U.S. DEPARTMENT OF
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Office of
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Electric Vehicle Fire Primer for Fleet Managers

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The U.S. Department of Energy's Vehicle Technologies Office provides project assistance through Clean Cities, technical expertise, and funding to help stakeholders implement alternative fuels and electric vehicles (EVs). Fleet managers considering EVs can learn about the potential for EV fires and measures to help reduce fire risk.

For technical assistance, please access Clean Cities technical assistance at https://cleancities.energy.gov/technical-assistance/.

What is the risk of EV fires?

Despite heightened media attention, the risk of an EV fire is statistically very low. EVs have historically been in use less than gasoline-powered vehicles, so it is difficult to compare their fire frequency and rates (especially for medium- and heavy-duty trucks and buses). However, for light-duty vehicles, an April 2021 Highway Loss Data Institute study (www.courthousenews.com/wp-content/uploads/2022/04/highway-loss-data-report-EV-noncrash-fire.pdf) found that non-crash fire claim frequencies between EV models and their conventional (non-EV) counterparts were comparable.

The National Transportation Safety Board also explored the frequency of fires occurring during fatal vehicle crashes with different fuel types between 2013 and 2017 using data from the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System database. The analysis found that EVs experienced less frequent fires than conventionally fueled vehicles, although the authors noted limitations with the data set (https://data.ntsb.gov/Docket/Document/docBLOB?ID=10003553&FileExtension=pdf&FileName=5%20Electric%20Vehicle%20Fire%20Data%20Factual%2012212018-Rel.pdf). One fire was noted out of 51 EV fatal crashes reported (approximately 2%), compared to a total of 7,939 vehicle fires noted in the more than 250,000 total fatal highway crashes (approximately 3.2%) involving conventionally fueled vehicles.

According to the National Fire Protection Association (NFPA), of the 290 million vehicles registered in the United States in 2022 (regardless of powertrain type), an estimated 222,000—or just 0.07%—were involved in reported fires (www.nfpa.org/education-and-research/research/nfpa-research/fire-statistical-reports/fire-loss-in-the-united-states).

What are the unique characteristics of an EV fire?

Fires involving EVs and traditional internal combustion engine vehicles are often similar in nature. Low-voltage electrical wiring, upholstery, mechanical components, and other parts used in both types of vehicles can ignite and can be addressed using similar firefighting methods.

Unique characteristics of an EV fire can arise when the high-voltage (HV) battery system catches fire or is otherwise compromised. Damaged HV battery cells can have energy remaining in them (known as "stranded energy") that can pose a risk of electric shock and potentially lead to thermal runaway (www.ntsb.gov/safety/safety-studies/Documents/SR2001.pdf). According to UL Research Institutes (ul.org/research/electrochemical-safety/getting-started-electrochemical-safety/what-causes-thermal), in a thermal runaway situation, "...the lithium-ion cell enters an uncontrollable, self-heating state."

There are two techniques that are typically used to fight HV battery fires depending on the vehicle and the situation: either directing a significant amount of water toward the battery pack or letting the fire burn itself out. No other tools or products are currently available that are proven to effectively extinguish an HV battery fire.

Regardless of vehicle type, first responders should reference the vehicle's emergency response guide (most are available at the NFPA or Energy Security Agency websites) when responding to an incident. The emergency response guides typically provide vehicle-specific information, including:

- Location of the high-voltage system components
- Instructions for high-voltage system disconnect
- Recommended firefighting methods.

Because of the firefighting techniques described above, it can take more time and water to extinguish a fire involving an EV HV battery than an internal combustion engine vehicle fire. There is also potential for latent ignition or reignition of the fire—hours, days, or even weeks later—if the source of the thermal concern is not completely addressed.

All vehicle fires can result in toxic vapors from the off-gassing of plastics, upholstery, and other components, and the HV lithium-ion batteries used in EVs can also off-gas toxic vapors.

What are some potential causes of fires involving an EV HV battery system?

Some potential causes of fire involving an EV or HV battery system include:

- Battery or HV system damage due to a crash
- Battery damage due to excessive heat, water intrusion (especially salt water), penetration, vibration, crushing, internal cell short, or other sources
- Vehicle or battery manufacturing defects
- Extreme environmental conditions, e.g., hurricane flooding.

What precautionary measures can fleet managers take?

- Before or upon delivery of the EV fleet, create or update a fleet safety plan that outlines the proper precautions and procedures to be used in case of a safety risk or incident.
- Outline specific steps to take if a vehicle's battery monitoring system detects a potential issue or an operator/team notes a potential concern, including a process for evacuating customers and staff to a safe location and contacting emergency services.
- Ask the vehicle manufacturer about features to help mitigate battery fires, including a battery management system (BMS). Discuss how the BMS works, what types of warning(s) will be provided, and what the manufacturer's recommended actions are if an issue is detected.
- Ask the manufacturer to provide an ISO 17840 compatible Emergency Response Guide and to ensure that it is posted to the NFPA website.
- Depending on the fleet's typical environment and weather conditions, consider parking EVs outdoors, especially if a potential vehicle safety issue has been identified. NHTSA recommends that severely damaged EVs be stored/parked at least 50 feet away from buildings or flammable materials.
- In coastal areas, consider parking fleet vehicles away from flood zones prior to hurricanes or storm surges (this is a good idea for non-EVs, as well).
- Understand applicable building codes and standards, including sprinkler system requirements and other fire safety measures, and make sure fleet storage buildings are up to date. Consider installing a dedicated fire department connection to supply firefighting water in fleet vehicle storage facilities.
- Inform the local fire department and first responders either before or during the delivery of the EV fleet and advise them of available training resources (see the following first responder resources).

What first responder resources are available?

There are a variety of first and second responder resources available on this topic. For a comprehensive list, see: afdc.energy.gov/vehicles/electric_responders.html ■

Other EV fire resources

- **NFPA – Vehicle-Specific Emergency Response Guides** (www.nfpa.org/education-and-research/emergency-response/emergency-response-guides)
- **NHTSA Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High-Voltage Batteries** (Law Enforcement/Emergency Medical Services/ Fire Department) (www.nhtsa.gov/sites/nhtsa.gov/files/811575-interimguidehev-hv-batt_lawenforce-ems-firedept-v2.pdf)
- **NHTSA Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High-Voltage Batteries** (Vehicle Owner/General Public) (www.nhtsa.gov/sites/nhtsa.gov/files/811577-interimguidehev-hv-batt_owner-v2.pdf)
- **SAE J2990: Hybrid and EV First and Second Responder Recommended Practice** (https://www.sae.org/standards/content/j2990_201907/)
- **International Association of Fire Chiefs (IAFC) Bulletin: Fire Department Response to Electrical Vehicle Fires** (https://www.iafc.org/docs/default-source/1haz/respondingtoelectricalvehiclefires.pdf?sfvrsn=9421650c_6)

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