

Safety Hazards

Battery Charging - Lithium-Ion Batteries

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Why is it important to follow safety procedures when charging batteries?

Battery charging can be hazardous, and it is important to identify potential [hazards](#), [assess the risks](#), and have [controls](#) in place to protect workers. Workplaces should always make sure that procedures and practices for battery charging are developed based on the manufacturers' instructions and recommendations. Requirements from occupational health and safety legislation, building codes, electrical codes, and fire codes must also be followed.

The hazards and risks associated with battery charging will depend on the type of battery, how it needs to be charged and maintained, and the area where it is being charged among other factors. Always make sure the charging stations and devices have a Canadian certification mark (e.g., CSA, cUL, cETL), indicating they meet Canadian electrical safety standards (jurisdictions may specify which certification marks are acceptable).

NOTE: This OSH Answers document provides general guidance on charging lithium-ion batteries and is not meant to replace the requirements from the manufacturer or legislation.

What are some of the hazards of lithium-ion batteries?

Lithium-ion batteries are commonly used and can be found in power tools, cellphones, laptops, tablets, cameras, wearable devices (e.g., body cameras), electric bikes, scooters, battery-powered lawnmowers or snowblowers, and other devices (note: this guidance is not intended for lithium-ion batteries used in vehicles). Lithium-ion batteries contain one or more cells that are electrically connected and contain a positive and negative electrode, a separator, and an electrolyte solution.

Rechargeable lithium-ion batteries are generally safe, but like any energy storage device, they can also pose health and safety risks. When these batteries are not used, stored, installed, disposed of, or charged properly, they can overheat, leak, burst, or cause a fire or explosion.

Improper use of batteries can also increase the risk of electrical shock. Batteries can be damaged by physical impact (e.g., dropped, crushed, punctured), improper charging (e.g., not following manufacturers' instructions), and exposure to certain temperatures (e.g., high temperatures and below freezing), which can increase the risk of an adverse event.

What are the hazards of thermal runaway?

Thermal runaway is often considered the greatest hazard related to lithium-ion batteries. When these batteries are defective, damaged, or not operated safely, overheating in the cells can occur, resulting in a chemical reaction. During normal operation and charging, small amounts of heat are generated but are safely dissipated. During thermal runaway, the temperature within the battery cell is greater than what can be dispersed, and the excess heat initiates a chemical chain reaction resulting in an uncontrollable self-heating state of the cells. The damage from a thermal runaway may result in leakage of the electrolyte and the release of by-products (e.g., carbon monoxide, carbon dioxide, hydrogen, and hydrocarbons). The battery may also burst or cause a fire or explosion. Explosions may shoot parts of the battery over 18 metres (60 feet), causing multiple fires.

Main hazards of thermal runaway:

- Release of corrosive, flammable, and toxic liquids and gases
- Released liquids and gases can cause skin or eye burns or damage, are harmful if inhaled, and can cause other health effects
- Fire or explosion caused by the intense heat and the flammable liquids and gases from the battery

How can I safely charge rechargeable lithium-ion batteries?

To minimize the risk of a lithium-ion battery overheating and catching fire or exploding while charging, you should:

- Follow the manufacturer's instructions for proper charging
- Only use the manufacturer-approved charging device and battery (e.g., some manufacturer-approved chargers cycle power when charging to avoid over-charging, and others may not)
- Make sure the charging device has a recognized Canadian certification mark (e.g., CSA, cUL, cETL)
- Unplug the charger or remove the battery when charging is complete. Do not leave the battery in the charger beyond the recommended charging time - most batteries have built-in protection to prevent overcharging, but for defective or low-quality batteries or a mismatched charger, extra time can result in the battery exploding or catching fire
- Do not use uncertified chargers, as they can pose a risk of electrical shock, fire and explosion
- Charge the battery when it is at room temperature – do not attempt to charge batteries in below-freezing temperatures (unless permitted by the manufacturer)
- Do not charge batteries on a soft surface, as it can cause heat to be trapped around the battery
- Do not charge near flammable materials, such as paper, cardboard, cloth, etc.
- Do not use extension cords. Extension cords change the level of electrical resistance and may affect how the battery charges.
- Do not charge damaged or defective batteries
- Charge in areas that are well-ventilated and where there's access to fire extinguishers, emergency eye-wash stations or showers, and other equipment that may be needed

How should lithium-ion batteries be stored?

- Do not store batteries where they can touch metal (coins, keys, tools, etc.), as they can catch fire or explode when in direct contact with metal.
- Remove batteries from devices (e.g., power tools) if they are not being used for extended periods if recommended by the manufacturer
- Store batteries at a charge between 30 and 50% when not used for long periods of time. Check the batteries every 3 months, and re-charge to 50% if needed.
- Store batteries in original packaging or case and in a cool dark place away from ignition sources and chemicals (do not store in a sub-freezing environment)
- Store batteries in a dry location, away from flammable and combustible products or anything that can catch fire

- Do not store batteries where they can touch metal (coins, keys, tools, etc.), as they can catch fire or explode when in direct contact with metal
 - Do not pile old batteries together – to prevent fires, cover terminals with non-conductive tape (e.g., electrical tape) and place them in separate plastic bags
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What are some other health and safety tips for working with lithium-ion batteries?

- Keep batteries away from direct sunlight and ignition sources, and do not leave them in hot vehicles
- Make sure the appropriate battery for the device is used and that it has been installed correctly
- If the battery overheats or there is a different smell, noise (hissing), bulging, cracking, change in the shape or colour, or anything other sign that is not usual, move the battery or charger away from items that can catch fire if safe to do so.
- If a fire occurs, evacuate the area immediately and call emergency services. Lithium batteries can explode and cause injuries.
- Properly dispose of old or defective batteries (do not put them in regular garbage or recycling) – many retailers and local governments have battery recycling programs or hazardous waste collection. Make sure to follow the applicable regulations for waste disposal
- Replace batteries when they are damaged or show signs of overheating. Only use batteries recommended by the manufacturer
- Avoid using poorly manufactured or after-market batteries. [Transport Canada](#) (2023) reports that "third-party lithium-ion batteries, which are usually lower cost and thus appear more economical, are much more likely to be substandard, counterfeit or poorly manufactured, and pose a higher safety risk during transportation and use than the OEM batteries that passed the test." (OEM: original equipment manufacturer)
- Install a smoke detector in the area where the battery is charged. When charging in a garage or shed, make sure you can hear the alarm from the workstation or house
- Make sure your workplace's [ventilation](#) and [fire protection](#)(e.g., fire suppression) systems comply with the applicable legislation, including occupational health and safety regulations, Building Codes, and Fire Codes
- Develop [emergency response](#) procedures and [first-aid](#) measures to address scenarios related to battery charging, including fires, explosions, worker exposures, and thermal runaway (see manufacturers' instructions and safety data sheets)
- Know how to safely use a [fire extinguisher](#)

- Provide training and instruction to workers on how to safely use, store, dispose of, and charge batteries and what to do in the event of an emergency
- Do not use different types of batteries together (e.g., do not mix old ones with new ones, do not mix rechargeable batteries with non-rechargeable ones)
- Do not modify or tamper with the batteries
- Do not use a battery if you detect overheating, an odour, a change in colour, a change in shape, leaking, odd noises, or other defects
- Do not block emergency exits

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