Dr. Judy Jeevarajan February 29, 2024
House Science Committee Hearing
Examining the Risk: The Dangers of EV Fires for First Responders
Testimony

Good morning, Chairman Obernolte, Ranking Member Foushee and members of the Committee. Thank you for this opportunity to testify on examining the risk and dangers of EV fires for first responders as this is indeed a very important and timely topic.

I'm the Vice President and Executive Director of UL Research Institutes' Electrochemical Safety Research Institute, where I've served since 2015. Before joining UL, I worked for the National Aeronautics and Space Administration (NASA) at the Johnson Space Center in Houston, Texas serving as the Group Lead for Battery Safety and Advanced Technology.

Since entering the commercial market in the 1990s, lithium-ion rechargeable batteries continue to maintain their rank for the battery chemistry with the highest energy density, while also enjoying a long cycle life, low level of self-discharge, and high-rate capability. The many advantages provided by this battery chemistry have made it the option of choice in sectors ranging from consumer devices to electric vehicles (EVs) and stationary grid-energy storage. Lithium-ion batteries have been used in the space sector since the late 1990s and more recently have been deployed in the marine sector. Unfortunately, associated with this high energy density is the potential for lithium-ion cells to undergo catastrophic failures that can generate fire and toxic gases when they fail to be designed, manufactured, charged, or used correctly.

One major challenge is the suppression of fires in EVs, where various difficulties arise. The first is the design and location of the battery. Lithium-ion fires need a suppressant that can efficiently cool down all the cells in the battery pack in order to prevent reignition. However, the physical location of batteries in EVs tends to be the underside of the vehicle, which means a rollover of the vehicle may be required to manage access. Additionally, the batteries are typically in a well-sealed container specifically to *prevent* water ingress in the event of a flood or if the vehicle is driven on water-logged roads. For ease of fire suppression, designs need to be developed where, in the event of a catastrophic failure, sensors allow the opening of a relief valve in the battery pack which could then be connected to an outlet that is accessible from a convenient location. Another area that requires research is finding methods to remediate possibly toxic chemicals in suppressant runoff.

An area of concern for first responders and fire fighters working with an EV battery pack that has undergone a catastrophic failure is determining the presence and location of stranded energy. Stranded energy is the energy that remains in a partially damaged battery, which can be significant. Based on the design of lithium-ion batteries in EVs, it is possible after a fire or other damage that some modules are fully compromised while others are not, and it is also possible that not all cells of a single module are compromised. Damaged modules may include energetic cells that can move around when a vehicle is moved from the scene of an incident to a tow yard, causing short circuits and possible reignition. It is therefore critical to determine the parts of the battery that are still energized and provide a means to discharge the cells or modules before moving the vehicle. Methods need to be developed to remotely access data to determine the existence of locations where the cells continue to be energized and designs that bypass fully compromised modules and discharge the energized modules should be developed.

When lithium-ion cells experience venting and thermal runaway with fire and smoke, they release combustible and toxic gases. The nature and volume of these gases depends on the battery chemistry, especially the composition of the electrolyte. Fire fighters and first responders have expressed concerns that they are unable to remove all traces of toxic and corrosive chemicals such as hydrogen fluoride (HF) and hydrogen cyanide (HCN) from their suits even after washing them. This may require research into more suitable materials for the suits of the fire fighters and first responders that are more resistant to corrosive compounds such as HF. Our studies on particulate emissions during fire and thermal runaway indicate that the quantity of particulates that are in the submicron sizes (so-called PM 2.5), is orders of magnitude higher than the limits established for safe human exposure. The type of respirators used by first responders may also need to be re-evaluated for their suitability to be worn during EV fire suppressions. In addition to toxicity concerns, first responders and fire fighters may also be in an area where combustible gases are trapped and reach a level above the lower flammability limit (LFL) that can lead to an explosion. More research studies are needed to understand the nature and volume of gases released by various chemistries of lithium-ion cells and batteries so that safe charging infrastructures with adequate venting can be implemented.

Mechanical impacts such as vibration and shock, and their effects on battery components such as cell-to-cell interconnects and integrity of cooling system designs, require further characterization.

Fast-charging of EV batteries and the safety of fast-charging new and aged batteries is an area where we still have inadequate data, although charging stations are now being deployed with fast-charge capability.

An area of rising concern is cybersecurity associated with batteries. The ease of updating EV vehicle and battery software remotely makes this approach very attractive. However, cybersecurity concerns exist especially if the updates can be intercepted easily and maliciously hacked. This could result in a battery being compromised and experiencing a catastrophic failure. Software security and verification of software are key to preventing catastrophic failures when IoT connectivity is used for software updates.

Globally, every country has its own method of setting regulations. In the U.S., apart from UN regulations for transportation of EV batteries, remaining applicable safety standards are voluntary. Today some countries have included stringent regulations for safety by including a test to confirm that a passenger in an EV has at least five minutes to get out of the vehicle before the smoke and fire produced during thermal runaway of the battery enters the passenger compartment. This is currently under review with authorities having jurisdiction in the U.S. A bigger concern is simply the ability of first responders and fire fighters to recognize an EV so that they can appropriately deal with the fire. Currently, there are no regulations or standardized methods for identifying the nature of a vehicle and determining if it is an ICE, pure EV, hybrid EV (HEV) or plug-in hybrid EV (PHEV). The ISO 17840 standard is followed in Europe, with symbols and QR codes being mandatory requirements for passenger sedans; these provide information to the first responder and fire fighter on the type of vehicle, battery and methods to tackle the catastrophic incident in a safe manner. Standardizing such practices would provide better guidance to the fire fighters and first responders in the U.S. too.

Again, thank you all for the opportunity to address the House Science Committee. I look forward to addressing your questions and comments.