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# SHARING EXPERIENCES AND BEST PRACTICES WITH BATTERIES IN WEEE

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## SHARING EXPERIENCES AND BEST PRACTICES WITH BATTERIES IN WEEE

Hazards from batteries in WEEE and fires in the collection and treatment chain, where high-energy batteries were at cause, have been well reported. EERA invited its members to share and exchange experiences in how to prevent fires at their recycling facilities and to minimise dangers from high-energy batteries. The basis of this report are contributions from experienced recycling companies. This document highlights experiences in two phases of the recycling chain:

### 1. COLLECTION AND TRANSPORT

Preventive measures and recommendations to the collection chain from collection points to recycling facilities

### 2. TREATMENT, INCLUDING STORAGE AT RECYCLING FACILITIES.

Preventive measures, infrastructural measures, and firefighting measures

Despite all the suggested technical, organisational, and infrastructural measures taken by recyclers, the key to prevent fires is to avoid damage to batteries at all stages of the recycling chain, including collection and logistics. Safety measures and further experience cannot eliminate the inherent risks associated with batteries. It is important that the dangers from waste batteries are addressed as early as possible in the collection and recycling chain. EERA calls on all stakeholders, EU and national rule makers and authorities, to contribute to improving the safety of the collection and treatment of WEEE.

- ADR rules (European Agreement concerning the International Carriage of Dangerous Goods by Road) clearly prohibit the transport of lithium-type batteries in bulk containers. The CENELEC Standard EN 50625 on the collection

and logistics associated with WEEE prohibits crushing, compaction, and uncontrolled tipping of electrical and electronic waste. ADR and EN 50625 must be enforced.

- Removable batteries must be removed prior to shipment. Devices with embedded batteries must be segregated and shipped in compliance with ADR.
- Small electronic equipment which contains an increasing percentage of devices with embedded batteries must not be transported in bulk containers.
- Standardised and easy to recognise labels for the identification of batteries in electronics are needed.
- The required level of knowledge for staff collecting WEEE often exceeds the level of training and qualification generally available to waste collectors.
- The increased costs of compliant handling and of safety measures must be borne by the stakeholders putting battery-operated devices on the market. Modulated fee systems are needed to cover the growing expense caused by batteries in electrical and electronic equipment.
- The future design of devices shall take into account the inherent danger from batteries in the end-of-life stage of electronic equipment. Producers are called upon to design safer batteries, and to facilitate the easy detection and removal of batteries from WEEE. The potential of modern technology for automated detection should be explored.

## INTRODUCTION

Hazards from batteries in WEEE, fires in the collection and treatment chain where high-energy batteries were at cause have been well reported. EERA has been instrumental in collecting data and other information on the issue of fire hazards from high-energy batteries in electronic equipment.

<https://www.eera-recyclers.com/news/characterisation-of-fires-caused-by-batteries-in-weee>

EERA Guidelines on ADR Rules for the Transport of WEEE containing Li-Io-batteries

<https://www.eera-recyclers.com/files/adr-a4def.pdf>

Incidents and large fires occur when batteries are damaged to an extent that the chemical process within the batteries is not contained any more. When batteries ignite, they burn at high temperatures, setting other materials, especially plastics, on fire. Firefighting is often hindered by the development of dense smoke. It is reported that very speedy intervention is needed to contain fires.

In October 2020, EERA invited its members to share and exchange experiences on how to prevent fires at their recycling facilities and to minimise dangers from high-energy batteries. The basis of this report are contributions from experienced recycling companies.

Of the different types of batteries, the Li-Io-type batteries are most often referred to when incidents were reported. Other types of batteries, notably high-energy batteries are also of concern. For the sake of convenience, we use the term Li-Io batteries or simply batteries in this report.

## STRUCTURE OF THIS REPORT

Recycling companies report that many devices with batteries or batteries within devices arrive damaged at their treatment facilities. Often fires occur during or after unloading. More fires occur during storage prior to treatment, during internal material movements and of course during treatment.

This document is highlighting experiences in two phases of the recycling chains:

### 1. COLLECTION AND TRANSPORT

Preventive measures and recommendations to the collection chain from collection points to recycling facilities

### 2. TREATMENT, INCLUDING STORAGE AT RECYCLING FACILITIES

Preventive measures, infrastructural measures, and firefighting measures

## COLLECTION AND TRANSPORT TO RECYCLING FACILITIES

The key to prevent fires is to avoid damage to batteries. Batteries should not get damaged during collection and transport; damaged batteries must not be accepted into the WEEE collection but must be segregated and dealt with separately.

ADR rules (European Agreement concerning the International Carriage of Dangerous Goods by Road) clearly prohibit the transport of lithium-type batteries in bulk containers.

However, waste electronics, especially small devices, are commonly transported in large containers or skips, except for some national collection schemes where smaller boxes or cages are used.

These collection schemes have a much better safety record than those who carry in bulk. The content of large containers is often compressed by the sheer weight of the material or is additionally compacted to increase loads. Unloading is often by tipping where the impact can cause damage to batteries. **This manner of transport is in violation of ADR rules. Also, the CENELEC standard EN 50625-4 on the collection and logistics associated with WEEE prohibits crushing, compaction, and uncontrolled tipping.**

Preferably batteries should be removed already prior to collection by the last owner or on receipt by collection centres to prevent unnecessary and avoidable damage that could take place during collection and transport activities resulting in the potential for fire incidents. In some countries there are concerns that this could be considered a treatment activity for which collectors usually are not licenced or permitted to operate. It is regrettable that legal concerns overrule safety issues. Policy and rule makers are called upon to develop solutions. Preparation of devices for safe transportation should not be considered treatment.

Where battery-containing devices are already required to be separated from devices without batteries in order to transport small devices in bulk containers (Germany), recyclers feel that the quality of separation is not sufficient or in some cases not even practised. In other countries, where WEEE is transported from collection to sorting centres (Netherlands) recyclers see that the sorting is not of sufficient quality and reliability. **Consequently, small devices which contain an increasing percentage of devices with embedded batteries must not be transported in bulk containers.**

Recyclers feel that governments, collection schemes, collection centres and the public are not sufficiently aware of the dangers from high-energy batteries. Last owners of devices know best whether their appliance is battery-operated. Consumers should be better informed about the importance of separating batteries.

Staff at collection centres should be well trained to recognise and prevent dangers. Unfortunately, there are no simple indicators as to whether a device contains a battery because fixed power cables are being replaced by plug-in cables and chargers. It would be preferable to have prominent markings on the devices but often their small size makes this difficult.

**EERA calls upon policy and rule makers to develop rules for standardised and easy to recognise labels for the identification of batteries in electronics.**

The fast-paced and rapid introductions of new electrical and electronic equipment (EEE) and technologies to the markets require comprehensive training and frequent refreshers to be provided to staff employed at recycling facilities as well as relevant contractors and other stakeholders.

These changes, for instance including the reduction in size of EEE, the embedding of batteries in EEE, the increase of devices being changed from plug to battery operation and the increased use of lithium-type batteries over other less hazardous battery types, make it difficult to guarantee battery identification, segregation and safety.

**The required level of knowledge for staff handling WEEE often exceeds the level of training and qualification generally available to waste collectors. Identification and sorting will not be fully satisfactory unless strictly enforced and supported by staff who are fully qualified and receive regular and recurrent training. Producer responsibility organisations and/or national authorities are asked to provide expert advice to collection centres. Video or on-line tutorials are recommended but regular on-site training is also required.**

**Despite the higher cost it is necessary to comply with ADR requirements and to modify the collection for small battery containing devices to box-only systems and to exclude bulk containers.**

- The transport of lithium batteries in bulk containers is prohibited – this includes the transport of devices that contain lithium batteries.
- Small electronic devices are to be collected and transported in boxes or cages not exceeding 3 m<sup>3</sup> or preferably smaller.
- If batteries are reliably removed prior to transport, then bulk transport would be compliant with ADR but there are doubts whether sufficient separation can be achieved in practical operations.
- The importance of removing batteries from devices must be communicated to consumers and all parties involved in collection and transport.
- Under no circumstances shall devices be compacted for transport as specified in EN 50625-4.
- Devices shall not be dropped into boxes or containers and small collection boxes shall not be emptied into large containers/skips from a height.
- Collecting, identification and sorting of WEEE and batteries require qualified, well trained, and motivated staff. Private citizens handing in WEEE to collection centres should not be allowed to dispose of devices without guidance and supervision by trained staff.
- The European Standard EN 50625 (CENELEC) “Collection, logistics & treatment requirements for WEEE - Part 4: Specification for the collection and logistics associated with WEEE” shall be enforced at all stages of collection and logistics.

## ELECTRONIC EQUIPMENT CONTAINING BATTERIES AT RECYCLING FACILITIES – RECEPTION, STORAGE AND TREATMENT

Recycling companies have extremely limited control over the quality of material received at their treatment plants. Many recyclers have commented that the reception and subsequent storage of incoming untreated WEEE requires much attention. Prevention of fire hazards includes organisational and technical measures and influences the layout and design of recycling facilities.

### OPERATIONAL MEASURES

An unfortunate tradition exists in the waste management industry of incoming waste material being tipped from vehicles without delay, for example at landfills, at incineration plants or at scrap yards. Logistics and transport operators expect this level of service turnaround and often such quick unloading is part of their calculation in competitive markets.

In some member states, the legislation for WEEE collection is designed to require this prompt removal of collected WEEE from municipal collection centres. In Germany, failing to collect WEEE within 96 or even 48 hours is considered a misdemeanour or administrative offence and heavy fines may be imposed. These practices are not conducive to the safe handling of WEEE at its delivery to treatment facilities. Storage capacity at the recycling facility may be stretched, resulting in large stockpiles and multiple material movements onsite. There are reports that many fires start with a delayed reaction as damaged batteries take some time for the chemical process to burn through the battery material.

EERA members report improved safety when imposing ‘just-in-time’ deliveries and not accepting deliveries two hours before site closing time. As a result of this move to better practice, however, they are facing serious conflicts with customers and logistics operators.

There should not be more material stored in the treatment hall than can be processed by the end of the shift. Any excess material must be stored in dedicated and safe storage areas such as bunkers. There should be no unloading activity unless supervised by staff trained to recognise potential dangers and with the ability to immediately intervene.

Tipping of WEEE from either trucks or large containers/skips is potentially dangerous. The impact on the ground may immediately cause sparks or flames. Containers should at least be placed on the ground before letting material slide out to reduce ground impact. The use of walking-floor/push-floor trucks is critical under these aspects as there should not be any force applied to push material out of the vehicle.

When unloading onto the ground or onto a storage pile a scrap-handler with sufficient range and long enough extension arm should be available to remove any hot or burning material from the pile and drop it into a safe area such as a bunker.

This requires the scrap handler to be sufficiently mobile to reach the pile. Electrically powered scrap-handlers are often used to reduce emissions within the building but are not ideal under the aspect of safety. Wheel loaders (wheeled front-end loaders) are not recommended to build stockpiles as they tend to compact materials.

On-site security is considered particularly important by recycling companies. Some employ security personnel on a 24/7 basis, others rely on technical supervision. Security staff should be equipped with portable temperature control equipment such as handheld temperature cameras.

All recycling operators emphasise the importance of good contacts with local and regional firefighting services. Regular site visits by external fire services are important, practical on-site exercises are recommended. Fire services should be informed about changes at the facility and alarm plans reviewed regularly.

- No unsupervised unloading
- No tipping from heights
- Just-in-time unloading at the treatment line
- Moving machinery at hand when unloading
- No material movement 1 or 2 hours before closing time
- No storage of untreated material in the same area as the treatment line
- Reduced storage capacity
- Limit height and volume of stockpiles and keep distant from other materials
- Site supervision 24/7 (security personnel or technical surveillance)
- Regular temperature control and smoke detection during operational and non-operational times
- Good communication with external local and regional fire services, site inspections

## TECHNICAL MEASURES

Recyclers consider it important that untreated material should be kept separate from treated fractions and stored in bunkers or containers. Bunkers should not be too large, but the roofing should be sufficiently high to allow access of a scrap-handler to remove critical spots of materials. Regulations request covering WEEE so bunkers should be roofed, containers equipped with covers or parked under roofing. Comments from recyclers in southern Europe also recommend protection from excess heat and sunshine. Dividing walls between bunkers shall be built high enough to prevent fires to cross divisions. Walls should be thick enough and of suitable material (such as concrete) to withstand heat.

Recycling companies commented on the need of sprinklers above bunkers. These provide high volumes of water to submerge burning material and to cool neighbouring stocks.

Automatic sprinkler systems are not recommended at storage bunkers during operation of the plant. Preference is given to sprinklers that are turned on remotely by supervising staff rather than the use of fire hoses. Fixed sprinklers can remain turned on even when staff must leave the building due to heat or smoke.

Positive results were reported from installing turret extinguishing systems in combination with heat or smoke detection or infrared cameras. These systems have large throw ranges and allow reaching burning materials over large distances, ideally with automated directing of the turret. A combination of infrared cameras and laser distance measuring allows pointing the turret to hot spots.

Infrared cameras, smoke, or heat detection units are recommended at bunkers and inside buildings. Some companies prefer smoke detectors rather than heat detectors as it might take some time for stockpiles to reach a detectable heat level. Smoke usually rises quite early from a stockpile. “Smart” infrared cameras allow for the programming of different temperature alarm levels within their range.

These cameras were also cited as useful by recyclers in the way that they can recognise other dangerous objects (e.g. gas cylinders).

Treatment machines such as shredders or granulators often have inbuilt water injection systems. Often operators prefer to keep shredders running to bring out burning materials and fight hot spots outside. Conveyor systems at machines or between machines should be designed with easy access to extinguish such burning material. It is noted that recyclers prefer manual firefighting measures on conveyor systems.

Batteries removed from WEEE should be stored separately to other materials in plastic or other drums with internal plastic liners. Batteries should be isolated by layers of vermiculite and it is recommended that damaged batteries are further singled out and stored in plastic foil or bags, such as plastic wrapping foil. The battery storage area should be outside and away from other buildings under roof or canopy.



## INFRASTRUCTURAL MEASURES

Segregation and separate storage of materials require enough bunkers, that are built to prevent the spread of fire. Buildings for processing units and machinery should not be used as storage areas. Silos or similar feed stores within the treatment areas must not be obstructed by machines or conveyors.

It is also recommended to keep free a safe area with easy access where material that is hot, emitting smoke or even already burning can be dropped far enough from other stored material.

Buildings should be divided by fire walls and smoke screens, but access for fire-fighting vehicles must be assured.

Bunkers for untreated waste should be outside and away from buildings but covered, roofed or under canopy. However, bunkers should also allow access to scrap handlers to hot spots. Containers and bunkers must be accessible to fire-fighting vehicles; “double parking” of containers must be avoided.

Bunkers should not be built to against the wall of buildings. Bunkers must have their own fire-resistant back wall which must be at a distance from the building to avoid heat carried to the structure of the building.

Treated fractions (plastics, metals, batteries) are to be stored well separate from untreated materials, preferably not in the same building.

- Firewalls and smoke screens
- Treatment and storage areas separate
- Easy access for fire fighting vehicles to all areas
- Storage in dedicated bunkers
- Not built directly onto building walls
- Bunkers of fire-resistant design
- Bunkers not inside building but away with roofing or canopy
- Bunkers large enough for operation of scrap handlers
- Segregation of materials – untreated WEEE, treated fractions and batteries in dedicated storage areas
- High volume sprinkler systems over bunkers, manual remote operation from safe distance during working hours, automatic operation at non-working periods
- Turret extinguishing systems, automated direction
- Permanent temperature surveillance
- Heat and/or smoke detection
- “Smart” detection systems, for example infrared cameras or object recognition
- Firehoses for manual intervention
- Easy, quick, and safe access to equipment, conveyors

## FIREFIGHTING

Despite the many operational and technical measures recycling companies have taken there remain many dangers from batteries and their potential to set large volumes of combustible materials on fire. Incidents like hot spots, sparks or small fires still occur regularly with the handling and storage of WEEE.

Some measures to prevent these incidents turning into full-scale fires were discussed in the previous chapters Operational and Technical Measures.

When fires, smoke or hot spots are detected, time is essential. A small incident can turn into a large fire within a short space of time, depending on the combustibility of the surrounding material. A mobile scrap handler with a long extension arm or large capacity wheel loaders on standby allows for the speedy separation of burning material to a safe area.

High volume sprinkler systems or turret extinguishing systems should be in place to be turned on immediately when detecting a problem. Fixed installations are preferable over fire hoses that must be unrolled and operated manually, because staff can escape with the sprinklers still running.

Portable fire extinguishers are not suitable as their extinguishing capacity is too small and the operator must go too near to the fire.

It is essential to “flood” fires with large volumes of water and to keep surrounding materials cool.

Members reported good results from injecting F-500 Encapsulator Agent as an additive to water extinguishing systems.

An alarm system - preferably automatic - must be in place to warn staff on site of the danger and to alert external firefighting services. External help must be alerted immediately to save time until their arrival. Management must accept potentially false alarms as preferable to delayed action.

The external services must be familiar with the site. It is advised that regular joint exercises with the facilities staff and external fire services take place. Firefighting strategies must be discussed with external fire services. Fire services often want to extinguish fires by using large amounts of water. Members reported that it is advantageous to transport burning material out of buildings using wheel loaders or scrap handlers if it is safe for the operators to do so. By isolating the burning material consequent damage from water may be reduced.

Staff must be trained regularly in the recognition of dangers and emergency response in case of fires. However, some companies expressed concerns that staff might be overambitious in their firefighting efforts and get themselves into danger. Only staff trained in the use of firefighting equipment should remain to fight a fire, all other staff should be directed to assembly points.

There must be a clear commitment by management and staff to withdraw from dangers from fire, heat, smoke or collapsing structures.

## FIREFIGHTING MEASURES

- Quick reaction is essential for successful firefighting
- Alarm system in place, preferably automatic
- High volume sprinkler systems over bunkers, manual remote operation from safe distance during working hours, automatic operation at non-working periods
- Turret extinguishing systems, automated direction
- Machinery on hand to remove burning material (scrap handler with extension arm)
- Firehoses for manual intervention
- Regular training for staff and joint exercises with external fire service
- Strong commitment by management to safety despite cost
- Safety of staff before cost – leave fires when health or lives are at risk

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## ECONOMICAL ASPECTS OF HAZARDS FROM BATTERIES IN WEEE

This report is based on experiences and recommendations of recycling companies. It is evident that many companies have already invested heavily in the safety of their operations. Additional preventive measures will continue to be developed and applied as the WEEE and battery markets transform. However, there are large risks in connection with waste electrical and electronic equipment and batteries.

More and more consumer products are modified for battery operation, increasing the load of batteries in the waste stream for recyclers to manage.

**The cost of increased risks, the cost of preventing fires and the damage caused by fires as well as the rising cost and difficulties of obtaining insurance cover are today not sufficiently rewarded by the contracts between recyclers and the parties in producer responsibility.**

**These increased costs must be borne by the stakeholders putting batteries on the market.**

EERA calls upon policy and rule makers to devise modulated fee systems to cover the growing expense caused by batteries in electrical and electronic equipment.

## CONCLUSION

**Recycling companies invested heavily in increased operation safety. They gained much valuable experience with the safer handling of batteries and electronics devices containing such batteries.**

**But all the safety measures and further experience cannot eliminate the inherent risks associated with batteries. It is important that the dangers from waste batteries are addressed as early as possible in the collection and recycling chain.**

**Removable batteries must be removed prior to shipment, devices with embedded batteries must be segregated. ADR rules and the standards for collection and treatment CENELEC EN 50625 must be enforced.**

### EERA EUROPEAN ELECTRONICS RECYCLERS ASSOCIATION

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*based on the shared experiences and  
best practices from EERA members.*

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### ABOUT EERA

**EERA, the European Electronics Recyclers Association, is a non-profit organisation that represents the interests of 30 major recycling companies treating waste electrical and electronic equipment (WEEE) in Europe.**

The EERA members recycle ± 2.500.000 tonnes of WEEE annually at more than 100 locations in 22 European countries. EERA members are pre-processors and end processors. EERA recyclers treat 1/3 of the total WEEE market. (2/3 disappears). The total WEEE market in Europe is 9-10 million tonnes of WEEE per year. The total turnover of EERA members is more than 1 billion euros. EERA aims for the harmonisation of international and national regulations for WEEE recycling, in order to obtain a high level of treatment of WEEE.

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