Lithium-ion Batteries

Guidelines

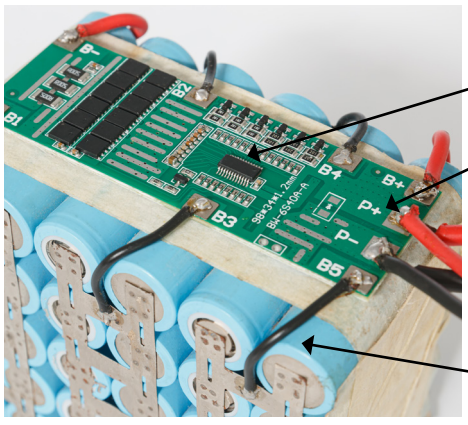
Lithium-ion is the most prevalent type of battery technology used throughout the world and has enabled the development of portable devices that we rely on everyday such as mobile phones, tablets, laptops and power tools, as well as electric vehicles, e-bikes and e-scooters.

Today, almost every portable electronic device contains a lithium-ion battery, and it is expected that demand will continue to increase almost seven-fold by 2030 due to the rising popularity of electric vehicles and battery energy storage systems.

There are many benefits to lithium-ion battery technology that help explain why it has become so ubiquitous:

- They offer a much higher energy density compared to other rechargeable battery technologies such as lead acid. This allows much greater energy storage for the same weight and size, allowing for smaller and more powerful portable devices with longer runtimes between recharges. This is particularly important for electric vehicles, where the range directly correlates with the size and weight of the vehicle, of which the battery pack is a significant part.
- They can be recharged (or 'cycled') hundreds or even thousands of times before needing to be replaced.
- They can be scaled in size to suit almost any purpose; anywhere from a coin sized battery up to a shipping container.

Lithium-ion Battery Pack Anatomy



This battery pack has been disassembled to reveal the internal layout. All battery packs in use should be protected by an external case or housing.

Fire Hazard

While lithium-ion batteries are generally reliable, and failures resulting in a fire or explosion are uncommon, they can be catastrophic if they do occur. Unlike other types of batteries, the electrolyte used in lithium-ion batteries is flammable, and excessive heat within the battery cells, which is usually caused by high electrical currents or short circuits, can cause the electrolyte to ignite. This can lead to what is commonly referred to as thermal runaway. Once thermal runaway occurs, a fire and/or explosion results, which can be very difficult to extinguish due to the ongoing release of the flammable electrolyte, which provides fuel to the fire.

Short circuits and excessive current can occur for several reasons, such as physical damage to the battery cells, manufacturing defects, overloading, overheating (from an external source), overcharging or over-discharging. Fortunately, modern lithium-ion devices are fitted with an electronic monitoring and control circuit known as a BMS, or Battery Management System, which limits the potential for thermal runaway during normal operation. These can limit the maximum charge and discharge voltage and current of the cells, provide balancing to prevent overworking weaker cells, temperature monitoring, and failsafes that can shutdown the battery system if any fault is detected.

General Handling and Battery Care Precautions

There are a number of steps you can take to reduce the risk of a lithium-ion battery failure:

Selection, Storage and Use

- Only use batteries and charging equipment sourced from a reputable manufacturer. Ensure that batteries are only charged using charging equipment that is specifically designed and certified for use with the battery and/or device being charged.
- Store and use the batteries within a safe temperature range. Batteries should be stored, charged, or discharged at temperatures between 0°C and 40°C. Any portable devices should be kept out of direct sunlight, away from hot surfaces and removed from vehicles parked outside in the sun.

  To keep batteries within this range, there are often mechanical heating or cooling devices fitted to battery packs, and you should regularly check to make sure these are working as required. This might include checking for coolant leaks, ensuring fans are operating, etc.

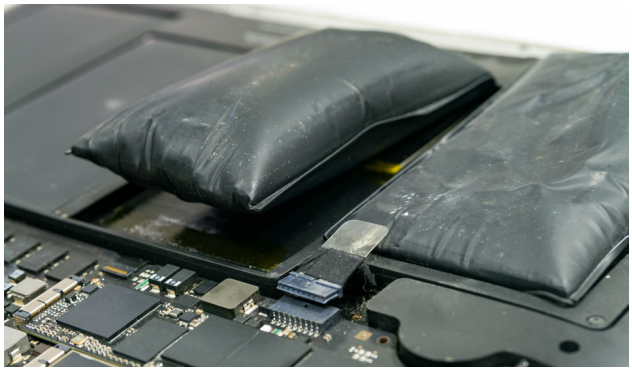
Charging

- If charging multiple portable devices (such as power tools) regularly, a dedicated cabinet designed specifically for battery charging should be used to prevent a battery fire from spreading to nearby combustible materials.
- Don't leave batteries connected to a charger for long periods after charging is complete. Keeping a battery at 100% charge constantly will significantly reduce its lifespan.

Battery Charging Cabinet

Inspection and Disposal

- Regularly inspect batteries, devices containing batteries and charging cables/equipment for any signs of physical damage, including any battery showing signs of swelling/expansion. Any damaged batteries or equipment should be removed from service and disposed of immediately.
- When disposing of lithium-ion batteries, cover the terminals with insulating tape to prevent accidental short circuits, and place the batteries in a metal bin fitted with a metal lid.
- Retired batteries should be removed from the site as soon as possible through a battery recycling provider; refer to B-cycle for a list of accredited recyclers.



Swollen Battery

Bulk Storage and Warehousing

There are some additional precautions that should be taken in warehouse and storage facilities where lithium-ion batteries, or devices containing lithium-ion batteries, are stored in bulk. It is also common for warehouses and storage facilities to use lithium-ion batteries in devices such as forklifts, automated vehicles, barcode scanners, laptops and other portable devices.

This guidance is applicable to devices where a significant portion of the internal volume/packaging of the device is filled with one or multiple rechargeable lithium-ion batteries, such as laptops, mobile phones, uninterruptible power supplies and other energy storage devices. Devices containing small (usually non-rechargeable) batteries are excluded.

Lithium-ion batteries in rack storage

Fire Protection & Storage

- Installation of a sprinkler system is strongly recommended in storage areas containing lithium-ion batteries, and should be designed for unexpanded plastic commodities in accordance with Australian Standard 2118.1 at a minimum. In addition, industry guidelines and internationally recognised standards more specific to lithium-ion battery storage should be consulted when designing the sprinkler system.
- Products should be stored in cardboard outer packaging only, as this allows the sprinklers to wet and cool the cardboard, reducing the risk and/or speed of fire spread due to thermal runaway of adjacent batteries. The maximum storage height should also be limited to 4.5m high with no storage of any products above this height, and a maximum ceiling height of 12m.[1]
- Any batteries or battery containing devices should only be stored with a charge level less than 60%.[1]

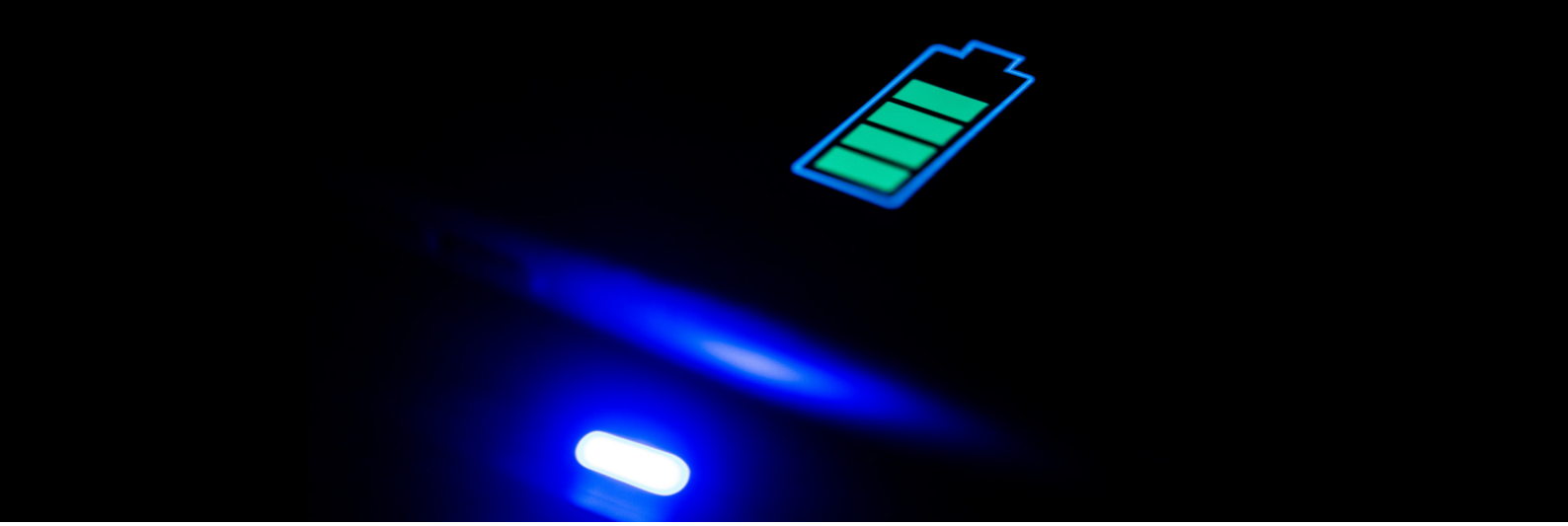
If a sprinkler system is not installed or is not adequately designed for unexpanded plastic commodities, storage should be limited to an area no larger than 20m^2 and up to 1.8m high. Aisles between adjacent storage areas should be at least 3m.[1]

A certified fire protection practitioner should be engaged in consultation with your insurer before installing, upgrading or otherwise altering any fire services/equipment. All fire protection equipment should be designed, installed and maintained in accordance with all relevant Australian standards.

Battery Charging

- All vehicles and portable devices should be charged in dedicated charging bays/areas. These areas should preferably be located in a dedicated fire compartment with minimum 2-hour fire separation[2] to the warehouse and any administration areas, plant rooms etc.
- For single charging bays or where a dedicated charging compartment cannot be created, charging bays should be located at least 3m from any storage areas.[2]
- All charging areas should be covered by monitored smoke detectors, particularly where charging is conducted after business hours or when the area is not supervised by staff.
- All charging areas should be well ventilated. This is especially important when charging lead acid batteries as they vent hydrogen gas during charging. Lithium-ion batteries do not vent gas under normal operation, but adequate ventilation is important to maintain an appropriate ambient temperature and vent flammable gas that may be released due to a battery failure.
- All charging units should be installed by a licensed electrician using fixed wiring. Extension cords or long charging leads should not be used, as these are susceptible to damage.
- Charging units should be mounted to or placed on non-combustible structures or stands. They should never be fixed to insulated sandwich panelling or external finishing systems where combustible core materials may be present.

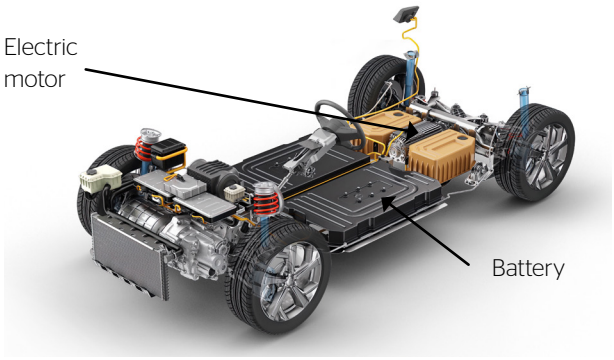
Dedicated forklift charging bays



Electric Vehicles

Demand for EVs (electric vehicles) is rapidly increasing due to a number of factors, including advancing technology, rising fuel costs and increasingly stringent emission standards. Due to the large, energy dense lithium-ion battery packs used within these vehicles, they pose a significant fire risk if not managed correctly. This includes hybrid vehicles, which typically contain a smaller lithium-ion battery in addition to an ICE (internal combustion engine).

Electric vehicles include road registered passenger vehicles, buses and trucks, as well as light electric vehicles (not road registered) such as e-bikes, e-scooters and mobility vehicles. Statistically, road registered EVs are about 100 times less likely[3] to catch fire than an ICE vehicle, however light electric vehicles pose a much greater fire risk.



Road Registered Electric Vehicles	Light Electric Vehicles
Typically use high quality battery cells and battery management systems due to stringent regulations and higher purchase costs.	May use lower cost/quality batteries and simpler battery management systems. Minimal regulation.
Charging often occurs in open spaces, with less risk of fire spread to nearby property.	Commonly charged indoors, particularly in homes, posing a significant risk of fire spread.
Robust physical protection for battery cells.	Requirements for lighter weight means less physical protection for the battery cells against impact damage.

The greatest risk of an electric vehicle fire occurs during or within an hour after charging. Therefore, precautions should be taken when installing and using charging stations:

Charging Locations

- Outdoor charging stations using charging equipment designed/rated for outdoor use is preferred over indoor charging. Any outdoor charging stations (including the vehicle parking bay, where applicable) should be separated by at least 6m from any storage and production areas, as well as any combustible building structures, and 10m from any hazardous area zones or storage of dangerous goods.[4]
- If indoor charging stations are required, they should be located in a detached, single-storey structure where possible. Otherwise, they should be installed in a dedicated structure/area with a minimum 2-hour fire resistance to all other parts of the premises.
- There should be no storage located within the charging area, and clear access for firefighting personnel should be provided, as well as readily accessible water supply.

Indoor EV Charging Stations

Batteries and Charging Equipment

- Charging equipment should be sourced from a reputable manufacturer, certified for use in Australia and installed by a licensed electrician in accordance with all relevant Australian standards, including AS3000 – Electrical Installations – Wiring Rules. Impact protection should be installed around the charging station and emergency isolation points should be provided in a safe, easily accessible location and clearly signed.
- For road registered EVs, it is recommended that fixed charging stations with dedicated wiring are installed when regular charging is undertaken at a location. Portable chargers that connect to 240V GPOs (General Purpose Outlets), while convenient, are more prone to physical damage to the unit and/or leads and may overload existing wiring due to the high-power draw of these units over many hours of continuous use, particularly in buildings with older electrical wiring.
- Only batteries supplied and installed by the vehicle OEM (original equipment manufacturer) or an OEM approved supplier should be used.
- Where employees or the public have access to charging equipment, appropriate training and signage should be provided on the safe use and selection of chargers.

Outdoor EV Charging Stations

Inspection and Testing

- OEM minimum testing and inspection requirements should be adhered to strictly.
- Chargers, cables, circuit breakers and RCDs (Residual Current Devices) should be regularly inspected for physical damage and tested to ensure correct operation.
- Level 3 charging stations, also known as DC (direct current) rapid/fast chargers, operate at high voltages and should be subject to weekly external visual inspections, annual servicing, testing and interior inspection, and three-yearly insulation and ground resistance testing to ensure continued safe operation.
- All inspection and testing activities should be undertaken by a certified and competent person in accordance with all manufacturer and Australian standards, including AS3000 – Electrical Installations – Wiring Rules and AS3760 – In-Service Safety Inspection and Testing of Electrical Equipment).

Fire Protection

- It is strongly recommended that indoor charging stations are protected with a sprinkler system designed to Australian Standard 2118.1 – High Hazard. The fire hazard associated with vehicles (both ICE and electric) has increased, as modern vehicles contain significantly more plastic and foam materials. Existing car park sprinkler systems (which are typically designed to Ordinary Hazard 2) may not be able to cope with this additional fire load.
- If a sprinkler system cannot be installed, the area should be protected by a monitored fire detection system compliant with Australian Standard 1670 – Fire Detection, Warning, Control and Intercom Systems.
- Where fire water supplies are provided by on-site tank storage (or similar private water supply) a minimum of 2 hours of continuous supply at the design demand should be provided.
- A certified fire protection practitioner should be engaged in consultation with your insurer before installing, upgrading or otherwise altering any fire services/equipment. All fire protection equipment should be designed, installed and maintained in accordance with all relevant Australian standards.