Loss Prevention Standards

Lithium Battery Storage and Recycling

Introduction

Lithium cell batteries are widely used by consumers and the commercial sector to power many modern electrical and electronic devices such as calculators, watches, mobile phones, laptop computers, cameras, e-cigarettes, through to larger applications such as industrial equipment, medical equipment, e-bikes and motor vehicles (plug-in hybrid and electric vehicles).

Due to their ability to power equipment for hours or days, they have become the battery of choice and are an integral part of everyday life, with billions of them manufactured each year.

In modern society with environmental and landfill initiatives we see recycling of all sorts of items, and batteries are no exception. There are many types of batteries but lithium-based batteries, whether they are lithium-metal (typically non-rechargeable) or lithium-ion (rechargeable), are a particular issue as they can be a serious fire hazard if disposed of or stored incorrectly. There is often little or no thought given by organisations to the safe disposal and/or storage of these batteries.

It is increasingly common to see recycling containers in many locations (especially offices, supermarkets, shopping centres, etc.), and the correct storage container and location is imperative in order to help prevent a possible fire and its spread.

Root Causes of Energetic Cell and Battery Failures

There are a number of ways to exceed the thermal stability limits of a lithium cell and cause an energetic failure. Energetic lithium battery failures may be induced by external forces, such as exposure to fire or mechanical damage, or they may be the result of problems involving charge, discharge, and/or battery protection circuitry design and implementation, or they may be caused by internal cell faults that result from rare or subtle manufacturing problems. Generally, the root causes of energetic cell and battery failures can be classified as:

- Thermal abuse, e.g. external heating
- Mechanical abuse, e.g. denting, dropping, impact
- Electrical abuse, e.g. overcharge, external short circuit, over-discharge
- Poor cell electrochemical design, e.g. imbalance between positive and negative electrodes
- Internal cell faults associated with cell manufacturing defects, e.g. foreign metallic particles, poor electrode alignment

Factors that Influence the Effect of Failure

The most flammable component of a lithium cell is the hydrocarbon-based electrolyte (a substance that produces an electrically conducting solution). The hydrocarbon-based electrolyte in lithium cells means that under fire conditions, these cells will behave in a fundamentally different way than other batteries which contain water-based electrolytes.

The severity of a lithium cell failure will be strongly affected by the total energy stored in that cell; a combination of chemical energy and electrical energy. Thus, the severity of a potential thermal runaway event can be mitigated by reducing stored chemical energy (i.e. by reducing the volume of electrolyte within a cell), or by changing the electrolyte to a non-combustible material (i.e. the cell chemistry).

Although all charged cells contain stored electrical energy, even fully discharged lithium cells contain appreciable chemical energy that can be released through combustion of the electrolyte. Water-based battery chemistries, under some charging conditions, can produce hydrogen gas through electrolysis of the water. However, this hazard is seldom a concern during storage where no charging occurs.

If cells with water-based electrolyte are punctured or damaged, leakage of the electrolyte can pose a corrosive hazard but this does not pose a flammability hazard. In comparison, leakage or venting of lithium cells can release flammable vapour.

Fire impingement on lithium cells will cause release of flammable electrolyte, increasing the total heat release of the fire, assuming there are well-ventilated conditions.

When a cell vents the released gases mix with the surrounding atmosphere. Depending upon a number of factors, including fuel concentration, oxygen concentration and temperature, the resulting mixture may or may not be flammable.

Safety Controls

Lithium batteries should be stored, charged, used and disposed of in accordance with the manufacturer's instructions. As they can present distinct fire protection challenges, the following additional controls should be considered:

- Storage – batteries should be segregated from other combustible items if stored in a warehouse, shop stores, etc. or, alternatively, stored in a clearly labelled, normally closed secured metal container
- Disposal – consideration should be given to how the batteries are safely disposed of and how/where they are kept, such as in a lidded non-combustible container, not mixed with other waste and away from heat/ignition sources including direct sunlight. They should be collected by a professional waste management company, and regularly removed from the premises to avoid substantial accumulation
- Fire protection – measures should be proportionate to the risk and be based on the findings of the fire risk assessment. If the premises are fitted with automatic fire detection and automatic sprinkler protection, the lithium batteries should be appropriately stored within a protected area

Disposal and Recycling of Lithium Batteries

There is currently no specific advice that is tried and tested as to how to store recycled lithium batteries in order to prevent fires occurring. Some research suggests storing in a non-combustible ventilated container whilst other research suggests an enclosed container. If we consider the three components required for a fire (ignition source, oxygen and fuel), then it would make sense for any containers used for the storage of these batteries such as in offices, shopping centres, etc., to be non-combustible with a normally closed lid in order that any fire runs out of oxygen quickly and does not spread.

Further research by various bodies, both here in the UK and in the USA, is likely and no doubt this will provide new information about the hazards and causes of fires involving these batteries, but for now the above precautions appear to be sensible.

For any arrangement to be pertinent at any site, the hazards posed by lithium batteries should be managed by way of a formal documented risk assessment. This should specify the safe handling, storage and disposal arrangements for the batteries.

It is also worth mentioning that the above comments do not apply to the large-scale collection of general household and commercial waste, where there are specific problems in the control of the batteries in the waste that they collect.

Checklist

A generic Lithium Battery Exposure Checklist is presented in Appendix 1 which can be tailored to your own organisation.

Additional Information

- RISCAuthority – RC61: Recommendations for the storage, handling and use of batteries

Further risk management information can be obtained from Aviva Risk Management Solutions

Appendix 1 – Lithium Battery Exposure Checklist

Location	
Date	
Completed by (name and signature)	

	Lithium Battery Exposure	Y/N	Comments
1.	Has the site's fire risk assessment given consideration as to whether there are lithium batteries stored and/or recycled on the premises? If so, have any recommendations been made and actions taken?		
2.	Are lithium batteries stored in any quantity and if so, are they stored in a normally closed non-combustible cabinet, and in accordance with the manufacturer's instructions? If not, are they stored away from other combustible items?		
3.	Is there any recycling of lithium batteries, and if so, are they separated from other recycled items and kept in a lidded non-combustible container? Are they in an open area and away from where they could be accidentally damaged/knocked over?		
4.	In relation to item 3, are there suitable fire extinguishers in close proximity? Are individuals trained to use the fire extinguishers?		
5.	Are recycled batteries removed from site at an appropriate frequency to keep quantities to a minimum?		
6.	Are batteries handled in a way to prevent exposure to elevated temperatures, impact and physical damage?		
7.	Are lithium batteries being recharged on the premises? If so, are they in a well-ventilated area and away from combustible items?		
8.	In relation to item 7, are they left unattended for any length of time? Have these variables been included in the risk assessment?		
9.	Additional comments:		

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