

<p>Carnegie Mellon University Environmental Health & Safety FIRE LAB WORK </p>	<p>Environmental Health and Safety Guideline on Lithium ion batteries</p>
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1. Purpose

Carnegie Mellon University has prepared this guideline to provide safety requirements for purchasing, working with, charging, transporting, handling emergencies, and disposing of Lithium Ion Batteries (LIB). Without proper controls, the potential life/health safety risks associated with lithium batteries are high in both impact and likelihood. As a result, these guidelines should be thoroughly reviewed and understood. Li-ion is a generic term, covering several types of battery chemistries and several formats for various applications. This guideline is intended to educate users toward important safety considerations as it related to LIB's. However, it is not to be considered as the sole source of information. Concerns and/or clarifying questions, should be e-mailed to safety@andrew.cmu.edu.

2. Scope

The scope of this guideline includes; Purchasing, General Safety Considerations, Charging, Transporting & Shipping, Handling Emergencies and Disposal. This guideline specifically covers Lithium ion batteries as Secondary Batteries. Secondary batteries are such that their chemistry allows for them to be recharged. Primary batteries, such as Lithium metal and Alkaline, are not covered in this guideline. Primary batteries are defined as being portable and not rechargeable. Additionally, although there are many types of secondary batteries, such as Nickel Metal Halide/Nickel Cadmium/Lead Acid, this guideline addresses the more common version (i.e. Lithium ion). Further, this guideline can be used as a *starting point* when designing and building battery systems, but it is not the only safety considerations for joining cells together to make your own battery system. Consult safety@andrew.cmu.edu when building battery systems.

3. Definitions

- a. Purchasing – refers to the procurement of LIB's in accordance with Finance-Management Purchasing Policy.
- b. Charging – specifically referring the safety aspects of charging, this guideline does not cover types or ways of charging.
- c. Transporting – refers to carrying, moving, or taking batteries with you whether on campus, over the road, or as an aircraft carry on.

- d. Shipping – refers to the requirements for sending either lithium ion batteries, or lithium ion batteries contained in equipment.
- e. Emergencies – refers to any event involving a lithium ion battery whereby there is a sudden release of energy, battery swell, explosion or fire, and steps to take to mitigate hazards.
- f. Disposal – refers to the process for submitting lithium ion batteries for recycle, in accordance with regulatory requirements.
- g. Parallel Charging – when multiple LIB batteries are plugged into each other via a special board or harness so that all of their negative leads are connected to each other, and all of their positive leads are connected to each other.

4. Roles and Responsibilities

- a. Carnegie Mellon University Environmental Health and Safety is responsible for:
 - i. Developing and updating the written guideline for LIB's.
 - ii. Developing a training program for the guideline.
 - iii. Inspecting work areas applicable to this guideline.
 - iv. Assisting with the shipping of LIB's.
 - v. Managing the disposal/recycle of LIB's.
- b. Departments are responsible for:
 - i. Complying with the requirements of this guideline.
 - ii. Supporting and enforcing the requirements of this guideline.
 - iii. Contacting CMU EHS for assistance as needed.
- c. Lithium ion battery users are responsible for:
 - i. Completing training as necessary.
 - ii. Complying with the procedures outlined in this guideline.
 - iii. Contacting EH&S for assistance as relating to this guideline.
 - iv. Reporting incidents involving LIB's, especially those involving fire.

5. Guidelines

- a. *Purchasing*
 - i. Use a Preferred Supplier. If purchasing from a supplier not on the preferred list, prior to purchase, contact Procurement Services to ensure the vendor is properly set up in the system.
 - ii. Use a Purchase Order. As many LIB's meet the classification of Hazardous Material, you should not put them on a P-Card, unless pre-approved by Procurement Services & EH&S.
 - iii. Purchase LIB's from an approved manufacturer. Standards for safety testing should be indicated on the cells/battery. The following are approved testing labs/organization for batteries: Underwriter Laboratories (UL), National Electrical Manufacturers Association (NEMA), Society of Automotive Engineers (SAE), Institute for Electrical and Electronics Engineers (IEEE), Battery Safety Organization (BATSO), and Japanese Industrial Standards (JIS).
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Be sure batteries have been tested to at least one of these standards. This information is provided by the supplier and/or manufacturer.

- iv. Be responsible, know your needs. Do not over purchase size or volume, and do not purchase from unapproved manufacturers.

b. General Safety Considerations

The most recognized hazard of a LIB is the potential for “Thermal Run Away”, whereby the battery safety mechanisms fail and the battery undergoes sudden and rapid release of energy. It should be noted that the cells/battery are designed to bulge and safely release energy, but this is not guaranteed. Recognize and control the following potential hazards:

- i. A rupture of casing tightness, spillage of electrolyte which may contain corrosive materials, release flammable gas, as well emit volatile organic compounds. Always work with LIB’s in a well ventilated area, or under a fume hood/ventilation system.
- ii. Potential electrical energy hazards, and sudden release of energy by Joule effect, heat, temperatures elevate and spark/fire/smoke hazards are generated. Always work on non-conductive surfaces. Proper Personal Protective Equipment (PPE) should be worn, such as: Electrically rated gloves, floor pad, table pad, and eye protection or face shield.
- iii. Potential for parts ejection from the Run Away effect, as well as electrical hazard. Work with a blast shield and always wear PPE.
- iv. Loss of power to equipment. Remember that safety features dependent on electrical energy from the battery will fail when the battery fails. Always isolate equipment from batteries, use lockout tagout of equipment with faulty batteries.

c. Charging

Most commercial smart devices, laptops, and electronics that contain LIB’s have a Battery Management System (BMS) which provides the critical safety controls for properly charging and not over-charging the battery. The main consideration is to use the manufacturer’s recommended AC adapter. Additionally, be alert of warning signs such as over-heating, hot batteries, or hot charging plugs/wires. Note: many charging connections might fit your device but it doesn’t necessarily mean you have the correct volt and amp ratings.

- i. Charge batteries in a well ventilated area, fume hood, or exhaust ventilation system.
- ii. Battery charging should be conducted away from exits doors. A clear egress to the exist must be maintained.
- iii. Have a portable fire extinguisher in the work area and get trained on its use (EH&S Fire Safety). Note: as LIB fires are difficult to

extinguish, the fire extinguisher is meant mostly for protecting the surrounding area/materials. As this type of fire represents an electrical hazard Do Not Use Water. The preferred extinguishing media is Carbon Dioxide (CO₂) or Dry Chemical (ABC) type.

- iv. Use nonconductive work materials (bench, tools, etc.). Do not charge on wood or combustible surfaces. Use a box, charging bag or charge on a charging pad.
- v. Be aware to avoid things that cause static electric discharge, such as carpeting.
- vi. Never leave a battery charging unattended.
- vii. Keep area clear of flammable liquids or gases.
- viii. Series packs should balance charge, the charger should be capable of monitoring the condition of individual cells to prevent over charge.
- ix. Do Not Over Charge.
- x. Avoid Parallel Charging.
- xi. Monitor the charging process, check temperature and equipment regularly.

d. Transporting & Shipping

There are a number of best practices for transporting LIB's, as well as regulations that apply to shipping LIB's.

For the purposes of this guideline, the definition of "Transport" refers to hand carrying around campus buildings and/or on campus property LIB's that are not subject to official shipping regulations. This section applies to batteries being used for, or in teaching or research projects (and not specifically personal devices, such as smart phone), though many of these considerations are applicable to all LIB's being transported:

- i. Do not transport batteries in a metal box.
- ii. Do not carry in your pocket. Coins, keys or other metallic objects can cause batteries to short circuit.
- iii. Keep away from heat, transport in a container or padded bag to prevent shock if dropped or impacted.
- iv. Do not transport or ship a fully charged battery. The recommended State of Charge (SoC) is 30% or less. Note: this does not refer to your smart devices, computers or lithium ion batteries contained in equipment with an approved battery management system.
- v. Tape terminals to prevent contact being exposed to short circuiting.
- vi. If contained in equipment, make sure the power is isolated from the electronic device, or disconnect the battery.
- vii. Loose batteries, or batteries contained in equipment, as carry-on no more than 2 LIB's with a watt-hour rating above 100 watt-hours (Wh), but below 160, with Lithium content above 2 grams but not more than 8 grams may be carried (IATA 2018).

For the purposes of this guideline, the definition of “Shipping” refers to the sending LIB’s via private carrier to off campus destinations. This section applies specifically to IATA Regulations for the proper packaging, marking and labelling of LIB’s, or equipment containing LIB’s:

- viii. LIB may never be sent via United States Postal Services (i.e. regular mail). Note: this also includes campus mail.
- ix. Lithium ion cells above 20 Wh, and batteries below 100 Wh are regulated for shipping purposes. To ship a battery that meet this criteria, please submit a shipment review request to safety@andrew.cmu.edu. Note: shipping LIB’s is heavily regulated, violations can result in serious penalty. Improper shipping of LIB’s can cause catastrophic accidents. Persons shipping these batteries may be held liable for losses relating to these accidents. Citations of up to \$40,000 may be issued for mismanagement of shipments. Civil and criminal penalties can be issued for knowingly violating shipping regulations. Please check with EH&S when in doubt.

e. Handling Emergencies

LIB’s contain flammable liquid electrolytes which may vent, smoke, spark, or even ignite due to high temperature or impact. Known as a “Runaway Event” the battery poses both physical and health hazards. The following recommendations are for users to be aware & prepared to handle the emergency as it unfolds:

Damaged battery, not yet a full runaway event, whereby the battery has been impacted, dropped or overheated, and there is potential for an event. If not runaway is occurring, users should:

- i. Put on appropriate Personal Protective Equipment (PPE), which includes Eye Protection & Gloves (at a minimum).
- ii. Disconnect the battery from any terminals (equipment or charging).
- iii. Place the battery in a metal can with a lid, if no metal can is available you can use a hard plastic container with a lid.
- iv. Submit a request for pickup to EH&S (email safety@andrew.cmu.edu) indicating “Potentially Damaged Battery for Disposal”.

Heating, bulging, or leaking battery, whereby a runaway event is occurring, users should:

- v. Put on appropriate PPE. This includes; eye protection, face shield, and chemical resistant gloves. It is recommended to also use tongs or other device so as not to actually touch the battery.
- vi. Only if safe to do so, disconnect the battery from the charger or equipment, and place into metal can with lid and contact EH&S for the battery to be removed (412-268-8182).

- vii. If not safe to handle, remove other batteries and combustible materials from the nearby area and move away from the runaway battery and contact Campus Police (412-268-2323). Inform them of the event, and provide Building and Room Number.
- viii. Only if safe to do so, locate and have ready a portable fire extinguisher for a potential fire.

LIB's that have exploded or on fire are the most severe and hazardous scenarios of a runaway battery. Users should follow these critical steps:

- ix. Immediately evacuate the area, stay clear, and keep others out.
- x. Contact Campus Police (412-268-2323) and report the accident, be sure to provide the Building and Room Number.
- xi. Contact EH&S and report the incident 412-268-8182.
- xii. Care for any injured persons. Byproducts of the burning battery are extremely toxic and you should evacuate the area.
- xiii. Only if you can safely do so, locate a Portable Fire Extinguisher and put out the fire. NOTE: a LIB will burn itself out but typically ignites surrounding items. Extinguish the surrounding area as well as the battery.

f. Disposal

The disposal of LIB's falls under the regulations set forth by the Environmental Protection Agency, and is further defined by the Pennsylvania Department of Environmental Protection as being Universal Waste. The requirement is for these items to be diverted from landfill and recycled for the purpose of sustainability. To have batteries disposed:

- i. Submit an On-line Request for Universal Waste Pickup (<https://www.cmu.edu/ehs/Hazardous-Waste-Management/universal-waste.html>).
- ii. Do Not Submit Runaway Batteries via On-line Request, these should be called into 412-268-8182. If the Runaway Battery leaks or catches fire, first contact Campus Police (412-268-2323).
- iii. Do not send LIB's via campus mail.
- iv. Do not deposit LIB's in the Recycling Kiosk's or CUC Green Room.

For additional questions and concerns please contact EH&S: safety@andrew.cmu.edu