

Environmental Health and Safety

Lithium-based Battery Safety

Purpose

Lithium-ion batteries provide power for a variety of devices that many people use daily, including smart phones, laptops, power tools, drones, delivery robots, e-scooters and e-bikes, e-cigarettes, smoke alarms, toys, golf carts and vehicles, etc.

If used incorrectly, not charged according to manufacturer's specifications, or damaged, lithium batteries can catch fire and/or explode. All university users of rechargeable lithium batteries (e.g., lithium-ion (Li-ion) and lithium polymer (LiPo) cells) and battery packs must be alert when using, charging and storing them. University employees must dispose of batteries spent batteries through EHS/Facilities, whereas students should take their batteries to Moscow Recycling.

While fires and explosions involving lithium batteries are relatively rare, their consequences can be very serious because when a lithium battery catches fire it emits very toxic gases, flames and heat and are very difficult to extinguish. Therefore, it is important to understand the risks, be able to recognize potential problems and know how to avoid these problems before they occur.

Frequently Asked Questions

Q1. Lithium vs. lithium-ion vs. lithium polymer batteries — what's the difference?

Lithium-based batteries differ from other battery types (e.g., alkaline, & lead acid, etc.) in that they store a much greater amount of energy in a smaller space.

- Lithium batteries are “single use.” These non-rechargeable (also referred to as primary cell lithium batteries) batteries have a longer shelf life than lithium-ion per charge and have a lower upfront cost.
- Lithium-ion (Li-ion) batteries are rechargeable (secondary cell). The ability to recharge them for many cycles makes them more cost effective than single use lithium batteries over time. Li-ion batteries use a liquid electrolyte (an electrically conductive material).
- Lithium polymer (LiPo) batteries are also rechargeable but can hold more stored energy in a much lighter-weight package than Li-ion batteries by using a semisolid (gel) polymer electrolyte.



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Q2. What is the difference between a cell and a battery pack?

In its simplest sense, a cell is a single primary or secondary battery (e.g., AA, AAA battery). When multiple cells of the same type are connected together and sealed inside a case, it's referred to as a battery pack.

Q3. Why do lithium-based batteries present fire hazards?

Lithium-based batteries, rechargeable or not, have high energy densities, or the ability to store a much greater amount of energy in a small amount of space. Damaged lithium batteries can enter an uncontrollable self-heating process known as thermal runaway, which may happen during charging, use or storage under certain conditions.

Thermal runaway may cause a fire and/or an explosion. In either case, there is a lot of stored energy available to sustain the process, more than other battery types (e.g., alkaline & lead acid batteries, etc.). Additionally, lithium batteries create oxygen as they burn, making it more difficult to interrupt the burning process, which further intensifies the amount of heat emitted and accelerates thermal runaway. Thermal runaway can cause severe damage to property, inflict burns, potential exposure to toxic gases and is harmful to the environment.

Q4. How might lithium batteries become damaged?

Damaged batteries can lead to thermal runaway, so care must be taken to protect your batteries and devices from any of the situations below.

- Over-charging or discharging. Lithium batteries are best kept between 20% - 80% of their charge capacity. Both fully-charging batteries and a fully-discharging them can reduce their lifespan and overall capacity.
- Unbalanced cells. Using mismatched cells can cause excessive cell wear and degradation reducing the lifespan of the entire battery. When replacing multiple single-cell batteries in devices, be sure they are all fresh and identical batteries to help avoid this problem. Never mix batteries from different manufacturers.
- Excessive current discharge. A battery that discharges faster than its rated capacity may overheat and be physically damaged.
- Short circuits or poor electrical connections. Both situations may cause overheating and physical damage.



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- Physical damage. Dropping, crushing or puncturing a lithium battery or exposing it to temperature extremes (roughly, below freezing or above 130 degrees Fahrenheit), can cause damage to the internal structure and potentially trigger thermal runaway.
- Improper storage.

See also: Q12, Can I store Li-ion batteries?

Q5. What are indications that a lithium battery is damaged?

According to the US [Occupational Safety and Health Administration](#) (OSHA), signs of damage include:

- Bulging
- Cracking
- Hissing
- Leaking
- Abnormal odors
- Rising temperature
- Smoking

Always inspect batteries for any signs of damage before use. Any battery that is known or suspected to be damaged must be taken out of service. Contact EHS at 208-885-6524 promptly to arrange for proper disposal.

Q6. How do I dispose of old, malfunctioning or damaged lithium batteries?

Dispose of used lithium batteries by contacting EHS directly (208-885-6524). You may be asked to complete an online [Chemical Waste Collection Form](#), but start with a phone call so we can respond quickly. EHS staff will arrange to collect the batteries. Never send lithium batteries to Surplus, through Campus Mail or place them in regular trash.

Although EHS can only take batteries used by the university, we still want to know about any damaged lithium batteries on campus. Report damaged batteries to EHS directly (208-885-6524).



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Q7. What should I do in case of emergency?

If batteries are showing evidence of thermal runaway, or if there is any other indication of immediate danger to life, property or the environment, call 911 and notify EHS at 208-885-6524. Outside of regular business hours, call 911 and notify Campus Security at 208-885-7233 (SAFE).

ONLY if it is safe to do so, follow these steps if there is evidence of a battery malfunction (e.g., swelling, heating, abnormal odors):

- Use personal protective equipment, such as gloves, goggles/safety glasses and a lab coat.
- Use extreme caution because the emitted gases may be flammable and toxic.
- Disconnect the battery from its power source/charger.
- Remove the battery from the equipment/device.
- Place the battery in a metal container away from combustibles. Ceramic pots or cinderblocks may also work as emergency containers. Fill the container with sand or kitty litter if readily available.
- Contact EHS at 208-885-6524 for assistance. Outside of regular business hours, call the fire department (911) and Campus Security (208-885-7233).

Q8. Are electric hover boards, e-bikes, e-scooters and similar devices allowed to be charged and/or stored inside university buildings?

No. Given the fire hazards that come with lithium-ion batteries, these items are not allowed in university buildings. The batteries on these devices are much larger than those in cell phones, laptops, and similar devices, and can store substantially more energy. If a battery malfunction occurs, the larger batteries will be able to burn longer and have a much higher potential for personal injury and property damage.

Because there are many variables that lead to lithium-ion battery failures, and the safety of any individual battery cannot be ensured, hover boards, e-bikes, e-scooters and other similar devices are not allowed in university buildings.



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Q9. What are the best practices for using Li-ion batteries?

If you are using lithium batteries, you should:

- Always purchase batteries from a reputable manufacturer or supplier.
- Read all documentation supplied with your battery.
- Never burn, overheat, disassemble, short-circuit, solder, puncture, crush or otherwise damage battery packs or cells.
- Do not put batteries in contact with conductive materials, including water, seawater, strong oxidizers or strong acids.
- Avoid excessively hot and humid conditions, especially when batteries are fully charged.
- Do not place batteries in direct sunlight, on hot surfaces or in hot locations.
- Do not store batteries at low or freezing temperatures.
- Immediately disconnect the batteries if, during operation or charging, they emit an unusual smell, generate heat, change shape/geometry or behave abnormally.
- Contact EHS for disposal; do not request collection by Surplus, send through Campus Mail or place in regular trash.

See also: Q10, Are there safe battery charging protocols?

Q10. Are there safe battery charging protocols?

Yes, the National Fire Prevention Association (NFPA) and battery manufacturers have common charging recommendations. Here are some general recommendations:

- If a battery will not take a charge, something is likely wrong with the battery. Remove it from the charger and contact EHS.
- Always use the charger that came with the battery and follow manufacturer's instructions.
- Never charge a disposable (lithium or alkaline) battery; store one-time use batteries separately.



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- Charge or discharge the battery to approximately 50% of capacity before long-term storage.
- Use chargers and methods designed for lithium batteries and their specific charge profile.
- Disconnect batteries immediately if, during operation or charging, they emit an unusual smell, develop heat, change shape/geometry or otherwise behave abnormally. Contact EHS for proper disposal.
- Remove cells and packs from tools/devices when not in use and chargers promptly after charging is complete. Do not use the charger as a storage location.
- Charge and store batteries in a fireproof container and on a noncombustible surface.
- Do not parallel charge batteries of varying age and charge status.
- Do not overcharge Li-ion batteries.

Q11. Can I ship Li-ion batteries or devices containing Li-ion batteries?

No; however, EHS can help. Li-ion or equipment containing Li-ion batteries are considered “dangerous goods” because they can pose significant safety risks in transportation. If you must ship Li-ion batteries or equipment containing Li-ion batteries, contact EHS for assistance. EHS has qualified staff with specialized training in shipping dangerous goods.

For your awareness: Failure to comply with regulations for shipping hazardous materials can result in significant civil penalties for the shipper of up to \$100,000.00 per violation; \$235,000 if the violation results in a serious injury, death or substantial damage to property.

Q12. Can I store Li-ion batteries?

Absolutely. Proper lithium battery storage is critical for both battery performance as well as for your safety.

- Store Li-ion batteries at room temperature.
- Li-ion/LiPo batteries should never be stored fully charged. When not in use, store the Li-ion/LiPo battery pack at about 50% of the pack’s rated capacity.



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- Remove the battery from a device before storing.
- Use a Li-ion/LiPo battery fireproof safety bag or other fireproof container when storing batteries.
- Cell terminals must be protected by covering them with non-conductive electrical tape.
- Have a reserved storage area for Li-ion/LiPo batteries ONLY. It must be a cool and dry place, away from heat sources and separated from any combustible materials.
- The ideal surface for storing Li-ion batteries is concrete, metal, ceramic or other non-flammable material. A rated metal flammable cabinet is also an option.
- A smoke detector should be in the battery storage area.
- A class ABC or CO2 fire extinguisher should be readily available near the storage area.
- Do not store Li-ion batteries on loading docks, behind buildings, in basements or in stairwells.
- Do not store Li-ion or equipment containing Li-ion batteries under any stairway, indoors or out
- Do not leave e-bikes and other similar equipment near building stairs or doors where they may prevent people from exiting the building if a fire occurs.
- Do not send Li-ion batteries to U of I Surplus or through Campus Mail.
- Do not store malfunctioning or bad Li-ion batteries. Contact EHS promptly for proper disposal.

Q13. Is it safe to use Li-ion or LiPo batteries at my workplace?

With proper handling, the risks are minimal, and these batteries are safe for daily use. Most incidents involving lithium batteries result from inadvertent mishandling, overcharging and damage to the battery's shell.

