MABAS Division 16 Standard Operating Guideline

Title: Response to Incidents Involving Lithium-ION Batteries

Effective: 03/05/2024

Revised / Reviewed: --/--/----

I. Objective

This procedure describes the hazards associated with lithium-ion batteries of varying sizes and configurations. This guideline addresses size-up, operational awareness, and response practices when faced with an incident involving Lithium – ION batteries and associated technology.

II. Operating Guideline:

A. **Hazards & Precautions regarding Lithium-Ion battery incidents including fire.**
a. Battery Rupture / Explosion - Batteries may rupture and vent toxic flammable gases and/or explode violently when the gases ignite, when subject to the following stresses:
   i. Thermal – This includes either extremely hot or cold temperatures.
   ii. Mechanical – Damage both visible or reasonably inferred from impacts or batteries which have been crushed or pierced.
   iii. Electrical – Over charging or forced discharge is a common source of electrical stress. Electrical stresses can also be caused by internal manufacturing defects.
   iv. Environmental – batteries which have been exposed to moisture or were submerged.

b. Signs of Possible Battery Failure
   i. Visible gas, popping sounds, or suspicious odor emanating from an electrified device can be an indication of an abnormal and hazardous condition.
   ii. Battery thermal runaway fires are frequently preceded by visible gas vapors.
   iii. The absence of flaming or gases/smoke does not indicate there is no event. Flaming and off-gassing may be intermittent over minutes, hours, or days.

c. **Discerning Compromised States of Cells or Packs** - It may be difficult to discern if a lithium-ion battery pack or cell is compromised; the resulting heat signatures may not be easily discerned by a thermal imaging camera (TIC) due to the packaging and insulation surrounding a battery container.
   i. A thermal imaging camera shall not be relied upon as the sole source of identification to determine if a lithium-ion battery pack or cell is compromised. When in doubt assume the battery is compromised. Thermal imaging may provide temperature trends over longer operational periods.

d. **Thermal Runaway** - When the stable state of batteries or individual cells rapidly fail due to increased heat from charging or external conditions such as fire, the cell transitions from a stable state to an unstable state and then to catastrophic failure of the cell. Once thermal runaway begins, it can propagate to the adjacent battery cells.
   i. There is no defined time limit for a battery to enter thermal runaway. This can occur in a matter of seconds given the correct conditions.

e. **Dry Chemical and Clean Agents** – These extinguishing agents have not demonstrated effectiveness for lithium-ion related extinguishment, especially when cells are contained within equipment.
f. **Flammable and Toxic Gases** - Lithium-ion batteries in thermal runaway produce many different gases. These gases combine to form a flammable, explosive and toxic atmosphere. Toxicity and flammability levels vary depending on specific battery technology and manufacturer.
    i. Li-ion batteries in thermal runaway with no visible flames represent an explosion risk and ventilation should be considered when operating in enclosed spaces.
    ii. Active metering from a safe distance should be in use for all responders who may come into contact with the products of combustion from a battery fire.
    iii. Active monitoring should be used to guide evacuation or shelter in place decisions for protection of the public.
g. **Unexpected Re-ignition** - Lithium-ion batteries are known to unexpectedly reignite minutes, hours or even days after all visible fire has been extinguished.
h. **PPE** – Structural firefighting gear including SCBA shall be worn at all times while interacting with compromised or potentially compromised Lithium-Ion Batteries.

B. Small Scale Batteries or Battery Powered Device Incidents (laptops, hoverboards, e-scooters, electric wheelchairs, or other e-mobility devices) Inside or Outside of Structures.

a. For exterior / outdoor incidents involving fire stage apparatus upwind of the event.
b. A charged handline shall be in place whenever interacting with damaged batteries or batteries which have previously been involved in fire.
    i. When lithium-ion batteries or mobility devices are involved in fire, use an appropriate extinguishing media to extinguish the fire.
        1. Flames from a lithium-ion battery should be suppressed with appropriate extinguishing media including copious amounts of water.
        2. If water is utilized as the extinguishing media, water application should continue until conditions are dormant i.e., when no more flame, gas or smoke is being released from the battery or mobility device.
c. Lithium-ion batteries or mobility devices which are involved in fire, found within a fire area, or subjected to elevated temperatures must be moved from the area in which members will be operating. This should be accomplished before overhaul operations begin.
    i. When possible, prior to overhaul in the area of the lithium-ion battery or mobility device, members should conduct a diligent search for stray battery cells. These individual cells may have become dislodged from the battery pack during the fire or by the hose stream during extinguishment. These dislodged battery cells can spontaneously reignite leading to unexpected fire growth within an area or structure.
    ii. Lithium-ion batteries shall be moved by use of a nonconductive tool, a shovel with a wooden handle or other method that does not require members to carry in their hands.
d. A damaged lithium-ion battery or mobility devices shall not be moved in an elevator or via stairs unless overpacked with appropriate materials as approved by the IC and Safety Officer.
    i. Regarding larger e-mobility devices such as electric wheelchairs this may involve removal and overpacking of the battery pack itself.

C. Hybrid & Electric Powered Vehicle Incidents

a. Stage apparatus upwind of the event

b. Complete area size-up and establish hazmat exclusion zone and water supply. Evacuate the area of all non-emergency personnel and consider evacuation/shelter-in-place for the public.

c. Response to Hybrid and electric vehicle incidents initially focuses on a three-step process.

i. Identify

1. Look for external badging to indicate a hybrid or electric vehicle.
    1. Badging may be hidden in a crash or fire event. Alternative methods of identification may be required.
2. Determine the vehicles make, model and year to access more specific vehicle information found in the Emergency Vehicle Field Guides.

ii. Immobilize

ALL VEHICLES SHOULD BE IMMOBILIZED IMMEDIATELY UPON ARRIVAL.

HYBRID AND ELECTRIC VEHICLES MAY APPEAR TO BE SHUT DOWN EVEN WHEN THEY ARE NOT DUE TO THE POTENTIAL LACK OF ENGINE NOISE.

1. Approach the vehicle from its side to avoid the potential path of travel.
    1. Chock the wheels both front and rear.
    2. If safe to do so set the parking brake for the vehicle and place the vehicle in park.
2. If available utilize an emergency response charging plug kit to further ensure immobilization of the vehicle.

iii. Disable

1. Primary Shutdown Method
    1. Turn off the vehicle's ignition.
        i. If equipped with a proximity key ensure that the key is removed a sufficient distance from the vehicle to avoid reactivation.
2. Secondary Shutdown Method
    1. Consult the vehicle specific Emergency Response Guide.

d. Incidents Involving Fire.

i. Tactics

1. Offensive attack is recommended for vehicle fires to determine if the high voltage battery is involved, or in situations where exposure concerns are present.
2. Defensive attack is recommended during incidents where the high voltage battery is involved in fire and exposure protection is needed.
    1. Large amounts of water may be required, and a secure water supply should be established.
3. Nonintervention – allowing the battery to burn itself out can be an effective tactic in these situations given no life safety or exposure risks.

ii. Overhaul Operations / Considerations

1. Immobilize and disable the vehicle if not already completed.
2. Avoid contact with any exposed high voltage components or wiring.
3. Never breach or remove a high voltage battery.
    1. This action may result in severe electrical burns, shock and/or electrocution.

iii. Fire Involving EV Charging Stations

1. Treat fires within or involving EV charging stations as Class C electrical fires.
2. Where fire condition allow disconnect any actively charging equipment from the charging location.

D. **Battery Energy Storage Systems (BESS)or Energy Storage Systems (ESS)**
   a. Stage apparatus upwind of the event.
   b. Protective Actions and Incident Mitigation for fires occurring with a battery energy storage system component or multiple units.
      i. Upon arrival at the scene all non-essential personnel shall be evacuated from the area to a minimum safe distance of 150ft. upwind. Greater distance may be required due to conditions within and immediately around the structure.
         1. Consider evacuation/shelter-in-place for member of the general public and impacted structures.
      ii. Only fire response personnel in full protective PPE including SCBA should be allowed within the immediate area of the structure.
      iii. Activate the BESS or ESS emergency stop, if located a safe distance from the affected unit to isolate battery from charging or discharging.
         1. Note: Electrical energy will still be present within the BESS or ESS due to stored energy within the battery system.
      iv. For stationary BESS incidents determine if any provided exhaust systems are operating.
      v. DO NOT open any door to an ESS or attempt to make entry upon initial arrival.
         1. Toxic and combustible gases may be present inside the structure. Entry should only be attempted following appropriate monitoring for flammable and explosive atmospheres within the structure.
         2. BESS / ESS have a variety of safety mechanisms. Some are designed to maintain the doors in a close position, and some have automatic doors designed to aid in ventilation.
      vi. Priority should be assigned to exposure protection and evacuation of personnel and citizens in danger from toxic smoke and fire gases escaping the structure.
         1. Exposure protection should be the primary means of containing fires within an energy storage system.
   c. Direct Extinguishment
      i. Note: Direct extinguishment is not recommended and is only appropriate given a very narrow set of circumstances. Direct extinguishment may be appropriate if BESS or ESS cabinet doors are already open due to an explosion, or automatic release system where the battery racks are able to be directly impacted by fire streams. The decision to attempt direct extinguishment is at the discretion of the incident commander.
      ii. If direct extinguishment is chosen as the safest option for mitigation the following considerations should be taken:
         1. Extinguishment should only be attempted from the exterior of the structure. At no time should entry to the structure be made for extinguishment of a lithium battery fire.
         2. Extinguishment should be performed by unmanned master streams when possible.
            1. When direct suppression is attempted fire suppression run off must be considered and accounted for due to contaminants present within the water.
            2. Significant quantities of water are required to control lithium-ion battery fires. Consideration should be given to the available water supply prior to attempting direct suppression.
            3. Care should be taken to avoid direct water application to unaffected BESS to limit water intrusion and potential additional electrical fires.
         3. Incidents involving Lithium-Ion Batteries and Battery Energy Storage Systems can last for long durations over multiple operational periods. Consideration should be given to the long-term monitoring of the incident.