Industry guidance for collecting, handling, and treating waste lithium batteries.

Disclaimer

The content of this document has been complied through extensive consultations with experts, thorough research within the waste management and collection and recycling sector, and the insurance industry. It should be read as a set of various recommendations and advice, which are put together for different stakeholders to use as a source of inspiration to improve their way of handling lithium containing batteries and/or appliances containing them. It is crucial to note that the effectiveness of these suggestions may vary based on specific circumstances since the situation of all stakeholders will be different. There is no such thing as one golden rule or simple solution to ban all possible risks when handling such batteries and/or devices. The information herein is intended to offer best practices and recommendations for creating risk assessments, implementing mitigation procedures, and addressing fires potentially caused by lithium batteries. Therefore, it is strongly advised to conduct thorough testing and assessment of the suitability of these recommendations before their actual implementation. Additionally, seeking the guidance of an expert in fire emergency management is highly recommended to ensure the utmost safety and reliability in emergency situations. It is important to raise the awareness of all possible risks and check them with each situation and procedures and guidelines for staff and/or people bringing in batteries and/or appliances.

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[1] *Details of what pervasive electronics are can be found here: https://www.step-initiative.org/webinar/what-are-pervasive-electronic-products.html*

1. Introduction and Scope

In the effort to reduce the uncertainty of battery and electronic waste management facilities, eight industry Associations and Insurance Europe[2] agreed to work jointly to create this guidance document, which aims at providing more clarity on the technical fire protection criteria and a non-exhaustive list of good practices. This work builds on studies and research carried out in 2019 and 2020 by the industry and the Batteries Roundtable[3] about the growing issue of fires associated with waste electrical and electronic equipment (WEEE/ewaste) that contain lithium batteries, to present measures to address the problem.

Lithium batteries are increasingly used in most electrical and electronic products and light means of transport[4] (LMT) equipment, which impacts their repair or treatment, and often gives rise to thermal events. This is a key issue that affects the repairing and refurbishment sector as well as waste electrical and electronic equipment (ewaste) and battery management chains is that of fires caused by lithium batteries. Fires associated with waste batteries cost waste management facilities millions of euros annually due to the loss of production time and of material damage in general; danger and injuries to workers, and re-build outlays. Consequently, operators experience a rise in insurance fees or find that they cannot agree insurance terms. This can have a ripple effect, especially when their operational permit entails specific conditions regarding their insurance coverage. In addition to the economic impact, lithium battery fires also have negative effects on the environment and preclude the recovery of the various secondary raw materials contained in the destroyed lithium batteries.

Producers (manufacturers, importers etc.), Producer Responsibility Organisations (PROs), Collection Schemes, municipalities, preparing for re-use operators and ewaste recyclers and consumers have crucial roles in ensuring the appropriate management of lithium batteries and ewaste containing lithium batteries throughout their lifecycle. PROs and Collection Schemes are obligated in establishing and implementing collection and recycling schemes, albeit some producers in certain Member States can elect to meet this requirement directly.

The European Battery Regulation[5] Article 11, requires that by 2027 all portable batteries embedded into portable appliances and batteries contained within LMT equipment should be removable and replaceable by the user or a professional re-use operator, thus the onus will be on consumers to remove batteries from products when they are changing to a new battery, or when they are discarding the item. There are exceptions for products requiring continuity of power and data, and those where water ingress may impede the safety of the product, but for the majority of new products placed on the market in 2027, batteries must removable (and replaced if re-use is intended). The final step will be for the disposing of discarded batteries correctly at designated collection points and not with their general waste.

Although the future looks (more) bright, the reality is that ewaste with embedded and difficult and/or dangerous to remove waste lithium batteries will continue to arise for the next ten+ years. This is one of the key reasons for developing this guidance document.

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[2] *See Section 5 – partners to this guide.*

[3] *See Section 6 – references and recommended reading from the Batteries Roundtable: Recommendations for tackling fires caused by Lithium batteries in WEEE (2021) and the Characterisation of fires caused by batteries in WEEE (2020). The Batteries Roundtable meet regularly to consolidate knowledge, share experience and engage in new activities addressing the issues of fires caused by batteries. https://weee-forum.org/batteries-roundtable/*

[4] *Light means of transport" (LMT) typically refers to modes of transportation that are small, compact, and often used for short distances or light cargo including e-bicycles, e-scooters, e-skateboards, e-rollerblades, and similar devices that are human-powered or have small engines.*

[5] *REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC*

Scope

The scope of this guidance document is to provide examples of good practice for all aspects of the waste lithium battery chain to mitigate risks and assist with the health and safety management of personnel, plant and equipment etc. Where relevant, this guidance document refers to legal obligations and policies as a point of reference and/or to provide further instructions or information.

This guidance document does not include the management and controls needed for the packaging, transportation and storage and onward sale of new lithium batteries.

Whereas incidents of fires due to lithium batteries are prevalent in single type battery collection and ewaste treatment streams, similar risks exist in other waste streams, such as in general waste, textile waste, and waste packaging and end-of-life vehicle recycling. These sectors are not included in this guidance due to their own distinct characteristics and regulatory frameworks.

The term "**lithium battery**" refers to a family of batteries with different chemistries, comprising of several types of cathodes and electrocytes.

Lithium batteries are generally divided into two categories, also corresponding to the two UN classification numbers: UN 3090 and UN 3480

- Lithium metal batteries (classified UN 3090): all primary (non-rechargeable) batteries are in this category, based on the use as an anode of lithium metal or lithium metal ally. Some rechargeable lithium metal batteries are also on the market. In the portable battery applications, lithium metal batteries are generally used to most electrical and electronic appliances sold on the market today for memory back-up.

- Lithium -ion batteries (classified UN 3480) : these batteries are generally secondary (rechargeable). They are based on intercalation technologies the lithium is only present in an ionic form in the electrolyte and intercalated in the anode (intercalation materials are for example graphite or lithium-titanate). These are generally used to power portable devices such as in ICT equipment, power tools and in LMT equipment and other electromobility (e-mobility) vehicles (hybrid or plug in) and energy storage systems.

This guidance document is recommended for:

- Waste municipal recycling personnel (where ewaste including e-mobility equipment is received from householders)

- Waste collection site personnel (e.g. for retail/supermarket collections of ewaste and/or loose lithium batteries)

- Waste logistics personnel operating household refuse collection vehicles, kerb-side collectors, transport operators collecting ewaste (including e-mobility equipment) that may contain lithium batteries and loose lithium batteries (either sorted as just lithium batteries or unsorted mixed chemistry batteries)

- Ewaste facility personnel accepting ewaste (including e-mobility equipment) that may contain lithium batteries for disassembly and treatment

- Battery recycling facility personnel who may be sorting into different chemistries and/or carrying out recycling operations

- Officials at policy making institutions as well as market surveillance, inspection and environmental agencies

- Managers at companies manufacturing and importing electrical and electronic equipment, compliance schemes, including Producer Responsibility Organisations, battery producers

- Personnel at insurance companies, and

- Any other entity or person with a stake in the discarding, collection, handling and treatment of waste lithium batteries.

2. Considerations from an insurance industry perspective

The role of insurers is to offer protection to individuals, businesses, and public institutions, thus helping them recover quickly from damage and disruption and reducing hardship. Insurance thereby also supports economic development, and so plays a vital role in enabling resilient, modern societies.

To play their roles, insurers usually do not only provide financial compensation, but they also contribute to prevention, notably through their risk management expertise.

Importantly, there is no “one-size-fits-all” approach to insurance coverage, whatever the sector, and so also not in the case of e-waste recyclers. This is due to the fact that each facility has unique needs and faces a distinct range of challenges, and that each insurer assesses risks in its own way, based on its own internal policy or risk appetite.

Having said that, there are conditions of insurability which have to be met, irrespective of the insurer. For instance, the insurer needs to have a solid understanding of the risk being insured, and this usually requires having access to sufficient data of appropriate quality.

Another condition consists in the premium being affordable for the policyholder and in turn, this requires the risk not being too big. For this reason, insurers invest in prevention and other risk reduction measures.

Prevention efforts are also essential, as they make risks more manageable and, therefore, insurable. This requires, for instance, that facilities maintain robust safety and maintenance practices. The specific practices required will depend on the unique characteristics of each facility.

When assessing risks and whether to insure them, insurers may take the following into account:

- Legal requirements, certifications, and permits.
- Property: condition of buildings, land, and other infrastructure, as well as maintenance.
- Location of the property and related risks or hazards.

- Fire safety mechanisms in place.
- Loss experience of the facility.
- Evaluation of fire hazard of the activity.

Insurance Europe's Prevention Forum, a platform gathering fire safety engineers from different markets, are developing a guidance document for insurers on e-waste recycling, which will cover lithium-ion batteries. The document will be available in due course, and its findings will be reflected in this Industry Guide.

https://www.insuranceeurope.eu/

3. Waste Management Operators

Waste management operators are actively involved in all aspects of waste operations, including those connected with the collection, transport, storage, sortation, re-use and recycling and disposing of waste products containing batteries, or separated / removed waste batteries.

Operations take place at licensed facilities that vary in size and activities, and at the foremost, who manage their safe working conditions in order to prevent and minimise adverse impacts on the environment and human health.

In the context of this guidance, "operations" (but are not limited to) include:

- General obligations and good practice
- Collection points/facilities – where consumers or businesses may deposit ewaste and/or batteries.
- Logistics operators – responsible for the transport by road, rail, or ship
- Storage facilities – that may include the initial sortation of ewaste products and/or different battery chemistries.
- Re-use facilities – where preparing for re-use activities may take place on ewaste, and/or for repairing and/or repurposing batteries (see 3.5)
- Recycling facilities – where the dismantling ewaste activities may be manual and/or mechanical; and also, when loose batteries are received at dedicated battery recycling facilities, that may also be dismantled manually and/or mechanically prior to the recovery of the materials (see 3.5).

3.1 General obligations and good practice

Legal obligations and certifications (all waste operators)

All waste facilities must comply with health and safety requirements defined in the operational permit and applicable legislation.

This would include the Seveso III Directive (2012/18/EU)[6] which has been implemented in the EU to limit risks related to the storage and handling of hazardous chemical and may be applicable to large facilities and waste batteries management operators. In this case, the operator must draw up a document setting out

[6] *DIRECTIVE 2012/18/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC:* https://eur-lex.europa.eu/eli/dir/2012/18/oj

their major-accident prevention policy (MAPP), including prevention and emergency plans, and to ensure that it is properly implemented.

The MAPP is designed to ensure a high level of protection of human health and the environment. Depending on the hazard classification of the substance there is a maximum amount allowed on site at any one time. The maximum amounts are listed in Annex I, PART I of the Directive.

In general, waste management operators are recommended to have the following in place:

- The authorisation documentation issued by the competent fire brigade office, where applicable.
- A (Fire) Risk Plan document from which it is possible to confirm that risks have been assessed by the facility and that prevention measures implemented have been deemed adequate in relation to the law and the applicable technical standards.
- Operators should have enough water available for firefighters to tackle for all types and severity of fire. This could be water in storage tanks or lagoons on site, access to hydrants or mains water supply. Operators should take all the steps that are reasonably practicable to minimise pollution from fire water by installing or deploying suitable containment options such as bunds, drain mats or tanks.
- The control register of the fire-fighting equipment (integrated with the test reports of the extinguishing and detection systems) from which it is possible to deduce the correct management and maintenance of the system.
- An Emergency Plan including the organisational (hierarchy) chart and a site plan and details of emergency contact numbers for local fire departments, medical services and relevant authorities and evacuation procedures and designated meeting points. This plan should be accessible at all times. Good practice being on the boundary or outside of the waste facility.
- Training procedures covering the fire safety protocols, including running regular drills in how to operate fire-fighting equipment, evacuate safely, and respond to fire alarms, and to ensure employees and contractors understand their roles and responsibilities during a fire emergency. Good practice would include the appointment of nominated Fire Marshalls across all teams and shifts.

Furthermore, good practice would also include at least one of the following certifications:

a) Environmental Management System (EMS)
b) Eco-Management and Audit Scheme (EMAS)
c) ISO 14001 environmental management certification,
d) ISO 45001 occupational health and safety management system
e) EN 50625 treatment of waste electrical and electronic equipment (ewaste)
f) EN 50614 preparing for re-use of ewaste
g) Other equivalent national certifications

Prevention measures (all operators)

Where there is no mandatory requirement, operators should consider developing their own fire response plan so that if a fire occurs, it will be quickly identified, the person responsible on site is confident to start the process of addressing the risk of the fire until the fire service arrives, if required. It is recommended that this includes developing a contingency plan for fire incidents and treatment instructions for personnel who encounter abnormal battery behaviour.

Good practices to prevent fire hazards and incidents should be employed by all operators. This includes organisational and technical measures, which should influence the layout and design of the waste management facility.

A facility sign should be located at the main entrance(s) to a facility to identify a map of the site, location of firefighting equipment and hazardous waste including battery storage areas, and key contact information and permit number(s).

Good practice would include a 'What3Words[7]" identity to identify ingress/egress points and shared with the fire services.

Information regarding the numbers of personnel on site at the time of an event to affect a rollcall, should also be available externally from the site (e.g. in a 'grab-bag' or emergency box) along with a copy of the emergency plan.

General measures and protection against common causes of fire should include:

a) Ingress and egress: access to a facility should be accessible to the fire service. Regular interactions and tours of the site would be a good practice process so that key personnel from the fire service understand the issues and layout of the site, and where hazards and the operator's fire management systems may be situated. A good working relationship between the operator and the fire services should ensure that there will be a coordinated response if a fire event occurs.
b) Smoking: facilities should apply a no-smoking policy or ensure there are designated smoking areas situated away from combustible materials.
c) Arson / theft: facilities should ensure that only authorised personnel access a collection vehicle such as locking main doors when loading, that tail-gates and/or side doors or curtains are restricted and locked when not supervised. Unauthorised personnel should also be prevented from entering a site, which may include security measures such as barriers, gates and fencing (of sufficient height), intruder alarms and CCTV.
d) The facility should ensure there is a regular maintenance and inspection programme for all site areas, including site machinery, and ensures good housekeeping, e.g. keeping levels of dust, fibre and paper in buildings and around the site to a minimum.
e) The facility should ensure that all visitors are aware of the correct safety and fire prevention procedures to follow while on site. Visitors should be accompanied during their stay onsite.

The above recommended practises identify some parts of activities in general waste facilities but should not be taken as the only steps to be taken as other operational aspects should also be considered on a site-by-site basis.

Staff with specific operational responsibilities such as in emergency planning and fire event control and evacuation processes, should receive additional instruction and training appropriate to their role. Good practice would include using external operator competence scheme training for the types of wastes being received. This is so they can implement all the measures set out in the Emergency Plan promptly in the event of an incident. In addition, consideration should be given to having chemical or bio-hazard experts available (internal or external), to avoid and reduce the occurrence of possible risks of a chemical nature.

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7 The world is divided into 3 metre squares and each square has a unique combination of three words. It's the easiest way to find and share exact locations. https://what3words.com/

Fire detection (all operators)

Good practice should ensure that there is adequate maintenance of all areas and ingress/egress points and work vehicles and technological systems, as well as the fire protection systems and equipment. The facility should be provided with an appropriate fire detection and alarm system, which is regularly maintained and regularly tested.

Operators should ensure that there is the means of detection for their facility that ensures a fire is discovered quickly enough for the alarm to be raised in time for all the personnel to escape to a place of safety. The alarm should be clearly heard and understood by everyone throughout the whole building and outside storage or operational areas, and in addition, all administration buildings / areas. If the fire-detection and warning system is electrically powered, the operator should ensure that it has a back-up power supply.

General prevention measures should include:

a) The facility is equipped with adequate video surveillance systems (CCTV), possibly with 24-hour supervision and night vision, and key personnel monitor risk areas such as the perimeter of the facility or the storage areas. The video recordings and storage systems for recordings in areas should not be reachable by the fire (e.g. kept in the cloud or on a remote server).
b) The facility is equipped with an industrial-type fence with a minimum height of 2.5m to prevent access by unauthorised persons.
c) A minimum distance should be kept between the fence and stored waste or other combustible material so as to make any type of intervention easy and timely should emergency situations arise;
d) The facility has automatic fire and/or heat detectors (also thermographic cameras) on continuous surveillance and capable of signalling a fire at the early stages, both for internal areas and for outdoor storage.
e) The facility is equipped with external open sea container(s) with a deep-water reservoir.
f) There should be arrangements in place for each working day and outside normal working hours, including facility 'shut-down' procedures, where relevant;

Mitigation measures

The facility should apply the following measures in order to contain the spread of fires, allow fires to be controlled fast, and ensure timely intervention by the fire brigade. In particular:

- Planning

As noted above under legal obligations, a Fire Risk Plan (may also be called a Fire Response Plan) and Emergency Response Plan should be in place. Good practice demonstrates this should include the following elements in line with national technical guidance:

a) A description of the communication arrangements for example:
   - named contacts and key-holders with their telephone numbers.
   - the types, quantities, and properties of combustible and other hazardous materials on the site.
   - the number of people working on site (staff and contractors), including any differences between weekdays/weekends and times of the day.
   - the number and types of heavy facility equipment and machinery and relevant personnel on site to assist with initial fire breaks.
   - the likely burn times of the material.
   - procedures for the disposal of firewater and any other waste arising during a fire.

b) A site plan showing:
   - layout of buildings.
   - hazardous areas on site (location of the batteries, gas cylinders, process areas, chemicals, stacks of combustible materials, oil, and fuel tanks, etc.).
   - main access routes for fire engines and any alternative accesses if available.
   - access points around the site perimeter to assist firefighting.
   - hydrants and water supplies.
   - any watercourse, borehole, or well located within or near the site.
   - areas of natural and unmade ground.
   - the location of facility and pollution prevention equipment and materials.
   - drainage systems, including foul and surface water drains, and their direction of flow.
   - the location of drain covers and any pollution control features such as firewater containment systems.

c) The procedures staff should follow if a fire starts. This covers the period before and after the fire services arrive and arrangements during and outside normal working hours.

d) Media interaction, including prepared draft statements regarding the potential cause of the fire, details of any injuries or damage, any implications for inbound deliveries, and when normal operations are expected to resume. Details of a nominated key person for further information should be included.

Site layout and systems

The operator should consider the following measures when designing the layout of reception, unloading, initial sortation and operational activities. These good practices can assist with the spread of fires and ensure timely intervention by the fire brigade. Care must be taken however to ensure that the choice of firefighting equipment and supplier is appropriate to the site and the product / battery streams being received, and the activities being carried out:

a) The facility should have defined fire safety compartments (division of the building into areas delimited by fire-resistant structures or sufficient spatial distance and/or fire-breaks[8]), in line with national technical guidance, to slow down its spread.

b) Temperature detection equipment in storage and operational areas should be included for the early detection of a rise in heat as this is often an early sign prior to there being any smoke. Smoke detection equipment and heat evacuators that can capture and filter a smoke plume also serve as good early warning systems, as well as maintaining a safe environment for personnel until they can safely evacuate the area.

c) Fire suppression systems in line with national technical guidance, should be installed in areas of high-risk, including automatic fire extinguishing systems. Fire control (suppression) systems vary from simple, portable hand-held extinguishers to fixed fire-fighting equipment such as hose reels, sprinklers or foam systems. Such equipment must be regularly maintained and tested, and records kept in the operators management system.

d) The facility should have means of escape that are:
   - easily, safely, and immediately usable always.
   - adequate for the number of people likely to use them.
   - generally usable without passing through doors requiring a key or code to unlock, or with low-level manual over-rides for metal roller shutter doors.

[8] *Examples of fire-rated walls, partitions, steel beams etc. may be seen here: https://www.promat.com/en/construction/*

- free from any obstructions, slip or trip hazards, including from combustible materials that may be stored along or around the escape route.
- well-lit by normal or emergency escape lighting.
- available for access by the emergency services.

e) The facility should have exit signage and wayfinding that:

- Provides clear, unambiguous information to enable people to leave a building or storage or operational area safely in an emergency.
- Incorporates, or is accompanied by, a directional arrow.
- Is indicated by additional intermediate (wayfinding) signs if the escape route to the nearest exit is not obvious.
- Have signs are positioned so that a person escaping will always have the next escape route sign in sight.
- Have signs are sited at the same height throughout the escape route, so far as is reasonably practicable.
- Have signs are pictographic. This assists personnel whose first language is not of the location of the facility.
- Have illuminated signs when in operation to ensure they are conspicuous and legible.

Regular inspections of the signage and wayfinding should be carried out by key personnel to ensure that the routes are still clear, relevant, and clean. The inspections, and any changes should be documented in the operator's management system.

f) The facility must have emergency lightening that illuminates:
- Each exit door.
- All escape routes, including outside on each final exit and external escape routes.
- The emergency exit and wayfinding signage, fire-fighting equipment, and fire alarm call points.
- All equipment that would need to be shut down in an emergency.

Training and awareness (all operators)

All operators should ensure that suitable information and regular on-going training of the actions to be taken in an emergency is given to all personnel working for them, including part-time staff, cleaners and contractors working (in line with national technical guidance).

- It is essential to make sure that personnel are familiar with fire precautions needed for transporting products containing batteries and/or loose batteries, and for procedures and preventative measures at each operational site.
- Details of the training given/received should be recorded in the training records and fire safety manual or in a logbook.

All activities of outside contractors should be strictly supervised and controlled, with the provision of training appropriate to the activities they are undertaking, including alarm drills and evacuation plans.

All personnel, including visitors, agency staff, part-time staff, cleaners, and contractors should be trained and instructed in the following matters:

- the action to be taken upon discovering a fire.
- raising the alarm, including the location of alarm indicator panels.
- how they will be warned if there is a fire and the action to be taken upon hearing the fire alarm.
- how the fire and rescue service and any other necessary services will be called and who will be responsible for doing this.

- the location of firefighting equipment.
- knowledge of the escape routes, especially those not in regular use.
- appreciation of the importance of fire doors and of the need to close all doors at the time of a fire and on hearing the fire alarm.
- stopping machines and processes and isolating power supplies, where appropriate.
- how the evacuation of the premises should take place.
- where people should assemble after they have left the premises and procedures for checking whether the premises have been evacuated.
- arrangements for fighting the fire.
- the duties and identity of staff who have specific responsibilities if there is a fire.
- any machines/processes/appliances/power supplies that need to be stopped or isolated if there is a fire.
- specific arrangements, if necessary, for high fire-risk areas.
- contingency plans for when life safety systems, such as fire detection and alarm systems, sprinklers or smoke control systems, are out of order.
- procedures for meeting the fire and rescue service on their arrival and notifying them of any special risks, e.g. the location of highly flammable materials.

3.2 Collection points/facilities – where consumers or businesses may deposit ewaste and/or loose lithium batteries.

- **Collection bins:**

  These types of bins may differ in size (e.g. drums, barrels, boxes etc.) may be located within retail stores and supermarkets, shopping malls and educational facilities to encourage the end-users to responsibly (and easily) dispose of their waste batteries. The designs of the bins should include having small openings (to prevent inappropriate items being deposited) and clear signage including pictures of the types of batteries accepted. Warning labels informing of the potential for the bins to include lithium batteries must be shown on the bin in compliance with the Dangerous Carriage of Waste requirements.

  The bin should ideally be put in a safe and visible location, that is kept dry and away from the rain / sun. The location of the bin should be where the battery user can easily discard the batteries, and to enable the collector to be able to change the container once the bin is full. However, this should not be in general access or egress or fire route locations. Containers should be regularly monitored for defects and replaced when needed.

  Good practice would include locating the bin in an area where fire monitoring systems and sprinklers / extinguishers are in place or may be installed if there is a more convenient location for consumers. As a minimum, the location should be chosen so that it can be regularly inspected to check for damaged batteries, incorrect items being deposited, and for full bins that may encourage discarding bags of batteries on the ground around the container area. Collections should be arranged at the earliest convenience, especially if batteries show signs of damage.

  Safety information must be provided to staff (and be on hand always) at the collection point to train them in the dangers of batteries, how to handle the batteries and frequency of inspections that should be made (and why) and preventative steps and actions in the case of damaged batteries.
  The information should include the types of batteries that may be accepted at the location, and what to do should a battery be presented that does not meet that specification (e.g. lead-acid batteries and larger batteries that do not fit into the bin available) or a damaged battery (e.g. swelling of a casing, twisted or cracked casing etc. – See ANNEX D)

The collection site should maintain good contact with the battery collection scheme in their area, who are responsible for the free collection of the batteries. Agreements should be in place as to the minimum collection times necessary to ensure that nearly full bins are emptied / changed to prevent overflowing. The arrangements should include emergency collections where damaged batteries are notified.

- **Municipal collection centres**

Appropriate signage should be in place to inform those using municipal collection / recycling centres of where ewaste collection containers are placed to enable them to responsibly deposit ewaste containing embedded batteries and loose waste batteries.

These containers should have lids and be kept out of the rain and direct sun and inspected for damage and replaced as necessary.

Information available to employees and householders should include those ewaste products that are known to contain embedded lithium batteries such as ICT, LMT e-bikes, e-scooters, power tools, toys, vapes etc., with separate containers provided for these products.

Staff should be trained to monitor the types of batteries being deposited to ensure that different categories are segregated e.g. lead-acid batteries, portable and industrial batteries should have separate collection container options. Personnel must also be trained in how to spot damaged / unsafe batteries, and shown how to isolate/wrap the larger batteries to prevent the battery terminals (contacts) from meeting.

The location of the battery containers must be noted on the collection site plan and an emergency plan be in place in case of fire. See section 3.1. Good practice would include ensuring the emergency plan is always accessible at the boundary / outside the collection site area.

The collection site should maintain good contact with the battery collection scheme in their area, who are responsible for the free collection of the batteries. Agreements should be in place as to the minimum collection times necessary to ensure that nearly full bins are emptied / changed to prevent overflowing. The arrangements should include emergency collections where damaged batteries are notified.

Good practice recommendations for suitable collection bins, barrels, drums and boxes can be found at **ANNEX A**.

3.3 Logistics operators – responsible for the transport by road, rail, or ship

Because ewaste contains embedded lithium batteries, these should be carried, loaded, unloaded and handled in compliance with the international rules on the carriage of dangerous goods (ADR, ADN, RID, IMDG Code, SOLAS[9]).

This also applies to the transport of loose lithium batteries or a mix of batteries that also include lithium batteries.

[9] *These acronyms refer to various international regulations and standards related to the safe transportation of dangerous goods, both by land and by sea. ADR: Dangerous goods transport by road in Europe; ADN: Dangerous goods transport by inland waterways in Europe; RID: Dangerous goods transport by rail in Europe and some other regions; IMDG Code: Guidelines for sea transport of dangerous goods, worldwide; SOLAS: Broad maritime safety treaty, with provisions for dangerous goods transport on ships. See **Annex B** for further details.*

Logistics operators of ewaste and/or unsorted batteries should first consider any Dangerous Goods requirement and at the very least, ensure that all vehicles are fitted with appropriate fire extinguishers and dust filters and the operator should ensure vehicles are maintained and safely parked according to their nature (e.g., engine drive, liquid gas drive or electric vehicles).

There are three types of transport to consider when shipping lithium batteries: transport by road or rail networks, or transport by water (inland or open seas). Transport of waste batteries by air is banned.

From a road or rail transport of lithium batteries perspective

All road and rail transport operators are recommended to ensure that they understand their obligations with regards to ADR, and to ensure that personnel are trained in the handling and transporting ewaste containing lithium batteries and/or loose batteries according to the requirements in the regulation – see **ANNEX B** and www.batteriestransport.org for up-to-date information.

From a maritime perspective:

There are two main concerns that should be considered:

- Transporting electric vehicles, light means of transport equipment (e.g. electric bicycles and e-scooters etc.), and ewaste that may contain lithium batteries and transporting loose batteries as cargo on car carriers.

  In these cases, safety has become critical. Key issues include the increased danger of thermal runaway for waste batteries and equipment containing batteries, the potential for damaged batteries to reignite weeks after a fire, or the lack of consensus on effective fire extinguishing systems (often due to competitive approaches). Water-based and high-pressure water mist systems have demonstrated their efficiency in the industry, but early detection of fires, ideally before thermal runaway, is crucial. Better fire protection and detection, such as fixed water monitors and individual temperature detection for each container will be key moving forward for shipping lines. Operators should decide which is the more appropriate system for their specific site conditions or operations, as determined by a risk assessment.

- Mis-declared cargoes exacerbate these risks, highlighting the need for improved questionnaires on booking, and increased detection and management controls. It is key to align these, and other safety measures, with environmental, social, and governance responsibilities, in view of making the transport of waste electrical equipment / vehicles containing lithium-batteries and the loose batteries themselves safer, and therefore insurable.

3.4 Storage facility operators – that may include the initial sortation of ewaste products and/or different battery chemistries.

Storage facilities should be adequately arranged, with separation of entrance, storage, and work areas. Storage areas should be kept in line with national technical guidance, and internal cleaning plans where applicable:

a) kept tidy, respecting the maximum authorised capacities, and ensuring that access to the area is always guaranteed;

b) kept adequately ventilated, ensuring that volumes being stored are in line with national technical guidance regarding safe heights and internal fire-barriers;

d) provided with a quarantine area intended for the storage of waste that does not comply with acceptance procedures; constructed (at least) with fire-rated building materials and components[10].

e) As battery fires may linger for a long time and still can reignite, it is recommended to follow local regulations and to have the longest fire rating possible. The fire rating can be determined in accordance with EN 13501-2 or individual test standards on components which are referred to in EN 13501-2.

See **ANNEX E** for good practice procedures in storing, packaging and transporting waste lithium batteries.

3.5 Re-use facility operators – where preparing for re-use activities may take place on ewaste

This guidance document does not cover the activities of companies who are receiving and assessing used and working equipment (i.e. non-waste) prior to its final discarding step, which is the most preferable route under the Waste Hierarchy[11]. Re-use operators are recommended to read previous sections that relate to all operators and general advice. The good practices set out within the guidance document however will apply equally to the handling, storage, and transportation activities of used or second-hand goods and electrical vehicle repair facilities.

Batteries in electrical equipment may be integrated in the device or removable without technical or professional tools including batteries typically integrated in a tablet or a toothbrush, and those that are removable in a TV remote control or a calculator. Some electrical equipment may contain both, batteries that are easily removable and integrated at the same time.

The European Battery Regulation[12] Article 11, requires that by 2027 portable and LMT batteries incorporated into appliances should be removable and replaceable by the user and/or by independent professionals repairing products prior to being placed on the European marketplace. The obligation also requires safety information to be made available to consumers and professional operators. This will not cover exempted products that may require continuous data collection/retention and those products that could be impacted by water ingress. The impact of this change is unlikely to be seen at re-use operators before 2030.

For facilities that are preparing ewaste for re-use, operators are recommended to follow the good practices set down in sections 3.1, 3.3 and 3.4 above. In addition, criteria set down in EN 50614 Preparing for Re-use Standard[13] for the removal and storage and transportation of ewaste and components and removed waste lithium batteries, and products prepared for re-use that contain lithium batteries, should be considered.

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[10] *Examples of fire-rated walls, partitions, steel beams etc. may be seen here: https://www.promat.com/en/construction/*

[11] *In 2008, the European Union introduced a new five-step waste hierarchy to its waste legislation, Waste Framework Directive 2008/98/EC. Article 4 of the directive lays down a five-step hierarchy of waste management options. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098*

[12] *REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC*

[13] *EN 50614 and EN 50625 were published by CENELEC, the European Electrotechnical Committee for Standardization responsible for developing and defining voluntary standards at European level https://www.cencenelec.eu/about-cenelec/*

Good practice would include procedures and record keeping for training, safe working procedures, regular assessments of risks and maintenance of battery testing equipment to ensure that internal batteries or battery chargers are functional and safe to use.

Good practice procedures include, but are not limited to:

- Access to the products specifications

The ewaste re-use operator should ensure that that there is information about the products they are assessing for a preparing for re-use activity. This is to ensure that the location of any batteries, along with disassembly and battery replacement instructions, are known. The information can usually be found in the products instruction manual[14] or technical manual. If the original manual is not made available with the product at the discarding stage, then online manuals can be found and consulted. Where product specific protocols relating to the discharging and removal of the battery are available, these steps should be followed.

The European i4R Platform (https://i4r-platform.eu/) is an online database designed to support recycling companies and facilities in Europe by providing them with detailed product information on electronic and electrical equipment. The platform provides technical details and schematics about various electrical and electronic products, including information on materials, hazardous substances and components, and recycling instructions.

Given the likely timeframe when new products are placed on the market, to when the waste is generated (i.e. > 2030), re-use operators and recyclers are unlikely to see improvements for some years after the 'in-force' dates above, and until such time caution should be taken when disassembling ewaste to location and remove and replace embedded lithium batteries.

Ewaste re-use operators removing spent waste lithium batteries are recommended to follow the steps set out in **ANNEX E** for good practice procedures in storing, packaging and transporting waste lithium batteries.

For used/end-of-life EV and LMT batteries there is a growing industry performing assessments and repairs – either to return them to the market in the format they were originally intended, or to make available individual functioning cells for the repair and refurbishment sector or create new products incorporating the battery pack, module or cells into energy storage systems / packs etc. (known as second-life[15]).

The general good practice procedures set out in this document may be useful to professional operators carrying out these activities today. Further updates specifically to consider the EV and second-life sector, will be developed in 2025.

[14] *The user manual/information can be located from a number of online resources including brand-owner manuals for their products on their official websites; ManualsLib (manualslib.com); ManualsOnline (manualsonline.com) SafeManuals and iFixit (ifixit.com).*

[15] *The second life of batteries refers to the re-use of in new applications after they can no longer efficiently power an electrical vehicle, or LMT equipment. For example, though EV batteries may no longer meet the performance needs for driving (typically dropping below 70–80% of their original capacity), they can still retain substantial capacity for less demanding applications. The concept of second-life batteries supports sustainability and the circular economy by maximising the batteries' usable lifespan and delaying their entry into recycling process.*

- **<u>Replacing spare battery packs in products and LMT</u>**

Attention and caution should be given to the replacement of battery cells within an EV or LMT battery pack. This should only be undertaken by a professional and should be regarded as a repair operation of the battery pack.

Repair and refurbishment and second-life professionals are recommended to follow the steps set out in **ANNEX E** for good practice procedures in storing, packaging and transporting waste lithium batteries.

3.6 Ewaste Operators – where the dismantling of ewaste may be manual and/or mechanical

All ewaste recyclers are recommended to consider the good practices set out in sections 3.1, 3.3 and 3.4 above, and in particular to consider the sources of ignition, sources of fuel and their procedures and fire detection and fighting equipment in place to minimise the risk and impact of fires so that improvements can be implemented and regularly monitored and updated.

It must be noted that an internal short-circuit within a battery (either loose or found within ewaste) can happen at any time post reception and operators should continue monitoring steps continuously.

Sources of ignition may include:

- Machinery and Plant – overheating electric motors, sparks from electric motors, heat from friction in conveyers, static electricity from rubber conveyors.
- Mechanical Processes – sparks caused by metal elements of ewaste coming into contact with each other and heat build-up. For example in granulators and shredders.
- Electrical fire[16] from other electrical circuits in the building such as lighting and ventilation and as a subsequence in hydrocarbon fires and cellulose fires.
- Electrical fire from high voltage electricity equipment such as a substation or transformer on the site.
- A capacitor is NOT a battery and is also present in many electronics and can also cause fires
- Hot processes such as grinding, and welding carried out by maintenance teams or contractors.
- Damaged batteries which give off large amounts of heat.
- Chemical fires or sparking from damaged or shorted batteries.
- Hot exhausts from mobile plant.
- The sun's rays being concentrated by distorted plastic or broken glass.
- Smokers' materials.
- Arson.

Sources of fuel may include:

- Flammable materials such as propane/butane from gas cylinders delivered within ewaste loads.
- LPG cylinders stored on site for use in maintenance operations.
- Storage and use of diesel fuel.
- Flammable hydrogen gas from damaged lead-acid batteries.
- Flammable liquids such as petrol from items delivered as ewaste (e.g. garden equipment).
- Combustible materials such as wood, cardboard, plastics and rubber.
- Oil from oil filled radiators delivered within ewaste loads.
- Plastic and/or polystyrene storage bins.
- Wooden pallets.
- Dirt and dust build up on the machinery and conveyers.

[16] *An electrical fire is a type of fire that is caused by an electrical fault or malfunction – See **ANNEX C** .*

- Toner dusts.
- General wastes.

Mitigation measures (in addition to those noted in 3.1 above):

- Acceptance areas should allow for sufficient room to allow for vehicles turning and/or backing into a separate area for unloading prior to inspection.
- The acceptance area should be concreted and allow space to carry out inspections and assessments and additional space for the ewaste to be moved prior to depollution / treatment once inspected.
- Access to clearly signed evacuation routes must not be impeded during the acceptance, unloading and inspection steps.
- Heat/smoke detection cameras should be installed in the acceptance and inspection areas with early warning systems in place to quickly identify potential risks from ewaste that arrives damaged or that is damaged during the unloading and inspection process. The possibility of detecting lithium fires via visual smoke (gas) detection equipment is an additional good practice step to include.
- Incoming ewaste should not be mixed with existing stockpiles prior to assessment to allow greater opportunity for the efficient inspection processes, and for the prevention of the spread of hazardous components / substances.
- Delivery inspections should be carried out on all ewaste deliveries in order to give trained personnel the opportunity to assess quality, and remove where identified, dangerous objects such as loose batteries, oil-filled radiators and gas canisters, and other combustible materials (e.g. cardboard / plastic wrapping).
- Concrete walls to create bunkers would serve to reduce the risk of fire spreading between ewaste waiting for assessment and assessed ewaste. The recommended maximum storage capacity within one bunker is 150m^3 subject to the volume of ewaste being received daily (that can be assessed each day) and other local restraints and limits within site licenses or permits.
- Unprocessed or partially treated ewaste should be stored outside and as far away from operational or administrative buildings as practicable – ideally 20m or as a minimum, 10m.
- Weatherproof covering should be considered for storage locations for components and fractions containing hazardous substances or components (e.g. batteries) to prevent the dispersal of the hazardous materials to the environment and to prevent exposure to excessive heat, water, or any crushing or physical damage during handling, sorting, and storage. This may be a condition within a site license or permit.
- Fire-cut-off switches which operate in the event of fire water or plant failure should be installed and accessible to unloading and sorting and operational personnel.

Reception and unloading of ewaste:

On arrival of a loaded vehicle at a ewaste recycling facility, the details should be checked against transport records to confirm the type of waste and origin and weight etc. If a consignment is not as expected it should be quarantined until such time as the details can be verified.

The vehicle should be monitored during reception and unloading in case of damage to the ewaste during transport. Good practice would see the installation of heat-detection equipment at the reception area to quickly establish any immediate problems such as increased heat spots, when emergency measures and isolation (quarantine) of the vehicle / trailer / container should be taken.

The unloading and quarantine areas should be marked on site plans (and within the emergency plans) so that the areas where inbound trailers and containers are confined is known to all site personnel.

Tipping of ewaste from either trucks or large containers/skips or the use of large grab cranes or loading bucket equipment is potentially dangerous as this can cause damage to the ewaste (and internal batteries and other components/substances) and any impact on the ground or other equipment of the ewaste may

cause short circuits in ewaste that build up slowly over the storage and transport period, or immediately cause sparks or flames, hence this practice should be avoided.

Containers should be placed on the ground before letting material slide out, to avoid or at least reduce, ground impact. This is also critical when a logistics operator uses walking-floor/push-floor trucks as there should not be any force applied to push material out of the vehicle.

Once the ewaste is unloaded trained unloading personnel should then assess the incoming ewaste stream and identify and segregate ewaste that may contain internal batteries along with other hazardous components so that they can be removed prior to the mechanical shredding/grinding operations to separate the various fractions.

The use of grab cranes or similar material moving equipment should be avoided during the inspection phase, or only permitted using extreme care to ensure that ewaste is not damaged or crushed as this may impact internal waste batteries and trigger a thermal event. Care must also be taken to ensure that heavy items are handled appropriately to prevent likely them falling and crushing small appliances.

Good practices to also consider for the unloading area include:

- Having different compartments / bunker areas with fire-rated internal walls[17] to prevent the spread of fires
- Having a programme of cleaning to reduce the build-up of dust on the machinery and in the processing buildings and around site generally. Dust extraction systems should be installed where dust has been identified as a risk. .
- Fixed wiring testing for lighting, heating etc. should be carried out every three years.
- Automated and linked fire alarm systems are installed.
- Fire exits must be marked up with the correct signage, ideally photoluminescent so they can be seen in the occurrence of a power failure.
- Suitable material handling equipment (e.g. fork-lift trucks, bucket loaders) and long-arm tongs, welding gloves and heat/spark masks should be available to all personnel handling ewaste containing waste batteries or loose waste batteries so that suspect ewaste and/or waste batteries can be removed from the unloading area to an outdoors area away from structures, vehicles and equipment and personnel, and into separate containers with appropriate fire suppression non-flammable materials. These tools should also be provided in the dismantling and depollution areas. Waste batteries that are swelling, smoking, leaking or overheating should be treated with extreme caution and immediately segregated and placed away from the ewaste activities. See section 3.4.
- Smoking should be prohibited on site (except in a defined smoking area)

For facilities that are receiving whole untreated or partially treated ewaste for recycling, it is further recommended that the criteria for waste batteries set out in EN 50625 Collection, Logistics and Treatment Requirements for ewaste (part 1)[18] should be consulted including for other components that should be removed during a depollution process.

Depollution and treatment of ewaste

This may include a manual depollution and dismantling step and/or an initial 'cracking' mechanical step that lightly opens moulded appliances before the items travel along a picking line for operatives to remove embedded / internal waste batteries. Any cracking of the cases should be minimalised to prevent decompression and internal damage, including avoiding the removal of battery labels.

[17] *Examples of fire-rated walls, partitions, steel beams etc. may be seen here: https://www.promat.com/en/construction/*

[18] *EN 50614 and EN 50625 were published by CENELEC, the European Electrotechnical Committee for Standardization responsible for developing and defining voluntary standards at European level https://www.cencenelec.eu/about-cenelec/*

Waste batteries that are accessible in the equipment without using tools should be removed from ewaste before any further treatment process that can cause damage to them.

Waste batteries which are not accessible within the ewaste without using tools (e.g. moulded equipment that has no opening or access point to manually remove the battery) should be handled as an identifiable stream where special attention to the risks can be given.

Batteries that are removed following a mechanical step (e.g. using a 'cracking' plant to open the carcasses without damaging the batteries) should be segregated as an identifiable stream during the treatment process.

Bank readers and e-price tags and other small digital equipment (pervasive electronics[19]) containing lithium batteries

These products arising at ewaste facilities are known to be a cause of fires due to their size, the volumes arising and additional hazards such as textile materials. The majority of the waste batteries found in these products are lithium types and usually button cells (similar to those found in hearing aids).

Attention should be given to identifying these streams, and where possible, arrange for distinct / separate consignments and safe packaging prior to collection so that on arrival at the ewaste facility manual dismantling steps can be taken to remove the waste batteries prior to further treatment.

See **ANNEX D** for examples of small and pervasive electronics.

Waste lithium battery button cells should be taped in batches to prevent contact and short-circuits during interim storage and transport to the waste battery facility (see **ANNEX E** for good practice procedures in storing, packaging and transporting waste lithium batteries).

Storage of mixed / unsorted waste batteries

All waste batteries should be stored in a cool and dry zone and removed from the main ewaste treatment area. Portable unsorted waste batteries should be packaged in either 60L UN-approved drums or boxes. All drums or boxes must have the "Portable Waste Batteries Only" label that bears the mark "Contains Lithium Waste Batteries for Recycling". Good practice would include using intermediate packing material such as vermiculite or sand over the waste batteries at different levels within each container – e.g. at the end of each shift, and when the drum is full prior to a lid being attached.

Damaged waste lithium batteries must not be placed into these containers but segregated with further fire prevention measures such as additional taping. Damaged waste lithium batteries should be clearly identified and stored in a separate area away from other waste batteries and the ewaste treatment area. They should be consigned to the waste battery facility as expediently as possible.

Inspections and monitoring of the containers of waste batteries should be carried out on a regular basis. Good practice would include the use of heat and smoke sensors to provide an early warning system.

Storage of sorted / segregated waste lithium batteries

Lithium batteries segregated from other battery chemistries, these should be protected to prevent exposure to excessive heat, water, or any crushing or physical damage during handling, sorting, and storage.

[19] *Details of what pervasive electronics are can be found here: https://www.step-initiative.org/webinar/what-are-pervasive-electronic-products.html*

All separated and/or loose batteries should be:

- Inspected for damage
- For larger waste lithium batteries, when battery terminals are /can be close to each other, the battery terminals should be protected or isolated to avoid sparks or heat from a residual charge. Unless alternative procedures are in place for particular types/groups of lithium batteries (e.g. using the manufacturers specification and guidance), the positive (raised) terminal should be protected with tape: either packing, duct, or electrical tape. Alternatively, each battery can be placed in its own clear, sealable bag or wrapped securely with shrink-wrap.

- For smaller waste lithium batteries, other more practical protection means may be used, such as storing them in barrels with vermiculite.
- Stored in appropriate containers that are clearly labelled so that all site personnel can quickly identify the correct storage area, and for site personnel to be able to direct fire service in the event of an emergency.
- Stored in clearly marked / signed areas, with good access to allow the quick access from 360^{o} for distinct firefighting and evacuation actions
- Stored in compartmentalised storage bays constructed with fire-proof / non-flammable materials.
- Regularly monitored with gas and / or temperature detectors (e.g. hand-held heat cameras) and be in areas with additional fire monitoring systems.

See **ANNEX E** for good practice procedures in storing, packaging and transporting waste lithium batteries.

- **E-bike / e-scooter batteries**

These products contain large lithium batteries that are known to be volatile due to the potential for damage during the products use.

Additional steps should be taken prior to transporting to the waste battery facility:

- Extra isolation with isolation tape on contacts and wires
- Shrinkwrap at least five or six times per waste lithium battery to prevent contact of the terminals / short circuiting
- Store drums in a cool and dry dedicated storage area that is marked with the UN codes and labels for transport.
- Good practice would be to use more sturdy ASP's ADR compliant container (with vents to prevent them becoming pressure vessels) instead of drums that is appropriate to the volume of batteries being stored.

See **ANNEX E** for good practice procedures in storing, packaging and transporting waste lithium batteries.

Transport to the waste battery facility

Batteries arising as a waste at a ewaste recycling facility should be handed over to a Battery Collection Scheme or network[20] so they can be transported to a specialised waste battery treatment facility as soon as is practical. .

[20] *The Battery Regulation (EU 2023/1542) Article 56 sets down that the battery producers have extended producer responsibility for the batteries they make available on the market. A producer responsibility organisation (PRO) is a legal entity that financially, or financially and operationally, organises the fulfilment of extended producer responsibility obligation on behalf of the producers connected to the specific PRO. EUCOBAT https://www.eucobat.eu/ is one such Collection Scheme, whose members are PRO's in the various battery categories, across the EU.*

When preparing batteries for transport to a waste battery treatment facility, attention should be given to the requirements under 3.3 regarding compliance with the international rules on the carriage of dangerous goods (ADR, ADN, RID, IMDG Code, SOLAS[21]). This includes where battery chemistries are not sorted at the ewaste recycling facility, and the ewaste is to be consigned as mixed/unsorted batteries.

Good practice points to consider:

- **Damage Assessment**: Before transport, inspect the waste batteries for signs of damage, such as bulging, corrosion, or leakage. Damaged batteries require special handling due to the increased risk of thermal events.
- **Photographic Documentation**: Once the waste batteries are packed, take photographs of each container (with lids removed) to confirm and document the packing method for compliance and safety records.
- **Emergency Preparedness for Transport**
    - **Emergency Response Plan**: Develop a response plan for lithium battery incidents during transport, ensuring drivers understand emergency procedures. Regularly update and review the plan.
    - **Vehicle Safety Equipment**: Equip all vehicles with **Class D fire extinguishers** (suitable for lithium battery fires) and spill kits for handling electrolyte leaks from damaged batteries.

3.7 Waste Battery Facilities – where loose batteries may be received for sortation and/or interim storage and onward treatment and recycling operations.

To accommodate the diverse range of treatment and recycling processes across Europe and recognising the commercial sensitivity of innovative techniques and operating plants installed at privately owned facilities, this section provides recommendations for the sorting and interim storage of waste batteries and a general overview of the activities conducted at waste battery facilities where these treatment and recycling processes are performed.

Sortation operations

Ewaste facilities are unlikely to sort the waste batteries into different chemistries following their removal during the ewaste dismantling process due to space, expertise and staff available.

Mixed waste batteries from these facilities will therefore be packed in accordance with transport rules as unsorted consignments. These mixed waste battery consignments will contain a proportion of waste lithium batteries.

Waste battery facility operators are therefore advised to consider the unique hazards that mixed waste batteries present, as well as to consignments of pre-sorted and segregated waste lithium batteries that may be delivered to them. See section 3.6.

The waste battery facility operator should apply additional good practice procedures for waste lithium batteries that have been damaged or are defective as they pose significant fire and explosion risks, which can lead to thermal runaway, being a rapid, self-heating reaction that may release flames or toxic gases.

[21] *See **Annex B** for the explanations of these UN transport regulations.*

In the Netherlands, guidelines[22] were published in 2023 (*available only in Dutch at present*) setting out which measures can be used to manage the risks of storage of lithium batteries, including the charging and discharging of energy.

These measures are based on a risk approach that is based on the scenarios that can occur. Based on the scenarios, goals have been formulated with the aim of creating an acceptable level of safety.

The measures were then derived from the goals. These measures may reduce the chance of an incident or prevent or limit the adverse consequences of an incident. Information about the risk approach taken can be found in Chapter 3 of these guidelines.

Sorting by Chemistry and Type:

To facilitate recycling, waste batteries should be sorted by chemistry (e.g., Nickel Manganese Cobalt (NMC), Lithium Manganese Oxide (LMO), Lithium Iron Phosphate (LFP), etc.) and by type (e.g., portable, industrial, automotive). Ensuring accurate sorting by chemistry helps direct each battery type to the correct recycling process, maximising material recovery and maintaining safety.

Battery Identification Process:

- **Identify Battery Chemistry and Type:** Check battery labels for key indicators of chemistry, such as NMC for Nickel Manganese Cobalt, LMO for Lithium Manganese Oxide, and LFP for Lithium Iron Phosphate. Ensure that batteries are indeed lithium-ion, as this affects recycling and handling procedures.
- **Simplified Codes:** Some labels may include basic codes that indicate battery shape and dimensions, e.g., numbers for cylindrical sizes (like 18650) or type abbreviations (such as "LFP" for Lithium Iron Phosphate). Use these where available for faster identification.

Storage Controls

- **Storage Layout and Monitoring**:
  - **Avoid Stacking**: Store batteries on stable, non-combustible surfaces and avoid stacking to minimise risk of damage or overheating.
  - **Thermal Monitoring**: Use thermal imaging cameras or handheld thermal imaging devices to monitor for signs of heat generation or thermal events, allowing early detection and response.
  - **Ventilation and Access**: Ensure storage areas are well-ventilated to disperse any gases that may be released, particularly from damaged batteries. Maintain sufficient space around each container for safe inspection and handling.

- **Separation from Hazards**:

[22] *Guidance on the transport and storage of lithium batteries – NL* https://publicatiereeksgevaarlijkestoffen.nl/publicaties/online/pgs-37-2/2023/1-0-december-2023#top

- Store waste batteries away from combustible materials, heat sources, and both **moisture and water** to minimise fire risks and prevent hazardous reactions. Batteries should be stored in dry, enclosed areas, protected from outdoor elements and locations where water can collect.
- **Protection from Impact**: Ensure battery containers are stored in designated areas away from high-traffic zones or areas where they could be accidentally damaged by vehicles or equipment. Use physical barriers if necessary to prevent impact.

TREATMENT OVERVIEW – Recommended overview of safety measures

Safety at a waste battery recycling facility is essential to protect workers, equipment, and the environment from potential hazards, such as toxic chemicals, flammable materials, and heavy machinery. Here are some core safety measures that should be in place:

- **Risk Assessment and Safety Planning**
  - Conduct comprehensive risk assessments to identify potential hazards, such as chemical exposure, fire risks, and machinery accidents.
  - Develop and regularly update an Emergency Response Plan to address incidents like chemical spills, fires, or worker injuries.

- **Personal Protective Equipment (PPE)**
  - Provide appropriate PPE based on the nature of work, including gloves, safety goggles, face shields, respirators, and chemical-resistant clothing.
  - Ensure PPE training and make regular checks to confirm proper use and maintenance.

- **Battery Sorting and Handling Procedures**
  - Implement protocols for handling and storing different types of batteries (e.g., lithium-ion, NiMH, NiCd, alkaline), as different battery chemistries pose unique hazards.
  - Ensure that batteries are inspected and sorted before processing, with damaged or leaking batteries handled with special care to prevent chemical exposure.

- **Fire Prevention and Control**
  - Install fire suppression systems, such as sprinklers and gas-based extinguishers, especially near areas with lithium-ion batteries, which are highly flammable. See section 3.1.
  - Ensure all workers are trained in fire safety procedures, including the use of fire extinguishers and evacuation routes.

- **Ventilation and Air Quality Control**
  - Install ventilation systems to prevent the buildup of toxic fumes, particularly in areas where batteries are crushed or broken down, releasing hazardous chemicals.

- Monitor air quality regularly and maintain ventilation filters and alarm systems to ensure a safe working environment.

- **Chemical Spill and Leak Containment**
  - Establish containment areas and spill kits to address potential chemical leaks or spills promptly.
  - Train workers in spill response procedures and ensure they understand how to manage different types of chemical hazards.

- **Equipment Safety and Machine Guarding**
  - Ensure machinery is fitted with appropriate safety guards and emergency stop functions to prevent accidental contact with moving parts.
  - Conduct regular maintenance checks and provide training on safe operation of machinery, such as crushers and shredders.

- **Training and Safety Drills**
  - Train workers on the proper handling of hazardous materials, use of PPE, emergency response, and reporting protocols for unsafe conditions.
  - Conduct regular safety drills, including fire, chemical spill, and evacuation exercises.

- **Storage and Segregation of Waste Materials**
  - Segregate batteries by chemistry (e.g., NiCd, NiMH, lithium-ion etc.) to reduce the risk of reactions between incompatible materials.
  - Store batteries in designated areas with appropriate labels and protection against temperature fluctuations, which can lead to thermal runaway in lithium-based batteries.

- **Environmental Protection Measures**
  - Ensure wastewater from battery processing is treated before discharge to prevent contamination of local water sources.
  - Use filters and containment measures to capture and safely dispose of any harmful dust or particles generated during processing.

- **Regular Audits and Compliance Monitoring**
  - Perform regular safety audits to verify adherence to safety standards and compliance with local and international regulations.
  - Address any identified safety gaps and ensure continuous improvement through feedback and updated safety protocols.

Implementing these safety measures helps ensure that waste battery recycling sites operate safely, protecting workers, the surrounding environment, and the community.

Post treatment – considerations for the safe handling and transport of lithium black mass:

Black Mass is an intermediate output material produced from recycling lithium-ion batteries. It contains key minerals like cobalt, nickel, and lithium, which are recovered through the recycling process.

Exports of hazardous waste, including black mass, are permitted only to OECD countries with facilities that meet regulatory standards for hazardous waste processing. Exports to non-OECD countries are prohibited.

Due to its hazardous properties, black mass requires careful handling and storage to ensure safety, including:

Classification and Packaging Requirements

- European Waste Category (EWC) Code: Black mass is classified as EWC 19 12 11* (Other wastes from mechanical treatment of waste containing dangerous substances).
- UN Number and Classification: Black mass falls under UN 3077, classified as a Class 9 Dangerous Good (Environmentally Hazardous Substance, Solid, N.O.S.), with Packing Group III.

Dangerous Carriage of Goods -Compliant Packaging: as per transport requirements:

- Lined, UN-Approved FIBCs (Flexible Intermediate Bulk Containers) are suitable for large quantities when transported in sealed shipping containers.
- Steel Drums or Rigid Containers with double liners provide additional protection from moisture exposure.

Storage and Handling Controls

- Keep Dry: Black mass is reactive and can releases gases it becomes damp. Store in a dry, enclosed area, avoiding conditions where water could enter containers.
- Ventilation and Dust Control: Ensure adequate ventilation to avoid dust buildup
- Handling: Black mass is toxic; appropriate PPE must be worn whenever handling is required.
- Spill Control: In case of a spill, wear PPE and prevent black mass from entering surface water drains. Sweep up the material carefully and repackage it according to handling instructions

Documentation and Labelling Requirements

- Dangerous Goods Note: Transport requires a Dangerous Goods Note indicating its UN number (UN 3077), hazard classification, and specific handling requirements.
- Consignment Labelling: Containers must display Class 9 hazard labels and the UN number, ensuring compliance during transport.

4. Conclusions

This guidance document offers both broad, general advice and specific, actionable recommendations for best practices in industry operations. It is intended for anyone involved in the collection, logistics, storage, re-use, and treatment of ewaste and waste batteries. While users may focus on the topics most relevant to their specific activities, it would be important and useful to evaluate the additional operational recommendations throughout this document, as many practices for the different waste activity flows are interconnected.

Finally, collection and logistics operators, municipalities, preparing for re-use operators, and ewaste recyclers should stay attentive to developing regulations and ongoing innovations in product and battery design. With lithium batteries now being integrated into unexpected areas of equipment (as highlighted in **ANNEX D**), handling and processing this equipment will present increasing challenges to ensure safety. It is crucial to prioritise the safety of personnel, equipment, and businesses amidst these evolving complexities.

If you (the reader) have any recommendations for good practice not covered in this document, or suggestions for future versions, please contact industryguideforwastelithiumbatteries@eera-recyclers.com

5. Partners to this Guide

Thanks are given to the following contributors to this guidance document who gave their time and expertise in its development:

The British Metals Recycling Association (BMRA) is the UK trade association representing all metal recyclers. It focuses on engaging with key stakeholders while representing, promoting and supporting their members while in turn fostering a viable and successful metals recycling industry. https://www.recyclemetals.org/

EBRA is the European organisation defending the interests of professional companies involved with the collection, sortation, treatment, material recovery and repurposing or reusing of portable, industrial and EV batteries. www.ebra-recycling.org

EERA is the voice of ewaste recycling in Europe being the professional association for the ewaste recycling and reprocessing industry. Our mission is to achieve a level playing field for fair competition in the ewaste value chain, harmonisation of regulations, effective and efficient recycling and reprocessing with prevention of pollution, minimization of emissions and a high quality of secondary raw materials and components. www.eera-recyclers.com

EUCOBAT is the European association of national collection schemes for batteries. They represent the interests of the national compliance organizations for batteries in Europe; and to harmonise the procedures, in particular in regard to participating companies, and activities of national compliance organizations that assume the financial and/or organisational responsibility of manufacturers for the management of waste batteries and accumulators. https://www.eucobat.eu/

EuRIC is an umbrella organisation for European Recycling Industries. Through its Members, EuRIC represents companies involved in the collection, processing, recycling, transport and trade of a variety of recyclables (metals, paper, plastics, glass and beyond) across Europe. By servicing its Members, EuRIC contributes to promote recycling, which is first and foremost a business activity driven by an ecosystem of thousands of Small and Medium-size Enterprises (SMEs) and fewer but equally important larger companies. All of them are local and global actors. https://euric-aisbl.eu/

FEAD is the European Waste Management Association, representing the private waste and resource management industry across Europe, including

19 national waste management federations and 3,000 waste management companies. Private waste management companies operate in 60% of municipal waste markets in Europe and in 75% of industrial and commercial waste. This means more than 320,000 local jobs, fuelling €5 billion of investments into the economy every year. https://fead.be/

Insurance Europe is the European insurance and reinsurance federation and the expert and representative voice of the insurance industry. It provides the infrastructure for an exchange of information and experience between members and plays a supporting role in relation to its members activities providing information and guidance on issues of interest to the sector and community as well as in contributing to economic growth and development. https://www.insuranceeurope.eu/

As the advanced rechargeable and lithium batteries association in Europe, RECHARGE promotes the development of rechargeable batteries such as lithium or next-generation zinc, sodium or nickel batteries. They advocate for the sustainable development of an innovative and competitive rechargeable and lithium batteries value chain.
https://rechargebatteries.org/

The WEEE Forum is an international association speaking for fifty-one producer responsibility organisations (PROs). PROs are entities, mandated by producers, that responsibly manage the collection, treatment and recycling of electrical and electronic waste from households and businesses. Every year, the PROs collectively collect in excess of 3 million tonnes of end-of-use electricals. The PROs have operations in all five continents. The WEEE Forum's why is to take on the worldwide societal challenge of ewaste through research and innovation projects, outreach to start-up PROs across the world, campaigns, #ewasteday, partnerships and offering tools and platforms to share best practices and optimise operations.
https://weee-forum.org/

6. References and Recommended reading

References:

- BatteriesTransport is a joint industry initiative with the goal to inform professionals as well as end users on the legal requirements applicable to the transport of battery cells, batteries and equipment containing batteries. www.batteriestransport.org

- Guidelines for the safe storage of lithium-containing energy carriers (***37[2] Lithiumhoudende energiedragers: Opslag*** – in Dutch only). The purpose of this PGS guideline is to record which measures can be used to manage the risks of storage of lithium-containing energy carriers, including the charging and discharging of energy carriers. https://publicatiereeksgevaarlijkestoffen.nl/publicaties/online/pgs-37-2/2023/1-0-december-2023#top

- Batteries Roundtable: The Batteries Roundtable meet regularly to consolidate knowledge, share experience and engage in new activities addressing the issues of fires caused by batteries. *https://weee-forum.org/batteries-roundtable/*

- The European i4R Platform (https://i4r-platform.eu/) is an online database designed to support recycling companies and facilities in Europe by providing them with detailed product information on electronic and electrical equipment. The platform provides technical details and schematics about various electrical and electronic products, including information on materials, hazardous substances and components, and recycling instructions.

Recommended Reading:

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7. Definitions

Battery

Battery' as defined in the Battery Regulation EU 2023/1542, means any device delivering electrical energy generated by direct conversion of chemical energy, having internal or external storage, and consisting of one or more non-rechargeable or rechargeable battery cells, modules or of packs of them, and includes a battery that has been subject to preparation for re-use, preparation for repurposing, repurposing or remanufacturing; Furthermore:

- electric vehicle battery (EV) means a battery that is specifically designed to provide electric power for traction in hybrid or electric vehicles of category L as provided for in Regulation (EU) No 168/2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles, that weighs more than 25 kg, or a battery that is specifically designed to provide electric power for traction in hybrid or electric vehicles of categories M, N or O as provided for in Regulation (EU) 2018/858 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles;
- industrial battery means a battery that is specifically designed for industrial uses, intended for industrial uses after having been subject to preparation for repurposing or repurposing, or any other battery that weighs more than 5 kg and that is neither an electric vehicle battery, an LMT battery, nor an SLI battery;
- non-rechargeable battery means a battery that is not designed to be electrically recharged;
- portable battery means a battery that is sealed, weighs 5 kg or less, is not designed specifically for industrial use and is neither an electric vehicle battery, an LMT battery, nor an SLI battery;
- rechargeable battery means a battery that is designed to be electrically recharged;
- starting, lighting and ignition battery or 'SLI' means a battery that is specifically designed to supply electric power for starting, lighting, or ignition and that can also be used for auxiliary or backup purposes in vehicles, other means of transport or machinery;

Collection

The gathering of ewaste or batteries for the purposes of transport to a sortation facility or a treatment facility. The term "collection" is defined in the Waste Framework Directive 2008/98/EC

De-pollution

Selective treatment during which certain substances, mixtures and components are removed from the ewaste stream. The term "de-pollution" is defined in EN 50625 Treatment of Waste Electrical and Electronic Equipment

Electromobility (or e-mobility)

Electro mobility (or e-Mobility) represents the concept of using electric powertrain technologies, in-vehicle information, and communication technologies and connected infrastructures to enable the electric propulsion of vehicles and fleets. Powertrain technologies include full electric vehicles and plug-in hybrids, as well as hydrogen fuel cell vehicles that convert hydrogen into electricity. e-Mobility efforts are motivated by the need to address corporate fuel efficiency and emission requirements, as well as market demands for lower operational costs. Source: Gartner. "Electromobility" in the context of this document covers both the private and public transport sectors, from electric cars, scooters, and bicycles to buses and trains.

European Waste Category Code:
A harmonised list of wastes that sets out the classification code for each waste type. Each waste type is characterised by a six-digit code. Any waste marked with an asterisk (*) in the list of wastes shall be considered as hazardous waste pursuant to the Waste Framework Directive 2008/98/EC[23].

EWASTE (ewaste):
Otherwise known as Waste Electrical and Electrical Equipment (WEEE) as defined in Directive 2012/19/EU "*..which is waste within the meaning of Article 3(1) of Directive 2008/98/EC[21], including all components, subassemblies and consumables which are part of the product at the time of discarding*".

LMT
Light means of transport battery or 'LMT battery' means a battery that is sealed, weighs 25 kg or less and is specifically designed to provide electric power for the traction of wheeled vehicles that can be powered by an electric motor alone or by a combination of motor and human power, including type-approved vehicles of category L, within the meaning of Regulation (EU) No 168/2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles of the European Parliament and of the Council, and that is not an electric vehicle battery;

Municipal Collection Centre(s) / Municipal Recycling Centre(s)
Municipal waste consists of waste collected by or on behalf of municipal authorities and disposed of through waste management systems. Municipal waste consists mainly of waste generated by households, although it also includes similar waste from sources such as shops, offices and public institutions. Source: Eurostat. In the context of this document, "Municipal Collection Centres" are public facilities provided by municipalities and local authorities for the collection and sortation and onward recycling of various types of waste. They are also called Recycling Parks (Parcs), Civic Amenity Sites or Household Waste Recycling Centres in some countries. They allow residents to dispose of waste that is not suitable for regular household collections, either because of its size, nature, or recycling potential. (This explanation is a common understanding of the terms used within Europe).

Personal protective equipment (PPE)
Personal protective equipment, including items of clothing or equipment such as helmets, goggles, gloves and steel toe-capped shoes or boots designed to protect the wearer from the risk of injury or infection.

Removal
The Waste Electrical and Electrical Equipment (WEEE) Directive 2012/19/EU contains the following: "removal means manual, mechanical, chemical or metallurgic handling with the result that hazardous substances, mixtures and components are contained in an identifiable stream or are an identifiable part of a stream within the treatment process. A substance, mixture or component is identifiable if it can be monitored to verify environmentally safe treatment".

Re-use
The Waste Framework Directive 2008/98/EC[21] contains the following: "'re-use' means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived".

[23] *Waste Framework Directive https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098*

ANNEXES

A. Recommendations of suitable collection bins, barrels, drums and boxes

B. Summary of transport requirements

C. Descriptions of the types of electrical fires

D. Examples of vapes, bank readers, e-tags and other small digital equipment (pervasive electronics) containing lithium batteries

E. Photo of how button cells are recommended to be safely secured for storage and transport

ANNEX A – Recommendations of suitable collection bins, barrels, drums and boxes

For the transport of waste electric equipment containing lithium batteries by road, the special provision SP670 of the ADR regulation is applicable. The equipment containing only button cells (such as cells for memory back-up) is exempted, but other equipment should be transported under the packaging instruction P909, or similar packaging condition as described in the SP670. See www.batteriestransport.org for more information.

Ewaste is not recommended for collection or transport in open top, large bulk containers as this can potentially damage the product casing during the drop to the container floor or on top of other ewaste, and also allow the ingress of rain, as well as damage to the internal parts and batteries. Good practice includes the use of smaller cages where householders and other users can place discarded electronic equipment into so that greater care can be taken, and allowing site personnel to monitor the condition of the items being stored.

These are good examples – courtesy of www.ipp-pooling.com



Combination of Q1210 pallet and P80L, 4 side-walls with closed transparent PET-interior.



Combination of Q1210 pallet and P80L, double-stack, and L1210 plastic lid.

The following information and links are examples of appropriate collection containers for segregated waste lithium batteries, based on industry suggestions. The containers below are suitable for different stakeholders and different applications and are not endorsed or advocated as the only options available on the market.

The specific circumstances and needs of the operators must be considered following the risk assessment of the suitability of these recommendations before their actual purchase. The guidance of an expert in fire emergency management is highly recommended to ensure the utmost safety and reliability in emergency situations.

Further collection container information may be available from your National Battery Collection Scheme.

ASP containers

https://doorveen.nl/en





Gelkoh Drums and LiBa Boxes

https://www.nefab.com/solutions/packaging-solutions/





P908 /P909 EV containers

https://www.wellplast.com/products/battery-packaging/





Bebat Pro

ASP containers and drums

https://bebat-pro-bv.odoo.com/#product





Kuusakoski has teamed up with Olfactomics, a leader in the design and manufacture of 21st century gas analytics for medical and industrial applications, to solve the inescapable threat of Lithium-ion batteries. SBS (Smart Battery Sensor) is a Lithium-ion battery fire detection device that gives you up to 90 minutes of reaction time before smoke appears. When SBS detects critical Lithium-ion battery failure, alerts are sent through your business's communication channels (MC Teams, Slack, SMS, etc.) and an automatic voice call. Local fire authorities can be notified, and key responders will be walked through a step-by-step Lithium-ion battery fire safety guide. Smart Battery Sensor - Kuusakoski Global



ANNEX B – Summary of transport requirements

For more information visit www.Batteriestransport.org where up-to-date legal advice can be found.

The transport of battery cells, batteries and equipment containing batteries is regulated by the international UN Regulation for the Transport of Dangerous Goods ADR, ADN, RID, IMDG Code, SOLAS

These acronyms refer to various international regulations and standards related to the safe transportation of dangerous goods, both by land and by sea. Here's a summary of each:

ADR (Accord Dangereux Routier)

The "European Agreement concerning the International Carriage of Dangerous Goods by Road" (ADR) is a treaty that governs the international transport of hazardous materials by road in Europe. It applies to the classification, packaging, labelling, and transportation of dangerous goods by road across continental European countries and some neighbouring countries.

ADN (Accord Européen relatif au Transport International des Marchandises Dangereuses par Voie de Navigation Intérieure)

The "European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways" (ADN) regulates the transport of dangerous goods on rivers and other inland waterways in Europe. This is similar to ADR but specific to waterways, covering packaging, labelling, and securing dangerous cargo for river and canal transport.

RID (Règlement concernant le transport international ferroviaire des marchandises dangereuses)

The "Regulations concerning the International Carriage of Dangerous Goods by Rail" (RID) is a set of rules under the Convention concerning International Carriage by Rail (COTIF) that governs the transport of hazardous materials by rail in Europe and some Asian countries. This includes requirements for the classification, packaging, labelling, and securing of dangerous goods for rail transport.

IMDG Code (International Maritime Dangerous Goods Code)

The IMDG Code is a set of guidelines issued by the International Maritime Organization (IMO) for the safe transport of dangerous goods by sea. It covers packaging, labelling, handling, and storage of dangerous goods on cargo ships, and it applies worldwide.

SOLAS (Safety of Life at Sea)

The "International Convention for the Safety of Life at Sea" (SOLAS) is an international treaty that sets minimum safety standards for the construction, equipment, and operation of merchant ships. Although broader than just the transport of dangerous goods, SOLAS includes provisions for the carriage of hazardous materials and requires compliance with the IMDG Code.

The Regulations aim to ensure safe transport of battery cells, batteries and equipment containing batteries by road, air and sea, the UN Transport of Dangerous Goods Regulation sets out the internationally mandatory testing, packaging and reporting obligations for these products. The regulation applies to professional transport only.

The obligations apply to:

- lithium-based batteries,
- lead-based batteries,
- nickel-based batteries, and
- sodium-based battery technologies.

All four battery chemistries are classified as **Dangerous Goods**. Non-compliance with these requirements represents a severe safety, financial and reputational risk.

Lithium-ion batteries

Due to their dual hazard properties associated with their chemical and electrical content, lithium-ion batteries (UN 3480) as well as lithium-ion batteries contained in equipment or packed with equipment (UN 3481) are classified under CLASS 9 Dangerous Goods.

Nickel- & Lead-based batteries

Non-lithium batteries are classified as "Class 4.3" and "Class 8 " Dangerous Goods in accordance with United Nations Recommendations on the Transport of Dangerous Goods Model Regulations.

Packaging and Documentation Requirements

The guidance table below details some of the appropriate packaging and documentation for lithium-ion batteries based on their condition, in line with ADR regulations. See www.batteriestransport.org for further information:

Battery Condition	LoW Code[24]	Applicable UN Number	ADR Packaging Requirements	Packaging Options	Documentation Required
Undamaged Lithium-Ion Batteries	16 06 05	UN 3480 (Standalone)	ADR-compliant packaging per Packing Instructions P903 & P908 P909, according to Special Provision SP377	(particularly for batteries < 12kg) - **UN-certified boxes** (cardboard, metal, or plastic) - **UN-approved barrels** (metal or rigid plastic) - **Non-combustible** cushioning material such as vermiculite	- **Waste Transfer Note** - **Dangerous Goods Note** for UN 3480
Damaged Lithium-Ion Batteries	16 06 05	UN 3480 (Standalone)	ADR-compliant packaging per Packing Instruction P909 P908, according to SP376	- **UN-certified boxes** (cardboard, metal, or plastic) - **UN-approved barrels** (metal or rigid plastic) - **Non-combustible** cushioning material such as vermiculite - **Electrolyte leakage containment**	- **Waste Transfer Note** - **Dangerous Goods Note** for UN 3480
Lithium-Ion Batteries in Equipment (e.g embedded in ewaste)	16 06 05	UN 3481 (Contained in or with equipment)	ADR-compliant packaging to prevent short-circuits and secure items during transit SP637	- **UN-certified boxes** - **Barrels or crates** with internal supports to prevent movement - maximum quantity of 333kg of lithium	- **Waste Transfer Note** - **Dangerous Goods Note** for UN 3481

[24] The List of Waste (LoW) codes for batteries is being amended under the Waste Framework Directive and is expected to be in force in 2026. Once the reclassification for all batteries and batteries waste is in force, for any exports of waste containing batteries or waste batteries themselves will be subject to pre-informed consent notifications and approvals before shipments can be arranged.

				batteries per transport (truck)	
Damaged or Defective Lithium-Ion Batteries liable to react during transport	16 06 05	UN 3480 and / or UN3481	ADR Packing Instruction P911 for damaged batteries, according to SP 376, requiring fire-resistant packaging	- **UN-certified Box** (tested under ADR P911 and certified to UN Packing Group I for high-risk items) - Metal drums with non-conductive liners - Plastic barrels with non-conductive, absorbent materials like Battery Fire Pillows	- **Waste Transfer Note** - **Dangerous Goods Note** - Special Handling Instructions if needed - Packaging test report

Example labelling for containers and boxes:






9
UN3480


9

Decision Flowchart for products (EEE and WEEE) containing batteries classed as 'Dangerous'

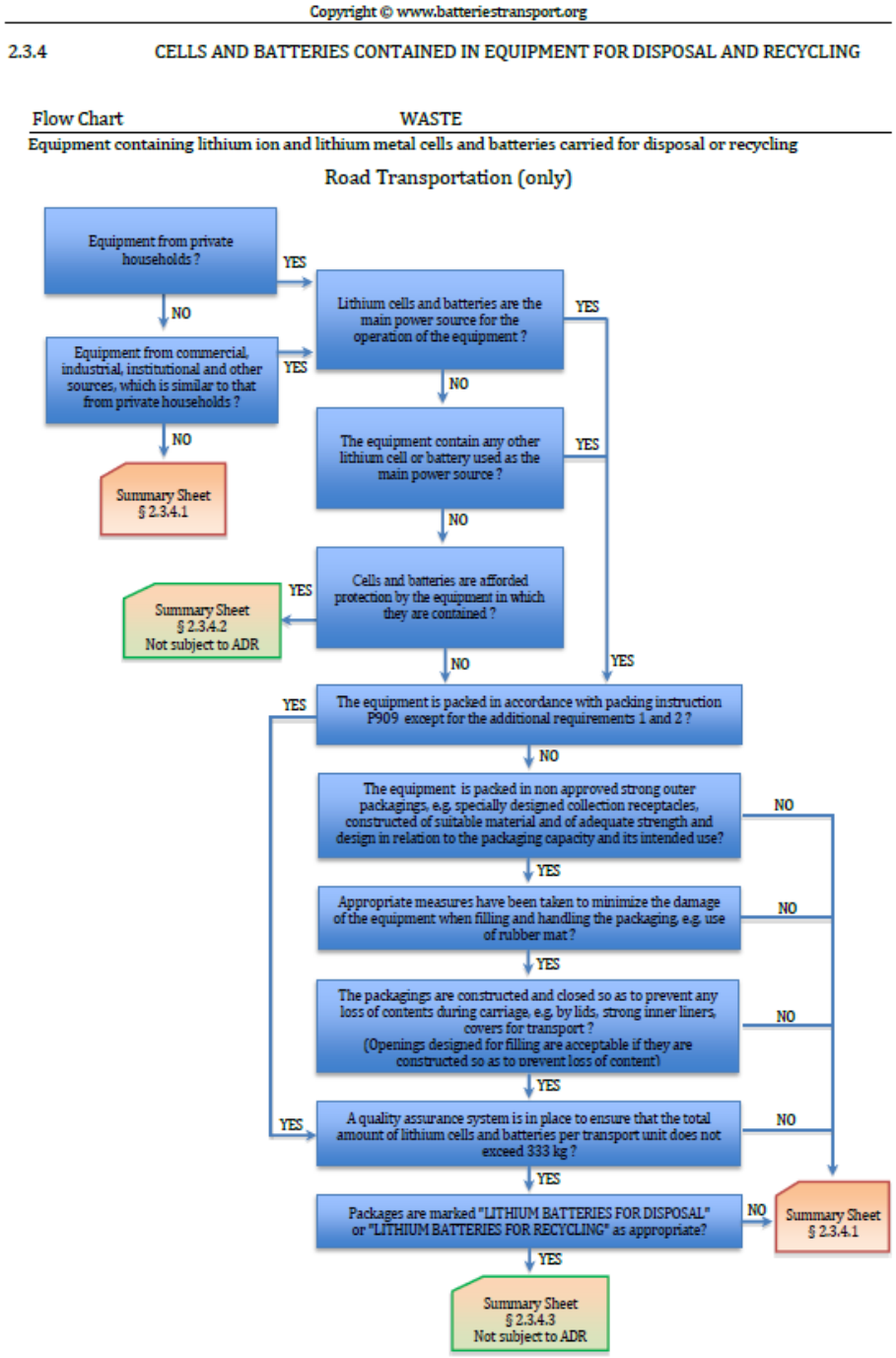


Diagram courtesy of www.batteriestransport.org

ANNEX C – Descriptions of the types of electrical fires and photos of lithium battery fires

Electrical fires occur when electrical components malfunction, leading to sparks, overheating, or arcing that ignites nearby flammable materials.

The fires are simulated, in certificated fire bodies in a furnace, following standard curves that defines the relationship between temperature vs time, to get to a classification, according to the time that the system stands the temperature (30 minutes, 60 minutes, 120 minutes,…).

Some common examples of electrical fires:

- Overloaded Circuits

Overloading an electrical outlet or circuit with too many devices can cause overheating. This often occurs when multiple high-wattage appliances, like space heaters, are plugged into a single outlet or power strip, which may not be designed to handle such a load.

- Faulty Wiring

Damaged or frayed wires can lead to arcing, which generates heat and can ignite materials around the wire. This can happen in old or poorly installed wiring, especially if the insulation has degraded or been punctured.

- Outdated or Damaged Electrical Panels

Electrical panels manage the power distribution throughout a building. Older or damaged panels may not handle modern power needs, and if a circuit breaker fails, it can lead to overheating. Some older panels have known defects and have been linked to higher risks of electrical fires.

- Loose Connections

Loose connections in outlets, light fixtures, or other electrical devices can cause intermittent arcing, producing heat. Over time, the accumulated heat can lead to ignition, especially in confined spaces with flammable materials.

- Poorly Installed Lighting Fixtures

Installing light fixtures with bulbs that exceed the fixture's wattage rating can create too much heat, damaging the fixture and leading to ignition. Similarly, using a high-wattage bulb in an enclosed fixture can cause it to overheat.

- Misuse of Extension Cords

Extension cords are often used temporarily, but when they're used long-term or with high-power devices, they can overheat. This can happen especially when cords are run under rugs or furniture, preventing heat dissipation.

- Lightning Strikes or Power Surges

A power surge from a lightning strike or a sudden power spike can overload circuits and cause overheating. Surges can damage insulation or wiring, leading to a fire hazard if not managed by surge protectors.

Photos of waste lithium battery fires / risk of fires





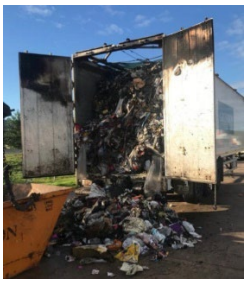


Photo courtesy of Grundon Waste Management Ltd







Damaged ewaste / lithium batteries that need special handling and attention.









ANNEX D – Examples of vapes, bank readers, e-tags and other small digital equipment (pervasive electronics) containing lithium batteries

The following examples show the broad range of pervasive electronics that is entering the marketplace and already reaching ewaste recycling facilities. Extreme caution must be taken by all stakeholders as waste batteries and wiring may be hidden in unexpected locations. Manual disassembly is the best)and only) approach to ensure the removal of waste lithium batteries prior to shredding and granulation.

Vapes







Bank readers, e-tags, shelf labels and monitors







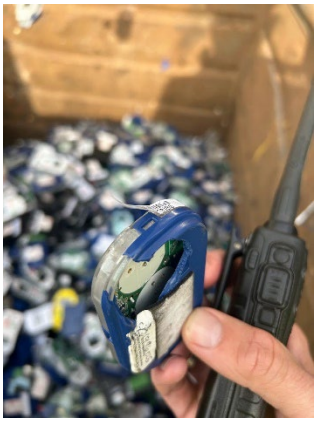
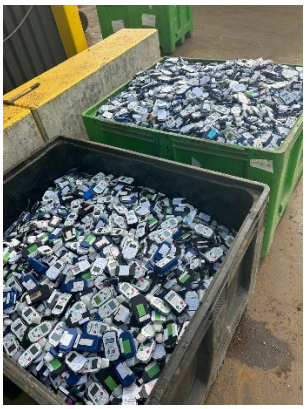


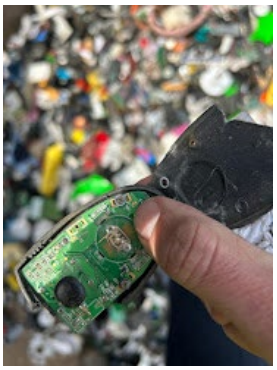
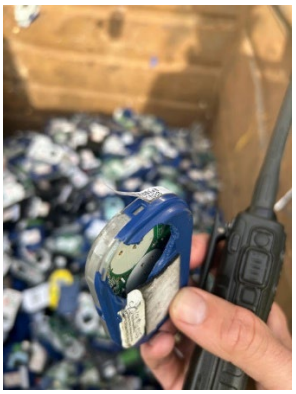






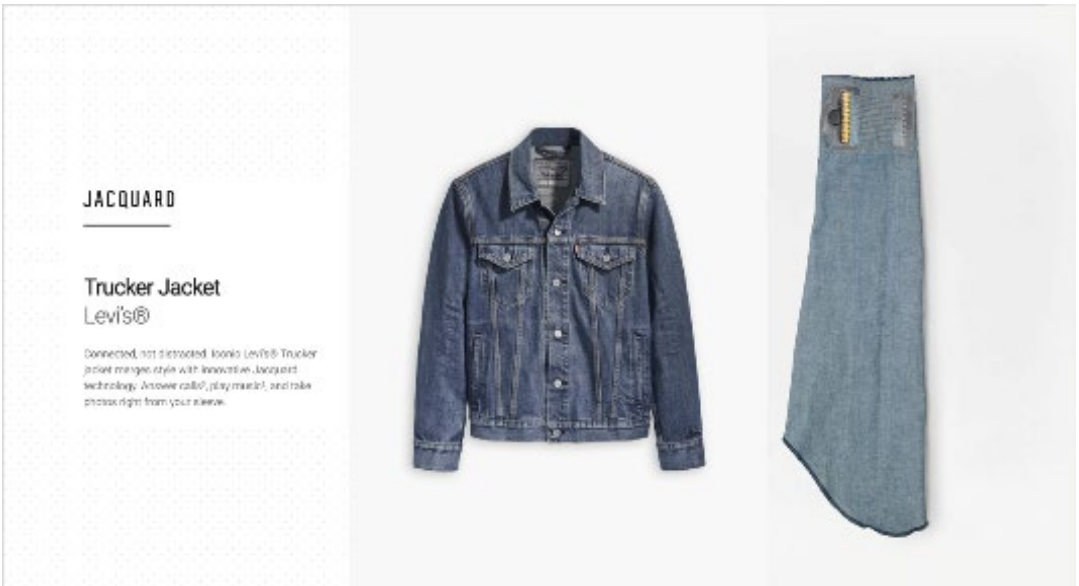
Bank cards and toll tags

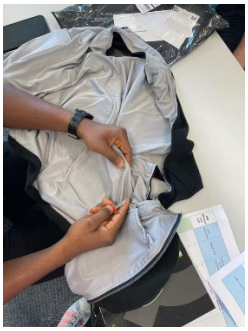


An e-textile denim jacket with inbuilt electrical functions to take photos, play music etc.



E-textile - Heated Gilet for Men with 16000mAh 7.4V Power Bank, with 17 Heated Zones, USB Electric Jacket
Amazon - BEKOMIYA-Heated-Jacket







E-Textile rechargeable gloves that provide heat



Ladies Sports Shorts – measuring temperature and sweat.

Before treatment to remove battery/electronics



After treatment



Wearable fitness rings – with up to 7-day battery life:

These are designed to collect data from the (sub)surface of the skin (HR, SP02, temperature…) via sensors and provides recommendations, reports, calculates other data (HRV, sleep phases) etc. via a mobile app.





An example of a curved lithium batter (3.7v)

These small curved products and batteries are unlikely on their own to be the cause of a fire incident unless they are faulty or damaged.

Disposal in the general waste stream (likely, due to their small size) may cause problems at material recycling facilities and/or waste incinerators; or if they arrive at an ewaste recycling facility then identification and safe removal of the battery will be challenging.

Medical wearables -

According to the DiCE Project (https://circulardigitalhealth.eu/), 83 million units of medical wearables were placed on the market in Europe in 2020, with an expected growth of up to 20% by 2027.

These products include: e-paper labels; bed number labels, smart wearable sensors and smart pill boxes.

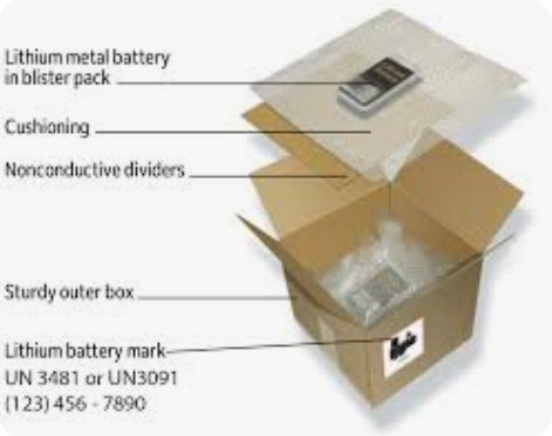






ANNEX E – Good practice procedures for storing, packaging and transporting lithium button cells and other types of waste lithium batteries

Packaging good practice:



Packaging Decision Trees:

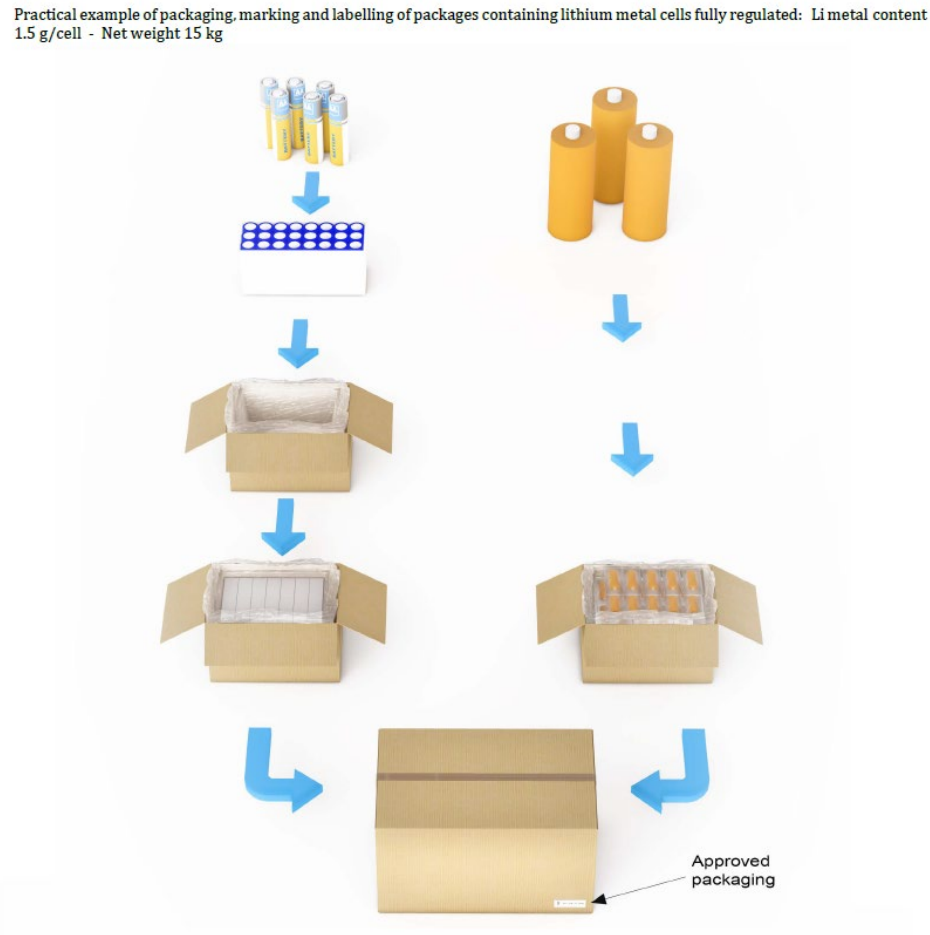


Diagram courtesy of www.batteriestransport.org



Examples courtesy of www.batteriestransport.org

Safe packaging of loose button cells batteries – examples of good practice



Examples courtesy of BEBAT - https://www.bebat.be/en