EMS Guidance for Responding to Crashes and Fires Involving Electric and Hybrid-Electric Vehicles Equipped with High-Voltage Batteries

I. Introduction

Sales of hybrid, plug-in hybrid and battery-electric vehicles in the U.S. continue to increase, and these cars now make up about 16% of light-duty vehicle sales. While so far there's little to no evidence showing electric vehicles (EVs) and hybrid-electric vehicles (HEV) are less safe than internal combustion-engine (ICE) vehicles, they do present a new and different set of challenges for first responders.

In a crash, a high-voltage (HV) lithium-ion battery in a damaged EV or HEV can off-gas or ignite (what's known as *thermal runaway*) rapidly with little or no warning. The gas and smoke emitted when the battery is off-gassing or burning is not just flammable but highly toxic. Battery fires also burn much hotter (3000+ degrees) than those in an ICE vehicle, which burn at about 800 to 1000 degrees.

II. What EMS should do at the scene of an EV/HEV crash

BE ALERT! **Physical damage to the vehicle or battery may result in the immediate release of toxic and/or flammable gases and fire.**

When you arrive at the scene

- First determine if any of the vehicles involved in a crash is an EV or HEV. If so, notify dispatch and all other responders of this.
- Always assume the HV battery and associated components are energized and fully charged.
- Avoid contact with orange, high-voltage cabling and look for warning labels or markings in the vehicle that indicate a high-voltage risk.

How to safely approach and immobilize the vehicle

- Always approach the vehicle from the side. It has been difficult to determine if the vehicle is running due to lack of engine noise. If it's running, it may move, placing personnel in danger.
- If possible, chock or deflate the tires to stop the vehicle from moving, put the vehicle in Park, and set the parking brake.

Emergency Response Guides for Alternative-Fuel Vehicles

The National Fire Protection Association (NFPA) website contains more than 35 Emergency Response Guides (ERG) from alternative-fuel vehicle manufacturers. While a guide does not currently exist for every EV and HEV, when responding to a crash involving one of these vehicles, EMS personnel can look for a vehicle-specific guide at the NFPA site to guide their emergency response.

These resources contain valuable guidance on identifying, immobilizing, stabilizing, and disabling the vehicle as well as accessing occupants, extinguishing a fire, and understanding the potential hazards within the vehicle. The ERGs also include information about what to do if the EV/HEV is submerged and how to tow and store it following a crash or submersion.

How to safely disable the vehicle

- Turn off the vehicle, activate hazard lights, and move vehicle key at least 16 feet away from the vehicle.
- Disconnect the vehicle's 12-volt battery.

CAUTION **Safety restraints, air bags, and other safety systems may be active for up to 5 minutes after disconnecting the 12-volt battery.**

What to look for

- **If you detect leaking fluids, sparks, smoke, flames, increased temperature, gurgling, popping, or hissing noises** from the HV battery compartment, ventilate the passenger area by rolling down windows or opening doors, and request fire department response.
- **If you detect any unusual odors or experience eye, nose or throat irritation**, move away from the vehicle and evacuate others from the immediate area. Rapid extrication have been needed for injured or trapped occupants.

Remain a safe distance upwind and uphill from the vehicle and out of the way of oncoming traffic until other appropriately equipped emergency responders arrive.

What to do for a fire involving or exposing the vehicle battery

- Follow local standard operating procedures (SOPs) for vehicle fires.
- Wear appropriate, NFPA-compliant Personal Protective Equipment (PPE) and Self-Contained Breathing Apparatus (SCBA).
- If you are unable to quickly remove the occupants, use a fire extinguisher to protect them from the flames.
- As with any vehicle fire, the byproducts of combustion will be toxic, and all individuals should be directed to move to a safe distance upwind and uphill from the vehicle fire and out of the way of oncoming traffic.

Treating patients who have been exposed

Anyone exposed to gases or by-products from a burning HV battery have been exposed to toxic chemicals and/or heavy metals. Follow local SOPs and medical protocols for treating patients exposed to hazardous chemicals and materials.

Do not assume patients are only experiencing the effects of smoke inhalation.

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III. Resources for EMS

- High-Voltage Battery Events in Hybrid Electric and Electric Vehicles
- US DOT NHTSA, Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped With High-Voltage Batteries (Fire/EMS/Law Enforcement)
- US DOE, Alternative Fuels Data Center, EV Safety Training Resources for Responders
- NAFTC First Responder Safety Training
- NFPA on-line EV training
- NFPA Emergency Response Guides (ERGs)
- IAFC Lithium-Ion and Energy Storage Systems
- IAFC Bulletin on FD Response to EV Fires (2021)
- NVFC Virtual Classroom, EV Safety: An Awareness Level Training
- ESA Hybrid/EV Responder Awareness Training
- Illinois Fire Service Institute's Alternative Fuel Vehicle Course
- AFV Educates EMS EV Safety Training