

**Lithium Battery Safety Guidance**

Health, Safety & Wellbeing Team

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**Purpose of this guidance**

This guidance is to provide users of lithium-ion (Li-ion) and lithium polymer (LiPo) cells and battery packs with enough information to safely handle them during normal use and during potential emergency conditions, including safe disposal.

Caution must be taken in lithium battery storage, use, management, and disposal due to the potential for fire and injury if these batteries are misused or damaged. The media has reported recently on a number of serious incidents involving lithium batteries. We have also had incidents at BU, relating to batteries left on charge for extended times, unattended charging, incompatible chargers, and the use of imported, less safe batteries.

Further information, technical language and data on batteries can be found in Appendix A of this document (page 12).

**1. Background**

1.1 Lithium batteries present an increased fire risk that has been highly documented recently in the media, from exploding hover boards, self-igniting mobile phones, exploding e-scooters and e-bikes, resulting also in a recent ban of electric scooters on many main line train companies and the London Underground system. It has been recognised that the potential for lithium battery fires has historically been of concern, but as the popularity of products and subsequent development of batteries has expanded, so has the potential fire threat.

1.2 In recent years, there have been a growing number of product recalls involving lithium batteries, citing overheating, fires and explosions that relate to the use of this type of battery. Given these risks it is important that lithium batteries are managed in a safe way and that all staff and students are aware of the risks and hazards in using these types of batteries.

**2. Advantages and disadvantages of lithium batteries**

 Lithium batteries have advantages over traditional batteries. For example, they:

• Are lighter in weight, compared to other similar types of rechargeable battery.

• Are able to hold their charge better and have the ability to handle an increased level of charge.

• Have a limited self-discharge in comparison with similar types of battery.

• Have limited charge memory problems since it is not necessary to completely discharge the battery prior to recharging.

Disadvantages: -

• Lithium batteries have a tendency to begin to degrade soon after their manufacture.

• The average life span of a lithium battery is typically limited to 2 to 3 years from manufacture. The lifetime limitation will occur whether the battery is in use or not.

• Increased heat levels can cause lithium batteries to break down faster than other batteries will.

• They have an increased sensitivity to high temperatures which must be considered when using or storing. If the battery is not in use, then it is recommended that it is kept in a cool environment which will help to reduce the aging and reduction in quality of the battery.

• Battery users should be aware of the recommended storage temperatures specified by the battery manufacturers and keep their batteries in the recommended environment.

• Lithium batteries require a battery charge monitor that will manage the charging process. This will ensure that the batteries will be charged as safely, quickly, and fully as possible. However, it needs to be recognised that this monitor also drains power from the batteries during its use which will cause the batteries to degrade and lose power over time.

• If a battery was to become completely discharged, then it would be ruined and unusable.

• Should the battery erode or be damaged, then there is a likelihood that it could overheat and catch alight or even explode.

• If water gets into a lithium cell it can create a chemical reaction with the lithium salt in the electrolyte which releases toxic hydrogen fluoride.

• It is also recognised that water can create a short circuit because of its high conductance which could lead to overheating, fire and/or explosion.

**3. Handling and use**

3.1 If the cells and batteries are correctly handled, the risk of fire developing from a lithium battery from a reputable manufacturer is very low. Most incidents involving lithium batteries are caused by the mishandling or unintended abuse of such batteries. Possible causes of lithium battery fires include over charging or discharging, unbalanced cells, excessive current discharge, short circuits, physical damage, excessively hot storage and, for multiple cells in a pack, poor electrical connections.

3.2 Best practice for lithium battery use

• Always purchase batteries from a reputable manufacturer or supplier. Cheap or counterfeit batteries may not undergo the same quality control processes and have a higher likelihood of failing.

• Be sure to read all documentation supplied with your battery.

• Never overcharge, burn, disassemble, short-circuit, solder, puncture, crush or otherwise mutilate battery packs or cells.

• Do not put batteries in contact with conductive materials, water, seawater, strong oxidizers and strong acids.

• Avoid excessively hot and humid conditions, especially when batteries are fully charged. Do not place batteries in direct sunlight, on hot surfaces or in hot locations.

• Always inspect batteries for any signs of damage before use. Never use and promptly dispose of damaged or puffy batteries.

• Lithium batteries assembled to offer higher voltages (over 60 V) may present electrical shock and arc hazards. Therefore, adherence to applicable electrical protection standards (terminal protection, shielding, PPE etc.) is required to avoid exposure to electrical hazards.

• Do not reverse the polarity.

• Do not mix different types of batteries or mix new and old ones together (e.g., in a power pack).

• Do not open the battery system or modules unless you have been trained to do so and have permission.

• Immediately disconnect the batteries if, during operation or charging, they emit an unusual smell, develop heat, change shape/geometry, or behave abnormally.

• Exercise caution with products like e-scooters, powered skateboards and e-bikes (banned from all buildings on BU Campus) where all safety considerations may not be recognised or that may encourage cheap copies built without adherence or thought to safety standards.

3.3 Transporting lithium batteries

Take precautions to avoid dropping batteries during transporting. When you need to transport a battery, protect the battery terminals and uninsulated connections from contact with other objects, use the original packaging or a suitable transportation container.

3.4 Charging/Discharging

3.4.1 The lithium battery packs found in **portable laptops and similar devices** usually, if from a reputable manufacturer, require no user input for charging other than connecting it to the charging cable. They contain a Battery Management System (BMS) in the battery pack that controls the charging process. Be sure to use the manufacturer’s AC adapter. Those charging these batteries still need to follow all manufacturer recommendations and be alert for anomalies like unusually hot batteries.

3.4.2 Batteries used in **cameras, power tools and other similar equipment** require a much more conscious effort by users to charge safely and avoid battery damage. Lithium battery users for these products MUST use the charger supplied with the equipment and incorporate the following recommendations into their charging practices:

• Batteries must only be charged with a charger or charging method supplied/designed to safely charge cells or battery packs to within specified parameters.

• Be absolutely sure that the charger settings are correct for the battery pack being charged – both voltage and current settings.

• Never leave a battery pack unobserved during charging - unless being charged in a specialist charging cabinet or approved type charging pouch.

• Always stay in or around the charging location so that you can periodically check for any signs of battery or charger distress.

• The charger and the battery should be put on a heat-resistant, non-flammable and non-conductive surface. Charging pouches/bags designed for lithium batteries must be made available with the equipment if not being charged in specialist charging units on campus.

• Never place charging batteries on a car seat, carpet or similar flammable surface.

• Keep all flammable materials away from operating/charging area.

• Do not overcharge (greater than 4.2V for most batteries) or over-discharge (below 3V).

• Make sure that batteries do not exceed manufacturers recommended operating temperatures during charging or discharging.

• Use caution if charging a battery that is still warm from usage, or using a battery that is still warm from charging.

• Best practice is to charge and store batteries in a fire-retardant container like a high-quality lithium battery charging bag or box

• Do not leave batteries connected to chargers after charging is complete.

3.5 Working area

• Make sure the working surface is made of a material that is not conductive and non- combustible. If you are working on a conductive material cover the surface with an insulating material.

• The area should be clear of any flammable or combustible materials such as wood tables, carpet, furnishings, petrol, chemicals or solvents.

• Ambient temperature should not exceed 60°C. Best working temperatures are between 15°C and 35°C.

**4. Storage**

4.1 Appropriate lithium battery storage is critical for maintaining an optimum battery performance and reducing the risk of fire and/or explosion. Many accidents regarding lithium battery fires have been connected to inadequate/inappropriate storage/charging area or conditions. While lithium battery spontaneous fires are rare, they need just an internal short circuit to start a series of reactions that may lead to increased heat and a fire.

4.2 Following are some guidelines that if correctly followed will reduce the risk of fire and/or explosion of stored batteries. A lithium battery charging bag or box provides a safe means of storage.

4.2.1 Cells - Batteries - Packs

• Every time a battery is not used actively (e.g. for more than 3 days), it should be placed in an appropriate storage area to avoid being damaged and becoming unsafe.

• Remove the lithium battery from a device before storing it.

• It is a good practice to use a lithium battery fireproof safety bag or other fireproof container when storing batteries. Always follow manufacturer recommendations on fireproof bags for details on how to correctly use them. Do not buy cheap fireproof bags, they might not be effective.

• Cell terminals must be protected by electrical insulating material.

4.2.2 Storage area

• Store batteries in a dry and well-ventilated place at room temperature or lower. While batteries can be used safely between -20 and 60 °C (-4 to 140 °F), it is strongly suggested to avoid storing them at a temperature that is close to the upper or lower range.

• Storing batteries in a refrigerator may create internal condensation when the battery is brought to room temperature, and they may become dangerous when operated.

• It is best to have a reserved area ONLY for lithium battery storage. It has to be a cool and dry place, away from heat sources.

• The area should be kept free from any materials which can catch fire such as wood tables, carpet, furnishings, petrol, chemicals, or solvents. The ideal surface for storing lithium batteries is concrete, metal, or ceramic or any non-flammable material.

• Batteries can be stored in a metal cabinet, or specialised charging cabinets but make sure that batteries are not touching each other.

• It is recommended to have in place fire detection in the storage area.

• Never leave batteries unattended where they can be damaged by someone.

• Have a P50 fire extinguisher nearby the storage area for use in emergencies.

**5. Emergency procedure**

5.1 While all batteries need to be handled with caution, lithium batteries pose additional safety risks due to their high energy density and flammable electrolyte content. When these batteries are poorly manufactured, overcharged or over discharged, incorrectly handled and/or connected, or exposed to excessive mechanical and physical stress, conditions may arise and lead to increased heat that in turn may lead to the venting toxic fumes, leaking, explosion and/or fire of the battery cell or pack. All lithium battery users must be aware of, prepared for and equipped to deal with the emergencies mentioned above.

5.2 When a lithium battery’s internal temperature and pressure rise faster than the rate at which they can be dissipated, cell overheating will occur. This may be caused by electrical shorting, rapid discharge, overcharging, manufacturer defects, poor design, or mechanical damage, among many other causes.

5.3 The overheating of a given cell may produce enough heat to cause adjacent cells to overheat in response. If the cell does not return to room temperature it may vent and catch fire or explode. Sounds like “clicks” and “puffs” may indicate a preliminary vent release. Follow this emergency procedure if you have overheating, venting or leaking cells.

Procedure

• If you notice unusually hot or bulging batteries, disconnect the charger and remove to a safe area.

• Immediately dial 222 on campus or from a mobile 01202 962222 to initiate emergency assistance.

• If a battery is venting or smoking, leave the area. If the fire alarm hasn’t automatically activated, operate the nearest fire alarm break glass call point so the building is evacuated, and normal fire procedures are followed.

• The area should be secured to ensure that no unnecessary persons enter as toxic gases may be present. If leaking material is present, do not touch it.

5.4 Exploded battery cell

Like a vented cell, an exploded cell is the result of an overheated or mechanically damaged cell. After the explosion of a lithium battery, the room could fill quickly with dense toxic white smoke that could cause severe irritation to the respiratory tract, eyes and skin. All precautions must be taken to limit exposure to these fumes.

Procedure

• If a cell has exploded, If the fire alarm hasn’t automatically activated, operate the nearest fire alarm break glass call point so the building is evacuated, and normal fire procedures followed.

• The area should be secured to ensure that no unnecessary personnel enter.

• Immediately dial 222 on campus or from a mobile 01202 962222 to initiate emergency assistance.

5.5 Lithium battery fires

Lithium battery fires may occur as a result of shorting and other conditions that result in increased temperatures. Once the battery begins to vent flammable vapours, it may quite easily and quickly catch fire.

Procedure for a lithium battery fire

• All personnel from the area should be evacuated.

• If the fire alarm hasn’t automatically activated, operate the nearest fire alarm break glass call point so the building is evacuated, and normal fire procedures followed.

• Dial 222 on campus or from a mobile 01202 962222 to initiate emergency assistance.

• If you are trained in fire extinguishers (Fire Marshals) and knowledgeable of the type of battery in use, take the closest P50, extinguisher and try to extinguish the fire if safe to do so.

• Make sure you are positioned between the fire and the nearest exit before attempting to extinguish the fire.

• If the use a portable fire extinguisher has little effect on extinguishing the fire, exit immediately. Do not initiate a second attempt.

• By-products of combustion may be toxic when inhaled. In the event of heavy smoke, exit the area immediately. Ensure others have left the area and close doors behind you as you leave.

• Estates Department will need to assess the situation for clean-up and waste management after the situation is under control.

5.6 First Aid procedures in case of contact with lithium battery electrolyte

• Dial 222 on campus or from a mobile 01202 962222 to initiate emergency assistance.

• While the electrolyte composition will vary depending on the type of the battery cell, the general first aid procedures are the same for an exposure to the electrolyte.

• EYES -- Immediately flush eyes with a direct stream of water for at least 15 minutes while forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissue.

• Remove contaminated garments.

• SKIN -- Flush with cool water or get under a shower. Remove contaminated garments. Continue to flush for at least 15 minutes. Get medical attention, if necessary.

• INHALATION -- Move to fresh air. Monitor airway breathing; if breathing is difficult, have trained person to administer oxygen. If respiration stops, give appropriate first aid and/or appropriate CPR procedures only if CPR-trained.

• For significant exposures to the electrolyte, get immediate medical attention. The applicable Safety Data Sheet (SDS) should be sent with the patient to the hospital.

**6. Damaged lithium batteries**

Lithium battery damage may not always be visible, events that may damage a lithium battery include a fall of 300mm or greater; crash with a speed of 20mph in electric vehicles/scooters/e-bikes; puncture by a sharp object; expansion due to overheating. Use of a damaged battery may lead to increased heat and a subsequent fire.

Procedure

• Following the battery damage, if the battery is not hot and/or leaking or smoking, disconnect the battery.

• Remove the battery from the equipment wearing gloves, goggles/safety glasses and lab coat (if available).

• To discharge the battery, move in a well-ventilated area and place the battery in a metal or hard plastic bucket.

• Fill the bucket with a 3% saltwater solution if available or if not contact [Estates Helpdesk](https://staffintranet.bournemouth.ac.uk/aboutbu/professionalservices/estates/estatesservicedesk/) for assistance.

• After 2 days in the saltwater bath, call [Estates Helpdesk](https://staffintranet.bournemouth.ac.uk/aboutbu/professionalservices/estates/estatesservicedesk/) to have the battery safely disposed.

• Keep in mind that there may be no visible damage, a delayed fire can occur hours or days after the impact/accident. It is safest to discharge the battery immediately.

**7. Waste management**

7.1 BU Estates Department controls and manages the disposal of batteries, both intact and damaged. All lithium batteries (both intact and damaged) are hazardous waste and must be collected through the Estates Department. The following paragraphs describe the steps needed to comply with the above requirement. It applies to all BU staff, students and visitors that work with lithium batteries.

7.2 Intact batteries can be collected for recycling in any type of container. Spent battery terminals must be taped and gently placed into a container, which should then be properly labelled for recycling. Labels should indicate: “Hazardous waste – lithium batteries.” Do not mix lithium batteries with other types of batteries, such as alkaline, cadmium or other rechargeable spent batteries. A list of designated areas for the accumulation of batteries or to request collection, can be found by contacting the [Estates Helpdesk](https://staffintranet.bournemouth.ac.uk/aboutbu/professionalservices/estates/estatesservicedesk/).

**8. Responsibilities**

8.1 BU Staff/Students/Contractors or Visitors

• To implement all applicable elements of this guidance to ensure safe use, handing and storage of lithium batteries.

• Obtain, review and make available as required, the battery manufacturer’s Safety Data Sheet (SDS), Technical Specification sheet(s) and/or other documents available.

• Carry out local hazard analysis within each Faculty and Professional Service to assess the likelihood for harm and control measures required to comply with this guidance – including where equipment is hired in or loaned to students and charged/used off site.

• Ensure that written standard operating procedures (SOPs) for lithium battery devices are developed locally and include methods to safely mitigate possible battery failures that can occur during assembly, deployment, charging, transportation, storage, and disassembly/disposal. A template for the production of a local SOP can be [found here.](https://intranetsp.bournemouth.ac.uk/policy/Developing%20a%20SOP%20for%20Lithium%20Batteries.docx?Web=1)

• Ensure that any prohibited items as defined at section 10 are not taken into any BU building at any time.

**8.2 Estates/Fire Officer/Health Safety and Wellbeing Team**

• Regularly review, monitor and maintain this guidance.

• Assist in communicating safety requirements to all users.

• Assist in the effective execution of appropriate waste management measures (removal of hazardous waste).

• Assist/investigation of incidents involving lithium batteries.

• Incident response in the event of a fire or explosion.

**9. Prohibited items in buildings containing lithium batteries**

The following products/items/devices use lithium batteries that are higher voltage, less likely to be within current regulation and are the primary cause of recent highly publicised and in many cases, fatal incidents. It has therefore been agreed that they MUST NOT be stored, used or charged in any BU building.

• E-Scooters of any kind.

• Electric bikes.

• Electric skateboards.

• Hover boards.

**10. Review**

This guidance will be subject to regular monitoring and review in accordance with the University’s commitment to continuous improvement and effective safety management.

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**APPENDIX A**

**Technical information and data on batteries**

Anode: the negative electrode typically made with a graphite active material coated onto a metal (usually copper) foil current collector.

Cathode: the positive electrode typically made with a metal oxide (LiMO2, where M= Ni, Mn, or Al) or a phosphor-olivine (i.e., LiFePO4) coated onto a metal (usually aluminium) foil current collector.

Electrolyte: lithium salt (i.e., typically LiPF6) in a mixture of flammable organic carbonate solvents.

Cell: A single battery (Understanding Battery Specifications).

Battery Pack: An assembly of cells that are connected in series and/or parallel (xPyS). Each battery pack contains only one type of cell. Connecting cells in parallel increase the pack capacity (ampere hour, Ah) and in series the pack voltage.

Primary (non-rechargeable) lithium metal cells: These cells have lithium metal anodes paired with a variety of cathode materials (i.e., MnO2, CFx, FeS2, and SOCl2) and corresponding nominal voltages (1.5V to 3.5V). Depending on the chemistry and application cells may be available in button and cylindrical form factors. These cells are not rechargeable.

Secondary (rechargeable) lithium (lithium-ion) cells: These cells are rechargeable. Depending on the quality, design, and operating window these cells typically can be cycled from hundreds to thousands of cycles. The long cycle life is made possible because the lithium is not present in metallic form. Lithium is intercalated into the electrode active materials (i.e., graphite – Li1- xC6 and lithium metal oxide – Li1-xMO2) Lithium-ion cells are generally available in cylindrical, prismatic, and pouch form factors.

Lithium-Ion: A lithium-ion battery is a type of rechargeable battery in which lithium-ions move from the negative electrode to the positive electrode during discharge and back when charging.

Lithium-ion Polymer cells: Same chemistry as lithium-ion cells but the electrolyte is made as a gel with a polymer host which reduces flammability and prevents leakage of liquid electrolyte from a damaged cell.

Watt-hour (Wh): A measure of energy. The cell will have a rated energy. The actual energy obtained from the cell will depend on the rate of discharge and the temperature of the cell. As rate increases and cell temperature is lowered the amount of energy obtained will decrease.