CONSIDERATIONS FOR RESPONDING TO AND OPERATING AT ELECTRIC VEHICLE FIRES

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Recently, there have been more electric powered vehicles (EV's) hitting the market and the roads. With that, have come some concerns about extinguishment of vehicle fires in these types of vehicles. As EV's become more popular and more widespread in the vehicle sales markets with dealers and direct manufacture to consumer selling, we may need to think about our strategy and tactics.

Basic EV Knowledge

According to the United States Fire Administration, in a June 2021 report there are some safety concerns we should be aware of when dealing with fires in these vehicles. EV Car Fires can be considered in one of many different categories:

- Class A (tires, fabrics, plastics),
- Class B (fuel),
- Class C (lithium-ion batteries in hybrid and electric cars),
- Class D (magnesium, titanium, aluminum and lithium).

Additionally, these fires tend to burn hotter and longer due to some of the materials involved, such as the Lithium Ion Batteries, which are difficult too cool. According to the Tesla Model 3 Emergency Response Guideline, 3,000 - 8,000 Gallons of Water applied directly to the battery is required to cool it. Tesla also does NOT recommend foam application. Additionally we should NEVER open the battery packs to cool or apply water.

Following an August 2021 EV fire, an Austin Texas Fire Department Division Chief noted the vehicle in question required nearly 40,000 gallons of water, as opposed to our standard vehicle fires that we have successfully extinguished with 500-1,000 gallons of water. Additionally, there is not a commercially produced extinguishment agent available today for EV fires. Other hazards we face in vehicle fires exist too, such as heating compressed gas cylinders for trunk closures can become projectiles.

We also need to remember to NOT touch any component of the electric distribution or power

systems as these my be energized. This may cause use to be a bit more cautions when doing vehicle overhaul.

Fighting EV fires may require us to examine our strategies and tactics as we learn more about the vehicles and components involved.

Strategy & Tactics

EV fires can burn, like traditional vehicle fires at thousands of degrees producing thick, toxic smoke. We already have a keen understanding of this with traditional vehicle fires, and do an excellent job of positioning upwind and attacking the fire while wearing full PPE including SCBA. One hazard associated with EV's is the toxicity of smoke produced by the heavy metals and other materials used to construct the vehicle frame, and batteries, along with the plastics and foams used in furnishings and other elements of the vehicle. And just like traditional vehicle fires,

EV fires can cause tremendous exposure problems due to the heat generated. EV Fires also have a tendency to burn for extended periods of time, and retain heat for almost 24 hours, and can reignite after they appear to be extinguished.

Based on recommendations from the US Fire Administration, here are a few Tactical and Strategic Considerations for EV Fires:

Pre-Attack/Arrival

- Scene Size-Up - What is burning, and what resources will you need?
- Life Safety Hazards (Rescue, Extinguishment, Extrication, Exposure Control)
- Exposures Involved - If not involved yet, will they be?
- Command Decisions - Do you need to upgrade the response for more apparatus/ manpower?
- Wind Direction - Position Uphill, Upwind
- Determine water supply/hydrant locations for continuous water supply
- EMS - Consider EMS care for involved parties and possibly responders - toxic smoke inhalation, especially from burning battery components, may cause irritation and/or difficulty breathing; additional injuries may also include burns

Fire Attack

- Wear full PPE & SCBA
- Secure Hydrant for Water Supply in addition to tank water
- Use Thermal Imaging Camera to identify areas of heat involvement
- Direct high-flow water operations - Consider 2-1/2" line with the Elkhart Brass RAM Ground Monitor, or multiple 1-3/4" lines for structure exposures, depending on involvement and extension
- Exposure Control - May need to shift focus to fighting fires in the exposures as the batteries and EV can burn for an extended period of time
- Consider all conductive surfaces as "Energized" until deemed otherwise
- If able, stabilize and Power Down the vehicle; consider using wood chocks t prevent the vehicle from rolling

Post Fire Attack

- Monitor the vehicle and batteries for rising temperatures or materials beginning to reignite
- If the vehicle is being towed, discuss with the tow agency that there is a possibility of the vehicle reigniting
- Gross Decontamination of PPE and SCBA at the scene utilizing the TFT Decontamination Pack and continuous water supply
- Clean PPE following our SFD protocols
- Wash SCBA face-mask and replace used air-bottles

Consider the RAM appliance to apply a high volume of water (505 GPM).

Tesla also specifies in their ERG, to continuously flow water until the battery reaches an ambient temperature, and to utilize our TIC to measure that. It is also not uncommon for battery fires to take up to 24 hours to sully cool.

One common tactic being explored across the country is to let the car burn and to cover the exposures to prevent further loss. While our job is to protect life and property, that property conservation effort sometimes includes writing off

what is already lost, and preventing further damage and fire spread in the exposures.

A concern with EV's are instances where the battery packs bust into flames while being plugged in and charging. This can be caused by the battery cell overheating and bursting, and then cascading and causing more cells to deteriorate. Depending on where the vehicle is located when this occurs, this may pose other challenges for us. For example, if located in a garage, this can cause rapid deterioration of the structure with prolonged flame impingement from fires that are fueled by the batteries and difficult to fully extinguish. A life safety concern will be interior primary searches for occupants. If this occurs at an outside charging station, exposures may include other vehicles.

Following a EV fire or collision, Tesla recommends a few additional steps, specifically for tow operations. While this is obviously out of our operational area, we should be working collaboratively with United Towing, or whomever may be towing involved vehicles. These safety items from Tesla include:

- Position the vehicle to drain excess water
- Park towed vehicle at least 50' from any exposure building or vehicle in a tow yard to mitigate any potential fire spread
- Assume all electrical components are still energized - Avoid crushing or cutting electrical components
- Tesla specifically requires 2 minutes to de-energize after deactivation

Batteries and Cause of Fire

Lithium Ion Batteries have been around since the early 1990's in consumer electronics, and likely we all have used them in some way, from cell phones, to cordless power-tools. Lithium is a light-weight element, that provides a tremendous ability to create energy through chemical reactions. These chemical reactions are how batteries operate and generate electricity. Ions move between the negatively charged Anode and the positively charged Cathode. Movement occurs within a material called an electrolyte, which in Lithium Ion batteries is an organic, carbon based material which is flammable. This material can become a fuel when the battery is overheated and combusts.

Fires involving Lithium Ion Batteries and EV's are likely to fall within two categories; from Impact or while Parked. Damage from impact includes damage or cracking to the batteries, or battery packs causing fluids to leak, and short-circuiting to occur. This can occur as a result of Motor Vehicle Collisions.

The latter can be due to "Thermal Runaway" which occurs when lithium metal forms on the on the battery anode instead of forming as ions inside the anode. Another portion of the chemical reaction is the formation of oxygen, which can be released and ignited by the rising temperatures of the battery packs.

Conclusions

While there may be some additional tactical and strategic considerations when fighting EV fires, we have to remember the basics; good hose stretching, life-safety/rescue, and following our basic SOGs and firefighting training, including situational and scene awareness.

Hopefully this article prompts some thoughts, as we are going to have to deal with more and more EV's hitting the road. One of the big take-aways for me, was the time it takes for the batteries to cool, and amount of water needed prompting the thought that size-up will be critical in determining if we need to upgrade the response.

Additional Resources

Here are a few links to research and resources that contributed to this article.

- https://www.usfa.fema.gov/blog/cb-061819.html
- https://www.nfpa.org/Training-and-Events/By-topic/Alternative-Fuel-Vehicle-Safety-Training/Emergency-Response-Guides
- https://www.tesla.com/firstresponders
- https://www.sciencenewsforstudents.org/article/lithium-ion-batteries-flames-fire-prevention-technology