TRAINING NOTES

DIVISION OF TRAINING

Lithium Ion Battery Fires

Resources:

Case study: 4 Firefighters injured in Li-Ion explosion SCAN ME

OSHA Li-Ion Battery Fire Prevention SCAN ME

Video: Why Li-Ion Batteries Explode, University of Michigan SCAN ME

Video: Li-Ion Battery Fires in Electric Cars SCAN ME

Litium Ion Batteries

Within the last couple years the fire service has observed an increase in incidents caused by lithium ion batteries. Lithium ion batteries are commonly used in devices such as phones, laptops, vaping devices, electric bikes and cars. Due to their large energy capacity, compact size, high energy output and their ability to be recharged, they have become an increasingly popular power source.

Lithium ion batteries refer to one or more cells that are electrically connected and consist of a positive electrode, negative electrode, separator, and an electrolyte solution. Energy is created when the lithium ions move from the positive electrode through the electrolyte solution to the negative electrode. This process converts chemical potential energy into electrical energy using lithium ions.

Thermal runaway

Lithium batteries are generally safe when undamaged and used in accordance with manufacturers instructions. When battery cells are physically damaged, made of low quality materials, exposed to high external temperatures such as direct sunlight or flame, or are over charged by chargers not approved by the manufacturer, lithium ion batteries can fail resulting in fire and explosion. Increase in heat due to internal or external factors can cause a dangerous chain reaction known as thermal runaway. Thermal runaway occurs when heat is generated within the cell causing rapid heating and pressure build up within the unit until the cell fails and releases vaporized flammable gases which are then ignited from the existing high temperatures.

Tactical Considerations:

- **Lithium ion battery fires are categorized as Class B liquid fires and are compatible with CO2 and dry chemical extinguishers.**
- **Treat battery fires as a hazardous materials incident due to their potentially toxic flammable and liquid by products.**
- **Wear full PPE to avoid battery contact with skin and to protect respiratory system from toxic gases.**
- **Utilize thermal imaging camera to confirm no heat signature from battery to eliminate chances of thermal runaway.**
- **Stranded energy can be present within extinguished battery fires and can result in secondary ignition.**

Stranded Energy

After a lithium ion battery has failed and experienced thermal runaway, there can still be residual energy remaining in the battery, this is called stranded energy. Stranded energy has the potential to reignite the battery even days after initial extinguishment.

Extinguishment

These batteries contain toxic fluids and produce toxic gases and should be also be treated as a hazardous materials incident. Flammable gases expelled during lithium ion battery fires include hydrogen fluoride, carbon monoxide and phosphorus pentafluoride and are extremely irritating to eyes, skin and respiratory system. Gas monitors and full protective equipment should be used, especially in confined spaces.

Despite the name, lithium ion battery fires are not considered a combustible metal class D fire. Lithium ion batteries contain liquid electrolytes that provide a conductive pathway for ions therefore are considered a class B flammable liquid fire. CO2 and dry chemical extinguishers are effective at putting out small lithium ion battery fires and specifically target the chemical reaction and flammable gases being expelled from the cell. In the event that the battery involved is large, stored near other batteries or has ignited adjacent objects, fire personnel should continue to use hose lines to cool the cell to prevent the continuation of thermal runaway.

After initial extinguishment, check the heat signature of the involved battery using a thermal imaging camera to eliminated the possibility of further thermal runaway then remove the battery from the dwelling away and from anything flammable.

Stranded energy within the cell still poses a threat to first responders. According to the NFPA there is still no standard operating procedure to mitigate the hazard of stranded energy and safely neutralize the batteries. The NFPA is currently working on a project to “establish mitigation procedures for safely handling stranded energy within damaged lithium-ion batteries across the full-spectrum of industry applications to provide guidance to first and second emergency responders.”