BHTA Lithium Battery Safety Guidance
-for-
Retailers and Consumers

NB: This Guide has been produced by BHTA to provide our members with key points of guidance. This Guide does not constitute legal advice and members should not rely on it in lieu taking their own legal advice. This Guide is provided for information only; BHTA disclaims and excludes any liability in respect of the contents, or for action taken based on this information.

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1. Introduction

As the UK's industry representative for assistive technology in the health & social care sector (H&SC), the British Healthcare Trades Association (BHTA) and its members are committed to helping people live healthier, more independent lives. Our member-companies do this by providing safe, effective, and environmentally responsible technologies – the right products and services, at the right time, and the right value.

Like other products powered by rechargeable batteries, mobility scooters, powered wheelchairs, and home-lifts increasingly feature Lithium Battery (Li Batt) technology. BHTA has been asked by its members to highlight safe practices for use, maintenance, and disposal of Li Batts. Working with industry, policy-makers, and environmental advisors, BHTA is assembling B2B guidance for each of the participants in the Li Batt lifecycle – manufacturers, distributors, and retailers[i]. Given Li Batts' unique health & safety and environmental risks, however, we are publishing immediately this B2C guidance for retailers to provide to consumers.

2. What Is a Li Batt?

Like all batteries, a Li Batt stores chemical energy and converts it to electrical energy to provide power. Specifically, a Li Batt is a type of rechargeable battery that uses the reversible reduction of lithium ions to store energy: the anode (-) carries positively charged particles via an electrolyte (a liquid or gel) through a separator (inside the battery) to the cathode (+); the movement of these particles creates energy (electrical current) in the anode (-), which flows through the device being powered, and back into the cathode (+), beginning the cycle again.

Unlike previous generations of "traditional" batteries[ii] – whose anodes/cathodes used combinations of metals including lead (anodes/cathodes) and acid (electrolyte) to move particles (electrons) – Li Batts typically use graphite/copper (anode), a metallic lithium oxide (cathode), and a lithium-salt-&-solvent solution (electrolyte) to move particles (lithium ions).

3. Not All Li Batts Are the Same

Li Batts come in several different types, or chemistries. This guidance does not seek to describe all Li Batt types, and ***any*** Li Batts of ***any*** chemistry should be treated with special care due to unique safety factors that make them different from other, more traditional battery technologies (see Sections 7-8 for more detail). Between two of the most commonly-used Li Batt chemistries in H&SC devices (e.g. mobility scooters, powered wheelchairs, stairlifts), it is important to note several distinctions.

Lithium Nickel / Manganese / Cobalt Oxides (Li-NMC)

Li-NMC Batts are mixed-metal oxides of lithium, nickel, manganese and cobalt, commonly used in lithium-ion batteries (as cathode material) for mobile devices and electric vehicles (aluminum is also sometimes found in Li Batts of this type). Li-NMC Batts are among the lightest, most efficient and most energy-dense chemistries, and their use is widespread.

Key Li-NMC Batt components (nickel, manganese, and cobalt), however, are expensive, supply-constrained, and subject to both human-rights and environmental concerns. Moreover, when Li-NMC Batts are damaged – due to improper charging, short-circuit, impact damage, or crush damage – they can produce very dangerous conditions including:

- Release of toxic gases
- Extremely energetic and hard-to-extinguish fires (see Section 8 for a more detailed description of materials combustibility, including "thermal runaway")
- Explosions

Lithium Ferro-Phosphate, sometimes aka Lithium Iron Phosphate ($LiFePO_4$)

A $LiFePO_4$ Batt is a type of lithium-ion battery using lithium iron phosphate as the cathode material, and a graphitic carbon electrode with a metallic backing as the anode. Compared to Li-NMC, $LiFePO_4$ chemistry yields a battery that is 20% heavier, less energy-dense, and sometimes more expensive (due in part to it being less widely used currently).

Unlike Li-NMC, however, $LiFePO_4$'s non-lithium components (iron and phosphate) are much more common in the Earth's crust – and they last longer (c. 1,000 – 2,500 cycles) than Li-NMC (c. 650 – 1,000 cycles); see Section 7 for a more detailed description of cycle life. Most importantly, compared to other Li Batt chemistries[iii], $LiFePO_4$ Batts have significant safety advantages:

- Much greater thermal and chemical stability – in part due to the absence of flammable electrolyte in $LiFePO_4$ Batts – which reduces significantly the risk of "thermal runaway"
- Greater physical and structural stability, which reduces the risk of impact damage or crush damage
- Greater chemical durability and resilience, which reduces the risk of fire/explosion in the event of mishandling (due to physical damage or improper charge damage) and increases battery stability across a greater range of atmospheric temperatures

4. Li Batt Support – Retailer to Consumer

To ensure the safe handling, storage, and disposal of assistive technology products that contain Li Batts – including, but not limited to, mobility scooters, powered wheelchairs, stair-and-home lifts – BHTA is asking its members to ensure the following issues are covered during sales, orientation, and aftercare. Companies will have differing practices and processes, but the overall aim should be to promote environmental sustainability, protect customers and employees from potential hazards, and comply with relevant regulations. *De minimis*, companies should take the steps below; we strongly encourage documentation of these steps as a matter of good practice and to facilitate conversations with business insurers, who are increasingly asking for this information as a condition of coverage.

All consumer advice should begin and end with a reminder to always follow the manufacturer's stated Li Batt instructions with regard to use, charging, transport, and recycling.

Battery Charging Instructions

Explain the proper charging procedure for the lithium battery. Advise the customer to use the provided charger and avoid using aftermarket or incompatible chargers. Emphasise the importance of not overcharging the battery to prevent damage.

Initial Charging

Instruct the customer on how to cycle the battery before their first use. Be very clear about the safety and lifecycle implications of proper Depth of Discharge (DoD) practices with Li Batts. International shipping regulations require that any batteries – Li Batts or traditional – must be at least 25-30% charged when shipped; confirm your battery manufacturer's safe initial charge level, communicate this to customers, and inform them that deviance from the safe initial charge level (especially in goods delivered by remote sale rather than physical/showroom sale) should be reported to the retailer as a possible problem *before* first use of the product.

Charging Frequency

Instruct the customer how to cycle the battery during ongoing use, in accordance with manufacturer's instructions (general Li Batt good-practice is to ensure a full charge no less frequently than every 4-6 weeks; check with your manufacturer for each battery type/application you supply). Be very clear about the safety and lifecycle implications of proper Depth of Discharge (DoD) practices with Li Batts (i.e. frequency of charge).

Storage Recommendations

Explain the manufacturer's recommended practices for storing the powered device and its batteries – especially when not in use for an extended period (e.g. "hibernating" a mobility scooter during winter months).

Temperature Considerations

Inform the customer about the safety and lifespan effects of extreme temperatures on Li Batts (e.g. avoiding exposing the battery to excessive heat or cold, as it can impact performance and longevity).

Battery Maintenance

Discuss essential Li Batt maintenance regimes, e.g. keeping the battery and the device it powers clean; how to inspect battery terminals for any signs of corrosion; how to monitor battery performance.

Charging Safety Precautions

Advise the customer never to leave a Li Batt device charging unattended for long periods and to avoid charging devices overnight or otherwise in periods of inattentiveness. Check your manufacturer's recommended practices; most advise charging devices at room temperature, and many will specify whether and how to remove batteries from the powered device when charging (which be an important consideration for safe, normal operation of the battery management system (BMS), a key component for safe Li Batt use). Under no circumstances should a Li Batt-powered assistive technology device be charged outdoors or in a space open to weather; battery chargers are not rated for outdoor use. Customers should check their local building regulations – especially tenants in group or shared accommodation – with regard to Li Batt-powered assistive technology device.

Battery Life Expectancy

Set clear, realistic expectations about the approximate lifespan of the Li Batt and factors that can affect its longevity, such as usage patterns and charging habits.

Weight Limitations

Ensure the customer is aware of the weight capacity of the device and how exceeding it can impact battery performance and overall functionality and safety.

Warranty Coverage

Explain clearly the warranty coverage for the device and its Li Batts, including any specific warranty terms related to battery replacement.

Recycling and Disposal

Instruct the customer to return old or damaged Li Batts to an appropriate take-back scheme or electronic waste handler retailer for proper recycling and disposal, highlighting the special concerns around proper Li Batt handling. If using 3rd-party transport, *no Li Batt of any capacity over 100Wh/4Ah should be transported as anything other than Dangerous Goods*. Other traditional batteries – e.g. spillable, sealed lead acid (SLA), absorbent glass matt (AGM), or gel – may be shipped as non-Dangerous Goods provided they are undamaged, clean, and have their terminals protected; *always check with the battery manufacturer for recommended transport modes*.

User Manual and Safety Guidelines

Show the customer the part of the device user manual that includes specific instructions for the device and its Li Batt – or, better, provide them with a stand-alone excerpt/precis of device-specific Li Batt practices – and emphasise the importance of following safety guidelines at all times. At a minimum, emphasise the following to consumers:

- Never fit Li Batts to a device that was not specifically designed to be powered by Li Batts – avoid "after-market" conversion products and services and follow all manufacturer instructions
- Only buy Li Batt-powered devices, chargers and batteries from reputable retailers; register your product with the manufacturer and check the product isn't subject to a product recall
- Always use the manufacturer-approved charger for the product, and if you spot any signs of wear and tear or damage buy an official replacement charger for your product from a reputable seller
- Do not charge batteries or store your device near combustible or flammable materials
- Avoid storing mobility scooters or powerchairs on escape routes or in communal areas of multi-occupancy buildings, where – in the event of a fire – they might compromise escape routes
- Never leave your device charging overnight or when you are away from the property – always keep it in sight
- Make sure you charge your device in a well-ventilated area and do not cover the battery

- When charging always follow the manufacturer's instructions
- Always unplug your charger when it is finished charging
- Ensure you have working smoke alarms, especially in the area where you are charging your Li Batt device

Troubleshooting and Warning Signs

Inform the customer about common Li Batt-related issues they might encounter and the steps they can take to troubleshoot and resolve them, advising on how/when to seek professional assistance. At a minimum, emphasise the following to consumers:

- Be alert to factors that can damage a Li Batt, or could lead to damage, malfunction or failure, including: overcharging, overheating, penetration of the physical battery casing, repeated underperformance or rapid draining, crushing forces that damage the physical battery casing, signs of short circuit
- Critical warning signs of Li Batt failure, including: the battery appearing to bulge or swell, discharging too fast, and/or being hot to the touch
- If a Li Batt overheats, hisses, or bulges, immediately move the device with the battery away from flammable materials and place it on a non-combustible surface; if it is safe to do so, put the device and battery safely outdoors to burn out
- In the event of a Li Batt fire, NEVER attempt to tackle it yourself; it is important to remember water isn't effective at extinguishing a Li Batt fire and can actually make it worse – Get out, Stay out, Call 999

Customer Support

Let the customer know all their support options – retailer, device manufacturer, battery manufacturer; including contact details – for questions, concerns, or assistance related to the device and its Li Batt.

All consumer advice should begin and end with a reminder to always follow the manufacturer's stated Li Batt instructions with regard to use, charging, transport, and recycling.

5. Li Batt Support – Consumer to Retailer

Encourage consumers to ask questions about the policies and practices your company has in place to ensure the safe handling, storage, and disposal of Li Batts by you as a retailer and your staff. Be prepared to explain how you approach:

- Lithium Battery Safety Training
- Battery Inspection and Testing
- Appropriate Battery Chargers for Private Use
- Safe Charging Stations for Public Use (if applicable)
- Battery Capacity Disclosure at Point of Sale
- Battery Disposal and Recycling
- Transportation Guidelines – *no Li Batt of any capacity over 100Wh/4Ah should be transported as anything other than Dangerous Goods*; other traditional batteries – e.g. spillable, sealed lead acid (SLA), absorbent glass matt (AGM), or gel – may be shipped as non-Dangerous Goods provided they are undamaged, clean, and have their terminals protected; *always check with the battery manufacturer for recommended transport modes*
- Storage and Shelf Life
- Battery Safety Information
- Recall Management – Product Registrations and Staying Informed
- Incident Reporting and Investigation

- Continuous Education

6. Li Batt Strategy – Companies' Own Practices

In advance of BHTA's forthcoming guidance (see Endnote i, Parts 1-2), companies should consider existing Li Batt Policy and End-of-Life Disposal practices. Within one's own company and company value-chain, it is especially important to determine:

- What processes already exist for consumers to return Li Batts via UK Government-mandated take-back/recycling schemes; and
- Who – within the company value-chain – is responsible for operating this scheme.

This will require cooperation and collaboration between Manufacturers and Distributors/Retailers, as well as clear instructions to Consumers; per OPSS/DEFRA guidance:

- "The ***manufacturer or importer*** that first places batteries on the UK market – including those in products – ***is classed as the producer and is therefore responsible for compliance*** if the business has a UK presence.
- ***The only exception is the collection of Portable Batteries[iv] – UK distributors and retailers that sell or supply more than 32 kg of batteries a year must provide a take back service [NB, batteries for mobility scooters and powered wheelchairs are Industrial Batteries, and fall outside this exception]***
- The guiding principles of [UK battery waste compliance] are that all waste batteries are processed by an Approved Battery Treatment Operator (ABTO) or an Approved Battery Exporter (ABE) and that producers pay for their collection, treatment and recycling. Distributors and retailers [per specific guidance] that sell or supply more than 32 kg of batteries a year must participate in the take back scheme. This involves providing a free collection point for waste portable batteries at their premises and arranging their transport to an ABTO or ABE, usually through a Battery Compliance Scheme."

7. Li Batts – Pros

Li Batts present many advantages for assistive technology, especially mobility scooters and powered wheelchairs.

Materials – Light Weight

Typically, Li-NMC Batts are around 1/3 the weight of traditional batteries – and $LiFePO_4$ Batts only 20% heavier than Li-NMC Batts – which makes them easier for users and carers to move and reduces the overall weight of the device being powered.

Long Life

Cared for properly, Li Batts may last significantly longer than traditional batteries – Li-NMC Batts up to 2 times longer and $LiFePO_4$ Batts up to 5-7 times longer – due in part to their higher cycle life (the number of charging and discharging cycles a battery can undergo without compromising its performance).

Even Discharge

Whereas traditional batteries' voltage drops significantly throughout the charge-life (experienced as weakening power output as the charge dissipates), Li Batts' voltage remains steady throughout the charge-life, weakening only when nearly fully discharged.

High Energy Density (power storage)

Compared to traditional batteries, Li Batts are capable of *storing* much larger amounts of energy.

High Power Density (power delivery)

Again, compared to traditional batteries, Li Batts are capable of *delivering* much larger amounts of energy relative to their weight.

Depth of Discharge (DoD)

DoD is the maximum capacity of a fully charged battery that can be used prior to recharging without negatively affecting the battery's overall lifecycle; traditional batteries have a c. 50% DoD whereas Li Batts have a c. 80-90% DoD – meaning, effectively, Li Batts can be used for longer without recharging.

Possible Lower Total Lifetime Cost

Li Batts for assistive technology applications are typically 2-3 times more expensive than traditional batteries – however, due to longer life, Li Batts (especially $LiFePO_4$ Batts) can, if maintained properly, reduce overall cost.

8. Li Batts – Cons

In addition to Li Batts' much higher upfront cost, many of their disadvantages are rooted in the same characteristics as their advantages.

Higher Upfront Cost

For assistive technology applications, Li Batts – both Li-NMC and $LiFePO_4$ – are typically 2-3 times more expensive than traditional batteries.

Depth of Discharge (DoD)

Compared to traditional batteries, for optimal performance, greater care and precision must be applied to charging Li Batts. Li-NMC Batts can become dangerously unstable at the end of their useful life, if charged improperly, or if their battery management system (BMS) fails; $LiFePO_4$ Batts are significantly less prone to these modes of failure.

Materials – Combustibility

In Li Batts, lithium metal (cathode) and lithium salts (electrolyte) are highly flammable, and if Li Batts are compromised, the resulting electrochemical process can lead to "thermal runaway" where the battery's internal temperature accelerates, releasing more energy, further increasing temperature, releasing more energy, etc. in a self-perpetuating uncontrolled cycle – which can lead to very intense, hard-to-extinguish fires and/or explosions. Research and experience generally show that $LiFePO_4$ Batts are significantly less prone to these risks.

High Energy and Power Density

Since they can store and deliver so much energy for their weight, when the medium-to-high-capacity Li Batts used in assistive technology applications (especially Li-NMC Batts) malfunction or fail, they have a much higher potential to do so catastrophically and dangerously compared to traditional batteries.

Environmental/Recycling Concerns

Currently, facilities are few for recycling Li Batts at the end of their useful lives back into constituent parts than can be used to make new Li Batts as part of a circular economy sustainability and social value plan. Specialist electrical waste management companies have to gather economically viable quantities of Li Batts and transport them to the nearest recycler – but assembling large quantities of end-of-life and/or damaged Li Batts has to be done very carefully to manage fire and explosion risks, adding significant expense and complexity to Li Batts.

For more information, please contact BHTA at info@bhta.com.

Endnotes

[i] This guidance will comprise five parts; the first two will support assistive technology companies that make, sell, or use Li Batts with their own practices; the final three will define processes and responsibilities between the four parties with a stake in Li Batt lifecycle responsibility (Manufacturers, Distributors, Retailers, Consumers). The five parts – and the topics covered in each – are:

1. **Policy**
2. **End-of-Life Disposal**
    a. Objectives
    b. Scope
    c. Definitions
    d. References
    e. Risk Assessment
    f. Procedures
    g. Work-Flow Diagram
3. **Manufacturers & Distributors/Retailers**
4. **Distributors/Retailers & Consumers (sales and aftercare)**
5. **Consumers & Manufacturers/Distributors/Retailers (battery recycling and end-of-life disposal)**
    a. Safe Use & Maintenance
    b. Marking
    c. Packaging
    d. Labelling
    e. Transport
    f. Damaged Goods
    g. References (UK regulations)
    h. Specialist Packaging

[ii] E.g. Sealed Lead-Acid (SLA) batteries, Absorbent Glass Mat (AGM) batteries, Gel batteries.

[iii] For more detail, please see the 'Comparison to other battery types' section of the Lithium iron phosphate battery Wikipedia page [accessed 13-Oct-23].

[iv] Defined as "a battery or battery pack [that]:

- Is sealed
- Is not an Automotive or Industrial Battery
- Can be hand-carried by an average natural person without difficulty"