CSN Procedure	Facilities Management
Category: Environmental Health and Safety	Effective Date: 09/15/2025
Lithium-Ion Battery Safety Procedure	

I. PURPOSE

The purpose of the Lithium-Ion Battery Safety Procedure is to establish standardized safety practices for handling and use of lithium-ion (Li-ion) and lithium polymer (LiPo) batteries; as well as to minimize the potential risk of fire, injury, or property damage associated with lithium batteries.
Given the comparable electrochemical characteristics of both battery types, they require similar precautions in charging and handling to minimize the risk of hazardous incidents.
This procedure outlines proper handling, charging protocols, storage requirements, emergency response actions, and disposal guidelines in compliance with applicable safety regulations and best practices.

II. SCOPE

This procedure applies to all faculty, staff, students, and contractors at the College of Southern Nevada (CSN) who handle, store, charge, transport, or dispose of Li-ion and LiPo batteries at all sites owned and operated by CSN. It covers the safe use of standalone cells, battery packs, and battery-powered equipment in academic, research, technical, and administrative settings.

EXCLUSIONS

Guidance in this procedure does not apply to lithium-metal batteries, as these batteries contain lithium metal, a water reactive material, the handling recommendations, in an emergency situation, for these batteries are different from Li-ion/LiPo.

III. DEFINITIONS

Cell: A single battery.

Battery Pack: A group of cells connected in **s**eries and/or parallel (xPyS). Each pack contains only one type of cell. Parallel connections increase the pack's capacity (measured in ampere-hours, Ah), while series connections increase the pack's voltage (e.g., y times 3.6V, where x and y represent the number of cells connected in parallel and series, respectively).

Lithium-Ion (Li-ion) Battery: A lithium-ion battery is a type of rechargeable battery in which lithium-ions move from the negative electrode to the positive electrode during discharge and back when charging. Lithium-ion batteries power devices such as mobile telephones, laptop computers, tablets, cameras, and power tools.

Lithium-ion Polymer (LiPo) Battery: Same chemistry as lithium-ion cells but the electrolyte is made as a gel with a polymer host which reduces flammability and prevents leakage of liquid electrolyte from a damaged cell. LiPo are commonly seen in applications like radio-controlled (RC) vehicles.

Lithium-metal Battery: Lithium-metal batteries are generally non-rechargeable and have lithium-metal electrodes. Lithium-metal batteries are generally used to power devices such as watches, calculators, temperature data loggers, car key fobs, flashlights, and defibrillators.

Battery Management System (BMS): Battery management systems are critical to the safe operation of lithium-ion battery packs. The system protects against over-charge, over-discharge, and excessive currents and temperatures. The BMS protects the pack from exceeding upper and lower voltage and temperature limits. It will also limit current as a function of temperature.

IV. PROCEDURE

A. Responsibilities

1. Environmental Health & Safety (EHS)

    - Ensure administration of this procedure and conduct periodic reviews and updates.
    - Assist in training and communicating safety requirements to CSN personnel.
    - Ensure the proper disposal of Li-ion and LiPo batteries.
    - Periodically inspect Li-ion/LiPo battery storage areas to ensure compliance with this procedure.
    - Assist in the investigation of incidents involving Li-ion/LiPo batteries.
    - Assist with the shipment of Li-ion/LiPo batteries, including proper packaging and documentation.

2. Managers and Supervisors

    - Ensure development, communication, implementation, and evaluation of proper work procedures and completion of required training in accordance with the programs identified herein.
    - Perform a hazard analysis to understand potential risks, failure modes, and hazards related to the specific battery type, setup, and quantity being used in your areas.
    - Make sure written Standard Operating Procedures (SOPs) are created for any research devices powered by lithium or lithium-ion batteries. These SOPs should include safety measures for handling possible battery failures during assembly, use, data collection, transport, storage, and disposal.

3. Employees/Students

    - Comply with the program methods described in this procedure and any subsequently developed program(s) and procedure(s).
    - Obtain and review the battery manufacturer's Safety Data Sheet (SDS), technical specifications, and any other available documentation.
    - After testing is complete, ensure batteries are either safely disposed of or stored in a secure and safe condition.

B. Procedures

1. Handling and Use

    When handled properly, Li-ion and LiPo batteries have a very low risk of catching fire. Most battery-related incidents are caused by mishandling or accidental misuse. Common causes of lithium-ion battery fires include overcharging or over-discharging, unbalanced cells, drawing too much current, short circuits, physical damage, high storage temperatures, and poor electrical connections in battery packs with multiple cells.

    - Choose certified products. Always purchase Li-ion and LiPo batteries from trusted and reputable manufacturers or suppliers. Cheap or counterfeit batteries often lack proper quality control and are more likely to fail.
    - Read all documentation that comes with your battery before use.
    - Follow manufacturer's instructions for storage, use, charging, and maintenance.
    - Protect batteries against mechanical damage, such as crushing, puncturing, and disassembly.
    - Avoid subjecting batteries to excessive shock and vibration.
    - Remove lithium-powered devices and batteries from the charger once they are fully charged. Do not use the charger as a storage location.

- Never burn, overheat, take apart, short-circuit, solder, puncture, crush, or otherwise damage battery cells or packs.
- Keep batteries away from conductive materials, water, seawater, strong oxidizers, and strong acids.
- Avoid hot and humid environments, especially when batteries are fully charged. Do not expose them to direct sunlight, hot surfaces, or enclosed hot spaces.
- Inspect batteries before each use. Do not use damaged, swollen, or puffy batteries—dispose of them safely and promptly through EHS.
- Batteries over 60V can pose electric shock and arc flash risks. Use proper electrical protection such as terminal covers, shielding, and appropriate personal protective equipment (PPE).
- Do not reverse polarity.
- Do not mix different battery types or combine new and used batteries in the same pack.
- Do not operate batteries without their battery management system (BMS) or protective circuitry.
- Avoid static electricity, which can damage the battery's protection circuit.
- Stop using and disconnect batteries immediately if they emit an unusual smell, generate heat, change shape, or show abnormal behavior during charging or use. Immediately remove a device or battery from service and place it in an area away from flammable materials if any of these signs are present.

2. Transporting Batteries

   Take care not to drop batteries while transporting them. Always protect the battery terminals and any exposed connections from touching other objects. Use the original packaging or a sturdy plastic container to safely carry the battery.

3. Charging/Discharging Batteries

   a. Li-ion and LiPo battery packs in laptops and similar devices have battery management systems (BMS) to automatically control the charging process, eliminating the need for user input beyond connecting a charger. Always use the manufacturer's AC adapter, follow all provided guidelines, and stay alert for any unusual signs, such as the battery becoming excessively hot.

   b. Batteries used in radio-controlled devices, such as drones and research projects require extra care and attention during charging to prevent damage or safety issues. Users working with Li-ion/LiPo batteries in these applications should follow these procedures when charging:

      - Only use chargers specifically designed for the type of battery you're charging and always set the correct voltage and current for the battery pack.
      - Never leave a battery unattended while charging. Stay nearby and regularly check for signs of overheating or malfunction.
      - For battery packs with two or more cells in series (2S and up), always use a balance charger that monitors each cell individually to prevent overcharging.
      - Place both the battery and charger on a heat-resistant, nonflammable, and nonconductive surface. Avoid surfaces like cardboard or carpets. Fire-safe charging containers, like quality LiPo safety bags, are strongly recommended.
      - Keep flammable materials away from the charging area.
      - Do not overcharge (above 4.2V per cell) or over-discharge (below 3V per cell).
      - Ensure batteries stay within the manufacturer's recommended temperature range during charging and discharging. Be cautious when using or charging a battery that is still warm.
      - Never parallel charge batteries, as most chargers can't safely monitor individual cell currents.
      - Disconnect batteries from the charger once charging is complete (refer to the storage guidelines).

4. Working Area

- Remove all sharp objects from the work area that could puncture a battery's insulating material.
- Cover conductive work surfaces with an insulating material.
- The area should be clear of any flammable or combustible materials such as wood tables, carpet and gasoline or other solvent.
- Use only non-conductive tools when handling batteries.
- Do not wear conductive items (e.g., watches or jewelry) when handling batteries.

5. Battery Storage

Proper storage of Li-ion and LiPo batteries is essential for maintaining their performance and minimizing the risk of fire or explosion. The following procedures, if correctly followed, will reduce the risk of fire and/or explosion of stored batteries:

- If a battery isn't used for more than three days, store it in a proper storage area to prevent damage and reduce safety risks.
- When storing LiPo or Li-ion battery packs, keep them at 60–70% of their full charge. Avoid storing lithium-ion cells fully charged, around 3.8V per cell is ideal.
- Most chargers have a "storage mode" that automatically brings the battery to the correct voltage. Utilizing this mode after each use is recommended to extend battery life.
- Remove batteries from charging devices before storing them.
- Always store batteries in a fireproof safety bag or fire-resistant container or cabinet. Follow the manufacturer's instructions for proper use.
- Cover the battery terminals with insulating material to prevent short circuits during storage.
- Keep lithium batteries separate from other types of batteries (lead-acid, alkaline, etc.).
- Store unused batteries away from used ones.

6. Storage Areas

- Store batteries in a designated storage area that is dry, well-ventilated, and climate controlled at room temperature or lower. While batteries can operate between -20°C and 60° C (-4°F to 140°F), avoid storing them at a temperature that is close to the upper or lower range.
- There should be no ignition sources anywhere near lithium battery storage areas.
- Storage areas should be equipped with fire suppression and containment systems that are adequate for the volume of batteries on hand at any given time.
- Ideally, areas or rooms should be protected with a smoke detector.
- Do not store batteries in a refrigerator, condensation can form as they warm up, making them unsafe to use.
- Keep the storage area free of flammable and combustible materials such as wood, carpet, or gasoline. Store batteries on surfaces like concrete, metal, or ceramic.
- Batteries may be stored in a metal cabinet, such as a chemical storage cabinet, make sure batteries don't touch each other.
- Never leave batteries in areas where they can be easily damaged or tampered with.
- Keep appropriate personal protective equipment (PPE) available (e.g., goggles/safety glasses, impact-resistant face shields, aprons or lab coats, and gloves).
- Keep a Class ABC or CO_2 fire extinguisher nearby for emergencies.

7. Shipping by Mail

- Only trained and authorized personnel are permitted to prepare, package, and ship Li-ion and LiPo batteries.

- If you plan to ship Li-ion/LiPo batteries, whether alone or installed in equipment, you must contact EHS to determine whether your shipment falls under Dangerous Goods Regulations.
- **WARNING: Failure to follow proper regulations for shipping hazardous materials can lead to civil penalties of up to $100,000 per violation.**
- EHS will help ensure your shipment is properly packaged, labeled, and that all required paperwork is completed correctly.

C. Emergencies

All batteries require careful handling, but Li-ion and LiPo batteries carry extra risks because of their high energy density and flammable electrolyte. If these batteries are poorly made, overcharged or over-discharged, mishandled, incorrectly connected, or exposed to physical damage or stress, they can enter a state called thermal runaway. This can lead to leaking, venting, explosion, or fire. Anyone using lithium-ion batteries must be aware of these risks and prepared to adhere to the following emergency procedures.

1. Damaged Batteries

   Damage to Li-ion and LiPo batteries isn't always visible. Situations that can damage a battery include:

   - A fall from 12 inches or higher
   - A 20 mph or faster impact or crash
   - Puncture by a sharp object
   - Swelling or expansion from overheating

   Using a damaged battery can cause thermal runaway, which may lead to a fire. Always inspect batteries and avoid using any that may have been compromised.

   Important: Even if there are no visible signs of damage, a delayed fire can occur hours or even days after an impact or accident. It is safest to discharge the battery immediately if there is any concern.

   If the battery is **not hot, leaking, or smoking**, follow these steps to safely discharge and dispose of it:

   - Suit up in appropriate PPE (e.g., gloves, goggles/safety glasses and lab coat/apron).
   - Disconnect the battery from the equipment.
   - Move to a well-ventilated area and place the battery in a metal or hard plastic bucket.
   - Fill the bucket with a 3% saltwater solution (mix 2.5 tablespoons of salt per one gallon of water until fully dissolved).
   - Leave the battery submerged in the solution for at least 2 days.
   - After 2 days, contact the EHS to arrange proper disposal.
   - Check the battery voltage across the terminals to confirm it has dropped to 0 volts.

   Alternate method to discharge the battery:

   - Use a resistor that has a resistance at least 10 times greater than the battery's internal resistance to discharge it slowly and safely.

2. Overheating, Venting, Leaking Cells

   Sounds like "clicks" and "puffs" may indicate a preliminary vent release. Follow this emergency procedure if you have overheating, venting or leaking cells:

- If you notice hot cells, disconnect the charger and remove any external short circuit if present.
- If a cell is venting or smoking, evacuate all personnel from the area. Secure the area to prevent anyone else from entering.
- If leaking material is present, do not touch it.
- Immediately call University Police Department (UPD) at 702-895-3669 to initiate emergency assistance.
- Do not approach the cell until it reaches room temperature. The cell temperature can be checked using a remote device (i.e. infrared thermometer).
- If a remote device is not available, do not handle the cell for a period of at least 24 hours.
- As soon as the cell reaches room temperature, contact EHS to arrange proper disposal.

3. Exploded Batteries

An exploded lithium-ion cell is usually caused by overheating or physical damage. When a battery explodes, it can quickly fill the room with dense white smoke that may cause serious irritation to the eyes, skin, and respiratory system.

If a battery cell has exploded, follow these steps immediately:

- Evacuate all personnel from the area.
- Secure the area to prevent anyone else from entering.
- Call University Police Department (UPD) immediately at 702-895-3669 to initiate emergency assistance.
- If it is safe to do so, activate the ventilation system to help clear the smoke and fumes. Keep it running until the damaged battery is removed and the odor is gone.
- Contact EHS for help with removing and properly disposing of the damaged battery as hazardous waste.

4. Battery Fires

Lithium battery fires differ from fire involving ordinary combustibles (e.g., wood or paper) because:

- They are extremely good at spreading.
- They are unique in terms of how they burn.
- They release toxic by-products.

Li-ion and LiPo battery fires can occur due to thermal runaway, short circuits, or other conditions that cause the battery to overheat. Once a battery begins venting flammable vapors, it can easily ignite. **CSN personnel are not required to fight fires. The primary responsibility is to evacuate and ensure personal safety.** Only personnel trained in fire extinguisher use may attempt to extinguish a small, early-stage (incipient) fire, and only if it can be done safely.

Appropriate fire extinguishers include:

- ABC (dry powder)
- Carbon dioxide (CO_2)
- Foam (non-combustible)

Smothering the fire with sand or sodium bicarbonate may also be effective.

Important: Ice should never be poured on top of a smoldering battery because it acts as an insulator and may cause the battery to explode.

a. Responding to Small, Incipient Stage Fire

- Evacuate all personnel from the area.
- Activate the nearest fire alarm pull station, where equipped.
- By-products of combustion may be toxic when inhaled. In the event of heavy smoke, exit the area immediately. Ensure others have left the area and close doors behind you as you leave.
- Immediately call University Police (UPD) at 702-895-3669 to initiate emergency assistance.
- If the fire involves an electronic device, unplug the device from its power source or shut off power to the outlet, if it is safe to do so.
- If trained in fire extinguisher use and familiar with the battery type, use the nearest ABC extinguisher.
- Make sure you are positioned between the fire and the nearest exit before attempting to extinguish the fire.
- If the use of a portable fire extinguisher has little effect on extinguishing the fire, exit immediately. Do not initiate a second attempt.
- If flames are extinguished, pour water over the battery to cool it, provided this does not create an electrical hazard. Apply 1–5 liters or more of water, depending on the battery size.

b. Responding to Large Scale Fire

- Evacuate all personnel from the area.
- Activate the nearest fire alarm pull station, where equipped.
- Do not attempt to extinguish the fire by using a portable fire extinguisher.
- Call University Police (UPD) at 702-895-3669 to initiate emergency assistance.
- Plan to be available for UPD to provide information. This may include the size, location, and nature of the fire, as well as identifying any hazardous materials, especially in the event of a laboratory fire.

5. First Aid

Incidents involving lithium batteries can cause exposure to the battery's electrolyte, toxic smoke, and flying metal shrapnel in case of explosion.

a. Exposure to Battery's Electrolyte

- For significant exposures to the electrolyte, get immediate medical attention. The applicable SDS should be sent with the patient to the hospital.
- SKIN - Remove contaminated garments. Immediately flush skin with water for no less than 15 minutes. For larger spills, the safety shower should be used. Get medical attention, if necessary.
- EYES - Immediately flush eye(s) with cool water for at least 15 minutes. The eyes must be forcibly held open to wash, and the eyeballs must be rotated so all surface area is rinsed. The use of an eyewash fountain is desirable, so hands are free to hold the eyes open. If an eyewash is not available, pour water on the eye, rinsing from the nose outward to avoid contamination of the unaffected eye. Get medical attention, if necessary.
  CONTACT LENSES - Remove contact lenses while rinsing. Do not waste time removing contact lenses before rinsing. Do not attempt to rinse and reinsert contact lenses.
- INHALATION - Move to fresh air. Monitor airway breathing; if breathing is difficult, have trained person to administer oxygen. If the victim is not breathing, give proper first aid and/or proper CPR procedures, only if CPR-trained. GET MEDICAL ATTENTION IMMEDIATELY.

b. Smoke Inhalation

- Move the victim to fresh air.
- Immediately call University Police (UPD) at 702-895-3669 to initiate emergency medical assistance.
- Ask the victim to drink large amounts of water.
- If breathing is difficult, have trained person to administer oxygen.
- Provide artificial respiration (CPR), only if trained, if the victim is not breathing.

c. Burns

- Move the victim to fresh air.
- Immediately call University Police (UPD) at 702-895-3669 to initiate emergency medical assistance.
- Cool the burn with clean, cool or lukewarm running water for 20 minutes.
- Treat burns immediately (remove any metal particles from skin).

D. Battery Disposal

Intact Li-ion and LiPo batteries are classified as Universal Waste, a category under hazardous waste regulations designed to simplify disposal and encourage the safe collection, storage, and recycling of certain materials. However, damaged lithium-ion batteries are considered Hazardous Waste and must be collected by EHS.

The following procedures outline the required steps for proper handling and disposal of intact batteries:

- Tape each battery terminal with non-conductive tape or place them in a sealed clear plastic bag to prevent short-circuits and potential fire hazard during storage and transport.
- Store in a plastic container or cardboard box, to prevent sparking, label the container “USED BATTERIES FOR RECYCLING.”
- Contact EHS to request a pickup of waste batteries, submit an online pickup request using the EH&S Chemical/Bio Waste Pickup Request form available at: https://csn.campusoptics.com/hw/chemical-bio-waste-pick-up-request-form.

For the disposal of damaged batteries and all spills from broken batteries and emergencies, contact the EHS Office for guidance.

V. AUTHORITY AND CROSS REFERENCE LINKS

CSN Hazardous Waste Management Procedure
https://www.csn.edu/sites/default/files/pdf_file/0024/157317/Hazardous-Waste-Management.pdf

CSN Used Batteries Fact Sheet
https://www.csn.edu/sites/default/files/used-batteries-fact-sheet_acsbl.pdf

Department of Transportation, Pipeline and Hazardous Materials Safety Administration (DOT PHMSA) - Transporting Lithium Batteries
https://www.phmsa.dot.gov/lithiumbatteries

Environmental Protection Agency (EPA) Guidelines - Used Lithium-Ion Batteries
https://www.epa.gov/recycle/used-lithium-ion-batteries

Occupational Safety and Health Administration (OSHA) Fact Sheet - Lithium-ion Battery Safety
https://www.osha.gov/sites/default/files/publications/OSHA4480.pdf