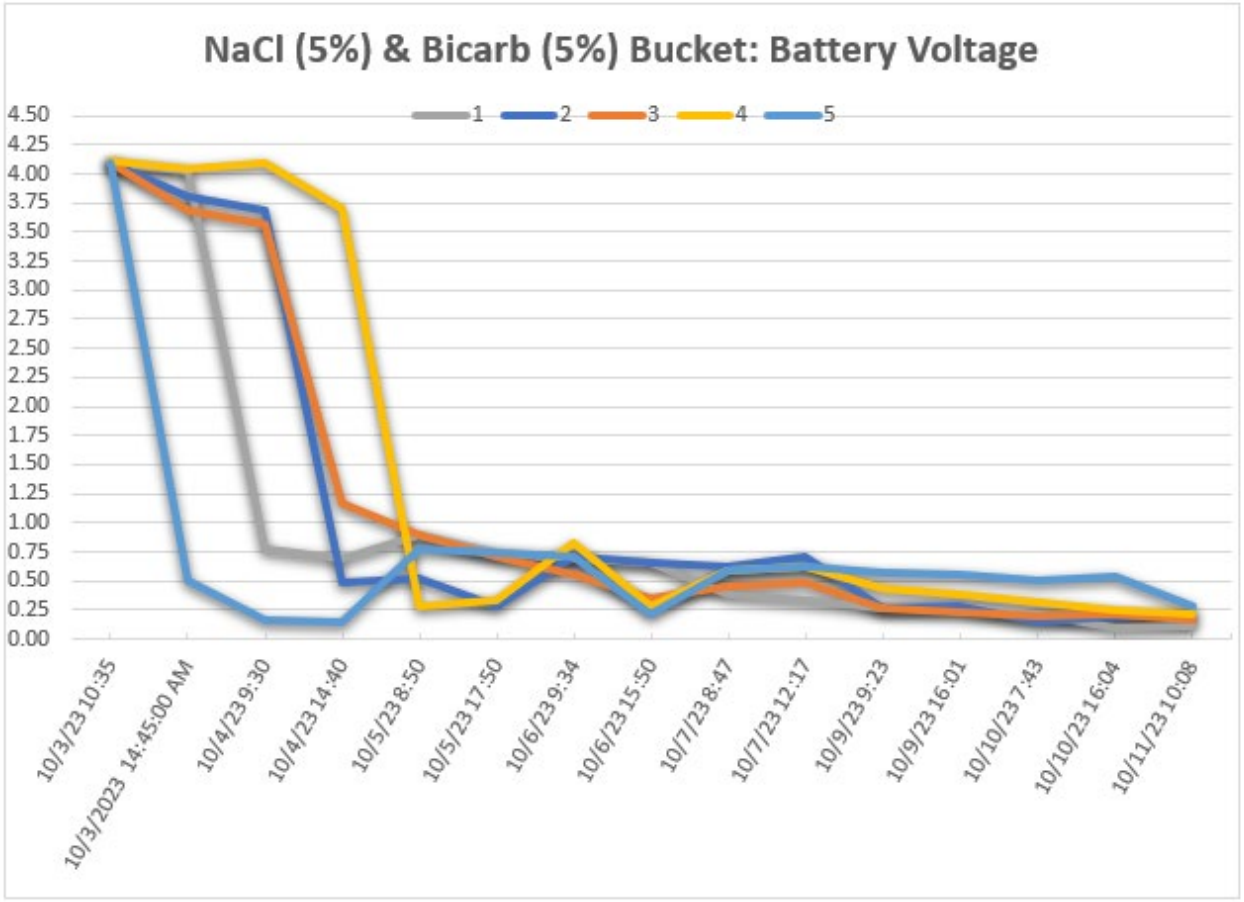
4-Buffalo Convoy Relo-Staging

Battery Processing – De-Energizing

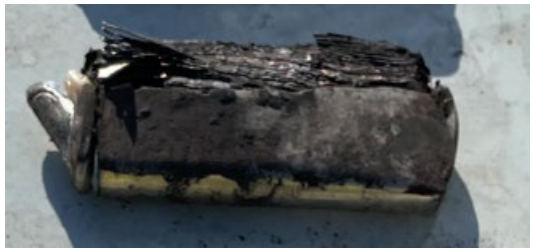


Battery Processing – De-Energizing

Battery Processing – De-Energizing



Battery Processing – Crushing



Battery Processing – Electric Vehicles

Battery Processing – Packaging

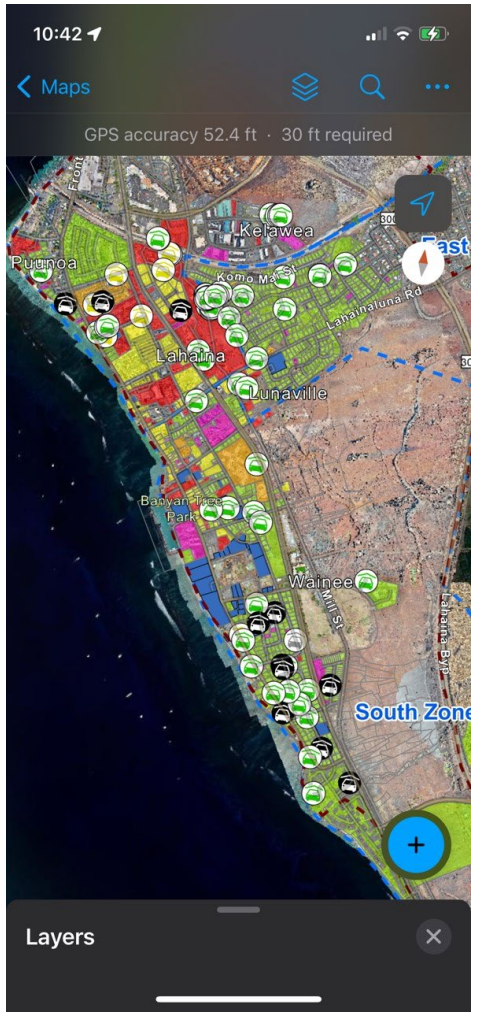
Electric and Hybrid Vehicles

Section 3

Reconnaissance - EVs

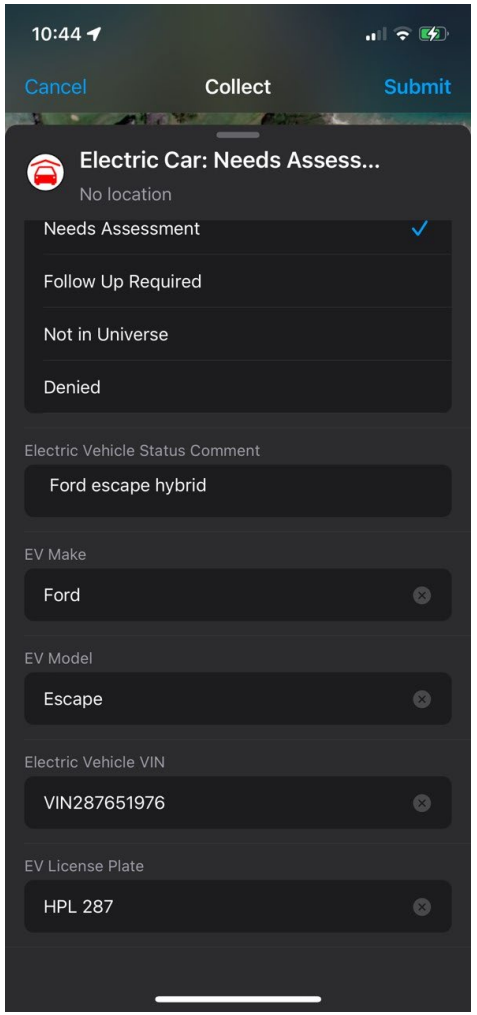
- Maui County Data
- Motor Vehicles Data
- National Insurance Crime Bureau
- Owner Self-Assessment & Re-entry Forms
- Hotline, Commercials, PSAs
- Ground Truth – EPA Teams

Reconnaissance - EVs



Data Management

- Assessment Info
- Point Collection in App
- Vehicle Research
- Battery Condition/Type



Battery Recovery - EVs

To gain an understanding of battery type, important to know:

- Make
- Model
- Year
- Option

This was a luxury if available.

No resources on-island for investigating battery health

Limited or No Technical Reference Support From Manufacturers/Dealers

Battery Recovery - EVs

Different Make = Different Battery

Different Model = Different Battery

Different Year = Different Battery

Different Option = Different Battery

Electrical Hazards-Voltage Checks

Electric Vehicle

Residential Battery Energy Storage System

Dust, Toxic Vapors, and Fire Hazards

Water/Pump and Hose Line in Place, PPE On

Temperature Checks & Load security

E. Nuchims/L. Wirschem

Flammable or Toxic Vapors
Corrosive Residues

Corrosive Residues

Removal/Recovery of Burned Electric Vehicle Batteries

Electric Vehicle - Battery Removal Ops

EV-Battery Removal Ops/Processing

4-Harvest

Battery Recovery – EVs (Toyota Prius)

Battery Recovery – EVs (Nissan Leaf)

Battery Recovery – Electric Vehicles

(Difficulty w/ Insurance/Auction)

EV-Battery Tech Ref / ERGs

Emergency Response Guides

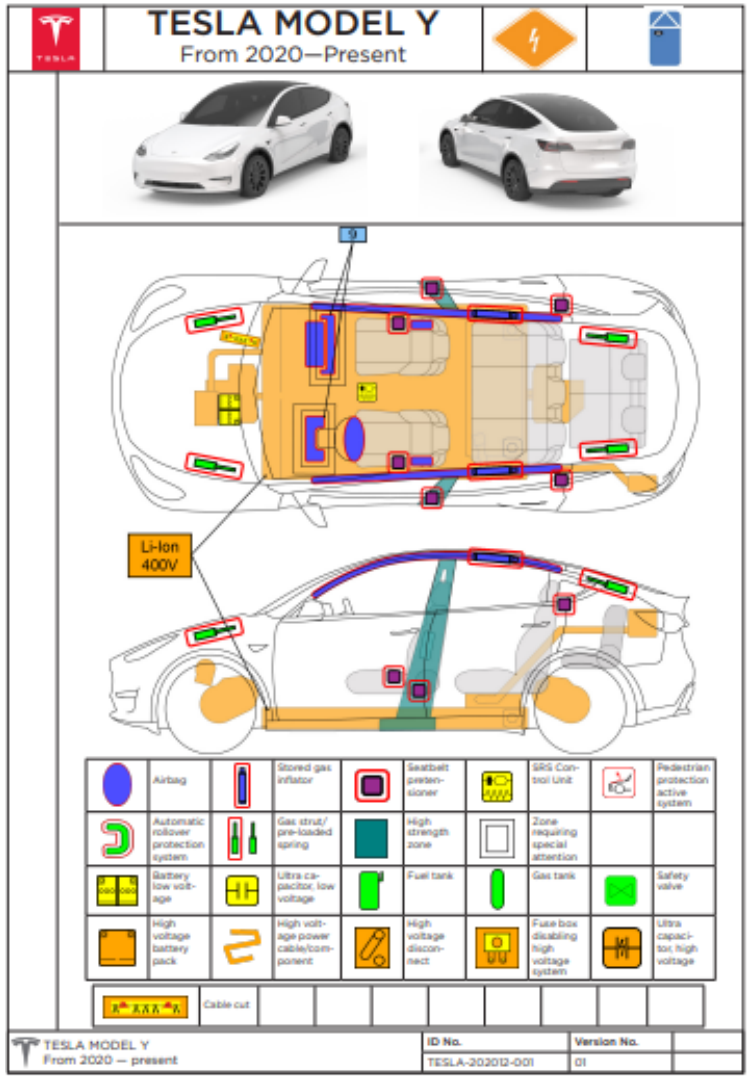
NFPA actively maintains a collection of Emergency Response Guides from 35+ alternative fuel vehicle manufacturers. The guides are free to download. To access these documents, visit our manufacturer web pages below:

- Acura
- Audi
- Autocar
- Automobili Pininfarina
- Azure Dynamics
- Bentley
- BMW
- BrightDrop
- Buick
- BYD
- Cadillac
- Chevrolet
- Chrysler
- Dodge
- Fiat
- Fisker Automotive
- Green Power Motors
- Hino
- Honda
- Hyundai
- Infiniti
- Jeep
- Karma
- Kenworth
- Kia
- Lexus
- Lightning eMotors
- Lincoln
- Lucid
- Mack
- Mazda
- Mercedes-Benz
- Nikola
- Nissan
- Nova Bus
- Optimal-EV
- Peterbilt
- Porsche
- Proterra
- Rivian
- Saturn
- Scion
- Smith
- Subaru
- Tesla
- Thomas Built Buses
- Toyota
- Van Hool Bus

NATIONAL FIRE PROTECTION ASSOCIATION

The leading information and knowledge resource on fire, electrical and related hazards

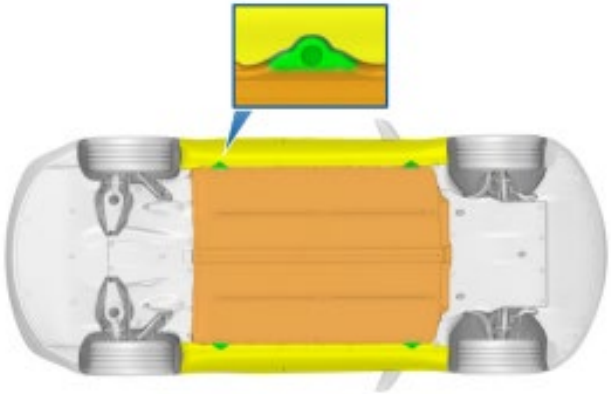
EV-Battery Tech Ref / ERGs



WARNING Be careful to not damage the battery pack while stabilizing / lifting the vehicle.

WARNING The vehicle should be lifted or manipulated only if first responders are trained and equipped at the technician level per National Fire Protection Association (NFPA) and are familiar with the vehicle's lifting points. Use caution to ensure you never come into contact with the high voltage battery or other high voltage components while lifting or manipulating the vehicle.

WARNING DO NOT USE THE HIGH VOLTAGE BATTERY TO LIFT OR STABILIZE MODEL Y.



	Appropriate lift areas
	Safe stabilization points for a Model Y resting on its side
	High voltage battery

Waste Determination

Section 5

What is it?
Battery? HazMat? Scrap Metal?

Waste Determination and Transportation

- Background
  - Lithium-ion Batteries present various hazards during use and at end of life
  - DOT damaged battery (DDR, 49 CFR 173.185 (f)) Regs burdensome, expensive and ineffective to address safety concerns.
  - Alternative techniques have been developed on Maui; however, required changes/updates to 40 CFR and 49 CFR are needed.

Waste Determination and Transportation

- Problem
  - Damaged, defective or recalled lithium-ion battery have special packaging that was intended to mitigate hazards but effectively does not prevent build-up/release of toxic and explosive gases; and is expensive.
  - Shipping of material is cost prohibitive and subject to risk-based acceptance procedures of carriers.
    - Shippers/carriers do not prefer to accept fire impacted batteries (DDR).
    - Without additional material processing, the general industry expectation is that fire impacted batteries will move as hazardous waste due to reactivity (DDR).

Waste Determination and Transportation

- Actions (Maui)
  - Assess state of battery cell condition and charge
    - Increase state of charge is related to risk and reactivity
    - Brine solution can significantly reduce the state of charge.
    - Based upon battery assessment, as necessary brine/de-energize battery cells (5% Sodium Chloride; transition 50/50 Mix of 5% Sodium Chloride and 5% Sodium Bicarbonate)
  - Crush/destroy/de-construct
    - No longer meets the definition of a battery per EPA or a lithium-ion battery per DOT/PHMSA

Waste Determination and Transportation

- Actions (Maui)
  - Crush/destroy/de-construct (No longer meets definitions)
    - 40 CFR 273.9 *Battery* means a device consisting of one or more electrically connected electrochemical cells which is designed to receive, store, and deliver electric energy. An electrochemical cell is a system consisting of an anode, cathode, and an electrolyte, plus such connections (electrical and mechanical) as may be needed to allow the cell to deliver or receive electrical energy. The term battery also includes an intact, unbroken battery from which the electrolyte has been removed.
    - 49 CFR 171.8 *Lithium ion cell or battery* means a rechargeable electrochemical cell or battery in which the positive and negative electrodes are both lithium compounds constructed with no metallic lithium in either electrode. A lithium ion polymer cell or battery that uses lithium ion chemistries, as described herein, is regulated as a lithium ion cell or battery.

Waste Determination and Transportation

- Actions (Maui)
  - Material still observed to generated very limited toxic and flammable gases (Electrolysis, hydrolysis, oxidation, and/or decomposition)
    - UN Test

33.5.4 ***Test N.5: Test method for substances which in contact with water emit flammable gases***

33.5.4.4.4 Packing group III/Category 3 should be assigned to any substance which reacts slowly with water at ambient temperatures such that the maximum rate of evolution of flammable gas is greater than 1 litre per kilogram of substance per hour, and which does not meet the criteria for packing groups I or II/Categories 1 or 2.

Waste Determination and Transportation

Actions (Maui)

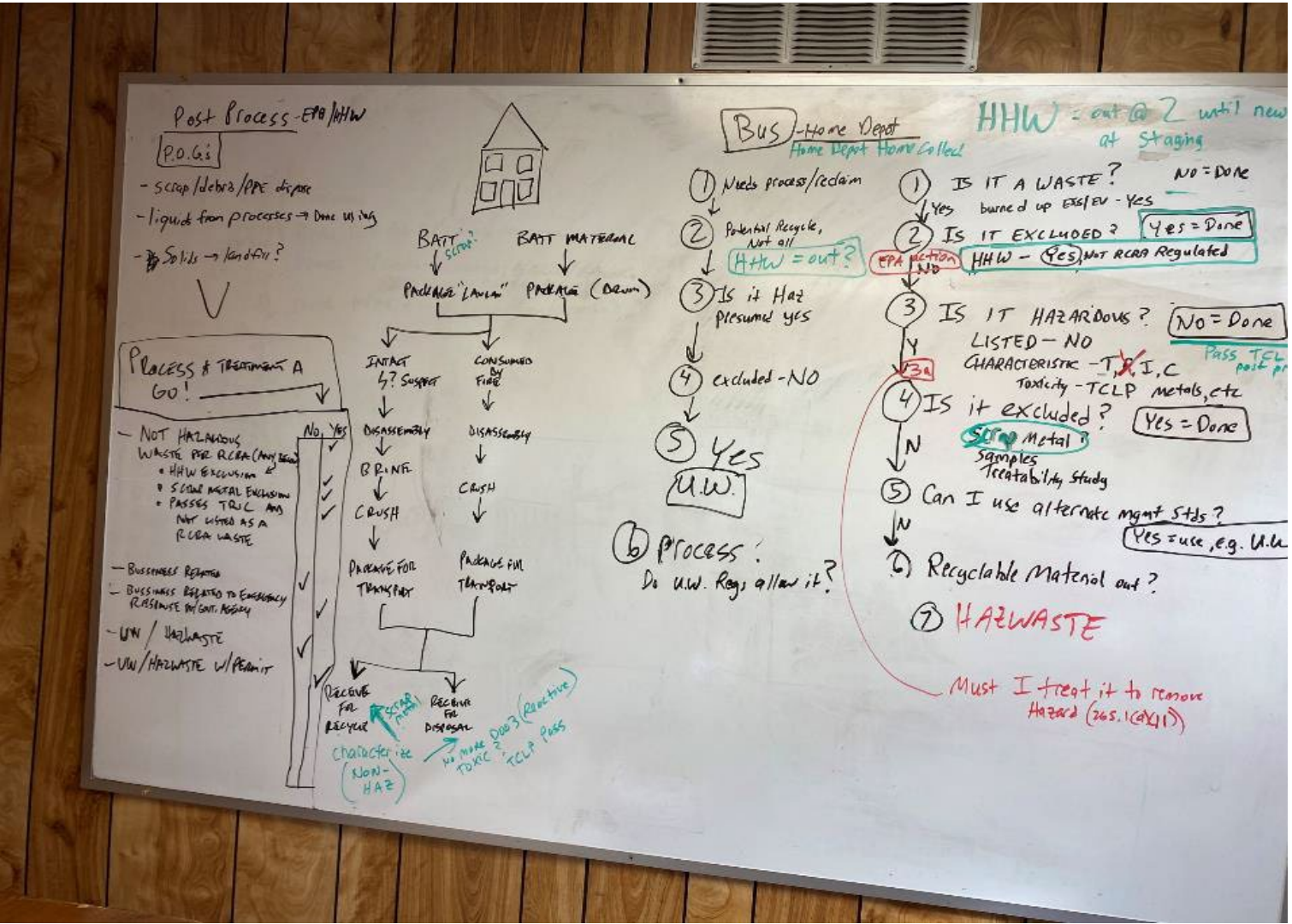
- Material moved in packaging that provides:
  - Ventilation (Highest Readings Taken)
    - CO sensor is a 40% H2 Sensor
    - 400 PPM of CO=1000 PPM of Hydrogen or .1%v
    - LEL of H2 is 4% so .1%v= 2.5% of LEL
      - (Drager Tubes: .2%, very light colored green)
  - Particulate Control
  - Water Intrusion Control
- Packaging transported in open top containers

Waste Determination and Transportation (Maui via Ocean Carrier to West Coast to Recycler)

Waste Determination and Transportation

- San Diego Lithium-ion Battery Study (Multi-Agency): February 21-23, 2024.
  - H2 Confirmation
  - Samples for lab analysis for: HF; HCN; Metals; Air/Gas
  - Instrument ground truthing
  - DDR and “Not Batteries” packaging ground truthing
  - Chemistry and SOC: volatility of gas or fire/explosion; gas production differences
  - PPE contamination and recommendations
  - Waste mitigation strategies
  - Additional waste analysis

Waste Determination and Transportation



- Batteries- RCRA vs CA considerations

Waste Determination and Transportation

- California has additional requirements:
  - CA does not offer full relief from regulation for HHW
  - CA has additional requirements for scrap metal (66261)
  - CA has additional requirements for recycled wastes (66261.2)
  - RCRA heavy metals found in batteries: Pb, Cd, Ag, Cr, As, Ba. They pass TCLP, but CA has STLC (66261.24)
  - CA has additional metals found in batteries, such as Cobalt, Nickel, Copper, Zinc, Thallium and more.
  - CA regulates Flouride Salts (66261.24)

Waste Determination and Transportation

- Additional Considerations:
  - Definitions may not be the same (needs review) for definition of treatment, battery and scrap metal.
  - 66265.1 Treatment exemptions are not the same as 40CFR, however immediate response exemption is still useful for Emergency Responses.
  - California treatment regulations are more restrictive than federal.
  - Universal waste has additional requirements (66261.9, 66273.2)
  - CA allows some recycling exemptions under HSC 25143.2, could this qualify?

Waste Determination and Transportation

- Things that could help:
  - Clarify when a battery is no longer a battery, such as when it no longer has a cathode and anode intact.
  - Work with DOT on definition of battery (49 CFR 171.8)
  - Work with EPA and DOT to determine when a Lithium-ion battery is no longer considered reactive (such as previous EPA determination for other Lithium batteries less than one volt). (40 CFR 273.9; UN Test 33.5.4)
  - Exclude from treatment the de-energizing of batteries using non-hazardous salt water (NaCl solution).
  - Define a Lithium-ion battery as scrap metal when no longer meets definition of a battery.

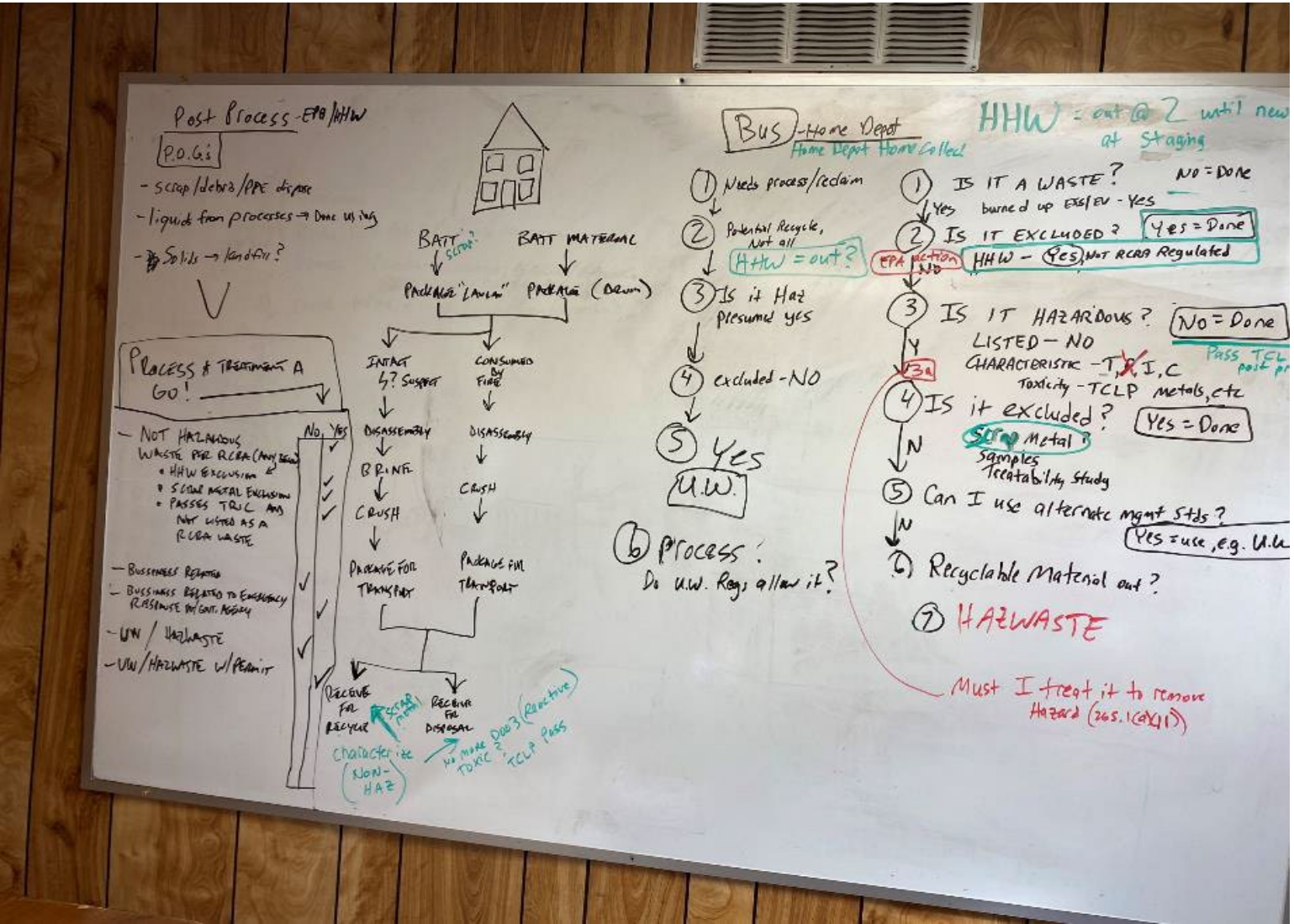
Waste Determination and Transportation

- Other Options:
  - Add an exclusion in 66261.4 similar to the exclusion for vehicle airbags (No longer Sodium Azide or Ammonium Nitrate; now Guanidinium Nitrate and Copper Nitrate oxidizer forming more stable production of Nitrogen gas).
  - Add a treatment allowance in 66265.1 for de-energizing of batteries or rendering batteries non-hazardous using no added heat or chemical (other than saltwater)

Waste Determination and Transportation

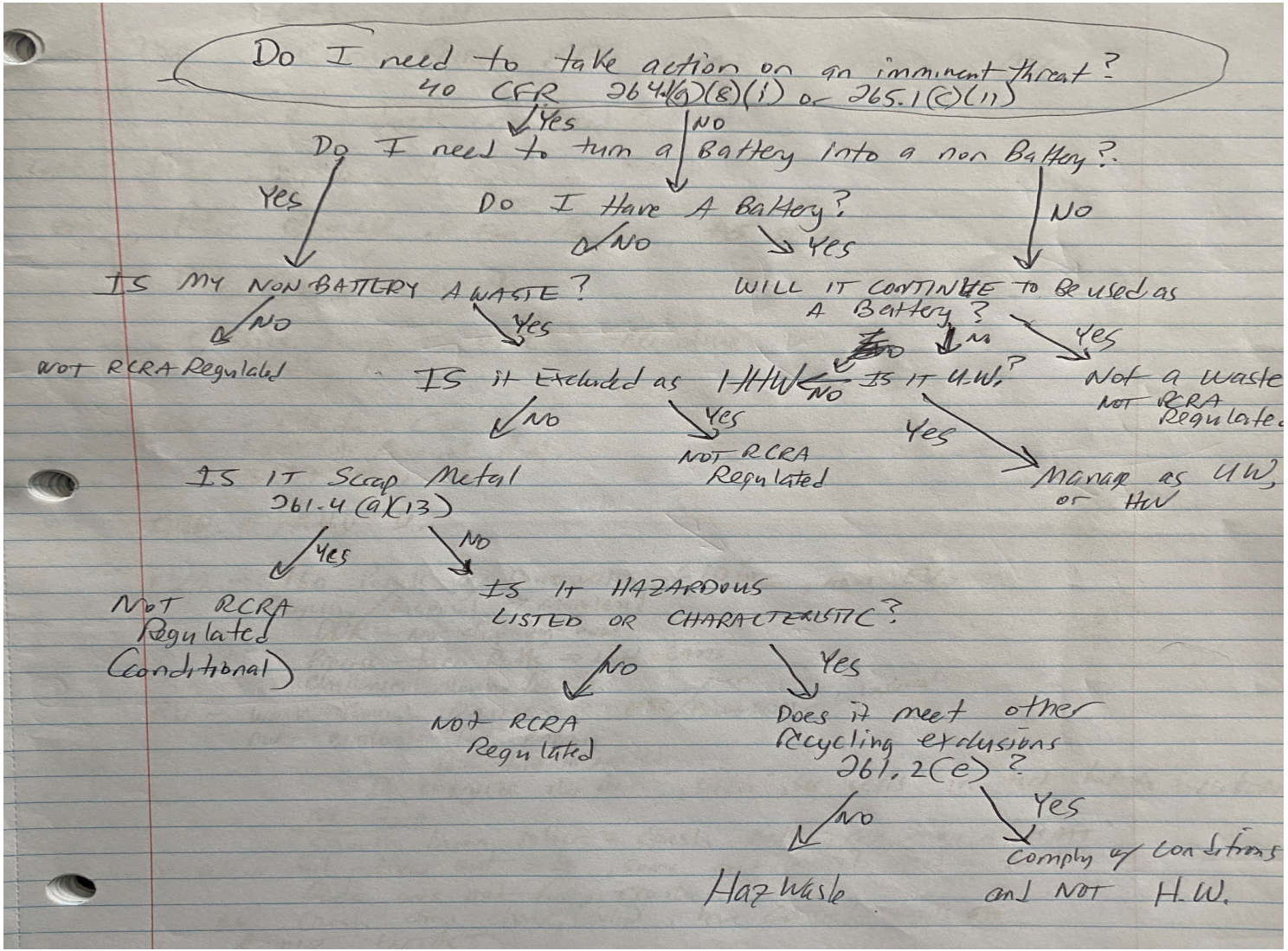
- Moving Forward:
  - EPA continue working with DOT.
  - EPA and DTSC work with battery recyclers
  - EPA and DTSC work with the TSDFs
  - Waste will move however the transporter/hauler determine it needs to depending upon current and future updated/effective regulatory requirements.

Waste Determination and Transportation



- Planning-SOPs & Waste Regulations Finding Solutions to Real World Problems:

Waste Determination and Transportation



- Planning-SOPs & Waste Regulations Finding Solutions to Real World Problems:

SOP's/JHA's

Section 6

SOPs - EVs

Maui Wildfires 2023
Damaged Lithium-Ion Battery Management Guide for Electric Vehicles
Version: November 2, 2023

1. OBJECTIVE

The handling of damaged lithium-ion batteries inherently presents significant hazards to response personnel. This Guide has been established as a set of general guidelines for the proper handling of lithium-ion batteries to protect all response personnel. The purpose of this procedure is to outline the minimum requirements for safe handling, transportation, and the disposal process considerations for fire damaged lithium-ion batteries through a process of hazard identification and exposure control practices resulting in risk mitigation (Hazard x Exposure = Risk).This Guide is geared towards the following categories of lithium-ion batteries: Battery Energy Storage Systems (BESS), electric and hybrid vehicles (EVs), micromobility devices (e-bikes and scooters), and small batteries (vaping devices, computers, cell phones, etc.)

2. HAZARDS

Thermally insulted, burned or partially damaged lithium-ion batteries are susceptible to thermal runaway. This chemical reaction produces self-sustaining high temperatures that can result in the release of toxic and flammable/explosive vapors with the potential for fire (Figure 1). In addition to combustion products, the vapor produced during thermal runaway and fire can include the following hazardous and toxic and flammable/explosive vapors.:

- Hydrogen (30%-50%)
- Carbon monoxide (CO)
- Hydrogen fluoride (HF)
- Hydrogen chloride (HCl)
- Hydrogen cyanide (HCN)
- Phosphoryl fluoride (POF_3)
- Organic solvent droplets
- Ethane, methane, and other hydrocarbons

Figure 1: Diagram depicting a cascading thermal runaway event.

Burned or damaged batteries are unpredictable and cannot be considered fully discharged or free of hazards. Reignition from propagation or thermal insult to other cells within a battery is common and can occur 30 to 90 days from an initial thermal runaway event. During transportation, extreme temperatures and mechanical damage (such as puncturing or jostling) can trigger additional thermal runaway events. Batteries, groups of cells, or individual cells that have suffered significant fire damage may be present as a mass of melted or consumed material that must be evaluated by the Electric Vehicle Task Force to determine if the article has the remaining potential to be a functional cell or battery. When in doubt, the fire damaged article(s) in question must be rendered safe by the Electric Vehicle Task Force (eliminate the hazard) to effectively manage any risks associated with any necessary future steps, such as: local ground movement/transportation, disposal or remediation, and long-distance shipping by ground or vessel, etc.

SUPERFUND TECHNICAL ASSESSMENT RESPONSE TEAM
STANDARD OPERATING PROCEDURE FOR RECONNAISSANCE OF ELECTRIC VEHICLES
2023 MAUI WILDFIRE RESPONSE
DRAFT OCTOBER 27, 2023

1. OBJECTIVE

This Standard Operating Procedure (SOP) describes the process to determine the presence and location of hybrid and electric vehicles (EVs) impacted by fire. Identification of EVs in a burn zone is necessary to ensure the proper handling and recycling/disposal of lithium ion and nickel-metal hydride battery packs. The objective is to identify and log all hydrid and EVs within the burn zone. This includes vehicles with partial or no visible impacts by fire since temperatures as low as 150 degrees fahrenheit can compromise the batteries. The purpose of the battery reconnaissance (recon) is to:

1) Understand the scope of the EV project and collect specific data in the site database which can then be queried for information;
2) Assist the battery recovery process;
3) Inform EPA's discussions of the disposition of EVs with interested third parties such as owners, insurance companies, local police and city officials, local auto recovery companies;
4) Plan battery processing activities; and
5) Plan disposal of EV batteries.

The Battery Recon Team will be followed by the Battery Removal Team which will be responsible for assessing the condition of the vehicle and the battery, if the battery should be removed, or if the owner of the vehicle or insurance company should be contacted (e.g., if the vehicle appears not to be impacted). The Battery Recon Team will typically be made up of 2-3 START personnel with oversight by an Federal On-Scene Coordinator.

2. SUMMARY OF METHOD

Recon is done by a team of trained hazmat responders familiar with vehicle manufacturers, models, and mechanical and battery technology. Teams will survey burned areas looking for vehicles with either hybrid or all electric drivetrains. Once a vehicle is positively identified with hybrid or EV technology, it is marked physically with paint or grease pencil, with a blue colored lightning bolt (typically paint can be used on burned vehicles and the grease pencil on non-burned vehicles on the windshield or glass) and digitally entered into electronic field collection and mapping software (QuickCapture via Field Maps). Additional methodology can be found in the Maui Wildfires 2023 Damaged Lithium-Ion Battery Management Guide for Electric Vehicles.

JHA – Battery Energy Storage Systems

2023 Maui Wildfires

U.S. Environmental Protection Agency, Region 9

Emergency Response Section

JOB HAZARD ANALYSIS #7: Power Walls / Lithium Batteries

JHA		
JHA #: 007	**Name of Task:** Power Walls / Lithium Batteries	**Location:** 2023 Maui Wildfires
Task Description: Managing power walls and lithium batteries		**Task Duration:** Daily

Physical Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Stored Energy (Electricity) / Fire and Explosion	1. Electric/Power supply lines 2. Power walls (Tesla and other brands or homemade versions) 3. Lithium batteries	1. Ensure all electrical power has been shut off/disconnected from the power wall: a. Licensed/certified electrician to verify power status. 2. Ensure no backfeeding to the power wall (i.e., solar panels or any other device that could potentially be feeding energy to or drawing energy from power wall). 3. Isolate the energy storage system (i.e., power wall) after verification that all energy to the system has been shut off or disconnected. 4. Prepare power wall for transportation: • Partially burned, Partially insulted, intact, but suspected insulted power walls: - Use SCBA for respiratory protection along with Flame-Resistant (FR) clothing. Completely charred or Completely charred and bulged power walls: – Use organic vapor/acid gas filters along with Flame-Resistant (FR) clothing. • Wrap powerwall in fireblankets (e.g., Bridgehill). • If any reaction occurs during handling, immediately drop the power wall and vacate the area to a safey place. • Place in transport vehicle and secure in place using straps or other equipment. • Ensure fire extinguisher and pressurized water sprayers are available during transport. 5. Transport power wall to secure staging area for further processing: • Coordinate with local fire department prior to transport. • If reaction occurs during transport, park vehicle immediately in a location with minimal fire risk (to the extent possible); call fire department (dial 911) immediately for assistance. • Maintain fire readiness (fire extinguishers and pressurized water sparyers to cool container during transport in the event of reaction/fire situation).					
Chemical Exposure	By-product of fires involving lithium batteries	See Chemical Hazards section below					

Biological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
COVID-19 Exposure	Unknown	Follow COVID-19 protocols					

Chemical & Radiological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Hydrogen Fluoride	By-product of fires involving lithium batteries	1. Partially burned, Partially insulted, intact, but suspected insulted power walls: - SCBA required for respiratory protection while handling power walls. – Completely charred or Completely charred and bulged power walls: organic gas/acid gas filters required for respiratory protection. 2. FR clothing required for potential fires. 3. In the event a reaction occurs during handling, immediately drop the power wall and vacate the area to safety. 4. Notify the fire department (dial 911).					

PPE

Level A	Level B	Level C	Level D Mod	Level D
	Partially burned, Partially insulted, intact, but suspected insulted power walls -(SCBA for respiratory protection combined with FR clothing)	Completely charred or Completely charred and bulged power walls: (Organic gas/acid gas filters required for respiratory protection combined with FR clothing.)		

Other

None

JHA – EV Battery Removal & Transport

2023 Maui Wildfires

U.S. Environmental Protection Agency, Region 9

Emergency Response Section

JOB HAZARD ANALYSIS #8: EV Battery Removal and Transport

JHA		
JHA #: 008	**Name of Task:** EV Batteries	**Location:** 2023 Maui Wildfires
Task Description: Managing EV batteries		**Task Duration:** Daily

Physical Hazards – EV Battery Removal

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Overhead Hazards	Burned out structure debris	Situational awareness. Hard hat					
Trip Hazards	Burned out structure debris	Situational awareness, test footing prior to stepping on unknown area					
Electrocution	Energized power lines. Charged EV battery.	Assume all electric lines and appliances are energized. Evaluate EV battery prior to handling.					
Traffic	Vehicles traveling in work areas	Situational Awareness. High visibility vests					
Fall Hazard	Open septic field or tree root burnout	Situational Awareness. Mark deep fall hazards with caution tape and orange spray paint					
Falling Trees	Burned out trees	Situational Awareness. Observe Arborist markings trees. Avoid hazardous tree fall zones. Cease work with wind speeds of 20mph.					
Puncture Risk	Sharp objects in debris	Situational Awareness. Leather work gloves.					
Heavy Equipment	Crush zones during vehicle rotation	Situational Awareness. Spotter usage.					
Pinch Points	Cutting metal/Jaws of life	Situational Awareness. Use leather work gloves.					
Heat Stress	Working in protective suits	Follow Work/Rest schedules. Stay Hydrated					
Lifting Injuries	Lift heavy batteries and equipment	Use propped lifting techniques. Use two man lift for heavy objects Do not carry heavy objects far distances					

Physical Hazards – EV Batteries

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Stored Energy (Electricity) / Fire and Explosion	1. Electric/Power supply lines 2. EV high-voltage and low-voltage batteries	1. Ensure all electrical power has been shut off/disconnected from EV vehicle: a. Licensed/certified electrician to verify power status. 2. Ensure no backfeeding to the EV vehicle (i.e., solar panels or any other device that could potentially be feeding energy to or drawing energy from EV vehicle). 3. Isolate the energy storage system (i.e., EV battery) after verification that all energy to the vehicle has been shut off or disconnected. 4. Remove EV battery from vehicle using methods identified in the SOP; methods may include rotating vehicle (on side or completely flipped over) using heavy equipment, cutting metal using "Jaws of Life", removing bolts or other metal fasteners (see physical hazards above). 5. Prepare EV battery for transportation: • Active thermal event or poorly ventilated area - SCBA required for respiratory protection along with Flame-Resistant (FR) clothing OR Standard EV battery removal - organic gas/acid gas filters required for respiratory protection along with Flame-Resistant (FR) clothing. • Wrap EV battery in fireblankets (e.g., Bridgehill) or place loose material in drum with bung off. • If any reaction occurs during handling, immediately drop the EV battery and vacate the area to a safey place (upwind). • Place in transport vehicle and secure in place using straps or other equipment. • Ensure fire extinguisher and pressurized water sprayers are available during transport. 6. Transport EV battery to secure staging area for further processing: • Notify local fire department if thermal or other event occurs that requires a response. • If reaction occurs during transport, park vehicle immediately in a location with minimal fire risk (to the extent possible); call fire department (dial 911) immediately for assistance. • Maintain fire readiness (fire extinguishers and pressurized water sprayers to cool container during transport in the event of reaction/fire situation).					
Chemical Exposure	By-product of fires involving lithium batteries	See Chemical Hazards section below					

Biological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
COVID-19 Exposure	Unknown	Follow COVID-19 protocols					

Chemical & Radiological Hazards

Hazard	Source	Control Measures	Exposure Potential H	M	L	Unk	N/A
Alkaline Ash and Battery	Remnants of burned out	Personal Data Ram worn by perimeter personnel. MultiRae monitoring by screening team. P100 respirators on EV					
Materials	structures and battery materials	battery removal crew					
Asbestos	Remnants of burned out structures	Personal Data Ram worn by perimeter personnel. MultiRae monitoring by screening team. P100 respirators on EV battery removal crew					
Flamable and Combustable gases	Batteries	Well ventilated area. P100 respirators and proper eye protection (i.e., goggles). If ventilation concerns, switch to SCBA.					
Acid gases	Batteries	P-100 respirators, acid-proof gloves					
Lead acid	Batteries	Tyvek suites, acid-proof gloves					
Hydrogen Fluoride	By-product of fires involving lithium batteries	1. Active thermal event or poorly ventilated area - SCBA required for respiratory protection OR Standard EV battery removal - organic gas/acid gas filters required for respiratory protection. 2. FR clothing required for potential fires. 3. In the event a reaction occurs during handling, immediately drop the EV battery and vacate the area to safety. 4. Notify the fire department (dial 911).					

PPE

Level A	Level B	Level C	Level D Mod	Level D
	Active thermal event or poorly ventillated area. (SCBA for respiratory protection combined with FR clothing)	Completely charred or completely charred and bulged EV battery: (Organic gas/acid gas filters required for respiratory protection combined with FR clothing.)		

Other

None

NOTES:

From draft SOP on EV Reconnisance – Hazards and required PPE are listed as:
Many hazards exist when performing reconnaissance of burned vehicles. Some of these hazards include sharp edges, broken glass, puncture hazards, structurally unsafe walls, beams, and roofs, high voltage hazards, toxic dust, compromised trees, heat/cold stress, and many more. The recommended PPE for this task is: long sleeve pants and shirts, hardhat, safety toe boots with steel shank, cut resistant gloves, eye protection, high visibility vests, and a dust mask or respirator. Higher level PPE such as Tyvek and boot covers is recommended when conditions require entry into ash footprints.

From draft SOP on EV Battery Removal – Hazards and required PPE are listed as: Numerous chemical and physical hazards are present during vehicle battery recovery. Chemical hazards include acid gases and occasional lead-acid. Physical hazards are heavy lifting of responder tools, sharp metal, fire, heat, ash and dehydration. The PPE level utilized is Level C with 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.

Next Steps

Section 7

Next Steps

The Future of Li-Ion Battery Response to Ensure Safety of All Involved

- RCRA Conversation within USEPA
- Development of a new North American or UN Identification Number or for the end-state material of the process in order to facilitate proper identification (labelling), transport and disposal. Collaborative approach between US DOT/PHMSA and US EPA.
- Recycling vs Disposal
- Regulatory framework will need to be changed and/or created to address the new waste-stream.
- USEPA Emergency Response SOPs
- USEPA Emergency Response Li-Ion Battery Taskforce
- Intellectual property determination (patent) of the process – ensure the process is available to all as appropriate.
- The intentional evolution of the process – ensure that the process can and will be scalable and usable by private industry and local through to federal response organizations.
- Provide and participate in national and regional studies, exercises and trainings (San Diego).

Li-Ion Battery Taskforce

Region	Contact(s)	Region	Contact(s)
1	Lina Takahashi Michael Cofsky	7	Gregory Dillon
2	Stephen Simonetti Keith Glenn	8	Eric Sandusky Joe Payne
3	Christopher Guzzetti	9	Christopher Myers Eric Nuchims
4	Bryan Vasser	10	Stephen Ball
5	Leonard Zintak	ERT	Joseph Bundens Brian Kovak
6	David Robertson	RM Reps	Peter Guria James Webster

How to contact EPA

- **EPA Region 9 Duty Officer(24Hr):**
  800-300-2193 x3

- **National Response Center:**
  800-424-8802

When to call EPA…Anytime you want

- Actual or threat of discharge of **oil** to surface waters.
- Actual or threat of release of CERCLA **hazardous substances**, pollutants, or contaminants.
- Technical support –desktop or in the field
- When a responsible party is:
  - In over their head with a cleanup
  - Not taking action
- When you think the cleanup is going to take awhile
- “Large” volume incidents
- Tier 2 Reporting facilities
- Mismanaged chemical or oils
- See visible mercury beads >2 tablespoons
- Looking for a sucker to take your problematic site

Cost Reimbursement

- **Hazardous Substances**
  - Up to $25,000 per incident
  - Must involve CERCLA hazardous substances
  - Local, County, Tribal government only

- **Oil**
  - Multiple options through US Coast Guard

Question & Answer / Feedback

- Thank You!