Electrically Powered Personal Vehicles

Risk Control Guide RCG034

Scope

This document is intended to provide guidance for the storage and charging of electrically powered personal vehicles, such as mobility scooters, electric scooters, and electric bikes.

Its primary scope is the risks associated with Li-Ion battery technology. However, it remains applicable to other battery types such as lead acid and nickel cadmium.

Introduction

Electric Vehicles and Charging

Rechargeable lithium-ion batteries are now in common use powering a variety of electric scooters and bikes having high energy densities, low weight, and low self-discharge characteristics.

However, lithium-ion batteries can be a safety hazard if not properly engineered and manufactured. Cells contain flammable electrolytes and if damaged or incorrectly charged, this can result in a thermal runaway event. Possibly leading to fire, explosion, and the release of toxic gases.

All of these could provide a risk to life, property, and business interruption.

Factors that can cause thermal runaway are: -

1) Thermal abuse, such as poor cooling, extended charging periods or an external fire

2) Electrical abuse, such as overcharging or a defective charger which creates heat or an external short circuit

3) Mechanical abuse such as a penetration or impact which causes an internal short circuit

4) Manufacturing defects, such as contamination or internal defect

Mobility scooters, electric scooters and electric bike batteries and chargers may be vulnerable to mechanical damage and may not be subject to regular maintenance. The battery and charging quality may also be inferior to other electric vehicle batteries. It is possible that non-Original Equipment Manufacturers or specific application chargers are used/borrowed.

Overview

General

It is suggested that equipment and chargers be adequately CE or UKCA marked, with the following standards currently applicable to certain devices:

- E- Bikes - EN 15194 and UL 2849
- Mobility scooters EN 12184 and UL 2272

Battery chargers ought to be subject to annual portable appliance testing. With monthly visual inspections of charging rooms and chargers undertaken.

Equipment, batteries, and chargers ought to be visually checked before and after charging for signs of distress, overheating, electrolyte leaks and cable damage.

Storage & Charging

It is recognised that the storage and charging of equipment such as mobility scooters, electric scooters and electric bikes will be undertaken at residential and commercial sites.

It is suggested that equipment and batteries are not stored in fire escape routes. They may impede both exit and emergency response access in the event of a fire. In addition, they ought to be kept in a cool environment away from excessive heat/cold/sunlight, such as next to radiators, heaters, and windows. This is to help prevent damage occurring to the batteries.

If charging is undertaken on premises, it is suggested that the below precautions, in order of preference, are considered: -

- Within a detached dedicated outbuilding at least 10 m from any other combustible structure

- If charging is undertaken inside occupied premises, located in a dedicated cut off room of fire resisting construction (minimum of 120 minutes fire resistance, including access/exit doors)

- Such room(s) located at ground floor level with an external door for fire brigade access.
- Heating, Ventilation and Air Conditioning (HVAC) provided to maintain an ambient temperature between 15-18 degrees C.
- Provide mechanical ventilation or have sufficient high level natural ventilation to an outside area.

- If the building is already protected by sprinklers, extend to the cut-off room at a minimum density of 5mm/min/m2 over the entire area

It is suggested that when charging batteries/devices, the following aspects are considered:

- The use of manufacturers approved chargers only

- Follow manufacturer’s instructions and unplug chargers when not in use

- For commercial areas, charging to be undertaken when the premises are occupied.

- For residential areas, as charging is expected to occur during overnight periods, it is suggested that hard-wired timers are used to limit durations to 4 hours, or cut offs when charged.

- Chargers and equipment are not covered when charging

- No combustible or flammable materials are present within dedicated charging rooms. And not within 5 metres of equipment/chargers.

- Batteries not to be overcharged (kept between 10% to 80% charged if possible).

- Wet batteries/equipment to be dried off and left to acclimatise to room temperature before being charged.

- Charging not undertaken at temperatures below zero degrees C

- Chargers to be plugged directly into a mains socket and not an extension lead.

- Charger transformers placed on a non-combustible surface when in use

- Provide clear notices at charging points that indicate which vehicles can be charged

- Provide fire extinguishers (CO2 and/or dry powder) to aide exit. As they will not extinguish a battery thermal runaway event.

- Provide RCD protection for chargers.

Fire Detection - Charging Areas

Consider fire detection using multi-sensor heads in storage and charging areas to BS 5839-1. Regardless of the presence of sprinkler protection. This is to aid in the early identification of smouldering fires. Carbon Monoxide (CO) or Hydrogen (H2) gas detection installed within charging areas, may provide early indication of thermal runaway prior to fire conditions.

Both fire and gas detection to be linked to a permanently attended location. From where a response can be arranged and the fire department called.

Activation of the fire alarm and sprinkler systems to be linked, where possible, to an electrical isolator for the charger supplies.

Emergency Response

Review fire risk assessments for all storage and charging areas. To include consideration of the items included in this document and any other mitigation measures that might be required.

Emergency plans ought to be reviewed/updated regularly to include actions to be taken in the event of a battery fire. If a battery overheats or there is an unusual smell, odd noise, or a change in the shape/ colour of the battery and if it is safe to do so, consider removing the battery or device outside, away from the premises and any combustible/flammable materials. Use caution when handling batteries as they may be hot and produce corrosive/toxic substances.

Damaged/used batteries and chargers ought to be removed from site immediately and disposed of correctly.

Technical Information / Glossary of Terms

Batteries and Cells

A Li-ion cell is an electrochemical unit that contains electrodes, separator, and electrolyte. There are alternating layers of anode and cathode materials separated by a porous film (separators) within the cell.

A Li-ion battery or battery pack is a collection of cells or cell assemblies, with housing, electrical connections, and possibly electronics for control and protection.

Lithium nickel magnesium cobalt oxide (LiNiMnCo02 or NMC) and derivatives are widely used as the negative electrode. With graphite commonly used as the positive electrode. The electrolyte is typically a mixture of organic carbonates (such as ethylene carbonate) and complexes of lithium ions.

The Li-ion cell works by electrochemical reactions in the materials of the anode and cathode. During discharge oxidation occurs at the anode to produce positively charged lithium ions and negatively charged electrons. The ions travel through the electrolyte and electrons through an external circuit. They then recombine at the cathode (together with cathode material) in a reduction reaction. During charging the reactions and flow of charge is in the opposite direction.

Thermal Runaway

Batteries can fail in an uncontrolled manner leading to thermal runaway. Thermal runaway is rapid self-heating caused by exothermic reactions between battery components. Normally following short circuiting between electrodes.

The high energy density of battery cells and presence of combustible electrolyte mean a thermal runaway event can be very energetic and difficult to extinguish.

During thermal runaway, internal degradation and oxidization processes can keep cell temperatures above 500 degrees C, with the possibility of igniting secondary combustibles, as well as possibly leading to leakage of flammable electrolytes, explosion, and fire. Toxic and flammable gasses (such as hydrogen fluoride (HF) and Carbon Monoxide) may also be emitted. These can ignite resulting in a rapid fire/explosion.

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