

Lead Acid, Lithium-Ion and Lithium Batteries

Standard Operating Procedure (SOP)

Type of SOP: ☒ Process/Equipment ☐ Hazardous Chemical

All personnel who are subject to these SOP requirements must review a completed SOP and sign the associated training record. The most current version of the SOPs is located in electronic form on the University's Share Drive. Follow the link below.

S:\University Info\General Information\Emergency Information\Standard Operating Procedures

In addition to the electronic copies, hard copies of the SOPs can be found inside the laboratory, if the SOP pertains to something within a laboratory.

Date SOP Written: 7/5/22	Approval Date: 1-11-2024
SOP Prepared By: Michi Dubes	
SOP Reviewed and Approved by CHO (signature): Rose Rakers	
☐ Department:	☒ Campus Wide ☒ Lisle ☐ Mesa
Principal Investigator (PI):	Phone:
Chemical Hygiene Officer (CHO): Dr. Rose Rakers	Phone: 630-829-6571
Emergency Contact: Campus Safety Dispatch	Phone: 630-829-6122
Location(s) covered by SOP: Building and Room #(s):	

1. **HAZARD OVERVIEW** (What are the hazards?) (i.e., hazards associated are chemicals, fire/explosion, electrical, ergonomic)

The hazards associated with the types of batteries listed above include chemical, fire or explosion, electrical shock, and ergonomic.

Lead acid batteries are relatively common large-capacity rechargeable batteries. They are used in automobiles, electric vehicles, boats, and uninterruptible power supplies. These batteries contain layers of lead alloy plates immersed in a sulfuric acid. Small quantities of other metals, such as antimony, calcium, tin, selenium, are added to enhance electrical properties.

Lithium-ion batteries are rechargeable batteries that are commonly found in cell phones, lap tops, drones, robotic equipment, and tablets. They contain lithium ions and an electrolyte solution that is usually a mixture of organic carbonates.

Lithium batteries are not rechargeable. These batteries are commonly found in medical devices, laser pointers, and remote car locks, and they are also referred to as primary batteries.

2. HAZARDOUS CHEMICAL(S)

Chemical hazard associated with lead acid batteries contains sulfuric acid, which is highly corrosive and can cause severe chemical burns to the skin and can damage the eyes. The solution is also poisonous if ingested.

In addition, overcharging a lead acid battery can produce hydrogen sulfide gas. This gas is colorless, poisonous, flammable, and has an odor similar to rotten eggs or natural gas.

Fire/explosion risk associated with lead acid batteries have little or no gas while discharging, but explosive mixtures of hydrogen and oxygen can be produced during charging. Hydrogen gas is colorless, odorless, lighter than air, and highly flammable; oxygen is an oxidizer that can promote a fire or explosion.

Lithium-ion batteries contain flammable electrolytes, and lithium batteries contain lithium metal, which is highly flammable. These batteries can fail and overheat for a variety of reasons, including puncture, overcharge, overheating, short circuit, internal failure, or manufacturing deficiency. Thermal runaway can occur with these batteries which is a reaction within the battery cell that causes temperature and pressure to rise at a faster rate than can be dissipated. Signs of thermal runaway include overheating, hissing, or bulging of the battery.

Exposed terminals can pose an electrical shock hazard even on disconnected batteries. There is a significant amount of stored energy, and some battery systems can discharge at high rates of current. Shorting of the terminals (using too small of a load) can result in severe electrical arcing, which can cause burns and or shocks to nearby personnel.

3. WHAT ACTIVITIES COULD POSE A RISK?

Activities that could pose a health hazard include:

- Refilling or checking the electrolyte solution of a vented lead acid (VLA) battery; and
- Overcharging a lead acid battery.

Activities that could pose a physical hazard include:

- Charging a lead acid battery in a poorly ventilated area;
- Lifting or carrying lead acid batteries;
- Using a damaged lithium or lithium-ion battery;
- Overcharging a lithium-ion battery;
- Short-circuiting a lithium or lithium-ion battery; and
- Exposing a lithium or lithium-ion battery to elevated temperature.

4. HOW CAN EXPOSURES BE MINIMIZED?

Elimination/Substitution – Use caution when considering the use of aftermarket lithium-ion batteries and chargers in place of the originals, as aftermarket equipment may not have sufficient safety provisions. Only use lithium-ion batteries that are well-built and approved by a safety agency (UL, Intertek/ETL, ANSI, IEC, or SAE).

Engineering Controls – Charge lead acid batteries in well-ventilated areas, specifically in fume hoods or below a snorkel if possible.

Administrative Controls

The following elements are required:

1. Complete the Hazard Communication and/or Laboratory Safety training if working in the laboratory;
2. Complete laboratory-specific safety orientation and training on laboratory-specific safety equipment, procedures, and techniques to be used, including a review of the Chemical Hygiene Plan, prior to receiving unescorted access to the laboratory;
3. Sign off that you read and understand the Chemical Hygiene Plan and what is expected while working in the laboratory;
4. Be familiar with the location and content of any applicable Safety Data Sheets (SDSs) for the chemicals to be used;
5. Implement good laboratory practices, including good workspace hygiene;
6. Inspect all equipment and experimental set-ups prior to use;
7. Follow best practices for the movement, handling, and storage of hazardous chemicals. An appropriate spill clean-up kit should be located in the laboratory. Chemical and hazardous waste storage must follow an appropriate segregation scheme and include appropriate labeling. Hazardous chemical waste must be properly labelled, stored in closed containers, in secondary containment, and in a designated location;
8. Do not deviate from the instructions described in this SOP without prior discussion and approval from the PI and CHO; and
9. Notify the PI, CHO and Emergency Preparedness Manager of any accidents, incidents, near-misses, or upset conditions (i.e., unexpected rise or drop in temperature, color or phase change, evolution of gas) involving the process or hazardous chemical(s) described in this SOP.

Additional administrative controls include:

- Handle all batteries and battery-powered devices carefully to prevent damage to battery casings or connections;
- Provide physical separation of batteries from conductive materials, water, seawater, strong oxidizers, strong acids, and flammable materials;
- Assess batteries for signs of damage before, use, and never use a battery that appears misshapen, enlarged, or damaged;
- Do not leave batteries in direct sunlight, on hot surfaces, or in hot locations;
- Allow the battery to cool before using after charging and before charging after using; and
- Use proper ergonomic techniques when lifting or moving lead acid batteries.

Personal Protective Equipment (PPE)

At a minimum, long pants (covered legs) and closed toe/closed heel shoes (covered feet) are required to enter a laboratory or technical area where hazardous chemicals are used or stored. In addition to the minimum attire required upon entering a laboratory, the following PPE is required for all work with hazardous chemicals:

1. Eye Protection
 - a. Eye protection must be ANSI Z87.1 compliant.
 - b. At a minimum, safety glasses are necessary.
 - c. Splash goggles must be substituted for safety glasses in chemistry laboratories, and are required for processes where splashes are foreseeable or when generating aerosols.
2. Body Protection: At a minimum, a chemically-compatible laboratory coat that fully extends to the wrist is necessary.
 - a. If a risk of fire exists, a flame-resistant laboratory coat that is NFPA 2112 compliant should be worn.

- b. For chemicals that are corrosive and/or toxic by skin contact/absorption additional protective clothing (i.e., face shield, chemically-resistant apron, disposable sleeves, etc.) are required where splashes or skin contact is foreseeable as per the SDS.
3. Hand Protection: Hand protection is needed for the activities described in this SOP. Define the type of glove to be used based on the following:
 - a. Chemical(s) being used;
 - b. Anticipated chemical contact;
 - c. Manufacturer' permeation/compatibility data; and
 - d. Whether a combination of different gloves is needed for any specific procedural step or task.

For VLA batteries, wear a lab coat, safety glasses, disposable gloves, and a face shield while checking electrolyte levels and /or refilling.

5. ADDITIONAL GUIDANCE

Charging Batteries

- Review the battery manufacturer's recommendations and voltage thresholds prior to charging. Ensure the voltage and current settings are correct for the battery and use chargers that are designed to safely charge at the specified voltage;
- Only charge rechargeable batteries, such as lead acid and lithium-ion batteries; do not try to recharge alkaline or lithium batteries.

Lead acid batteries

- Charge batteries in a well-ventilated area, preferably in a fume hood or beneath a snorkel;
- Ensure vents are clean so that hydrogen gas can escape;
- If a rotten egg or natural gas odor is observed during charging, the battery is likely releasing poisonous hydrogen sulfide gas. Evacuate the area and call the CHO for assistance.
- Always check the electrolyte levels of VLA batteries after charging and allowing them to cool. If the plates are not fully covered, fill with distilled or deionized (not tap) water to the designated level. Never add fluid while a battery is charging or while it is still warm from charging;
- Batteries should be stored in a charge state, and batteries should be recharged every six months during periods of extended storage.

Lithium-ion batteries

- Depending on the device, some lithium-ion batteries only require connecting to the charging cable whereas specialized electronics, such as drones, require more attention during charging to ensure safety and prevent battery damage;
- Remain in the area of the battery pack while charging and periodically check for signs of battery or charger distress, unless the battery is covered under the FCC laws (laptops/cell phones/etc.);
- Immediately disconnect batteries if they emit an unusual smell, develop heat, or change shape during charging;
- Remove batteries from charger promptly after charging is complete. Do not use the charger for device storage;
- Avoid parallel charging because chargers cannot monitor the current of individual cells;
- If charging series packs (25 and above), balance the charge with a charger that is capable of monitoring individual cells to prevent cells from being overcharged. The charger and the battery should be placed

on a heat-resistant, nonflammable, and nonconductive surface. If possible, charge the battery in a fire-retardant container designed for lithium-ion batteries, such as a Lipo sack;

- Do not charge battery beyond the manufacturer's recommendations;
- Before long-term storage, charge or discharge the battery to approximately 50% of the capacity. Charge stored batteries at 50% at least every six months.

Disposal and Decontamination Procedures

Hazardous waste must be properly labeled and removed from your laboratory within six (6) months of the accumulation start date. Hazardous waste should be brought down to the Chemical Stockroom. Speak with the CHO prior to bringing the waste.

- Lithium-ion batteries that no longer hold a significant charge should be referred for disposal. To assess the condition of a battery, charge it, let it rest for one hour, and measure the voltage. Do not charge battery beyond the manufacturer's recommendations.
- Lead acid, lithium-ion, and lithium batteries used at Benedictine University can be brought to the CHO for proper chemical waste disposal.

Upon completion of work with hazardous chemicals and/or decontamination of equipment, remove gloves and/or PPE to wash hands and arms with soap and water. Additionally, upon leaving a designed hazardous chemical work area remove all PPE worn and wash hands, forearms, face and neck as needed. Contaminated clothing or PPE should not be worn outside the lab. Grossly contaminated clothing/PPE and disposable glove must not be reused.

Shipping and Transportation

Follow the Shipping Hazardous Materials policy found at S:\University Info\General Information\Emergency Information.

Fires

If lithium batteries are showing evidence of thermal runaway failure (overheating, hissing, or bulging), use caution as the gases may be flammable and toxic. Use appropriate PPE, including gloves, safety glasses, and lab coat, and following the guidance below:

- Call 911 immediately
- If possible, disconnect the battery or remove it from the equipment it is being used in
- Place the battery in a heat-resistant container or outside, away from combustibles
- If a lithium-ion battery fire occurs, use a Class BC or Class ABC fire extinguisher. Use a Class D extinguisher for a lithium battery fire, as these batteries contain lithium metal.

Exposure Requiring the Use of Emergency Shower and/or Eyewash/Drench Hose

- Have someone call 911 (report the building name, street address (located near the door to the room on the Emergency Procedures sheet) and room number.
- Contact Campus Safety at 630-829-6122 to report the incident and let them know you called 911.
- Have someone obtain the SDS for the material and provide it to the first responders upon arrival.
- Assist the affected individual to position their head over the eyewash/drench hose located in the laboratory and activate it if the eyes or face are affected. If the exposure is on the body assist the affected individual to the emergency shower in the hallway and activate it. The activation of either the eyewash or shower located in the hallway will trigger an alarm notifying Campus Safety. Ensure your own safety before helping others. Only help if it is safe for you to do so.
- Instruct the affected individual to open their eyes and roll them around while the water is flowing or to stand under the shower with the affected area being covered in water.

- Flush the affected area for 15 minutes with water.
- Notify the Emergency Preparedness Manager as soon as possible and complete the [Accident/Incident Form](#).

6. TRAINING

To teach and learn inside a laboratory, certain training must take place. All individuals must take a Laboratory Safety online course. If your laboratory involves chemicals for chemistry or biology, individuals must also take the Hazard Communication online course. These two online courses are set up with the Emergency Preparedness Manager.

Refresher training for the Hazard Communication course will be taken if the individual completed the full three-part course within six (6) months. If it has been close to or over one (1) year, the full three-part course will need to be repeated. The Laboratory Safety course will be repeated if the individual completed the course over one (1) year prior.

In addition to the online courses, students are required to complete laboratory-specific training to be able to stay in the laboratory.

7. SOURCES AND ADDITIONAL RESOURCES

1. Lithium Battery Safety. University of Washington Environmental Health & Safety. <https://www.ehs.washington.edu/system/files/resources/lithium-battery-safety.pdf>
2. Lithium Ion Battery Safety Guidance. Massachusetts Institute of Technology. https://ehs.mit.edu/wp-content/uploads/2019/09/Lithium_Battery_Safety_Guidance.pdf
3. Navigating the Regulatory Maze of Lithium Battery Safety. Intertek. http://batterypoweronline.com/wp-content/uploads/2013/11/Intertek_Regulatory-Maze-WP.pdf
4. The Battery University website: <https://batteryuniversity.com/>
5. The Hazards of Lithium Batteries. Tufts University Environmental Health & Safety. <https://viceprovost.tufts.edu//ehs/files/The-Hazards-of-Lithium-Batteries.pdf>

All personnel shall read and fully adhere to and acknowledge the contents, requirements, and responsibilities outlined in this SOP.

☐ I have read and acknowledge the contents, requirements, and responsibilities outlined in this SOP.

Print Name

Signature

BenU ID

Date