Updated: August, 2023

ELECTRIC VEHICLE FIRE FIGHTING
& SCENE MANAGEMENT

ACTION CHECKLIST

Dispatch

Include on initial dispatch in addition to fire department:

1. Traffic Incident Management resources - probable long-term incident (over 4 hours)
2. Hazmat (Initially can just be a team representative)
3. EMS, add ALS if any exposure to smoke or runoff. Persons exposed to smoke should get additional evaluation for inhalation of hazards associated with toxic byproducts in smoke (e.g. hydrogen fluoride, H2S, toxic metals, etc.).

Arrival to Scene

1. Secure the scene and move all bystanders to a safe distance.
2. Evaluate smoke travel and consider down-wind, down-hill due evacuation to toxic smoke & runoff.
3. Maintain heightened situational awareness at all times due to dynamic environment and hazards.

Initial Attack

Remember:

- Traffic Incident Management for these incidents could be prolonged with a working period in excess of 4 hours based on current reports.
- Fire departments should brief their police departments on this issue prior to an incident.
- Always wear full PPE.
- **Access Emergency Response Guide ASAP.** NFPA bit.ly/3G0nD7e ESA bit.ly/3DQUysh

Disclaimer: *This document was prepared and reviewed by the DVRPC Electric Vehicle Task Force and is not an official guidance or training source. DVRPC serves strictly as an advisory agency. Actual authority for carrying out recommendations rest solely with the governing bodies that have the responsibility to implement transportation policy. The following recommendations are based on local industry best practices and should be taken in conjunction with hands-on training and individual vehicle manual instructions.* ***All personnel should be properly trained before operating at an electric vehicle incident****.*

Recommended Order of Operations & Considerations

1. Perform initial traffic incident management principles of creating a safe work area with temporary traffic control, advanced warning, blocking, tapers, etc. to protect responders working in the area.

2. Rescue injured persons. Consider treating HF exposure/poisoning (see attached *Supplemental Information* section).

3. Isolate vehicle power as soon as reasonably possible.
    a. **Unless otherwise advised by an ERG or vehicle manufacturer**, find the battery, cut 12 volt negative cable or first responder loop (look for cut diagram). **DO NOT CUT ORANGE CABLE(S).**
    b. Remove the electronic key fob from the vehicle and move at least 50' from the vehicle or isolate it in a RFID, EMF, EMI, or signal blocking/isolation type bag (Faraday bag).
    c. Obtain vehicle state of charge from vehicle operator.

4. Treat as HazMat response level (HazMat Lite), as needed.

5. Fight fire from a distance, protect exposures, and avoid smoke whenever possible. Limit persons in the Hot Zone.
    a. Smoke contains high concentrations of Hydrogen Fluoride (HF) / Hydrofluoric Acid. HF permeates turnouts and is very difficult to remove. Smoke also contains heavy metals.

6. **Cool battery to ambient temperature or no hotter than 120F.**
    a. Battery temperature monitoring should be a continuous process. Vehicles should not be released until battery compartment temperature is stabilized for at least 30 minutes post-suppression.
    b. Air should be continually monitored. Increasing carbon monoxide and other gas levels could be an indication that batteries are still in thermal runaway.

7. Extinguish small fires that do not involve the high voltage battery using typical vehicle fire fighting procedures, monitoring the underneath battery compartment with the TIC to ensure it is not heating up.

8. Consider defensive operations if there are no life safety or exposure concerns. It is exceedingly difficult to put water directly on the cells to effectively cool them and prevent further runaway.

9. If an open area and no hazards or exposures consider letting the vehicle burn. The battery can take up to 1.5 hours to burn out.

10. Do not try to open/pierce the battery for water application, damage to the battery could result in electrocution.

11. Monitor throughout the incident for HF (gas monitor with HF sensor & F paper) and consider fog streams to knock down or reduce vapors if indicated. HF compounds are extremely toxic and can be inhaled, as well as absorbed through the skin.

a. See link for more details on health hazards: www.emergency.cdc.gov/agent/hydrofluoricacid/basics/facts.asp.

12. Use a thermal imager (TIC) to monitor the battery compartment during the fire. Temperatures can reach >1400F (Lack of flames is not a sufficient indication that thermal runaway is not taking place).

13. When safe, chock the wheels. EVs move silently, so never assume it is powered off. Never assume that an EV will not move.

14. Use of foam (Class A or Class B) is not recommended.

15. Consider applying "specialized" agents, surfactants and encapsulating agents (F-500, Fire-Ice, Pryo-Cool, etc.).

16. Batteries should always be treated as energized. During overhaul do not make contact with any high voltage components (see above for battery isolation).

17. Note that runoff can be hazardous.

18. Plan for multiple hours of operation, traffic control (TTC safety), light and air unit, water tenders, and coverage/move-up issues.

19. Fire hoses can become easily contaminated, and must be bagged and properly cleaned.

20. When fire is suppressed sufficiently, lift the car on one side so the battery can be exposed to continue to cool and monitor (lift at least 24"). Have access to the full profile of the battery compartment. Consider other continuous cooling methods such as tanks and pools. Gear and personnel can become contaminated. Gross decontamination to be done on anyone in the Hot Zone at the scene. Bag gear for commercial cleaning due to heavy metals in addition to HF in smoke.

Incident Demobilization

First responders should brief the towing company and their personnel on associated EV hazards.

1. Provide 50' clear space around the vehicle once stored and never inside a building.
2. EVs must be towed "wheels up," either on a flatbed or dolly.
3. An engine company may need to escort the vehicle to the storage/salvage location.
4. Be aware of the stranded energy potential that could cause the battery to ignite again.
5. As the vehicle is moved, and the potential need to follow the tow truck to the yard.

Other Considerations

- [ ] Use Fluoride Test Paper (F paper) to test the atmosphere (tape to SCBA mask and/or turnouts to test for contamination). Also use the F paper for testing turnouts, hose, and other equipment used at the incident.
- [ ] Be alert for signs of a lithium-ion battery fire (leaking fluids, increased temperature, gurgling sounds, popping or hissing noises from the battery compartment, smoke, flames, sparks). If a lithium-ion battery fire is suspected, vent the passenger area, and remain alert for reignition.
- [ ] Remove the electronic key fob from the vehicle and move at least 50’ from the vehicle or isolate it in a RFID, EMF, EMI, or signal blocking/isolation type bag (Faraday bag).

Supplemental Information

Physical and Chemical Properties for Hydrofluoric Acid Vapors

Formula: HF Molecular Weight: 20
Flash Point: Non-Combus.ble Boiling Point: 151°F
Melting Point: -96°F
Rel Vapor Density 1.9 (Heavier than air)
Vapor Pressure @68°F: 0.16 atm (121.6 mm Hg) Liquid Specific Gravity: 1.26 (Heavier than water)
Ioniza.on Energy/IP: 15.98 eV

Toxic Levels of Concern NIOSH (IDLH/STEL/TWA)

IDLH: 30 ppm (24.54 mg/m³)
STEL: 6 ppm (4.91 mg/m³)
TWA: 3 ppm (2.45 mg/m³)
Acute Exposure Guideline Levels (One Hour AEGL)
AEGL-1: 1 p

Recommended Equipment for EV Fire Incidents

- [ ] Thermal Imaging Camera/TIC
- [ ] Fluoride Paper
- [ ] Air/Gas monitor with Fluoride sensor
- [ ] Special Ex.nguishing Agent to control battery - Lithium fires
- [ ] Large plastic bags (drum liners) to contain contaminated turnouts, hose, etc.

Notes

1. The electrolyte (Polymer Gel that the charging nodes are encased in) includes a volatile hydrocarbon-based liquid (electrolyte will contain petroleum/organic solvent and fluoride compounds) and a dissolved lithium salt (which is a source of lithium ions) such as lithium hexafluorophosphate. Another toxic gas, hydrogen fluoride (HF) may be also generated from the decomposition of electrolytes.

2. With a higher state of charge, battery failure and cell propagation will be much more energetic. It also takes less physical or thermal insult to cause a failure and subsequent thermal runaway. With less charge, it can take more to get it to fail. Once battery failure occurs, the state of charge has little effect on involvement of the available fuels in the form of electrolyte and anything else surrounding the cells. It also doesn't affect the compounds produced and released as a part of the post fire debris, smoke or water run-off. Overall duration of an EV fire is influenced more by construction and things that either allow or don't allow for propagation, such as being able to apply water to cells or modules that have not yet failed.

Additional Resources

ESA: www.energysecurityagency.com/
Fire Research: www.tkolb.net/tra_sch/CarFires/HybridVehicles/FFTacticsElecVeh.pdf
NFPA: www.nfpa.org/EV
NHTSA: www.nhtsa.gov/battery-safety-initiative
NVFC: http://virtualclassroom.nvfc.org/products/electric-vehicle-safety-an-awareness-level-training
Industrial Emergency Council: www.iectraining.org/ (special thank you!)

For more information on DVRPC's EV Task Force contact Kayla Bancone.