Sydney Trains

Safety Alert

Sharing information to prevent incidents

Lithium-Ion batteries in e-Micromobility Devices on the Rail Network

Target audience:

All Sydney Trains' workers, including contractors, who operate, store or charge e-Micromobility Devices.

The Issue

Sales and the corresponding use of e-micromobility devices incorporating large capacity lithium-ion batteries (including e-bikes, e-scooters, e-skateboards) have increased significantly in recent years, particularly in the greater Sydney metropolitan area.

In some circumstances, the failure of Lithium-Ion batteries can lead to a hazardous condition known as **thermal runaway**.

Thermal runaway is a self-sustaining, heat releasing (exothermic) chemical reaction within a battery cell or multiple cells, which may result in the battery catastrophically failing in a high intensity fire with vapours that can produce jet-like flames, intense heat, and in some cases, explosions.

Figure 1: e-bike damage following battery thermal runaway fire

! Lithium-Ion Battery fires are currently the fastest growing category of fire risk according to data from Fire and Rescue NSW.

What are Lithium-Ion batteries

Lithium-Ion batteries are energy efficient rechargeable batteries with high energy density (i.e. store more energy in less space than traditional batteries). They are more lightweight and compact than other batteries.

Lithium-Ion batteries are commonly used in:

- e-micromobility devices such as e-bikes, e-scooters and -e-skateboards;
- electric road vehicles;
- portable electronic devices such as laptops, tablets mobile phones and wearable devices;
- household devices such as handheld vacuum cleaners and power tools;
- battery energy storage such as *uninterrupted power supplies* (UPS) and *residential energy storage* systems (ESS).

Identifying Lithium-ion batteries

Lithium-Ion batteries are manufactured in a variety of shapes and may be embedded within electronic devices (e.g. mobile phones and laptops).

Large Lithium-Ion batteries are assembled from interlinked cells (like traditional alkaline batteries), arranged within a hard exterior casing (e.g. power tools and e-bikes). Casings are typically rectangular in shape, but cells can be arranged within any casing shape such as triangular cases commonly used on e-bike modification kits and may be manufactured from hard plastics or metal casings.

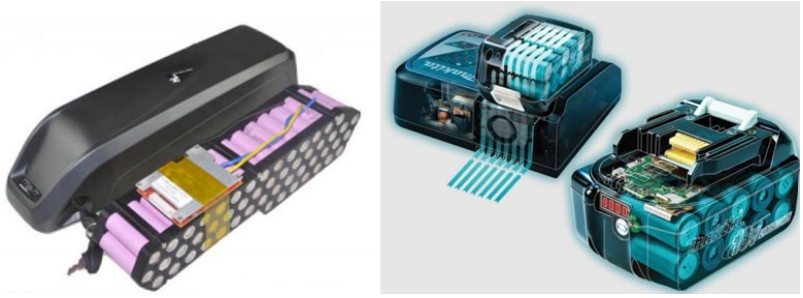


Figure 2: Typical e-micromobility Lithium-Ion Battery and typical power tool Lithium-Ion Battery pack.

Products using Lithium-Ion batteries may be marked externally with:

- Lithium-ion
- Li-ion'
- li-po'
- lithium-polymer'
- Li+

Causes of Lithium-Ion Battery Thermal Runaway

There are several causes of thermal runaway including:

Physical Damage mechanical damage resulting in significant deformation (crush, impact, bending) or penetration (piercing, cutting) leading to separator failure and short circuiting, causing thermal runaway

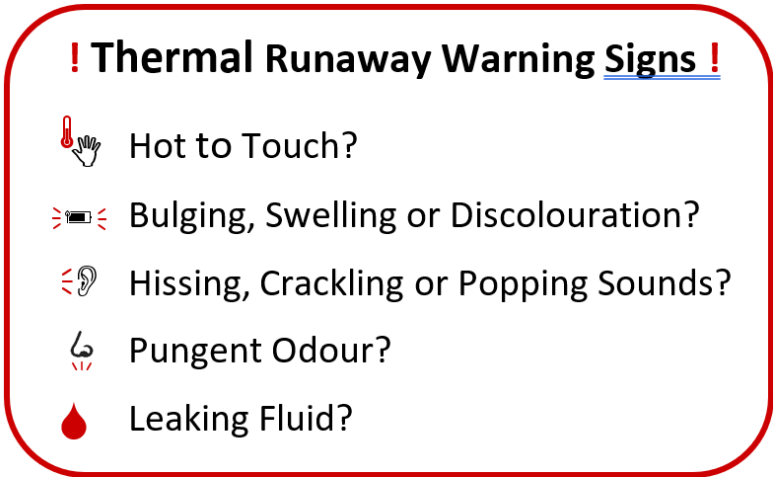
Thermal abuse – Overheating can cause the liquid electrolytes in the battery to boil, and internal cell damage (~130°C and above), resulting in short circuiting and thermal runaway.

Electrical abuse – Overcharging, over discharging, overcurrent, and incorrect electrical treatment, can lead to short circuiting and thermal runaway. Water ingress is also a common cause of short circuiting.

Manufacturing defects - Defects from manufacturing, e.g. inclusions, burrs, tears, crimping errors, uneven coatings, etc. can lay dormant and cause hot spots, dendrite growth, and separator failures while battery cells are in use or as they age.

Signs of a damaged Lithium-Ion Batter

The following are indications of a Lithium-Ion Battery that may have increased risk of failure:



Hot to Touch – damaged batteries will be hot to touch during operation. A battery that cannot be comfortably touched is damaged and at risk of **thermal runaway** failure.

Bulging / Swelling / Discolouration – if a sealed unit battery is damaged gasses may build up in the battery case resulting in it becoming swollen and bulging and the case being discoloured.

Hissing / Crackling / Popping – if your Lithium-Ion battery is damaged, gasses may leak from cracks or gaps in the battery case resulting in hissing and / or popping sounds that are signs of **Off Gassing** indicating that the battery has failed. Some battery cases have a specific valve for this purpose.

Pungent Odour – a bad smell from the Lithium-Ion battery is a sign of **Off Gassing** indicating that battery has failed. The smell may be in conjunction with the sound of hissing and popping as gases leak from the battery.

Leaking Fluid – if a battery has failed, the internal electrolyte fluid may leak through cracks in the casing. Leaking fluids are a sign of potential battery failure.

! Any Lithium Ion Battery that shows one or more of the indications above is at risk of failure.

Interim Protocols

What to do if you identify a hazardous Lithium-Ion Battery

Never touch a swollen or ruptured device or battery with bare hands as the heat and/or chemicals can cause severe burns where you observe an e-micromobility device with a potentially damaged Lithium-Ion Battery.

If there are no signs of smoke from the device and it is safe to do so:

- Approach the customer and discuss your observations of the potential hazard. e.g. *"I noticed that your e-bike battery seems to be damaged, it seems to be [swollen, bent, leaking, smoking]"*.
- Request that the customer does not board the rail service due to the risk of battery failure. e.g. - *"Did you know that damaged Lithium-Ion batteries can cause a fire. Please consider not taking your device on this service"*
- Recommend that the customer consult safety information on the safe use and disposal of Lithium-Ion batteries.
- Report incidents into the Sydney Trains' reporting system i.e. SHEM.

Lithium-Ion Battery Fire Emergency

If a Lithium-Ion Battery is smoking or on fire, follow the relevant Sydney Trains' specific emergency procedures e.g. the *Fire* Section of the Incident Response Guide and OSP 10 Dealing with fires on trains and in the Rail Corridor. In addition:

- **Do Not attempt to extinguish the fire**.
- **Evacuate** the immediate area. - Move passengers away from danger area and establish an exclusion zone.
- **Isolate** the Battery Fire – if safe to do so by closing doors, and turning off any ventilation systems to slow the spread of fire. The vented battery gases, vapour and smoke are highly toxic and flammable and should not be inhaled.
- **Contact** emergency services by following your agencies fire response plan and / or calling emergency Triple Zero (000).
- **Medical Emergency** - If anyone has been exposed to spilled electrolyte, flying debris, smoke or vapours, or flames, seek urgent medical assistance by calling Triple Zero (000).
- When safe to do so, report the incident to your Line Manager and into the Sydney Trains' reporting system i.e. SHEM.

Further information on Lithium-Ion Battery Safety can be found at:

- Lithium-Ion Battery Safety – NSW Fair Trading; and
- Battery and Charing Safety – Fire and Rescue NSW.

Contact your **SRA Business Partner** or **Line Manager** if you have any questions.

_____

Jamie McDonald
A/Head of Safety Risk and Assurance