Loss Prevention Standards – Asset Classes

Lithium-ion Batteries – Storage and Transit

Version: 1.1
Date: 19th July 2024

Lithium-ion batteries are an efficient and clean power source used by businesses in a variety of ways. As with any battery equipment, fires can occur, and careful management is required to reduce the potential for such incidents and impacts to business trading.

This Loss Prevention Standard provides guidance to help businesses identify, and mitigate the risks associated with lithium-ion batteries in storage and in transit.

AVIVA

Lithium-ion Batteries – Storage and Transit

Introduction

The use of lithium-ion batteries has steadily increased in recent years, and they are now found in a range of applications in many vehicles, homes, and businesses worldwide.

The batteries are mainly manufactured in China and the Far East; however, manufacturing and assembly is also carried out in Europe, South America, India, and the United States. Given the worldwide nature of manufacturing and the high international demand for these batteries and the products they power, it is inevitable vast stocks are at sea and in transit, as well as stored in warehouses awaiting distribution.

Whilst acknowledged as an efficient, clean, and generally safe means of powering equipment, the transit and storage of lithium-ion batteries, or goods containing lithium-ion batteries requires careful management to help reduce the potential for fire events. The following information illustrates some of the issues facing firefighters and businesses.

In early 2024, a fire at a large lithium-ion battery recycling warehouse in France took two days to bring under control. The building and its contents including some 900 tonnes of batteries were lost to fire. In May 2024 a fire at a storage unit in Surrey was believed to have been caused by a faulty battery.

In July 2023, fire aboard a car carrier believed to have started in an electric vehicle, significantly damaged the vessel and the nearly 3000 vehicles on board.

In February 2022 a fire, alleged to have started within a lithium-ion electric vehicle battery, on a car carrier with nearly 4000 vehicles on board, broke out and resulted in the loss of the vessel and all stock.

In 2021, a car carrier caught fire in Jacksonville, Florida. The vessel was carrying 2,420 used cars with a total value of $40million.

This Loss Prevention Standard discusses some of the concerns underlying this data, outlining the main risk exposures in the storage and transit of lithium-ion batteries, and provides some general considerations that can help reduce the potential for significant loss and consequences to business trading.

This document is one of a series of battery related Loss Prevention Standards. Other documents in the series provide guidance for specific battery applications or settings.

Note: This standard does not address any Liability exposures. It only focusses on Property loss prevention and risk management guidance.

Understanding the Risks

Lithium-ion batteries are generally safe and reliable to use. The risks of fire in new batteries or goods containing new batteries are very low, however manufacturing faults or defects, the storage of inferior quality products, poor handling and damaged incurred in transit or by warehouse operatives, drivers etc. can lead to fire events. Fires involving these batteries can be volatile with widely dispersed flaming; a 'chain reaction' effect as fire spreads between individual cells within the battery or batteries prolonging the burn time; potential explosion risks, particularly if contained in an enclosed environment and the potential for reignition from ongoing chemical decomposition after the initial fire. Fire can also spread to contents or goods in proximity and to the building or vehicle transporting the goods, potentially leading to a very significant loss event.

Business can be further impacted by expensive clean-up operations; impacts to trading and key customer supply during downtime, as well as impacts to Environmental, Social and Governance (ESG) programmes.

General Considerations

The following areas should be fully considered:

- Risk Assessments – Ensure relevant risk assessments including Fire Risk Assessment and where applicable, Explosion/DSEAR Risk Assessment have been reviewed to address the presence of lithium-ion batteries at the premises and any remedial or corrective actions implemented.
- Management of Change – Depending on the scale of the activities planned or undertaken, Management of Change protocols may need to be followed to ensure minimal impacts/exposure to the existing site activities and arrangements e.g., changes to layout to accommodate charging stations and risk management controls.
- Inform your Insurer and Broker – Changes to business activities and risk exposures, and risk control installations such as fire barriers; warehouse enclosures; fire resisting structures, automatic fire detection or automatic fire protections should be discussed with your Insurer and Broker, who can provide risk management advice and guidance.
- Standard Operating Procedures – Ensure the Management Policy rules on safe storage, stock handling and transit arrangements, charging; site inspections; training; emergency arrangements etc., are recorded within Standard Operating Procedures (SOP's) and shared with relevant staff.
- Self-Inspection – Storage and charging areas should be subject to recorded inspections to help identify issues or rule breaches. A minimum of weekly inspections is recommended using photographic and thermographic camera equipment to help detect and report issues or concerns.
- Emergency Response - an emergency response plan outlining key responsibilities and actions in an emergency incident involving stocks of lithium-ion batteries or goods containing such batteries, goods in transit and battery charging.
  Note - The explosive potential of lithium-ion batteries is increased when enclosed within compartments, particularly when oxygen levels rapidly increase, such as when compartment doors are opened. Access into such compartments during a fire event should ideally be limited to firefighters or other approved persons.
- Impairments – Ensure any impairments relating to fire detection and protection systems in areas housing stocks of lithium-ion batteries or goods containing such batteries or charging areas are reported to your Insurer and Broker. Temporary precautions may be necessary to some arrangements whilst impairments are ongoing.

- Fire and Rescue Service - Local Fire and Rescue Services are often amenable to inspecting premises to evaluate fire risk exposures and offer guidance. This is recommended for storage facilities with significant exposures e.g., stocks of lithium-ion batteries or goods containing such batteries, lift trucks etc. As a minimum any emergency fire information left at the premises for the emergency services should be updated to confirm the presence and location of stocks of lithium-ion batteries or goods containing such batteries. Fire and Rescue Service access to the storage and charging areas including smoke ventilation and emergency signage should be carefully considered, as should the risks to neighbouring properties including storage in yard areas, and any local environmental features e.g., ponds, lakes etc. from fire, smoke and firefighting water runoff should be assessed and any necessary damage mitigation measures agreed.
- Business Continuity – Review the site's Business Continuity Plan to ensure disaster recovery and continuity arrangements are adequate.

The Waste Batteries and Accumulators Regulations 2009

In addition to any responsibilities to undertake Fire and Explosion Risk Assessments as outlined above, producers, and some distributors of batteries, or stocks containing such batteries may be required to 'take back' damaged and waste batteries from customers and other persons under UK & EU Regulations/Directives. In the UK this is currently addressed via **The Waste Batteries and Accumulators Regulations 2009**, which also places responsibility to ensure waste batteries are safely processed, and the credentials of suppliers are checked. Your obligations under these Regulations, or other corresponding International Regulations/Directives, should also be investigated and any requirements complied with.

Procurement

Lithium-ion batteries should be manufactured to a recognised safety standard, such as those issued by the International Electrotechnical Commission (IEC) - IEC 62619, IEC 62133, and IEC 60086-4, and adopted by participating member countries. Whilst most batteries are produced by recognised manufacturers to strict manufacturing quality standards, inevitably some imported batteries may not be as reliable or as safe to use.

Stocks of lithium-ion batteries or goods containing such batteries should therefore only be procured from reputable manufacturers or suppliers with appropriate quality control processes in place. Adoption of a formal procurement policy, written and implemented by a competent person, will assist in ensuring the risks of purchasing poor quality and/or potentially unsafe products are minimised.

Goods in Transit

This Loss Prevention Standard does not focus on the legislative requirements or international and national transit agreements and advice should be obtained from legal representatives and/or a competent and reputable transport and shipping company in this regard. For reference however:

- The international shipping and transportation of lithium-ion batteries is primarily addressed via United Nations (UN) legislation, specifically:
  - UN 3480, Lithium-ion batteries (shipped by themselves).
  - UN 3481, Rechargeable lithium-ion batteries contained in equipment or packed with equipment.

- Lithium-ion batteries being transported by lorry for transport within Europe, must comply with all of the requirements as outlined in the Agreement Concerning the International Carriage of Dangerous Goods (ADR 2017 manual) and enacted within the UK under the Carriage of Dangerous Goods and use of Transportable Pressure Equipment Regulations 2009 (CDG Regs).
- Lithium-ion batteries being transported by train are addressed in the Carriage of Dangerous Goods by Rail (RID) guidelines.
- For lithium-ion batteries being transported by sea, the requirements are detailed in the International Maritime Dangerous Goods (IMDG) Code.
- For lithium-ion batteries transported via air, the Dangerous Good Regulations (DGR) must be reviewed and met. These regulations are governed by the International Air Transport Association (IATA) and the International Civil Aviation Organization (ICAO).

Regardless of the method of transportation, lithium-ion batteries are generally categorised as hazardous goods with strict labelling controls, including the UN code and Class 9 Dangerous Goods label; and packing requirements, to help prevent physical damage and short circuiting.

The transportation of lithium-ion batteries or goods containing such batteries presents a number of challenges, and which should be considered. To help reduce the risks of stock suffering damage in transit, which may manifest in a thermal runaway event at a later time, only use reputable shipping/transport companies and where possible ensure appropriate arrangements are made in respect of:

- Packing – Goods should be packed in accordance with legislative requirements ensuring adequate arrangements are made in respect of shock and water resistance.
- Temperature – Containerised freight at sea can be subject to extreme heat, with significant heat build-up within the container potentially leading to increased potential for overheating and fire. Temperature controlled transportation may be required if temperatures are likely to exceed 40° Celsius, or the critical reaction temperatures as indicated in manufacturers safety data information. Ideally containers should not be located near heated machinery/equipment etc., or top stowage on deck in hot climes. The same principle applies to road transportation and vehicles should be adequately ventilated to maintain cool temperatures during periods of hot weather. Manufacturers guidelines on maximum temperature exposures should be sought and followed.
- Ingress protection – Containers will need to be adequately protected against sea water ingress.
- Segregation - Lithium-ion batteries or goods containing such batteries should be adequately segregated from products or materials that may react harmfully in a fire or other emergency event. Other dangerous goods should not be stored in the same container (this is permitted in IMO regulations however best practice advice is to separate lithium-ion batteries from other dangerous goods.
- State of charge checks – Should be undertaken to ensure goods are charged in alignment with manufacturers minimum and maximum charge recommendations. Any goods exceeding or below these recommendations should be rejected by the shipping/transport company prior to transportation.
- General condition checks – The condition of stocks and packages etc. should be checked prior to transportation to ensure all are in good order, with no signs of damage suggesting trauma e.g., odours, high temperature, leaks, smoking, or vibration.
- Mechanical stress – Lithium-ion batteries are at risk of damage from vibration effects caused by the various stresses of sea transportation e.g., pitching, rolling etc. Packing and securing of containers for sea transportation should consider these potential stresses.

Acceptance Arrangements

When stocks of lithium-ion batteries or goods containing such batteries are delivered to the premises the goods should be immediately stored in a segregated area, remote from other stocks or combustible goods and inspected for signs of damage. Any stocks appearing damaged, or displaying signs of damage such as odours, high temperature, leaks, smoking, or vibration should be rejected and either segregated/quarantined pending removal or collection by the haulier or reputable waste recycling company. A thermographic camera can assist with check procedures.

Segregation should be:

- External and as far away from buildings, valuable assets, and combustible goods as possible. In most cases at least 10 metres separation is recommended. If the goods are contained, this should be within a non-combustible receptacle.
- If external storage is not possible, a dedicated storeroom specifically for the storage of damaged/faulty or returned, or recycled batteries, or goods featuring such batteries etc. should be provided, and which should be of non-combustible construction providing a fire resistance rating, including the ceiling of 90 to 120 minutes.

Daily thermographic camera inspections of damaged or faulty batteries, or goods featuring such batteries are recommended.

Stock Storage

New Stocks of lithium-ion batteries or goods containing such batteries invariably feature a 'state of charge' usually below or equal to 30%, for international transportation safety purposes. As such sales stock arriving at the premises will be at least partially charged and capable of a manufacturing fault or damage related fire event. The state of charge should be checked and should align with manufacturers recommendations, and any goods outside the recommended state of charge thresholds should be safely segregated from other stocks and advice sought from the manufacturers or supplier.

Where possible, sales stock containing lithium-ion batteries should ideally be stored in a separate small building or fire rated storeroom remote from other sales stock. The fire resistance guidance provided in this document is applicable. Refer - **Internal Charging – Charging Rooms/Halls.**

Where this is not viable, stocks of lithium-ion batteries or goods containing such batteries should be separated as far as achievable from other stock items and combustible goods. At least five metres separation is recommended for free standing goods.

For stock held in pallet beam racking or on shelving systems, the stocks of lithium-ion batteries or goods containing such batteries should be separated to reduce the accumulation of risk and stored on higher levels of racking/shelving to help reduce the risk of vertical fire spread to other stock.

The maximum warehouse temperatures should be assessed, and ventilation and cooling/heating systems configured to automatically operate in the event of battery temperature exposure thresholds being met. Automatic operation of ventilation and cooling systems should be subject to routine testing to ensure safe operation when required. Stock should also not be stored directly underneath warehouse roof lights if there is a danger of heat transfer to packaged lithium-ion batteries or goods containing such batteries.

Repacking of lithium-ion batteries or goods containing such batteries is not recommended if this involves disturbing the original transportation packaging. The batteries will have been packed to minimise the potential for damage, shorting and related fire events.

Regular use of thermographic cameras as part of stock inspection programmes can help identify hot spots within packaged stocks due to developing faults. Stock displaying such concerns should be safely removed to an external segregated quarantine area pending collection by a reputable waste recycling company.

Third-Party Warehouse Storage

Stocks of lithium-ion batteries or goods containing such batteries may be stored temporarily e.g., in dock warehousing between transits, or permanently at third-party premises.

To help reduce the risks of fire damage, ensure appropriate arrangements are made in respect of:

- Temperature - Stocks of lithium-ion batteries or goods containing such batteries should not be exposed to extreme heat and should not be stored externally in hot weather/hot climates unless canopy protected and adequately air cooled. Maximum warehouse temperatures should be confirmed with landlords/owners and the cooling and ventilation systems assessed for adequacy. Stock should also not be stored directly underneath warehouse roof lights if there is a danger of heat transfer to packaged lithium-ion batteries or goods containing such batteries. Whilst lithium-ion batteries are generally able to withstand cold temperatures, guidance should be sought from the manufacturer or supplier on recommended minimum temperatures for long term storage.
- Inspection – Third-party warehouse operatives should have procedures in place for inspecting stocks when they arrive, and whilst in storage, for signs of damage, and a segregation policy implemented for housing damaged stock away from the bulk stock holding.
- Separation – Where possible stocks should be stored separately in different ‘blocks’ or ‘islands.’ This helps reduce the risk of catastrophe fire losses to whole consignments of goods.
- Damage reporting – Agreement should be reached on the reporting and segregation of any dropped or damaged stocks. This helps reduce the risks of latent fire damage related to the original incurred damage.
- Handling – Stocks moved by hand for loading purposes should be handled with care to avoid stress to the lithium-ion battery. Clear labelling and training of operatives can assist reduce the risks of battery damage.

Charging of Lift Trucks and Other Mechanical Handling Equipment

The use of lithium-ion battery powered lift trucks and other mechanical handling equipment has become more prevalent in recent years. Benefits include:

- Less battery changeovers required.
- No tailpipe emissions.
- Have a high energy density meaning and low self-discharge rate, meaning they can store more energy and operate longer between charges.
- Have a long lifespan, in some cases supporting up to five years plus of use before needing to be replaced.
- Are low maintenance e.g., refilling, or periodic discharging, in comparison with some other battery types.
- Are suited to a variety of environments, making them more adaptable than some other battery solutions.
- Have steady load characteristics in comparison with other battery types, meaning they provide constant voltage before falling off as charge reduces.

Despite the benefits, fires involving lithium-ion battery powered lifting equipment can occur and safe arrangements for lift truck charging activities should be considered and formalised, reflecting the size and nature of the various battery related activities, and the associated hazards and exposures.

When deciding the most appropriate storage/charging locations, several factors should be considered within a risk evaluation:

- Number of vehicles or batteries – Significant numbers of trucks and/or batteries under charge increase the potential for fire growth and fire spread to other contents and the building.
- Fire Load – The combustibility of other stocks and materials in proximity and internal building surfaces may increase the potential for fire spread to those materials and surfaces.
- Compartmentation – Would the fire be contained to the compartment of origin, or could it spread unimpeded throughout the warehouse building or range?
- Fire protections – Are the premises sprinkler protected or are other active fire protections installed? Are they adequate for the proposed charging activities?
- Impacts of fire – How would a fire impact business activities? Even a small incident could significantly affect trading.
- Charging times – Charging lift trucks and/or batteries when the premises are unoccupied can result in delays to Fire and Rescue Service attendance and worsen the scale and size of the loss.

Once the potential scale of fire damage and the impacts to trading activities are evaluated, the most appropriate means of managing risk exposures can be considered.

Where provided or recommended, Battery Management Systems should be installed, used at all times, and never bypassed. These systems monitor the battery performance, heat output, ensures cells are used within their safe working parameters, detect faults, and isolate the charging equipment if required, reducing the potential for fire related events.

Overcurrent and undercurrent protection should be provided to all charging equipment.

Note: It is important that where any consideration is being given to the storage and/or charging of batteries that any additional risks posed must be fully assessed, with consideration given to the use of the building and its layout and be subjected to review within the premises Fire Risk Assessment.

External Charging

External charging sheds are recommended where possible. Such buildings should be located as far from buildings or other valuable assets, and combustible goods as possible. In most cases at least 10 metres separation is recommended, however this should be increased if there are concerns regarding the likelihood of fire spread due to the combustibility of warehouse buildings or the bridging of fire via external stocks or other equipment located between the charging shed and warehousing.

Where adequate separation distances cannot be achieved, the installation of a fire barrier providing a fire resistance rating of at least 60 minutes should be considered between the charging building and the main buildings, valuable assets or goods.

Any such charging building should preferably be of non-combustible materials. No other storage or activities should be undertaken within, and in proximity to such a structure. Charging equipment should be mounted at least 150mm from the ground to reduce the risks of water ingress during a water related event e.g., flooding, heavy rainfall etc.

In summer months or warmer climates, the upper safe operating temperatures of the batteries being charged should also be considered. In uninsulated or exposed charging areas, excessive or prolonged temperatures may have an impact on the batteries and may even initiate a thermal runaway event. Appropriate automatic ventilation and cooling/heating systems should be installed to minimise the potential for overheating and be subject to routine testing to ensure safe operation when required.

Lithium-ion battery powered lifting equipment is generally suitable for use and charging within colder environments. Guidance should however be sought from a reputable supplier.

Internal Charging – Charging Cabinets

For removeable batteries, as used with some powered pallet trucks etc., a proprietary storage/charging cabinet should be considered, and which should be:

- Specifically designed for the storage and charging of a small number of batteries,
- Independently tested and approved by a third-party accredited testing organisation and rated to provide a defined fire resistance period of at least 60 minutes. **Note:** increased fire resistance periods are available if preferred.
- Located in a defined 'safe' area of the premises, preferably a separate fire compartment but otherwise remote from combustible building linings; at least three metres clear of combustible goods, traffic movements and hazardous trading activities. Demarcation using hatching to specify clearance distances is recommended. Additional impact protection may be necessary in areas with significant vehicular movements.
- Fitted with overcharge isolation devices.
- Subject to appropriate electrical appliance testing of charging equipment.

Note: The use of non-fire rated cabinets for the charging of removeable batteries is not recommended in warehouse environments.

Internal Charging – Charging Rooms/Halls

Where external charging is not possible and a limited number of lithium-ion battery powered lift trucks are present, a charging room or hall is recommended, and which should be:

- Of non-combustible construction providing a fire resistance rating, including the ceiling of at least 60 minutes.
- Fitted with an appropriately tested and accredited fire door, providing at last 60 minutes fire resistance, and kept closed when not in use.
- Fitted with automatically operating fire shutters to all vehicle openings, certificated to LPCB Loss Prevention Standard - **LPS 1056: Issue 6.2 Requirements for the LPCB Approval and Listing of Fire Door-sets, Lift Landing Doors, and Shutters**
- Fitted with lighting and any necessary electrical fittings with an appropriate explosivity rating, to reflect the potential presence of explosive vapours.

Additionally, the store should not feature any other openings, such as windows and deposit/collection slots which open internally unless also fitted with fire shutters certificated to **LPCB Loss Prevention Standard - LPS 1056: Issue 6.2 Requirements for the LPCB Approval and Listing of Fire Door-sets, Lift Landing Doors, and Shutters,** providing at last 60 minutes fire resistance.

External openings, such as windows etc., should be assessed and similarly protected if there is potential for vertical fire spread across the external fascia of the building or fire entering the building via other openings above; valuable and/or combustible infrastructure located directly adjacent; or life safety concerns such as public highways, fire escape routes in proximity as stipulated in the premises Fire Risk Assessment.

Any openings for cabling and pipework etc. should be adequately fire stopped and/or fitted with intumescent collars to ensure the 60 minutes integrity of the store is maintained in the event of ignition.

Intumescent collars should be used to protect pipework which could collapse or melt in the event of fire filling any voids created and providing a fire barrier.

The installation of fire shutters and fire doors should be completed by a company certificated to LPCB Loss Prevention Standard **LPS 1271: Issue 2.3 Requirements for the LPCB Approval and Listing of Companies Installing Fire or Security Doors, Door-sets, Shutters and Active Smoke/Fire Barriers.**

Installation of other passive fire protection products such as fire stopping should be completed by a company certificated to LPCB Loss Prevention Standard - **LPS 1531: Issue 1.2 Requirements for the LPCB approval and listing of companies installing or applying passive fire protection products**.

Maintenance of such protections should be completed by a company certificated to LPCB Loss Prevention Standard - **LPS 1197: Issue 4.2 Requirements for the LPCB approval and listing of companies inspecting, repairing, and maintaining fire and security doors, door-sets, shutters, and active smoke/fire barriers.** Refer redbooklive for details of approved contractors.

The store or hall should not be used for any other purpose and a clear distance maintained between the store and its openings of preferably at least five metres is recommended. Marking the flooring to specify clearance distances is recommended.

Depending on the number of lift trucks or batteries on charge, explosion relief systems may be necessary. This should be assessed by a suitably competent person or Consultant within an explosion/DSEAR assessment, and any recommended actions implemented.

Increased fire resistance ratings of 90 to 120 minutes should be considered where more than three lithium-ion battery powered fork-lift trucks are charged at any one time, or as stipulated within the premises Fire Risk Assessment.

Internal Charging – Segregation Only

The installation of a charging room or hall may not be viable in all buildings, e.g., space limitations etc. For premises featuring single lithium-ion battery powered lift trucks, or large warehouses featuring single lithium-ion battery powered lift trucks in different warehouse cells, a dedicated charging area should be established and at least five metres clear of combustible building linings, other contents, or stock. Demarcation of the charging area using floor hatching is recommended, and the area routinely inspected for breaches of storage rules. Impact protection devices may be necessary to protect against the risk of vehicular damage to charging equipment, and ideally equipment should only be charged during periods of occupancy.

The charging of multiple large items of such equipment is not recommended unless within a fire resisting compartment and it would instead be prudent to charge externally within a dedicated charging shed or replace with alternatively powered equipment.

Internal charging of delivery vehicles is not recommended. Electric vehicle battery fires generate significant flaming over a prolonged period as fire passes between individual battery cells/modules and firefighters are unlikely to enter buildings to tackle such fires unless there are life safety concerns. As such, any fire event involving an electric vehicle within business premises could lead to a catastrophe level of damage and significantly impact business trading.

Charging and Electrical Hazards

Charging places stress on batteries and is one of the main fire related concerns. The increased load on the electrical supply, which if not well maintained or capable of supplying the demand safely, is also a potential source of ignition.

The following guidance can help reduce the risk of electric faults during charging operations.

- In all cases all manufacturers' recommendations and local regulatory requirements should be followed.
- All charger points should be installed and maintained in accordance with manufacturer's instructions and by a competent trained electrician (In the UK - such as those with current NICEIC, ECA, NAPIT accreditation).
- The circuits supplying the charging points should be checked to ensure adequate capacity for the proposed additional electrical load.
- All chargers should be suitably rated for the devices they are due to charge.
- Surge protection safety devices should be installed and regularly tested.
- Where possible as much of the wiring should be hard wired.
- Routing of cabling should be carefully considered, particularly if multiple cables are running through cable trays, as current draw may cause excessive heating within trays or conduits.
- All chargers should be clearly labelled and if different chargers or chargers with different ratings are proposed to be in use in the same area, the chargers should be grouped to help avoid confusion. Users should ensure the right charger with the correct rating is being used to charge the corresponding battery/device in question.
- The design and layout of the area should ensure charging cables do not become overstretched, tangled, or can be damaged.
- The risk of water damage should be assessed and appropriately IP rated equipment used where equipment is potentially exposed to rain or flood water etc. Charging infrastructure, chargers and cables should be stored and sited at least 150mm from ground level to protect from water ingress in an escape of water, or other water related event.
- All chargers should be arranged with a clearly labelled and readily accessible master isolation switch that is not in the same fire area as the charger itself.
- Depending on the nature of the arrangements and chargers used, these should be considered within all required electrical fixed wiring or portable appliance testing.
- If any charging equipment is damaged or is faulty it should immediately be removed from use, repaired, or discarded and the charging equipment isolated safely as necessary.
- The use of extension leads and/or multi plug adaptors should be prohibited.
- Thermographic cameras should be routinely used on the batteries and the charging equipment to check for hot spots and overheating components.
- An annual formal infra-red thermographic inspection of the charging infrastructure is also recommended.

Ventilation

In addition to preventing the spread of fire, the safe management of smoke and gas emissions resulting from lithium-ion battery combustion, off gassing or thermal runaway should be considered.

To minimise the potential for fire, explosion and/or undue smoke contamination you should arrange for appropriate, mechanical means of ventilating storage or charging rooms or halls to be installed. The potential explosivity of emitted gases should be assessed, and ventilation systems rated as suitable for use in explosive atmospheres as appropriate. This is of additional concern given the production of hydrogen gas that can be generated when firefighting water is applied to lithium-ion battery fires.

The exhaust point of the ventilation system should be to a safe area in the open, and not located in an area where any exhausted smoke could compromise the air intake of the building or that of neighbouring properties.

The ventilation system should be continuous and not actuated or stopped by performance of any fire protections and be subject to a formal inspection and maintenance programme by appropriately qualified and competent personnel.

Lithium-ion Battery Powered Stock Scanning Equipment

Warehouse operatives commonly use lithium-ion battery powered stock scanning equipment for order picking purposes. Exposures can range from single appliances to multiple items within extensive charging racks.

For smaller applications i.e., up to up to five devices:

- Charging bases should be located on, and/or against a non-combustible surface, e.g., bench, wet masonry construction, gypsum plaster on plasterboard etc.
- Combustible goods or materials should be maintained at least three metres clear, in all directions, to storage/charging areas and warning signage to this effect should be placed in proximity.
- Demarcation of the charging area using signage or physical barriers is recommended.
- The area should be routinely inspected for breaches of storage/charging rules.
- Ideally not charged when the building is unoccupied.
- Sited in an area covered by the automatic fire detection and automatic fire protection systems.

For larger applications, consideration should be given to charging the equipment within a proprietary storage/charging cabinet. Refer **Internal Charging – Charging Cabinets** above for guidance.

In respect of very large applications, a dedicated non-combustible charging container, located as far from buildings or other valuable assets, and combustible goods as possible, or a dedicated charging room should be provided. Refer **Internal Charging – Charging Rooms/Halls** above for guidance on fire resistance etc.

Where this is not viable an area of the warehouse should be allocated, and the racking segregated via V-mesh or similar fencing to walls and ceiling and located at least five metres clear of combustible building linings, other contents, or stock. Demarcation of the charging hub using floor hatching is recommended, and the area routinely inspected for breaches of storage rules. Impact protection devices may be necessary to protect against the risk of vehicular damage to charging equipment, and ideally equipment should only be charged during periods of occupancy.

Other Aviva battery related Loss Prevention Standards provide general and specific guidance on other battery applications.

Damaged or Faulty Lithium-ion Batteries

Damaged or faulty batteries, or goods featuring such batteries including lift trucks should not be stored at the premises longer than is necessary, and a strict rule to this effect should be established within the Standard Operating Procedures, detailing arrangements, and responsibilities for prompt collection by a reputable lift truck supplier or waste recycling company. Such batteries should be segregated and quarantined pending collection.

Segregation should be:

- External and as far away from buildings, valuable assets, and combustible goods as possible (in most cases at least 10 metres separation is recommended).

- If external storage is not possible, a dedicated storeroom should be provided, and which should be of non-combustible construction providing a fire resistance rating, including the ceiling of 90 to 120 minutes.
- If a storeroom is not available, a segregated area at least five metres of combustible building linings, other contents, or stock. Demarcation of the area using temporary barriers or warning signs is recommended.

Daily thermographic camera inspections of damaged or faulty batteries, or goods featuring such batteries are recommended pending collection.

The charging of damaged or faulty batteries, or goods featuring such batteries internally is not recommended.

End-of-Life Battery Management

All rechargeable batteries have a recommended lifecycle rating. The recommended life of lithium-ion batteries is also affected by the depth of discharge, or the amount of a battery's storage capacity that is utilized. This information will be available in the product specifications or the supplier/ maintenance company for larger battery powered equipment, such as lift trucks or other mechanical handling plant.

Batteries should only be removed in accordance with manufacturers or supplier's instructions and handled/stored in accordance with the guidance provided in this Loss Prevention Standard. Replacement batteries and accessories should only be sourced from the original manufacturer of the equipment or an official agent of the manufacturer.

You should not exceed recommended lifecycle charging, unless approved by your supplier.

Batteries that have reached end-of-life should be clearly labelled and stored separately to avoid re-purposing and collected by a reputable waste recycling company.

Fire Protections

Automatic Fire Detection

Charging of lithium-ion battery powered lift trucks and/or storage of lithium-ion batteries or goods containing such batteries internally should be within areas of the premises covered by the automatic fire detection system. Detection should also be extended to any external charging areas where canopies or protective enclosures have been installed.

Where not installed, automatic fire detection should be provided in all areas/rooms of the buildings to include the storage/charging areas. In the UK this should ideally be compliant with Category L1 or P1 of **BS 5839-1:2017 - Fire detection and fire alarm systems for buildings - Code of practice for design, installation, commissioning, and maintenance of systems in non-domestic premises**. This is vital for life safety and early notification to the Fire and Rescue Service.

The use of thermal and aspirating detection technology can provide very early warning of issues such as overheating batteries or initial gas releases and guidance should be obtained from an accredited fire alarm installer.

A means of manually raising the fire alarm should also be provided, especially in the storage/charging area if it exposes any other assets.

Any plans to change the existing fire detection system or install a new fire detection system should be discussed with your Insurer and Broker.

Automatic Sprinkler Protection

Where an existing automatic sprinkler system is installed, the design should be adequate for any changes in risk profile. A suitably accredited sprinkler maintenance company, such as one approved to LPCB Loss Prevention Standard **LPS 1048: Requirements for the approval of sprinkler system contractors in the UK and Ireland,** should be asked to confirm the sprinkler density, water supply demand and water supply duration are likely to be adequate and provide recommendations for enhancing the protection where necessary. Storage methods and packing materials used should support 'wetting' of stored stock in proximity to the seat of the fire, to help hinder fire growth and spread.

Note: International sprinkler standards have not yet developed clear and specific guidance on protecting against the risk of lithium-ion battery fires in all scenarios, and any recommended solutions are likely to be based on the judgment and experience of the sprinkler company. Any recommendations in relation to automatic fire protections should be discussed with your Insurer and Broker as early as possible for advice and guidance.

Alarms

Alarms associated from the above should raise a site fire alarm to ensure there is an appropriate emergency response and escalation if needed. If not already in place you may wish to consider connecting the alarm to a constantly attended location or an approved Alarm Receiving Centre. An accredited fire alarm installer can provide further guidance and assistance.

Off-Gassing Detection

These systems provide sensor and gas detection for stationary lithium-ion battery systems such as Battery charging hubs, Battery Energy Storage Systems, data centres and electric vehicles whilst under load, and work by detecting gases released in the early stages of battery failure, commonly known as 'off gassing'. The system can be interlocked to the power supply to isolate upon the detection of gases and prior to thermal runaway. An accredited fire alarm installer can provide further guidance and assistance if required.

Interlocks

The use of interlocks may help reduce the potential for an overheating lithium-ion battery or cell to enter thermal runaway. As such, the actuation of any of fire protections and alarms should be interlocked to de-energise the power supplies and isolate charging equipment. The interlocks should be tested at least annually and restored following any impairment to the fire protection and alarm systems.

Fire and Rescue Service

Whilst there are no defined requirements to notify the local Fire & Rescue Service of the presence lithium-ion battery powered lift trucks and/or storage of lithium-ion batteries or goods containing such batteries, this may be prudent if battery numbers in use or storage are significant. Such disclosure can aid the Fire & Rescue Service with deployment of firefighting resources and allow for any pre-emptive planning in respect of run off containment to be undertaken. As a minimum you should update any emergency fire information left at the premises for the emergency services to confirm the presence and location of:

- Any large items of lithium-ion powered lifting/mechanical handling plant.
- Battery charging rooms or containers (firefighters may opt to leave these environments sealed to prevent oxygen ingress).
- Damaged battery storage.

Local Fire and Rescue Services are often amenable to inspecting premises to evaluate fire risk exposures and offer guidance.

it is also important to maintain suitable access for the Fire and Rescue Services and consider the distances and location to the nearest source of fire water or hydrant that they may need use. The location and number of fire hydrants in the proximity of the premises should be documented in an emergency response plan or shown on appropriate drawings.

It is also good risk management practice to know what water supplies are available for the Fire and Rescue Service to use. Therefore, site management should always establish:

- What fire water is available.
- With static pressure, flows and residual pressure test results.
- Whether additional resources, such as a private hydrant system or water storage tanks are necessary.

Fire Extinguishers

Fire extinguishers specified for use in tackling lithium-ion battery fires are available, however whilst potentially providing some benefit require very early application and, may not fully extinguish a developing fire involving larger lithium-ion battery arrangements or prevent the batteries reigniting. The volatility of lithium-ion battery fires and their explosive characteristics also presents significant injury risks to persons tackling such a fire in proximity, and as such their use should be carefully considered within the premises Fire Risk Assessment.

Key Action Steps

- Ensure relevant fire and explosion related Risk Assessments have been reviewed to include the storage of lithium-ion batteries or goods containing such batteries and/or lithium-ion battery powered equipment such as lift trucks etc.
- Write clear rules within Standard Operating Procedures.
- Inspect all incoming deliveries of lithium-ion batteries or goods containing such batteries for signs of damage.
- Use reputable manufacturers, suppliers and hauliers who are able to advise on fire and general safety in respect of their lithium-ion battery related products and services.
- Complete weekly self-inspections to ensure equipment is in good order. Use thermographic cameras.
- Charge equipment externally if possible and contain internal charging and storage in fire rated enclosures (cabinets and compartments) where possible.
- Ensure ventilation systems are appropriate for use in potentially explosive atmospheres.
- Store stocks of lithium-ion batteries or goods containing such batteries in fire rated compartments where possible.
- Isolate damaged, faulty and end of life batteries, equipment or stock and arrange for urgent collection by reputable handler.
- Introduce emergency procedures and provide appropriate training to staff and contractors.
- Ensure fire detection systems and other fire protections are appropriate.
- Review Disaster Recovery and Business Continuity plans.

Checklist

A generic Battery Checklist is available, which can be tailored to organisation's needs.

Specialist Partner Solutions

Aviva Risk Management Solutions can offer access to a wide range of risk management products and services at preferential rates via our network of Specialist Partners, including:

- Fire risk assessment: Cardinus Risk Management
- Explosion/DSEAR Risk Assessments: Bureau Veritas
- Charging cabinets: Denios
- Thermographic imaging and PAT testing: PASS
- Automatic fire detection and portable extinguishers: SECOM
- Business continuity: Horizonscan

For more information please visit: Aviva Risk Management Solutions – Specialist Partners

Sources and Useful Links

- The Dangerous Substances and Explosive Atmospheres Regulations 2002.
- The Regulatory Reform (Fire Safety) Order 2005.
- The Fire Safety (Scotland) Regulations 2006.
- The Fire (Scotland) Act 2005.
- The Fire and Rescue Services (Northern Ireland) Order 2006.
- BS 5839-1:2017 - Fire detection and fire alarm systems for buildings - Code of practice for design, installation, commissioning, and maintenance of systems in non-domestic premises.
- LPS 1056: Issue 6.2 Requirements for the LPCB Approval and Listing of Fire Doorsets, Lift Landing Doors and Shutters.
- LPS 1271: Issue 2.3 Requirements for the LPCB Approval and Listing of Companies Installing Fire or Security Doors, Door-sets, Shutters and Active Smoke/Fire Barriers.
- LPS 1531: Issue 1.2 Requirements for the LPCB approval and listing of companies installing or applying passive fire protection products.
- LPS 1197: Issue 4.2 Requirements for the LPCB approval and listing of companies inspecting, repairing, and maintaining fire and security doors, door-sets, shutters, and active smoke/fire barriers.
- LPS 1048 approved sprinkler contractors - UK and Ireland.
- LPS 1048: Issue 5.0 Requirements for the approval of sprinkler system contractors in the UK and Ireland.
- HSE document INDG139 Using electric storage batteries safely.
- The Chartered Institute of Procurement & Supply.
- British Standard BS5306 – Fire Extinguishing Installations and Equipment on Premises.
- RiscAuthority document RC61 Recommendations for the Storage, Handling, and use of Batteries.
- RiscAuthority document RE2 Need to Know Guide Lithium-ion Battery Use and Storage.
- Redbooklive.

Note: Whilst UK standards and legislation are referenced in this document, other international standards and legislation should be referenced where applicable.

Additional Information

Relevant Loss Prevention Standards include:

- Business Continuity.
- Contamination Following a Fire.
- External Building Areas - Usage and Safety.
- Fire Compartmentation.
- Fire Doors, Fire Shutters & Fire Dampers.
- Fire Safety Inspections.
- Fire Safety Legislation.
- Heat and Smoke Venting Systems.
- Managing Change - Property.
- Smoke Contamination.
- Thermographic Surveys.
- Managing Contractors.

To find out more, please visit Aviva Risk Management Solutions **or speak to one of our advisors.**

Email us at riskadvice@aviva.com or call 0345 366 6666.*

*The cost of calls to 03 prefixed numbers are charged at national call rates (charges may vary dependent on your network provider) and are usually included in inclusive minute plans from landlines and mobiles. For our joint protection telephone calls may be recorded and/or monitored.

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19th July 2024

Version 1.1

LOSS PREVENTION STANDARDS