I. Purpose

This standard operating procedure describes the hazards associated with Lithium-Ion Batteries used to power equipment such as personal electronics, personal mobility devices, electric vehicles, residential and commercial battery energy storage systems. It also addresses size-up along with operational awareness and procedures when responding to these incidents.

II. Introduction

A. Lithium-Ion (Li-ion) batteries are prevalent in consumer products ranging in size from smaller personal products such as mobility devices up to and including use in large-scale power grid support. These smaller devices are being used in everyday applications by the public and are consequently being stored, charged, sold, or repaired inside residential and commercial occupancies.

B. Lithium-Ion batteries can be found as single cells, pouches, or prismatic packs. They can also be combined using multiple cells to make a battery module like found in a handheld tool battery or E-bike. Multiple modules can be combined to form a battery pack like is found in electric vehicles and battery energy storage systems.

C. Fires involving lithium-ion batteries have been increasing at an alarming rate and have resulted in fatalities. Even when the initial cause of a fire was not the lithium-ion device, the involvement of lithium-ion batteries in a fire can increase the intensity of the fire.

Lithium-Ion batteries are commonly used in the following applications:

a) Small electronic devices (i.e. cell phones, E-cigarettes, etc.)
b) Laptops
c) Personal Mobility Devices (PMDs)
   - Electric Bikes
   - Scooters
   - Hoverboards
   - Wheelchairs
d) Electric and hybrid vehicles
e) Battery Energy Storage Systems (BESS/ESS)
f) Residential – EV Charging, Photovoltaic
g) Commercial – Stand-alone units, In-building units

III. Hazards/Safety

1. Batteries may rupture and vent toxic flammable gases and/or explode violently when the gases ignite, when subject to the following:
   a) Thermal – Hot or Cold temperatures.
   b) Physical – Impacted, crushed, or pierced.
   c) Electrical – Over-charging or forced discharge, including internal manufacturing defects or internal short circuiting.
   d) Drying after being wet.

2. Respiratory protection should always be used by responders in the presence of suspect lithium-ion batteries to prevent unexpected inhalation of toxic gases. Any inhalation of these gases should receive a medical evaluation.

3. Full PPE with a donned facepiece must be worn at all times with lithium-ion batteries that have been involved in fire or subjected to elevated temperatures and are either intact or their status is unknown.

4. Due to the rapid re-ignition danger of batteries involved in fire, subjected to elevated temperatures or physical damage (impacted, crushed, pierced), full PPE with a donned facepiece must also be worn at all times during the following:
    a) Whenever members are operating in the immediate area (i.e. same room)
    b) Handling batteries or a Li-Ion powered device (i.e. removing from an area to the bathtub, sink or bucket)
    c) Whenever removing a Li-Ion battery, equipment or personal mobility device out of structure (i.e. removing through the interior or a rope removal via window).

5. It may be difficult to discern if a lithium-ion battery pack or cell is compromised; the resulting heat signatures may not be picked up by a Thermal Imaging Camera (TIC) due to the speed in which it can occur or the outer protective housing. The TIC should not be relied upon as the only indicator that a pack or cell is or is not damaged.

6. Thermal Runaway occurs when the stable state of batteries/cells rapidly fails due to increased heat from charging or external conditions such as fire or mechanical damage, the cell transitions from a stable state to an unstable state followed by catastrophic failure of the cell. Once thermal runaway begins it may propagate (spread, domino effect) to the adjacent battery cells. It may only take seconds for this dangerous event to take place and should be expected to occur.
    a) Usually there is a “pop” or rupture sound heard proceeding Thermal Runaway with pressurized white smoke (flammable / toxic gases) venting moments prior to ignition.

7. Water may not prevent a battery from entering thermal runaway. Water may provide a cooling effect when applied directly to adjacent battery cells or conducted through the case surrounding the cells.

8. Dry Chemical agents and foam are ineffective for any type of lithium-ion related extinguishment.

9. 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. Elevated carbon monoxide readings on a multi-gas meter absent any fire and smoke may inform responders of thermal runaway occurring.

10. Lithium-Ion Batteries are known to unexpectedly re-ignite (without warning) minutes, hours or even days after all visible fire has been extinguished. Reignition is a common occurrence and can happen with explosive force, especially in a confined area. Li-ion batteries have the ability to rupture and ignite with such force that walls can be blown down resulting in structural damage and extensive fire spread.

IV. Operations

Whenever the following procedures take place, a charged handline must be in position for Lithium-ion batteries or mobility devices involved in fire.

1. Use a handline to extinguish the fire; flames from a Lithium-Ion Battery should be knocked down with copious amounts of water. Water application should continue until conditions are dormant-that is when no more flame, gas or smoke is being released from the battery or mobility device.

2. Li-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.

3. Members should be aware of the need for scene preservation for fire cause and investigation prior to the arrival of the Fire Marshals. Life safety always takes precedence and if a device or battery must be moved or overpacked, pictures taken where possible prior to the operation. Fire Marshall's shall be informed of the battery's status and associated hazards.

4. 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 module or pack during a fire or by the hose stream during extinguishment. Special attention should be given to furniture where a cell may have become lodged.

5. Firefighters must not place the lithium-ion battery pack or cells in the pocket of their bunker coat or pants.

6. When possible, members should move the lithium-ion batteries by using nonconductive tools, a shovel with a wooden handle or other method that doesn't require members to carry in their hands.

7. Li-Ion battery cells, small modules or packs and personal mobility devices should be moved to a safe location in order of preference below until it can be appropriately overpacked:
    a) If batteries involved in fire or thermal runaway continue to present a life safety hazard, a risk assessment should be made to determine if the batteries can be moved safely to the exterior of a structure with on-scene personnel in full PPE using SCBA and buckets/containers.
    b) Bathroom tub in the fire structure, with all cells fully submerged in water.

c) A sink large enough that all cells can be fully submerged in water.
d) A salvage bucket, garbage pail or open container large enough that all cells are capable of being fully submerged in water.
e) When the above options are not practical, the Incident Commander may remove the batteries or mobility device via a window.
f) A lithium-ion battery or device shall NOT be moved in an elevator.

8. Li-Ion battery cells, small modules or packs and personal mobility device batteries should be ***overpacked*** using the following procedure:
   a) 2-8-6, 2-8-7, and 2-8-14 are equipped with *Cellblock* overpacking kits containing:
      - UN rated PG1 5-gallon steel pail
      - 10 anti-static bags
      - 10 lbs. CellBlockEX fire-suppressant media
      - Shipping overpack box
      - Regulatory (DOT) labels/marks
      - Reusable CellSafe Envelope
   b) For small quantities of batteries or a single large battery:
      - Place batteries in anti-static bags.
      - Open the inner bag of CellBlockEX in 5-gallon pail.
      - Do not remove from the pail.
      - Gently work the batteries into the CellBlockEX, maintaining space between each battery.
      - Replace the lid; ensure the lever latch is pulled tight to lid.
      - Engage the attached key into channel at top of lever and press down to ensure it locks.
   c) For larger quantities of batteries:
      - Place batteries in anti-static bags.
      - Remove the inner bag of CellBlockEX from the pail.
      - Dispense 3 inches of CellBlockEX into the bottom of the pail.
      - Place each battery in the loose fill providing 1” to 2” of spacing between each battery.
      - Cover batteries and cells with CellBlockEX loose fill. Allow 3 inches of spacing between small articles or 4 inches for larger batteries.
      - Continue layering batteries, cells and CellBlockEX as outlined above, making sure to leave 3 inches of loose fill space at the top.
      - Replace the lid; ensure the lever latch is pulled tight to lid.
      - Engage the attached key into channel at top of lever and press down to ensure it locks.
   d) For electronic devices such as laptops and cell phones you may use the reusable CellSafe Envelope by sliding the device into the envelope and press down on Velcro closure.

9. Residential battery energy storage systems
   a) In addition to a charged hoseline and full PPE while operating near the battery energy storage system, members will ensure that they activate any

emergency disconnects if safe to do so and understand that the battery system still poses an electrical hazard because of the stranded energy in the container.

b) Apparatus will position their equipment at the corners of a structure known to have a battery energy storage system, in case of an explosion.
c) Locate and prepare to hook into a positive water source.
d) Work with responsible party and manufacturer or contractor for incident handover and final mitigation.

10. Commercial battery energy storage systems
    a) First arriving units will isolate the area and provide directions, over the radio, for other incoming units. The recommended distance is 150 feet.
    b) Do not enter any fenced in area unless there is a savable life or known rescue.
    c) Place apparatus in a safe location away from the battery energy storage system and overhead power lines.
    d) Locate and prepare to hook into a positive water source.
    e) Protect exposures.
    f) If a fire develops, take a defensive stance toward the burning unit and apply water to neighboring battery enclosures and exposures.
    g) If personnel can identify a remote shut off to the unit or system by operating the visible disconnects.
    h) Work with responsible party and manufacturer or contractor for incident handover and final mitigation.

11. Electric vehicles
    a) Determine offensive or defensive tactics
    b) Consult vehicle emergency response guide if applicable (do not delay life safety for this)
    c) Locate and prepare to hook into a positive water source.
    d) Defensive tactics
        - Protect exposures
        - Be aware of sudden vehicle movement
        - Be aware of projectile battery cells
    e) Offensive tactics
        - Safely approach vehicle utilizing normal vehicle fire tactics
        - Chock EV wheels if possible
        - 1-3/4” hoseline with variable stream nozzle for fire attack and/or to cool any battery pack in thermal runaway.
    f) Continue to cool vehicle and battery pack to reduce chances of additional thermal runaway.
    g) Towing of vehicle
        - Vehicles should show no signs of fire or thermal runaway for 30 minutes prior to towing.
        - Dispatch should notify Huntington Highway Department that an EV is being towed to the yard on Rofay Drive.
        - Vehicles should be towed on a flatbed or with wheel dolly to prevent

power build-up.
- An Engine shall follow the tow truck to yard.
- The tow company should be advised to keep vehicle 50 feet away from all exposures.

V. Incident Command Considerations

1. Copious amounts of water will be needed for any fire or thermal runaway of lithium-ion batteries. Hydrant locations should be known and prepared to be hooked into for all lithium-ion responses. If in doubt, hook in.
2. The Town of Huntington Fire Marshals shall be contacted for all Lithium-Ion battery incidents.
3. The Town of Islip Hazmat Team should be contacted for all Lithium-Ion battery incidents for disposal and/or mitigation.
4. These notifications should be made as soon as possible after becoming aware of the situation involving lithium-ion batteries.
5. A charged handline shall remain ready until completion of overpacking and mitigation procedures.
6. The determination by the IC to establish a watch line for the overpacked batteries, while awaiting removal, should be determined at the IC's discretion and the guidance of the Huntington Fire Marshal, and/or the Hazmat team.