



Li-ion batteries

What is the hazard?

Lithium-ion (Li-ion) batteries are a popular source of power due to their high-energy density and the fact that they are rechargeable. This type of battery can be found in many different applications ranging in size from mobile phones to electric vehicles. The chemistries used in battery cells may be different depending on their use.

This type of battery system can be vulnerable to a phenomenon called thermal runaway, which may cause the battery to catch fire or even explode. When on fire the battery system may vent gases through a purpose-built port. It is also possible the built-up internal pressure causes the battery system's housing to rupture, creating an opening that allows the gases to escape. As these gases are often combustible (large) flames may come out of the battery system.

A short-circuit is the main failure mode of a battery system and will often lead to a thermal runaway. This occurs when a battery cell reaches a temperature at which the temperature continues to increase on its own and becomes self-sustaining as it creates oxygen which feeds the fire.

Both internal and external short-circuits exist. Internal short-circuits may be caused by the cell reaching high temperatures or due to the growth of a dendrite of lithium metal that penetrates the separator.



As quality systems have improved over time short circuits resulting from internal causes (e.g. production failures) have become rare with established brands. The quality of the electrolytes has improved reducing the risk of dendrites growing. Also cooling systems have improved over time.

External short-circuits may be caused when a conducting material that is external to the cell either touches the positive and negative terminals at the same time or is inserted in the cell with an electrical connection with the electrodes to occur. The nail penetration test is an example of the latter.

Of course, external heating or mechanical impact can also introduce internal and external shorts to occur in the battery system. Battery systems appear to be most vulnerable when under charge.

A thermal runaway in a battery system generally originates from a single cell. The heat generated at the failing cell heats the adjacent cells causing them to go into a thermal runaway too. When cooling is not applied this process may continue until all cells in a battery system are involved.

How to reduce the risk

We recommend that batteries have the proper CE marking and supporting documentation, which show all components comply with the relevant National and EN Standards.

The batteries should have an on-board Battery Management System (BMS), monitoring the battery system and preventing it from operating outside its safety parameters.

Battery charging should be done using battery chargers approved by the Original Equipment Manufacturer (OEM) this increases the chances that the BMS will be able to communicate with the charger, for example to communicate the preferred rate of charge and the maximum charge. Charging areas for forklifts, electric vehicles etc. should comply with the relevant guidelines.

The maintenance of battery packs should always be carried out according to the OEM's recommendations. If a Li-ion battery is damaged, hot, hisses or bulges, it must be immediately removed to a safe location preferably outside at a safe distance (> 10 m) from the buildings. If this is not possible it should be moved away from combustibles, preferably moved into a fire separated area and if possible cooled down using water.

The basic rule for battery charging areas is to have them away from combustibles, in a fire separated room with automatic fire detection and/or sprinkler protection overhead depending on the size and number of batteries.

Transport and storage of batteries should preferably be carried out at a reduced state of charge (less than 30%) reducing the likelihood that a cell failure leads to a thermal runaway.



Fire-fighting

A fire in a battery system can be handled like any other fire. At its early stages any fire can be put out using a portable extinguisher suitable for electric fires. As the Li-ion battery doesn't contain Lithium metal also water based (foam) extinguishers can be used, when suitable for electric fires.

However, when the fire grows it will produce large amounts of toxic gases and the area should be evacuated immediately.

For storage facilities the installation of automatic sprinkler protection according to an applicable standard is very much recommended. Water from the sprinklers will cool down the battery and prevent the fire from jumping over to nearby storage.

Make sure to discuss all details with your local Fire Brigade and your private Emergency Response Team. All should have a full understanding about when and how to fight a fire when it occurs on your premises. After extinguishing the battery should be moved outside immediately and/or cooled down using water as Li-ion fires may re-ignite.

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