



CEWASTE

Voluntary certification
scheme for waste treatment

CEWASTE REQUIREMENTS FOR IMPROVING CRM RECYCLING FROM WEEE AND WASTE BATTERIES

DELIVERABLE WP2



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ACRONYMS

BEV	Battery electric vehicle
CEWASTE	Voluntary certification scheme for waste treatment
CDD	Compact disk drive
CRT	Cathode ray tube
CRM	Critical Raw Materials
EEE	Electrical and electronic equipment
ELV	End-of-life vehicles
HDD	Hard Disk Drive
KCC	Key CRM component
KCE	Key CRM equipment
LIB	Lithium-ion battery
ODD	Optical disk drive
(P)HEV	(Plug-in) hybrid electric vehicle
P-D-C-A	Plan-do-check-act
PM	Precious metal
PPE	Personal protective equipment
REE	Rare earth element
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organization

NOTES TO THE READER

This document corresponds to the deliverables of “Work Package 2 – Normative Requirements” of the CEWASTE project funded by the European Commission Horizon 2020 programme. In the frame of this work package, a set of normative requirements for improving recycling of Critical Raw Materials (CRM) and valuable materials from waste electrical and electronic equipment (WEEE) and waste batteries has been developed. These include managerial, environmental, social, traceability and technical requirements.

Originally in the project’s proposal, it was planned to address these requirements in two separate deliverables, namely, “D2.1-Sustainability Requirements” and “D2.2-Traceability Requirements”. However, during implementation of the project, the project’s consortium decided to compile the two deliverables, and report all requirements in a single document titled “CEWASTE Requirements for improving CRM recycling from WEEE and Waste Batteries”. This approach was confirmed by the EC Project Officer supervising the project.

While the title of this document explicitly addresses the recycling of critical raw materials, along the document valuable materials (e.g. gold and silver) are also defined and covered in the requirements, following a decision made by the project’s consortium. This has been clarified for the specific cases and in the corresponding requirements. Critical raw materials addressed in this document are based on the latest list of CRM defined by the European Commission (in COM (2017) 490), as well as lithium (in COM (2020) 474).

It is acknowledged that WEEE includes waste batteries. However, for the purposes of this document, waste batteries are highlighted in the title and throughout the document.

For this deliverable, CEWASTE has taken stock of the existing principles and standards and only where they were not sufficient to meet the project’s objectives, new requirements were developed. To do this, more than 60 existing standards and verification schemes were mapped and assessed in the first work package of the project (WP1 - Baseline and Gap Analysis). The result of the baseline analysis revealed that the European Standards on Collection, Logistics and Treatment Requirements for WEEE (EN 50625 standard series) approved by CENELEC (European Committee for Electrotechnical Standardization) on 2014-01-27, are the most comprehensive standards relevant for the purpose of the CEWASTE project. The EN 50625 standard series are European Standards elaborated under the European Commission's Mandate M/518 (Mandate to the European standardisation organisations in the field of Waste

Electrical and Electronic Equipment (Directive 2012/19/EU (WEEE))). The study also highlighted gaps (of technical, managerial, sustainability and traceability nature) in the EN 50625 standard series required to be addressed.

Based on this conclusion, the EN 50625 standard series was considered as the basis for developing the CEWASTE normative requirements. The requirements that were sufficiently addressed in the EN 50625 series or other standards and guidelines have been referenced in the current document. Due to copyright issues, only the number of clause and the name of the corresponding standard have been mentioned for referencing. In the cases of gaps identified or when the existing requirements were not fulfilling the project's objectives, new requirements were developed. These are marked with "NEW" in respective clauses of this document.

European Standards including the EN 50625 standard series exist in three official versions (English, French, German) and can be obtained through the CENELEC National Committees at <https://www.cenelec.eu/dyn/www/f?p=web:5>; a version in any other language made by translation under the responsibility of a CEN/CENELEC member into its own language may additionally be available.

Since the EN 50625 standard series was used as the basis for developing the CEWASTE normative requirements, the structure of the latter was adopted. Accordingly, the current deliverable is structured into the following clauses (see also **Figure 1**):

Introduction

The Introduction provides specific information or commentary about the content of the document, and about the reasons prompting its preparation.

1. Scope

The scope clearly defines the subject of the document and the aspects covered, thereby indicating the limits of applicability of the document or particular parts of it. The scope indicates subjects that might be reasonably inferred to be covered but actually excluded from the document. The scope is succinct so that it can be used as a summary for bibliographic purposes, for example, as an abstract. Further details and background information can be found either in the Introduction or in Annex I. As per Annex I, identified WEEE and waste

components containing CRM are market relevant due e.g. the amounts generated and economically feasible treatment technologies available.

The Scope does not contain requirements, permissions or recommendations.**2. Normative references**

This clause lists, for information, those documents which are cited in the text in such a way that some or all of their content constitutes requirements of the document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

3. Definitions

This clause provides definitions necessary for the understanding of certain terms used in the document. If necessary, terminological entries can be supplemented by information (including requirements) given in the notes to entry.

4. Management, sustainability and traceability requirements

This clause contains the management, sustainability and traceability requirements for operators. The implementation of these requirements should be adequate to the type of operation and the respective requirements.

Aiming at developing and continuously improving the management system of operating facilities, collection and logistics facilities, treatment and final treatment operators shall comply with clauses 4.1 to 4.5 and 4.7 to 4.9 related to management requirements.

Sustainability requirements include the well-being of local communities (4.10.1), emissions control (4.10.2), and society related aspects (4.10.3). In the international literature, employees' concerns such as those about 'training', 'occupational health' and 'contractual aspects' are often considered sustainability issues. However, in order to facilitate the reading from the 'employee' perspective, these topics are placed in the personnel management part (clause 4.9) together with other general employee-related topics. This was done to facilitate the reading from the perspective of the 'employees'.

Traceability requirements are placed in clause 4.6 and are based on the due diligence approach. They apply to lead-acid waste batteries and printed circuit boards only. This decision followed the recommendation of the stakeholder consultation (at a CEWASTE

consultation meeting held during the World Resources Forum WRF 2019 Conference in Geneva) and of the Advisory Board members which based on the need to trace and control the critical environmental and social impacts associated to these two types of components. For printed circuit boards the traceability requirements are given in the CLC/TS 50625-5 document by means of contractual obligations in the supply chain and by downstream monitoring requirements.

Requirements on traceability (4.6) for others than lead-acid waste batteries and printed circuit boards, and sustainability requirements on the well-being of local communities (4.10.1) and contribution to society (4.10.3) have the status of recommendations.

5. Technical requirements

Technical requirements that operators shall follow to recover CRM and valuable materials from key CRM equipment (KCE), key CRM components (KCC) and fractions thereof are presented in this clause. Technical requirements developed for the key CRM components (KCC) base on the sufficient availability of evidences, experiences and national and European recommendations which contribute to advance in this area.

For economic operators running final treatment operations, specific guidance is provided in clause 5.10 for the following CRM components: fluorescent powders, waste batteries, magnets and printed circuit boards.

6. De-pollution monitoring

De-pollution monitoring during collection, logistics and the overall treatment requires an adequate documentation and description of the applicable methodologies for each treatment process.

7. Bibliography

The Bibliography lists, for information, those documents which are cited informatively in the document, as well as other information resources and background material used.

Annexes

Annexes are used to provide additional information to the main body of the document. These do not include requirements. These are specifically provided when the information or table is very long and including it in the main body of the document would distract the reader. Annex

I presents the list of CRM addressed as well as the CRM equipment and equipment covered in the frame of the CEWASTE requirements. Annex II presents an example of a Management, Monitoring & Evaluation Plan (MM&E) including performance indicators. Annexes III, IV, V and VI introduce technical information about the existing processes for recycling of fluorescent powders, waste batteries and magnets identified as gaps. List of CRM defined by the EU (COM (2017) 490) is given in annexes VII.

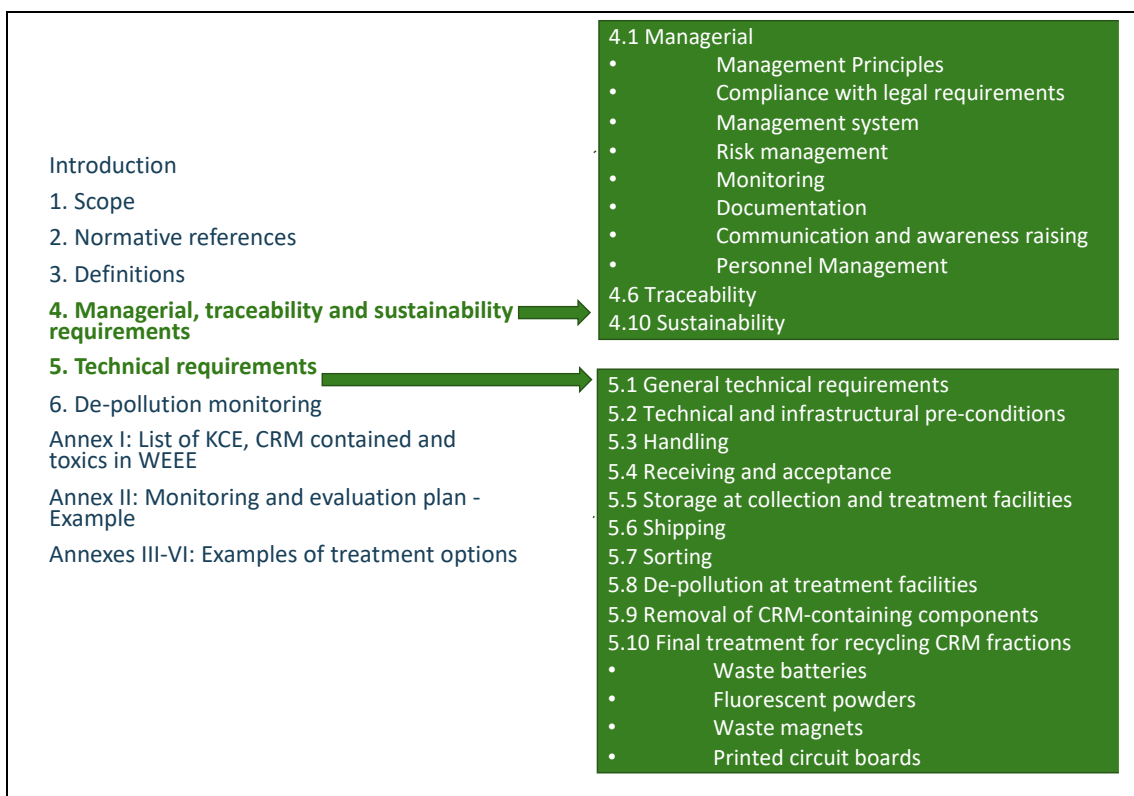


Figure 1. Illustration of the CEWASTE Requirements structure

In order to better understand how to read this deliverable and how to implement the clauses explained above, the following definitions apply:

- *"shall"* indicates a requirement: A requirement is defined as an "expression in the content of a document conveying objectively verifiable criteria to be fulfilled and from which no deviation is permitted if compliance with the document is to be claimed."
- *"should"* indicates a recommendation: A recommendation is defined as an "expression in the content of a document conveying a suggested possible choice or course of action deemed to be particularly suitable without necessarily mentioning or excluding others."

- *"may"* is used to indicate that something is permitted
- *"can"* is used to indicate that something is possible, for example, that an organization or individual is able to do something

In the document, equivalent expressions of the term 'shall' are: is to, is required to, it is required that, has to, only ... is permitted. The opposite 'shall not' can be also expressed through: is not allowed [permitted] [acceptable] [permissible], is required to be not, is required that ... be not, is not to be, do not.

In the document, equivalent expressions of the term 'should' are: it is recommended that, ought to. The opposite 'should not' used to discourage certain practice can be also expressed through: it is not recommended that, ought not to.

'Notes' found in this document include examples, recommendations – if so, then expressed as 'should' - and additional details that can be useful to the user of this document.

The term 'treatment' was used to refer to 'pre-treatment' and 'final treatment'.

INTRODUCTION

The overall objective of the CEWASTE project is to improve the recycling of valuable and critical raw materials (CRM) from waste electrical and electronic equipment (WEEE) and waste batteries, by using economically and technically feasible treatment processes with minimum environmental and social impacts and where monitoring of streams is applied. As such, CEWASTE addresses the specific challenge to secure the access to CRM and valuable materials for the EU economy and objectives set by the EU action plan for the Circular Economy (COM (2020) 98) and European Green Deal COM (2019) 640). It also supports the development of environmentally and socially sound recycling systems globally.

Prior to developing the requirements, the CEWASTE project consortium conducted a baseline and gap analysis to identify Key CRM Equipment (KCE) and condition enabling CRM recycling to define the scope related to waste streams, valuable and CRM, the value chain and treatment process. To identify the potential KCEs that qualify for CRM recovery, a series of characteristics and criteria were considered. These include different types of WEEE and batteries from EEE and end-of life vehicles (ELVs) with sufficiently high concentrations and processing technologies enabling the recycling of CRM. This analysis also led to the identification of the Key CRM Components (i.e. fluorescent powders, waste batteries, magnets and printed circuit boards) and the key CRM that will be addressed in the frame of the CEWASTE certification scheme. Out of the four KCC defined, two are intrinsically hazardous components: fluorescent powders and lead-acid waste batteries (also addressed in the Basel Convention). See “Clause 1 – Scope” and “Annex I” for more details about the list of KCE and KCC in focus and the criteria for selection of these equipment and components.

As per Annex I, identified WEEE and waste components containing CRM are market relevant due e.g. the amounts generated and economically feasible treatment technologies available. The CEWASTE normative requirements has taken stock of the normative requirements defined in existing relevant guidelines and standards in the field of electrical and electronic waste treatment and responsible sourcing of raw materials. Among others, development of the CEWASTE normative requirements is based on the European Standards on Collection, Logistics and Treatment Requirements for WEEE (EN 50625) approved by CENELEC (European Committee for Electrotechnical Standardization) on 2014-01-27.

By identifying and assessing the gaps, CEWASTE has expanded the current guidelines and standards through proposed new requirements that have a focus on recovery of critical raw

materials and additional valuable raw materials. This includes a set of normative managerial, environmental, social, traceability and technical requirements for waste collection, transport, pre-treatment and final treatment facilities.

It is noteworthy to mention that in the case of waste batteries, requirements and recommendations are provided for lead-acid and lithium-ion batteries and not NiMH batteries. This decision was made based on the sufficient availability of evidences, experiences and national and European recommendations which contribute to advance in this area.

Based on a decision made by the project's Consortium and Advisory Board, traceability requirements apply to operators handling and treating lead-acid batteries and printed circuit boards. Treatment facilities of these components are required to ensure a credible traceability of the materials received and compliance of their operations, hence, they need to have a validation and verification system in place. In addition, other operators such as producers and take-back systems, as well as collection, transport and treatment facilities that wish to ensure a credible traceability of the materials received and compliance of their operations with the CEWASTE requirements, will also need to have a validation and verification system in place. The traceability requirements described in this CEWASTE requirements document are based on a due diligence approach and experiences of its application in a number of materials, products or sectors (e.g. coffee, palm oil, bio-based products/biofuels, aluminium, gold, platinum products and conflict minerals). Traceability requirements include the definition of:

- Policy and procedures in line with the most commonly used material accounting model of mass balance,
- Responsibilities,
- Materials documentation and records including those confirming the traceable origin of input materials.

By following the CEWASTE requirements, operators implement the necessary measures to increase CRM recovery and improve the recycling. Firstly, WEEE, waste batteries and their components containing CRM and valuable materials are separated during the collection and pre-treatment phase, thus achieving larger amounts of streams with higher concentrations of CRM. Secondly, the standard formulates the necessary requirements that final treatment processes have to meet in order to recover CRM in an effective way, taking into account environmental and health & safety perspectives (see Figure 1). These requirements exclude

WEEE suitable for (preparation for) re-use which shall be separated from WEEE or waste batteries destined for recycling as early in the end of life supply chain as possible.

The following principles guided the development of the CEWASTE requirements:

Technological and economic feasibility. In order to increase recovery and reducing losses of CRM and valuable materials, the selection of priority CRM or alloys for recovery as well as the final treatment technologies shall take into account the technological processing, thermodynamic and economic limitations. Hence, it is acknowledged since the start that not all CRM will be possibly recovered.

Optimal collection, sorting and removal. Optimal collection, sorting and removal of equipment, components and fractions thereof containing CRM and valuable materials before further pre- and final treatment are key steps for minimizing losses in the treatment processes chain.

Continuous improvement. For reaching expected annual recovery goals and continued improvement along the periods, a management system with a regular monitoring (see example of annual plan in Annex II) is required that supports the implementation of the technical requirements and maximises the CRM recovery.

Auditability. This concerns the CEWASTE requirements being clear and coherent in order to facilitate substantiated assessment and confirmation of the level of compliance of the operations with the CEWASTE requirements.

Traceability. This allows substantiated demonstration that waste materials, fraction and thereof can be tracked to ensure that their recovery has been done in compliance with the CEWASTE requirements. This is only mandatory for waste lead-acid batteries and printed circuit boards.

While the first two principles are technologies related, the third, fourth and fifth ones focus on organizational aspects.

To ensure a transparent process and involve relevant stakeholders in development of the CEWASTE requirements, a face-to-face consultation meeting (held in October 2019 back to back with the World Resources Forum WRF conference in Geneva) and two rounds of online public consultation were conducted. The first round of online consultation referred to version

5.0 of this document and took place from December 2019 to January 2020. The second round referred to version 8.0 took place in February 2021. Additional relevant feedback was obtained from the pilot testing to be conducted in 2020 in about 20 companies from Europe, Turkey, Rwanda and Colombia. In order to increase the robustness of the CEWASTE standard, majority of comments and information were integrated accordingly in this final version.

1. SCOPE

The CEWASTE requirements are applicable to the recycling of Critical Raw Materials (CRM) from WEEE and waste batteries.

This document specifies:

- the sustainability requirements regarding the environmental, social and governance performance, and technical requirements for collection, transport, pre-treatment and final treatment for the development of a voluntary certification scheme.
- the traceability requirements to ensure the accuracy and verifiability of various aspects throughout the value chain of secondary raw materials, such as records of material inputs and outputs at facilities, product documentation and management, and product claims.

The CEWASTE sustainability requirements are relevant to all operators involved in the collection, pre-treatment and final treatment including related logistics, handling, sorting, and storage of WEEE and waste batteries.

Traceability requirements apply to operators handling and treating lead-acid batteries and printed circuit boards.

This document supports the essential requirements of Directive 2012/19/EU (WEEE).

1.1 PRODUCTS AND MATERIALS WITHIN THE SCOPE

This document focuses on WEEE containing CRM and valuable materials (like precious metals) as well as waste batteries from WEEE and ELV. Specifically, the following types of waste equipment (named key CRM equipment (KCE)) have been selected because of the potential to recover CRM (materials of interest contained in each item are indicated in brackets) and valuable materials (see Annex I with a more elaborated overview):

- Cathode ray tube (CRT) monitors and televisions (Eu, Tb, Y, Ce, La, Gd)
- (Compact) fluorescent lamps (Eu, Tb, Y, Ce, La)
- Desktop computers & professional IT equipment excl. batteries (Pd, Au, Ag, Bi, Sb)
- Laptops excl. batteries (Pd, Au, Ag, Sb, In)

- Mobile phones excl. batteries (Ag, Au, Bi, Pd, Sb, In)
- Tablets excl. batteries (Ag, Au, Pd, Bi, In)
- External compact disk drives (CDDs), optical disk drives (ODDs) and devices with internal CDD and ODD
- Lead-acid waste batteries from ELV and WEEE (Sb)
- Lithium-ion waste batteries from electric vehicles include those from e-bikes (Co, Tb, Gd, Nd, Dy, Pr). These include battery electric vehicle BEV, (plug-in) hybrid electric vehicle (P)HEV (Co)

NOTE: While acknowledging that lithium was not a CRM (according to COM (2017) 490), this metal is also recovered from Li-ion batteries recycling.

From the KCE listed above, components containing CRM and valuable materials are named KCC and include the following components: magnets, fluorescent powder, printed circuit boards and batteries. Average components identified per equipment are listed in Annex I.

In the case of lead-acid batteries minimum criteria are provided to tackle the worst unsound recycling practices. This document does not provide requirements addressing the more efficient recycling of Sb from lead-acid batteries.

1.2 VALUE CHAIN IN THE SCOPE

This document addresses the following phases of the value chain:

- Collection: gathering of WEEE after disposal by either consumers or companies, including the preliminary sorting and storage of WEEE (before transport to either a logistics facility or a pre-treatment facility);
- Logistics: planning, implementing and controlling of transportation, handling, preliminary storage and/or sorting of waste from the point of origin to point of delivery ;
- Pre-treatment: may include preparation for reuse, manual or mechanical pre-sorting, de-pollution, shredding and sorting of output fractions;
- Final treatment: refining of secondary materials from the output fractions of pre-treatment, through (pyro/hydro)metallurgical or chemical processes
- Recycling: any operation by which waste materials are processed into products, materials or substances.

Please note that a combination of the activities listed above may take place at the same facility. For example, a facility may hold collection, logistics and treatment activities.

2. NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. In case of contradictions, legislation and its amendments in force shall always prevail.

- CLC/TS 50625-3-2, Collection, logistics & treatment requirements for WEEE – Part 3-2: Technical specification for de-pollution – Lamps
- CLC/TS 50625-3-3, Collection, logistics & treatment requirements for WEEE – Part 3-3: Specification for de-pollution – WEEE containing CRTs and flat panel displays
- CLC/TS 50625-4, Collection, logistics & treatment requirements for WEEE – Part 4: Specification for the collection and logistics associated with WEEE
- CLC/TS 50625-5, Collection, logistics & treatment requirements for WEEE – Part 5: Specification for the final treatment of WEEE fractions – Copper and precious metals
- EN 50625-1, Collection, logistics & treatment requirements for WEEE – Part 1: General treatment requirements¹
- EN 50625-2-1, Collection, logistics and treatment requirements for WEEE - Part 2-1: Treatment requirements for lamps
- EN 50625-2-2, Collection, logistics & treatment requirements for WEEE – Part 2-2: Treatment requirements for WEEE containing CRTs and flat panel displays
- EN 50625-2-3, Collection, logistics & treatment requirements for WEEE – Part 2-3: Treatment requirements for temperature exchange equipment and other WEEE containing VFC and/or VHC
- ISO IWA 19, Guidance Principles for the Sustainable Management of Secondary Metals
- ADR 2019 ECE/TRANS/275, European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR 2019).

¹ European Standards can only be obtained from the national standardization body which is member of the European Committee for Standardization CEN or from the national committee which is member of the European Committee for Electrotechnical Standardization CENELEC as a national edition (national title page), the content of the European standard being unchanged.

- European Waste Catalogue (EWC) - 2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147)
- Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work
- Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel
- Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods
- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) and the Best Available Techniques Reference Documents as well as national regulations
- Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)
- Regulation (EC) No 1013/2006 of the European Parliament and of the Council on shipments of waste
- Commission Regulation (EC) No 1418/2007 of 29 November 2007 concerning the export for recovery of certain waste listed in Annex III or IIIA to Regulation (EC) No 1013/2006 of the European Parliament and of the Council to certain countries to which the OECD Decision on the control of transboundary movements of wastes does not apply
- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures
- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways – ADN (2017)
- UNEP (2003). Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (Basel Convention series/SBC No 2003/9)
- UNEP (2019). Technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention (E-waste)
- United Nations (2017). UN Recommendations on the Transport of Dangerous Goods

References listed above shall not be considered a complete list because other documents may have been omitted during the preparation of this document, or new applicable requirements may be released after the publication of this document.

3. DEFINITIONS (NEW & PARTIALLY REVISED)

For the purposes of this document, the following definitions apply:

3.1

Acceptor

any operator that physically and/or contractually takes ownership of the KCE, KCC or fractions thereof, after processing has been carried out by a treatment operator

3.2

Critical Raw Materials

CRM

materials which, based on a defined classification methodology, are economically important, and have a high-risk associated with their supply

Note 1 to entry: For the purpose of the CEWASTE requirements, CRM are the ones listed in Annex 1 of COM (2017) 490 final. Future updates to this list will apply and replace former versions of this list. See also Annexes VII and VIII of this document.

Source: adapted from EN 45558:2019, 3.1.1

3.3

Claim

statement used for the purpose of communication about compliance with the CEWASTE requirements, and about the main characteristics of materials containing CRM and valuable materials

Source: adapted from ISO IWA 19:2017, 3.5.

3.4

CRM equipment

equipment containing significant amounts of CRM and valuable materials

3.5

CRM yield

mass of CRM and valuable materials obtained ('output'), as product, from the processing of the mass of infeed materials ('input'), shown as a percentage for each CRM or valuable material

Source: Adapted from EN 50625-5, 3.15

3.6

Downstream monitoring

monitoring in which each party of the value chain is required to trace and document the compliance of the processing of waste and its streams by acceptors of the waste fractions it processes

3.7

Due diligence

monitoring in which each party of the value chain is required to conduct a verification of facilities upstream that process equipment, components or materials concerned (for example linked to the recycling of CRM and valuable materials) in order to trace and document their origin and compliance of their operations

3.8

End-of-life

any product or material which is waste, i.e. which is discarded, required to be discarded or intended to be discarded

Source: Adapted from Directive 2008/98/EC and Directive 2000/53/EC

3.9

Environmentally sound

all practicable steps to ensure that hazardous wastes and other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes

Source: Adapted from the Basel Convention (UNEP, 2019)

3.10

Final treatment

last steps in the treatment of key CRM equipment (KCE) whereby they are transformed using chemical or metallurgical processes and whereby valuable materials and /or CRM are purified into materials that can be used for the original or for other purposes

Note 1 to entry: Final treatment processes correspond to the operation R4 listed in Annex IV 'Recycling/reclamation of metals and metal compounds' of the Basel Convention.

3.11

Final treatment facility

location where WEEE and waste batteries undergo final treatment

3.12

Monitoring system

system of procedures and management applied to trace the compliance with the CEWASTE requirements of waste and its processed streams by each party of the value chain

Note 1 to entry: Processed streams of waste include: Key CRM components, key CRM equipment, CRM fractions and waste batteries

3.13

Operator

individual, enterprise, association, cooperative or organization involved in any aspect of the collection, manual or mechanical processing, pre-treatment, final treatment (chemical or

metallurgical processing), transportation and storage, of WEEE and waste batteries that contain CRM and valuable materials

3.14

Pre-treatment

manual or mechanical processing as first steps in the treatment of WEEE, waste batteries, or their fractions

Note 1 to entry: Manual and mechanical processing refers to processes to separate and concentrate fractions with higher CRM or valuable materials content.

Note 2 to entry: Manual processes may include sorting, separating, cleaning, emptying, dismantling, de-pollution and segregation.

Note 3 to entry: Mechanical processes may include shredding, milling and grinding, as well as segregation by, for example, eddy current or air stream classifiers.

3.15

Pre-treatment facility

location where WEEE or waste batteries undergo pre-treatment

3.16

Pre-treatment operator

operator responsible for pre-treatment

3.17

Quality risk

potential for CRM losses due to quality that fails to meet the minimum quality goals of the operator

Note 1 to entry: Examples of quality goals are: Outputs with a minimum level of purity reached; Outputs with a content of alloys that hinder the further treatment and recovery of CRM that do not exceed certain threshold established by the operator

3.18

Recovery

operation the principal result of which is waste or end-of-waste fractions serving a useful purpose by replacing other materials that would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy

Source: Directive 2008/98/EC

3.19

Recycling

process by which CRM and valuable materials fractions are extracted from WEEE, waste batteries or fractions thereof, whether for the original or other purposes

Note 1 to entry: Recycling does not include energy recovery and the reprocessing into materials to be used as fuels or for backfilling operations.

Source: Adapted from Directive 2008/98/EC

3.20

Removal

manual, mechanical, chemical or metallurgic handling with the result that targeted substances, fractions, mixtures and components are contained in an identifiable stream or are an identifiable part of a stream within the treatment process.

Note 1: Targeted substances, fractions, mixtures may be of hazardous nature and/or contain targeted CRM.

Note 2: According to EN 50625-1, which is based on Directive 2012/19/EU, a hazardous substance, mixture or component is identifiable if it can be monitored in order to verify that its treatment is environmentally safe.

3.21

Requirement

normative (prescriptive) element, quality or qualification, applicable to the whole or part of a business process that shall be followed in order to comply with regulations or a certification scheme

3.22

Shipment

transport of waste destined for recovery or disposal which is planned or takes place:

- (a) between States; or
- (b) between a State and overseas States and territories or other areas, under that State's protection; or
- (c) between a State and any land area which is not part of any State under international law; or
- (d) between a State and the Antarctic; or
- (e) from one State through any of the areas referred to above; or
- (f) within a State through any of the areas referred to above and which originates in and ends in the same State; or
- g) from a geographic area not under the jurisdiction of any State, to a State.

Note 1 to entry: If the shipment of wastes crosses States' borders, 'shipment' is considered a 'transboundary movement' according to the Basel Convention (UNEP, 2019). Transboundary movements are only possible prior approval made by the designated Parties of the States delivering or receiving the hazardous wastes and other wastes.

Note 2 to entry: The Basel Convention is an international treaty which aims at reducing hazardous waste streams, restricting transboundary movements of hazardous wastes and a regulatory system for those cases, where transboundary movements are allowed². It is implemented by the European Regulation (EC) No 1013/2006 on shipments of waste. Both, the Basel Convention as well as the Regulation (EC) No 1013/2006 provide a list of codes to identify different types of waste³. The European Waste Catalogue (EWC), as established in the European Regulation (EC) 1013/2006, distinguishes non-hazardous green listed wastes, which are subject to general information requirements from hazardous amber listed wastes, which are subject to the procedure of prior written notification and consent. The distinction between green and amber listed wastes is based upon wastes specified

² <http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx>

³ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_shipment_statistics_based_on_the_European_list_of_waste_codes&oldid=425439#General_overview

in List A and List B of the Basel Convention. (Source: Adapted from Regulation (EC) No 1013/2006 on shipments of waste, Annex III and Annex IV). For transboundary movements of non-hazardous e-waste, the Basel Convention does not provide specific procedures. As they fall under the category green listed wastes within the EWC, they are subject to the established general information requirements of European Regulation (EC) 1013/2006. For transboundary movements of e-wastes which are classified as hazardous under the Basel Convention or under national legislation, national import and export prohibitions must be respected. Where there are no national regulations, the requirements of the Basel Convention must be met (UNEP, 2019).

Source: Adapted from Regulation (EC) No 1013/2006 on shipments of waste, Article 3(34)

3.23

Sustainability requirements

criteria covering socio-economic and environmental aspects which ensure that the operator meets the needs of the present generation without compromising the ability of future ones to meet their own needs

3.24

Transboundary movement

any movement of hazardous wastes or other wastes: from an area under the national jurisdiction of one State, to or through an area under the national jurisdiction of another State, or to or through an area not under the national jurisdiction of any State

Source: Basel Convention (UNEP, 2019)

3.25

Treatment facility

location where WEEE and waste batteries undergo treatment

3.26

Valuable Raw Materials

materials which are economically important such as precious metals, among others

Note 1 to entry: valuable materials are displayed in Annex I and include, for example, Ag and Au. Although copper is not mentioned in Annex I, this is indirectly considered as this metal is recovered together with, e.g., Ag and Au from printed circuit boards.

3.27

Waste batteries

any battery which is waste, i.e. which is discarded, required to be discarded or intended to be discarded

Source: Adapted from Directive 2008/98/EC

3.28

WEEE (Waste Electrical and Electronic Equipment)

electrical or electronic equipment which is waste within the meaning of Article 3(1) of Directive 2008/98/EC, including all components, subassemblies and consumables which are part of the product at the time of discarding

Note 1 to entry: WEEE includes waste batteries, however, for the purposes of this document waste batteries is highlighted in the title and presented as 'WEEE and waste batteries'.

Source: Directive 2012/19/EU

4. MANAGEMENT, SUSTAINABILITY AND

TRACEABILITY REQUIREMENTS (PARTIALLY NEW)

This clause contains the management, sustainability and traceability requirements for operators involved in the collection, pre-treatment and final treatment including related handling, logistics, sorting and storage of WEEE and waste batteries, in particular, focusing on activities with highest potential of improving CRM and valuable materials recovery.

Facilities and operators (regardless of the scope of activities, except for collection points) shall meet the requirements established in clause 4.1 of EN 50625-1:2014 on management requirements. More specifically, operators involved in collection, handling, sorting, and storage shall apply the administrative and organizational requirements in clause 4.1 of CLC/TS 50625-4:2017.

Collection points are only required to apply the requirements established in clause 4.2 of CLC/TS 50625-4:2017.

NOTE 1: Collection points, typically, do not only collect WEEE and waste batteries. This differs from collection facilities that have as core activity the collection of WEEE and waste batteries. Examples of collection points are a collection bin or other collection mechanisms provided at a retail, a not-for profit outlet, public building, community space. Examples of collection facilities are a municipal or non-municipal collection centres (clauses 3.2 and 3.3 of CLC/TS 50625-4:2017)

NOTE 2: If takeback schemes are in place, collection operators could channel through them.

Traceability requirements in clause 4.6 shall only apply to lead-acid batteries and printed circuit boards.

Refer to clause 4.1 of EN 50625-1:2014

Refer to clauses 4.1 and 4.2 of CLC/TS 50625-4:2017

4.1 MANAGEMENT PRINCIPLES (NEW, EN 50625-1, CLC/TS 50625-4)

Main management principles of the management system that shall be in place include 'legal requirements and identification and review of compliance', 'risk assessment and mitigation', 'competency development' and 'continuous improvement'. Additional specific requirements of a management system are listed in 'clause 4.3 Management system'.

To support continuous improvement, a documented 6 to 12-month Management, Monitoring and Evaluation Plan (MM&E, see example in Annex II) shall be established including the scope of the activities which includes short-term and mid-term actions and key performance indicators and targets.

Operators of collection and logistic facilities shall meet the applicable requirements of clause 4.1.1 of CLC/TS 50625-4:2017.

Pre-treatment and final treatment operators shall meet the requirements of clause 4.1 of EN 50625-1:2014.

Regular planned internal audit shall be conducted to monitor progress on process performance as planned in the 'Management, Monitoring & Evaluation Plan (MM&E)'.

Refer to clause 4.1 of EN 50625-1:2014

Refer to clause 4.1.1 of CLC/TS 50625-4:2017

4.2 COMPLIANCE WITH LEGAL REQUIREMENTS (NEW)

Operators shall comply with all applicable legislation.

4.2.1 Applicable standards for waste Li-ion battery transport and storage (NEW)

Applicable standards for waste Li-ion battery transport and storage are specified in Table 1 below.

Table 1: Applicable standards for waste Li-ion battery transport and storage

Standard / Directive (Version / Date)	Requirements
European Agreement concerning the International Carriage of Dangerous Goods by Road – ADR (2019)	<p>The transport of waste lithium-ion batteries is subject to the following.</p> <ul style="list-style-type: none"> ● Part 4 Packing ● Part 5 Consignment procedures ● Part 6 Requirements for the construction and testing of packaging, intermediate bulk containers, large packaging, tanks and bulk containers ● Part 7 Provisions concerning the conditions of carriage, loading, unloading and handling ● Part 8 Requirements for vehicle crews, equipment, operation and documentation ● Part 9 Requirements concerning the construction and approval of vehicles <p>Examples: <u>Damaged or Defective Batteries via Road</u></p>

Standard / Directive (Version / Date)	Requirements
	<ul style="list-style-type: none"> • Special Provision 376, Packaging Instruction P908 • Appropriate marking • Necessary transport documents • Batteries are split in “non-critical” (no possible danger during transport) and “critical” (possible danger during transport). • “non-critical” damaged or defective batteries: <ol style="list-style-type: none"> 1. Each damaged or defective battery or equipment containing such batteries must be packed separately in leak proof inner packaging to prevent release of electrolyte 2. UN approved packaging required for all battery types (Packing Group II), e.g. fibreboard box 3. Must be secured against movement within the package 4. Sealed packaging shall be fitted with a venting device 5. Must be packed with non-combustible and non-conductive thermal insulation material, material class A1 or A2 (non-combustible, e.g. rockwool, glass wool, foam glass, Vermiculite) 6. Absorbing material to absorb leaking electrolyte from leaking batteries 7. Batteries shall be protected against short circuit 8. “critical” damaged or defective batteries: 9. Transport is only allowed with approval from the Competent Authority (e.g. in Germany: Federal Institute for Materials Research and Testing (BAM)) with detailed requirements as stated in the approval <p><u>Batteries for Disposal & Recycling <=100 Wh per battery</u></p> <ul style="list-style-type: none"> • Special Provision SP 377, Packaging Instruction P909 • Weight limit: 30kg gross weight per package • Appropriate marking • Necessary transport documents • batteries >100 Wh UN-approved packaging required (Packing Group II) • For batteries ≤ 100 Wh and for batteries contained in equipment, UN-approved packaging is not required. Strong outer packaging constructed of suitable material, and of adequate strength and design in relation to the packaging capacity and its intended use. • Batteries shall be packed to prevent short circuits and dangerous evolution of heat • Protection against short-circuits and dangerous evolution of heat. • This can be achieved by: individual protection of the battery terminal; inner packaging to prevent contact between batteries; batteries with recessed terminals designed to protect against short-circuits or; the use of non-conductive and non-combustible cushioning material to fill empty space between the batteries in the package • Batteries shall be secured within the outer packaging to prevent excessive movement during carriage (e.g. by using a non-conductive and non-combustible cushioning material or through the use of a tightly closed plastic bag)
<p>Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste</p>	<p>Written notification and consent; Article 3 (1); notification see article 4, contract see Article 5; financial guarantee see Article 6; transmission of the notification (Article 7); consent (Article 9); protection of the environment see Article 49</p>
<p>Regulations concerning the International Carriage of Dangerous</p>	<p>Packaging instructions (PI) and Special Provision (SP)</p>

Standard / Directive (Version / Date)	Requirements
Goods by Rail (RID). 2019	
International Maritime Dangerous Goods (IMDG) Code	Packaging instructions (PI) and Special Provision (SP)
International Civil Aviation Organization (IATA): Lithium Battery Guidance Document. Technical Instruction for the Safe Transport of Dangerous Goods by Air	Packaging instructions (PI) and Special Provision (SP)

4.3 MANAGEMENT SYSTEM (NEW)

The management system shall cover the activities in the value chain scope (see clause 1.2) of the CEWASTE certification of the operator.

The operator shall first determine the facilities, activities, sites, as well as associated temporary or mobile facilities that are relevant to the CEWASTE standard which shall be included in the scope for which it claims conformity with the CEWASTE requirements.

Exclusion shall be justified and justification records kept.

NOTE: Possible exclusion cases include:

- The facilities, activities, sites, are to undergo a change (upgrading of technologies and capabilities) in the short term;
- The facilities, activities, sites are to be di-installed/de-commissioned in the short term or any action that would mean that their use is to be discontinued;
- The list of KCE or CRM is foreseen to change in the short term;

The operator shall define and document its activities and waste streams within its facilities that are relevant for recycling of CRM and valuable materials and that are covered by the CEWASTE certification the operator applies for.

The operator shall specify the responsibility, authority and interrelationship of all personnel involved in the waste processing operations.

The operator shall identify management positions that have overall responsibility for the waste processing operations and for the identification and monitoring of legal and other requirements.

The management system shall set objectives and key performance indicators.

The management system shall also define review cycles of progress done for objectives and key performance indicators set.

The management positions should have the resources needed as established in the management plan (see example as provided in Annex II) to implement the CEWASTE requirements.

Management positions roles should be documented and communicated, for example, through an organizational plan that includes the functional levels responsible for the treatment of WEEE, waste batteries and/or fractions thereof, and the transport and the handling of materials that exhibit hazardous properties.

In order to assess progress done, identify improvement opportunities and pursue continuous improvement, the management for waste processing operations should pursue iterative cycles following the plan-do-check-act (P-D-C-A) sequence of well-spread management systems in place.

4.4 RISK MANAGEMENT (PARTIALLY NEW)

This clause concerns the management of the risks associated with the activities in the scope of the CEWASTE certification including those on health and safety issues for workers and community members, poor material quality, CRM losses and environmental damage.

4.4.1 Risk assessment procedures and activities (EN 50625-1)

The operator shall define and document risk assessment procedures and activities.

The operator shall review and update its risk assessment reports on a regular basis and take into account changes to the operating environment, its activities and the efficiency of the measures implemented.

Risk assessments shall be appropriately planned and of an acceptable level of reliability in order to allow continued operations in compliance with the CEWASTE requirements. Requirements in clause 4.2 of EN 50625-1 apply.

Refer to clause 4.2 of EN 50625-1

4.4.2 QUALITY RISKS (NEW)

The operator shall assess its quality risks and establish key quality goals for its operations.

Quality goals shall be part of the Management, Monitoring and Evaluation Plan (MM&E).

Quality goals for specific KCE or KCC are not required, if their markets are not mature.

4.4.3 HEALTH, SAFETY AND ENVIRONMENT (HSE) RISKS (NEW)

Operators shall take all necessary measures to prevent and mitigate risks posed to the environment and human health due to the (possible) presence of hazardous substances released during the handling and pre-treatment of WEEE and waste batteries, or formed during the final treatment processes (e.g. metallurgical processing).

Requirements for de-polluting hazardous substances are detailed in the existing EN 50625 series (see clauses on de-pollution).

As a minimum, a fire and explosion prevention plan and an emergency plan shall be in place. This includes emergency testing and corrective actions procedures.

4.4.4 RISK MITIGATION (NEW)

The operator shall implement documented action plans (including timetable, responsibilities and activities) including risk mitigation measures that cover the activities in the scope of the CEWASTE certification.

4.5 MONITORING (NEW, EN 50625-1, ISO IWA 19)

Monitoring supports continuous improvement and aims to track progress against set objectives for each monitoring cycle as well as to demonstrate and report on environmental, working conditions related outcomes in an efficient, transparent and accountable manner.

Operators shall maintain an adequate monitoring system by tracking compliance with the CEWASTE requirements of waste and its processed streams. This includes the tracking of:

- progress on process performance as planned in the 'Management, Monitoring & Evaluation Plan (MM&E)';
- critical risk factors and related responses at least for the risk points where the accidental release of hazardous solid, liquid and gaseous effluents is possible (including during transportation, treatment and disposal).

The operator shall have procedures in place to evaluate and control that its activities help improve CRM recovery, based on the key performance indicators set within the management system.

NOTE: Please note that de-pollution monitoring aspects are presented in clause 6 and occupational health monitoring is in clause 4.9.2 under the umbrella topic on 'occupational health' (4.9).

4.5.1. DOWNSTREAM AND UPSTREAM MONITORING (EN 50625-1, CLC/TS 50625-4, NEW)

Downstream and upstream monitoring requirements are established in clause 4.4 of EN 50625-1:2014.

As for downstream monitoring, this covers the monitoring in which each party of the value chain is required to trace and document the compliance of the processing of waste and its streams by acceptors of the waste fractions it processes.

As for upstream monitoring, the treatment operator shall record the origin of each consignment of WEEE and waste batteries accepted at the treatment facility as established in clause 4.4 of EN 50625-1:2014.

Refer to clause 4.4 of EN 50625-1:2014

The pre-treatment and final treatment operator shall maintain records for each waste stream (i.e. waste batteries, magnets, printed circuit boards, and lamps and displays containing fluorescent powders).

Records shall include:

- the input of each waste stream containing CRM and valuable materials, and output fractions containing them, provided complex and expensive samplings are not required;
- data on the mass or units of the input KCE or KCC and output of components or fractions containing CRM and valuable materials from each waste stream, rates of output divided by input;
- information on the sender of the materials and the downstream acceptor(s) of the fractions, pre-treatment and final treatment operators, and the treatment technology(ies) applied in the pre-treatment or final treatment steps.

NOTE: Example of input KCE in a dismantling facility is 20 units of appliances containing magnets; example of the output to be delivered to final treatment is 18 magnets.

For the collection and logistics phase, additional monitoring requirements are established in clause 4.1.4 of CLC/TS 50625-4:2017.

Refer to clause 4.1.4 of CLC/TS 50625-4:2017

4.6 TRACEABILITY REQUIREMENTS_(NEW)

Traceability requirements shall be complied with by upstream operators concerning lead-acid batteries and printed circuit boards waste streams and fractions thereof in order to:

- a. guarantee the origin of the waste streams, and
- b. demonstrate that waste lead-acid batteries and printed circuit boards as well as their CRM fractions treated or recovered along the supply chain (upstream) are in compliance with the CEWASTE requirements.

In order to ensure fluent communication and cooperation along the supply chain, operators concerned shall seek to reach a documented agreement regarding the implementation of the CEWASTE requirements throughout the supply chain.

Due diligence processes shall be implemented for issuing a credible claim of compliance associated with the fraction of CRM or valuable materials recovered.

This requirement is fulfilled if an equivalent traceability scheme is already in place.

For the purpose of public communications, the issuing of a third-party verified claim is recommended.

4.6.1 DUE DILIGENCE (NEW)

In case the collection, pre-treatment or final treatment operator receives WEEE and waste batteries from non-OECD countries, a verification process such as the due diligence shall be implemented for preventing shipments of WEEE and waste batteries from operators whose operations fail to comply with the purpose of this normative document.

NOTE 1: Refer to OECD Due Diligence Guidance for Responsible Business Conduct. 2018

NOTE 2: See the definition of due diligence in clause 3.7 and more specific requirements in clauses 4.6.1.1, 4.6.1.2 and 4.6.1.3

NOTE 3: If operators comply with CEWASTE requirements and the due diligence requirements (4.6.1), a claim on the materials recovered can be issued.

NOTE 4: Example of claim: Enterprise X supports the implementation of the CEWASTE requirements and is sourcing up to X % of compliant secondary Pt as of [date].

4.6.1.1 POLICY AND PROCEDURES (NEW)

Due diligence policy and procedures shall be developed, as well as implemented throughout the recycling chain (upstream) to ensure the accuracy and verifiability of records of entering and leaving waste streams and materials at facilities, documentation and claims.

The mass or units accounting of inputs and outputs shall be recorded.

4.6.1.2 RESPONSIBILITIES (NEW)

A due diligence manager responsible for the implementation of the due diligence policy shall be appointed by the operator seeking compliance with the CEWASTE requirements. Workers involved in the acquisition, processing and delivery of lead-acid waste batteries, printed circuit boards or fractions thereof shall be adequately trained and monitored by the due diligence manager.

4.6.1.3 DUE DILIGENCE DOCUMENTATION AND RECORDS (NEW)

The operator implementing a due diligence shall document and record important characteristics of the lead-acid waste batteries, printed circuit boards and fractions thereof including:

- a) name and address of supplier;
- b) unique reference number and type of lead acid battery / printed circuit board;
- c) date of receipt of the lead-acid waste batteries, printed circuit boards and fractions thereof and their date of release/shipment;
- d) origin (address) of batch or consignment;
- e) shipment address;
- h) weight;
- j) if available, proof of compliance with the CEWASTE requirements;
- k) if available, name and details of the assurance provider concerned with issuing the proof of compliance;
- l) name and address of all supplier(s), contractor(s) and subcontractor(s) upstream involved in the acquisition, processing and delivery of the batch or materials.

Recorded lead-acid batteries, printed circuit boards and fractions thereof without appropriate documentation shall be considered of unknown and uncontrolled origin and, therefore, not in compliance with the CEWASTE due-diligence requirements. If there is an interest in communicating results, claims shall not be issued. Non-compliance with the CEWASTE due-diligence requirements (for example, no information available or only partial documentation is available) shall be documented as deviation and mitigation actions planned, monitored and implemented. Actions shall be considered in the MM&E (an example is provided in Annex II).

4.7 DOCUMENTATION (NEW, 50625-1, 50625-4, 50625-5)

The management system shall include the following in addition to the requirements established in clause 6 of EN 50625-1:2014.

- Fire and explosion prevention plan, emergency plan, emergency testing procedures, records of tests performed and any corrective actions or amendments to the plans.
- Documents in which the environment, health and safety procedures are included.
- Environmental, health and safety (EHS) reports including environmental performance and incidents (Lost Time Injury frequencies, near misses) concerning the workers and sub-contractors working on the premises of the facility, and data on measured occupational health. If limit values have been exceeded there shall be a report on improvement actions and data shall be reported that also indicate any effects that such corrective measures will have.
- Documentation on special work procedures of processes performed for waste batteries, printed circuit boards, fluorescent lamps and magnets, and components or fractions containing CRM and valuable materials;

Refer to clause 6 of EN 50625-1:2014

The operators shall maintain records documenting compliance with legal and regulatory obligations applying to the activities defined in the scope, and with additional applicable CEWASTE requirements which the operator commits to comply with.

Informative materials should be available at collection points as per clause 4.2 of CLC/TS 50625-4:2017.

Specific documentation requirements for treatment facilities, as well as for fluorescent powders and waste batteries (lead-acid and Li-ion) are described in the next clauses.

4.7.1 DOCUMENTATION: COLLECTION AND LOGISTICS FACILITIES (EN

50625-1, CLC/TS 50625-4)

Documentation required for collection and logistics operators – excluding collection points - is established in clause 6 of CLC/TS 50625-4:2017.

Refer to clause 6 of CLC/TS 50625-4:2017EN

4.7.2 DOCUMENTATION: PRE-TREATMENT AND FINAL TREATMENT

FACILITIES (EN 50625-1, NEW)

In addition to the documentation required as established in clause 6 of EN 50625-1:2014 for pre-treatment and final treatment facilities (such as documents showing compliance with legal requirements, including necessary permits, among others), they shall have the following:

- reports from sub-contractors and sub-processors indicating the processors receiving the waste batteries, printed circuit boards, fluorescent powders, and/or magnets, or fractions containing CRM and valuable materials;
- an up-to-date organisational chart with all management and production personnel levels, including those positions regarding acceptance and treatment of WEEE and/or fractions thereof, waste management, the transport and the handling of materials that exhibit hazardous properties;

Pre-treatment and final treatment facilities shall keep records on an annual basis of:

- Units and mass input for each waste stream (i.e. batteries, WEEE containing magnets, WEEE containing printed circuit boards, lamps containing fluorescent powders, displays containing fluorescent powders etc.).

NOTE: Example for magnets processed: number and weight of magnets separated per ton of WEEE received, etc.

- Components and outputs containing CRM and valuable materials removed from the input waste, e.g., number and weight of magnets separated, fluorescent powders removed etc.

Refer to clause 6 of EN 50625-1:2014

If relevant changes occur from one period to the next, the operator shall identify the causes. If these are related to non-compliance with the CEWASTE requirements, other standards applicable or legal requirements, corrective actions shall be introduced and induced changes verified in the next auditing period.

The determination of recycling and recovery rates is established in Annex C of EN 50625-1:2014. As for the calculation of recycling efficiencies of the recycling processes of waste

batteries, calculation methods and reporting established in the Directive 2006/66/EC of the European Parliament and of the Council shall apply.

Refer to Annex C of EN 50625-1:2014

4.7.3 DOCUMENTATION: FLUORESCENT POWDERS (NEW)

If there is mercury present in the fluorescent powders of lamps and/or lead and/or cadmium present in the fluorescent powders of CRT, these fractions shall be labelled following the European Waste Catalogue - Commission Decision 2000/532/EC. The above-mentioned fluorescent powders are classified with the code 19 12 11*⁴.

The hazardous materials stream resulting from the hydrometallurgical process containing recoverable CRM such as Yttrium and Europium shall be indicated and labelled with a pictogram as a health hazard in the records produced.

The hazardous waste streams of the hydrometallurgical treatment are corrosive and need to be classified and labelled with a pictogram according to international conventions and agreements.

NOTE: In the EU use the European Waste Catalogue (EWC). The applicable EWC codes are:

- 19 02 04*⁵ and/or 19 02 05*⁶

See below examples of pictograms of 'corrosive' and 'health hazard' codes that need to be included in the packaging of the fractions concerned:



Corrosive



Health Hazard

⁴ Other wastes (including mixtures of materials) from mechanical treatment of waste containing hazardous substances. See here: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000D0532-20150601&from=EN>

⁵ premixed wastes composed of at least one hazardous waste. See here: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000D0532-20150601&from=EN>

⁶ sludges from physico/chemical treatment containing hazardous substances. See here: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000D0532-20150601&from=EN>

For transboundary movements the Basel Convention codes⁷ shall be also used or instead of the EWC (for example, A1-34 A1180 for glass from cathode-ray tubes and fluorescent lamps and A1030 for waste products containing mercury compounds).

For non-European countries with waste codes less detailed than these of the European Waste Catalogue (EWC), the EWC shall be used as a source.

4.7.4 DOCUMENTATION: LEAD-ACID AND LI-ION BATTERIES (NEW)

Waste lead-acid batteries shall be labelled following the European Waste Catalogue (EWC) - Commission Decision 2000/532/EC - with the code 20 01 33*⁸.

The hazardous waste streams are corrosive and need to be classified and labelled with a pictogram according to international conventions and agreements.

Note: In the EU use the European Waste Catalogue (EWC). The applicable EWC codes are:

- Metal waste from lead and waste consisting of lead alloys: A1-13 A1020 AA030

- Lead-acid batteries: 16 06 01*

Use the pictograms of 'corrosive' and 'health hazard' codes that need to be included in the packaging of the fractions concerned as in 4.7.3.

For transboundary movements the Basel Convention code (i.e. A1160 waste for lead-acid batteries, whole or crushed) shall be also used or instead of the EWC.

For non-European countries with waste codes less detailed than these of the European Waste Catalogue (EWC), the EWC shall be used as a source.

⁷ <https://www.informea.org/en/decrees-lists-wastes-transboundary-movements-contents-and-layout-documents-accompanying-transboundary>

⁸ batteries and accumulators included in 16 06 01* (lead-acid batteries), among others, and unsorted batteries and accumulators containing these batteries. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000D0532-20150601&from=EN>

4.8 COMMUNICATION AND AWARENESS RAISING (NEW)

For communication purposes, collection, pre-treatment and final treatment facilities shall identify key stakeholders including suppliers, general public and business sourcing WEEE and waste batteries, and other stakeholders (see examples of possible stakeholders in clause 4.8.1).

Grievance mechanisms shall be implemented (see clause 4.8.2), in order to ensure fluent communication with identified stakeholders, and prevent, anticipate and resolve conflicts or grievances.

4.8.1 STAKEHOLDERS COMMUNICATION (NEW)

In order to raise awareness of key stakeholders topics indicated in **Table 2** shall be considered in the communication means of the operators concerned (collection, pre-treatment and final treatment facilities).

NOTE: As indicated in Table 2, additional supporting information may be provided and communicated to the stakeholders concerned to complement the requirements in the communication.

Table 2: Topics to be communicated to stakeholders

Stakeholders	Topics...
Supply Chain	...that shall be communicated
	<ul style="list-style-type: none"> • Criteria for sorting key CRM equipment (as per Annex I) • Challenges or pollution issues that can be caused by a lack of technology or technical capacity during previous treatment steps • Grievance mechanisms
	...that may be communicated
	<ul style="list-style-type: none"> • Data erasure practices • Advantages of CEWASTE compliant CRM recycling and international trends • Advantages and business case of complying with the CEWASTE requirements, including mitigating environmental and social risks • Improving resource supply security, management and efficiencies through the continuous supply of raw materials to manufacturers without further exploitation of natural resources

Stakeholders	Topics...
	<ul style="list-style-type: none"> The importance of documentation
Workers	...that shall be communicated
	<ul style="list-style-type: none"> Challenges or pollution issues that can be caused from a lack of required technical set-up and/or operational skills Practical approaches on how to implement the CEWASTE requirements Possible difficulties when switching practices to implement CEWASTE requirements Grievance mechanisms, if not covered by the national regulations concerned
	...that may be communicated
	<ul style="list-style-type: none"> Advantages of complying with CEWASTE requirements and how to reduce health risks Environmental and health risks associated with unsafe recycling techniques of WEEE and waste batteries
Local Communities	...that shall be communicated
	<ul style="list-style-type: none"> Environmental and health risks associated with the processing activities at the facility Grievance mechanisms
	...that may be communicated <ul style="list-style-type: none"> Advantages of applying the CEWASTE requirements including the well-being of local communities, avoidance of environmental risks
Authorities	...that shall be communicated <ul style="list-style-type: none"> Reporting on legal compliance
General public potentially owning WEEE and waste batteries	...that shall be communicated by collection facilities <ul style="list-style-type: none"> Visual materials to raise awareness of the relevance of collecting WEEE containing CRM, and waste batteries.

4.8.2 GRIEVANCE MECHANISMS (NEW)

A grievance mechanism shall be made easily accessible and shall explain how to file a grievance, how it is being handled, length of time to receive a response, how the results are communicated and how to file an appeal.

NOTE: Examples of grievance mechanisms include help desks, complaint boxes and hotlines located inside and outside of the company vicinity.

4.9 PERSONNEL MANAGEMENT (NEW, EN 50625-1, CLC/TS 50625-4, CLC/TS 50625-5, EN 50625-2-1, EN 50625-2-2, ISO IWA 19)

4.9.1 COMPETENCES (NEW, EN 50625-1, CLC/TS 50625-4)

Training needs shall be identified and, as necessary, training programmes shall be provided to enhance the skills and capabilities on WEEE and waste batteries collection, handling, pre-treatment and final treatment processes to prevent losses of CRM and valuable materials.

Training shall be also provided on CEWASTE requirements, legal requirement identification and other relevant requirements.

As for lead-acid waste batteries and printed circuit boards recycling, training on due diligence shall be conducted and cover how to implement and assure its implementation in the value chain concerned.

The operator shall determine the criteria for the competence of personnel for each function in the waste handling process in scope of the CEWASTE requirements.

More specific requirements are established in clauses 4.3 of EN 50625-1:2014, 4.1.3 and 4.2 of CLC/TS 50625-4:2017.

Refer to clause 4.3 of EN 50625-1:2014 for pre-treatment operators

Refer to clause 4.1.3 of CLC/TS 50625-4:2017 for collection and logistics facilities

Refer to clause 4.2 of CLC/TS 50625-4:2017 for collection points

4.9.1.1 CRM RELATED TRAINING (NEW)

Personnel conducting any activity in collection, pre-treatment and final treatment chains shall have received adequate training covering the following aspects:

- key types of WEEE and waste batteries containing CRM and valuable materials also named KCE (see Annex I);
- importance of collecting KCE separately;

- sorting criteria for KCE;
- data erasure procedures that the facility follows to remove personal data from all WEEE containing such data;
- proper shipping;
- technical requirements for the pre-treatment and final treatment of KCE and key components containing CRM and valuable materials (KCC).

Training materials shall include information on the types of KCE as per the list included in Annex I of this document and on the sorting criteria. Training materials shall include information on the subsequent data erasure measures for ensuring data destruction of data containing devices, and on the processes and technical requirements that improve or hinder the recovery of CRM and valuable materials and reduce the risk of their losses.

4.9.2 OCCUPATIONAL HEALTH AND SAFETY (NEW, CLC/TS 50625-5)

To ensure safe working environments for workers, the operator shall meet the requirements related to a management system (4.3), compliance with the law (4.2), risk management (4.4), occupational health monitoring (4.9.2.1, 4.9.2.2 and 4.9.2.3), documentation (4.7), communication (4.8), well-established competences development programs (4.9.1), as well as proper technical facilities (5.2).

Personal protection equipment (PPE), first aid equipment and sanitary and eating spaces infrastructure shall be made available at no cost to workers potentially exposed to deleterious substances.

Specific measures shall be in place to address issues in relation to women's health (e.g. pregnancy, maternity).

NOTE 1: Examples of PPE include e.g. masks, goggles, gloves, safety helmets, safety equipment and clothing to protect workers from e.g. accidents, hazards and toxic emissions.

NOTE 2: Additional specific examples of PPE for use during the pre-treatment and final treatment of lead-acid batteries include masks with a vent which do not require to be removed when speaking.

Collection, logistics, pre-treatment and treatment facilities shall have clearly marked emergency exits, escape routes, firefighting equipment, fire detection and fire alarms for every indoor workplace, according to industry standards. Fire exits and escape routes shall be

kept clear of obstacles, allowing for swift and safe exit. Emergency exits shall be made known to all workers.

Specific technical guidance on facilities infrastructure required are presented in Clause 5.2.

Specific health-and-safety-related requirements for the final treatment of printed circuit boards are established in clause 4.3 of CLC/TS 50625-5:2017.

Refer to clause 4.3 of CLC/TS 50625-5:2017

4.9.2.1 OCCUPATIONAL HEALTH MONITORING (50625-2-1, NEW)

Regular (at least once a year) health monitoring shall be undertaken in treatment facilities handling KCC.

Exposure of employees to any toxic substance or heavy metal shall be monitored and tested regularly (at least once a year). Remediation measures shall be implemented, and its efficacy assessed when workers exposure places them at health risk. Medical checks should occur at least once per year.

Where a State requires more frequent medical checks, the frequency established in the applicable State legislation shall apply to the State concerned.

The permissible exposure limit (PEL) or occupational exposure limit (OEL) value at the treatment facility shall not exceed an 8-hour Threshold Limit Values (TLV).

Where a State imposes PELs for shorter periods (less than 8-hours), the stricter value shall be respected for that State, meaning the PEL of 8-hour.

In order to protect workers of pre-treatment and final treatment facilities, the following requirements shall be fulfilled:

- Occupational exposure of workers to toxics (such as lead released from lead-acid batteries, hydrogen fluoride and VOC from lithium-ion batteries and mercury from fluorescent powders recycling) shall be assessed and risk assessments shall be completed to ensure exposures respect the PEL (or OEL) values.
- If the case of lead-acid batteries and fluorescent powders pre-treatment and final treatment, based on the hierarchy of hazard controls, effective engineering controls

and use of adequate equipment and materials shall be in place before the routine use of personal protective equipment.

NOTE 1: The hierarchy of hazard controls is as follows: 1. Elimination of hazardous substances; 2. Substitution by a substance that is less hazardous; 3. Design of appropriate work processes and engineering controls and use of adequate equipment and materials, so as to avoid or minimise the release of hazardous chemical agents which may present a risk to workers' safety and health at the place of work; 4. Application of collective protection measures at the source of the risk, such as adequate ventilation and appropriate organisational measures; 5. Where exposure cannot be prevented by other means, the application of individual protection measures including personal protective equipment (PPE).

- In the case of pre-treatment and final treatment of fluorescent powders and lead-acid batteries, a segregated eating area shall be provided, which is air conditioned (HEPA filtered and slightly over-pressured⁹) to avoid lead- or mercury- contaminated dust ingress. Eating areas shall be regularly cleaned and tested to ensure they are lead-free.
- Ventilated masks shall be provided to all workers of lead-acid batteries smelters.
- During the shredding and crushing of printed circuit boards exposure of workers to heavy metals (Cu, Pb and Cd) through dust shall be avoided.

NOTE 2: This can be done by, for example, but not limited to, dust abatement techniques.

- Proper work wear shall be provided by the employer.
- For lead-acid battery recycling, clean work wear shall be provided by the employer for each shift or day of work and shall never be taken home for washing or cleaning by the employee.
- Shower and hand cleaning facilities shall be provided.
- Regular information and training on health risks shall be provided to workers.
- Suitable personal protection equipment shall be provided by the company and used by concerned workers.

In the absence of more specific requirements or stricter ones, all sections of the European Framework Directive on Safety and Health at Work (Directive 89/391 EEC) shall be complied with.

⁹ HEPA - High Efficiency Particulate Air filter to remove any traces of Lead dust. Therefore, the room should be under positive pressure to ensure that outside unfiltered air does not enter the eating area.

Lamps and CRT equipment (EN 50625-2-1, EN 50625-2-2)

Medical checks of employees and contractors of lamps and CRT equipment treatment facilities shall be in accordance with annex AA (of EN 50625-2-1:2014). See references in clauses 5.11 of EN 50625-2-1:2014 and 5.11 of EN 50625-2-2:2015.

Refer to clause 5.11 of EN 50625-2-1:2014

Refer to clause 5.11 of EN 50625-2-2:2015

Fluorescent powders (NEW)

Employees and contractors from fluorescent powders treatment facilities who are at potential risk of exposure to deleterious elements and/or compounds beyond the exposure limits, shall undergo at least annual health and hygiene-related checks. Records of each check shall be made.

The specific health test should include urine samples and the specific markers are cadmium, ALA-d (an indirect bio-marker for lead) and beta-2 macroglobulin (an indirect bio-marker for mercury).

NOTE 3: EU Member States have implemented national occupational exposure limit (OEL, eight hour average) values for “mercury and its inorganic divalent compounds (as Hg)” ranging from 0.03 mg/m³ in Lithuania, Sweden and Slovakia to 0.1 mg/m³ in Germany (EU OSHA 2007, GESTIS 2009, TRGS 900).

NOTE 4: On the European level no corresponding indicative value is available but (SCOEL 2007) recommended an 8-hour TWA of 0.02 mg mercury/m³ for “elemental mercury and inorganic divalent mercury compounds”. A biological limit value (BLV) of 10 µg Hg/l blood and 30 µg Hg/g creatinine in urine is also recommended by (SCOEL 2007).

Employees and contractors who are exposed to the hydrometallurgical treatment of the fluorescent powders shall use special PPE consisting of:

- Splash guard visors;
- Anti-acid overalls;
- Chemical and mechanical resistant gloves;
- Specific solvent and powder filters protection masks;
- Anti-acid boots.

Lead-acid waste batteries (NEW)

Lead exposure and blood lead levels of employees working in lead-acid batteries pre-treatment and final treatment facilities shall be monitored and tested regularly. Depending on the exposure risk, test intervals as established in Table 3 shall be applied (minimum frequency)**Error! Reference source not found..**

Table 3. Intervals for blood level tests

Job Position	Blood lead level test interval
E.g. workers at furnace and off-gas treatment systems, in battery breaking area or other high exposure positions	3 months or more often if the trend is towards the restriction level
E.g. workers operating in a pre-treatment facility	6 months
Office job	12 months

NOTE 5: According to the UK Health & Safety Executive Publication “Control of lead at work” (Third edition as of 2002), the following actions shall be triggered if the lead blood level in a male employee reaches or exceeds 50 µg/100ml, and in a female employee reaches or exceeds 25 µg/100ml:

- Warn the employer that an employee’s blood-lead concentration is approaching the suspension level.
- Prompt the employer to investigate why the threshold has been breached and to review the range and effectiveness of control measures used with the aim of reducing the employee’s blood-lead below the action level.
- During the investigation the employee should be counselled by the Line Manager to prevent the employee reaching the removal or suspension level, if possible.
- Removal of male workers at 60 µg/100ml and females at 30 µg/100ml from work areas where they might be exposed to lead dust and return to their place of work only when new test results are below the above stated action level.

Where no national legislation or guidelines are available, all employers shall commit to reduce employee lead exposure to levels as low as reasonably practicable. Facilities’ policies shall ensure that women are adequately protected.

Lithium-ion waste batteries (NEW)

The indoor air quality (particularly levels of hydrogen fluoride (HF) and volatile organic compounds VOC) shall be monitored every three months.

Occupational exposure limits have to be ensured. Exposure time shall be defined for the operators in accordance to the Directive 89/391 EEC. Indicative values for hydrogen fluoride are:

- Eight hours: 1.5 mg/m³; 1.8 ppm
- Short term: 2.5 mg/m³; 3 ppm

NOTE 6: As based on the US Occupational Safety and Health Administration (OSHA) the Permissible Exposure Limit (PEL) are:

- Fluoride: 2.5 mg/m³;
- Nickel: metal 0.5 mg/m³, insoluble 0.1 mg/m³
- Cobalt: metal 0.02 mg/m³
- Manganese: metal 0.2 mg/m³

The PEL is reduced for shifts longer than 8 hours by the equation $PEL = 400/\text{hours worked}$.

NOTE 7: Detailed requirements are elaborated by OSHA.

Workers handling lithium-ion batteries during treatment shall use protective work wear and gear such as goggles and HF-proof (HF = hydrogen fluoride) gloves.

Magnets *(NEW)*

Measurements at the final treatment facilities include those of Nd and Nd oxide concentrations in the air. Medical checks of workers before and after the treatment include the presence of irritated eyes and mucous membranes.

NOTE 8: Magnet scrap powders generated after the cutting processes contain a large amount of fine powders (1mm or less), which can ignite violently, or explode in an air-dried condition posing risks to workers. In addition, Nd dust and salts highly irritate the eyes and mucous membranes and moderately the skin. Nd oxide (Nd₂O₃) was reported as mutagen.

4.9.3 CONTRACTUAL ASPECTS (NEW, ISO IWA 19)

In the context of contractual agreements required, the parties concerned include operators in the recycling chain and their workers.

If gaps exist in labour-related legislations of the States where the collection, logistics, pre-treatment and final treatment facilities operate, requirement on contractual aspects of the ISO IWA 19:2017 shall be considered.

Refer to ISO IWA 19:2017, Sustainability requirements, Section 6.2 – Principle Objective 1.2 – Establish working terms and conditions that are decent and equitable

4.9.3.1 ENTITIES RESPONSIBLE FOR THE COLLECTION (NEW)

In order to improve the collection of key CRM equipment, collection facilities and encouraged to set agreements with the entities responsible for collecting or/and delivering collected equipment. Examples of such entities are:

- extended producer responsibility organisations;
- municipal waste collection services;
- producers of electric and electronic equipment (EEE) and batteries including distance selling producers;
- companies such as retailers, business entities, installers;
- other potential sources of WEEE.

4.9.3.2 EMPLOYEES (ISO IWA 19)

If gaps exist in labour-related legislations of the States where the collection, logistics, pre-treatment and final treatment facilities operate, requirements established in Principle 1, Objective 1.2 of the ISO IWA 19:2017 on employment contracts, working hours and overtime, remuneration and holidays shall be complied with.

Refer to ISO IWA 19:2017, Sustainability requirements, Section 6.2-Principle 1, Objective 1.2 – Establish working terms and conditions that are decent and equitable

4.10 SUSTAINABILITY REQUIREMENTS (NEW)

Sustainability CEWASTE requirements focus on ‘environmental impacts control’ (4.10.2). Recommendations are provided on ‘well-being of local communities’ (4.10.1) and contribution to ‘society’ (4.10.3).

4.10.1 WELL-BEING OF LOCAL COMMUNITIES (NEW)

The operator should contribute to the well-being of the local communities and regional development. Social management systems and outreach programs help to address environmental and social risks and improve the contribution to sustainable development.

This is supported with proper communications required for this stakeholder group (see clause 4.8).

NOTE 1: In support of waste collection activities in the local community, facilities may join outreach programs e.g. led by the municipality to facilitate the collection of WEEE and waste batteries as input materials for the facilities implementing CEWASTE.

NOTE 2: Pre-treatment and final treatment operators and collection facilities are encouraged to support social management systems in the local community already in place as part of the corporate social responsibility.

4.10.2 ENVIRONMENTAL IMPACTS CONTROLS ^(NEW)

The operators shall demonstrate an understanding of the potential environmental impacts of their activities and of how to limit the adverse impacts.

Operators shall therefore have an environmental management plan in place with performance indicators and monitored regularly (see example of a Management, Monitoring and Evaluation Plan in Annex II).

If limit values established in national regulations exist, and if these have been exceeded, mitigation measures shall be implemented to remediate the effects as soon as possible.

Measures shall prevent and mitigate all forms of pollution and aim to reduce greenhouse gas emissions through, e.g., low-carbon technologies and/or energy efficiency measures.

NOTE 1: Forms of pollution include direct or indirect introduction, as a result of human activity, of substances, vibrations, heat or noise into air, water or land which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment.

Assessment of the efficacy of the measures shall be carried out.

Specific emissions monitoring and control requirements for waste fluorescent powders, batteries, printed circuit boards and magnets treatment are described in the following clauses.

NOTE 2: Emissions monitoring and control requirements for chemical substances in general are in the Internationally Peer Reviewed Chemical Safety Information System – INCHEM (also accessible per CAS Number)¹⁰.

¹⁰ <http://www.inchem.org/#/search>

4.10.2.1 EMISSIONS MONITORING AND CONTROL - FLUORESCENTS

POWDERS TREATMENT ^(NEW)

For hazardous waste and non-hazardous waste resulting on-site from the hydrometallurgical treatment the following measures shall be in place:

- A procedure for the handling of waste packaging material;
- A procedure for safe handling and disposal of all waste that cannot be recycled or recovered;
- If the waste is sent to a third party, such facilities shall have the required permits from the relevant authorities as needed and the treatment operator shall demonstrate compliance if such facility is located in a non-OECD State;
- The final treatment operator shall document the conformity of the third parties accepting its waste making available the required permits from the relevant authorities;
- The provision of weight notes for each consignment of output wastes dispatched and an electronic or written registration system to record the destination and weight(s) of each output waste consignment.

Environmental monitoring shall be carried out on a regular basis covering process effluents. If limit values have been exceeded, there shall be a report on improvement actions and data shall be reported that also indicate any effects of such corrective measures will have.

The values of permitted limits in final water effluent streams discharged to the environment (from process and surface water drainage when applicable) are:

Element/parameter	Concentration in final effluent discharge
Pb	≤0,5 mg/l
Cd	≤0,1 mg/l
Zn	≤ 1,0 mg/l
Hg	≤0,02 mg/l
pH	6,5 - 10

NOTE 1: Limits are expressed as yearly averages based on 24 h qualified random or weekly samples.

If stricter limits are set by the applicable legislation, these shall prevail over the ones indicated in the list above.

NOTE 2: These limit values apply without prejudice to the BAT-AELs provided in the BAT conclusions of the non-ferrous metals BREF in accordance with the European Directive 2010/75/EU.

4.10.2.2 EMISSIONS MONITORING AND CONTROL – WASTE

BATTERIES TREATMENT (NEW)

In lead smelters for lead-acid waste batteries (NEW)

Effective measures shall be in place to keep all working environments and the surrounding areas free from acid and acid mist and lead containing fume and dust.

Emissions to air and discharges to soil and water shall be measured, restricted, monitored and controlled. Respective national or regional emission standards shall be applied. If no suitable or applicable national standards are available, then appropriate international and EU standards contained in the International Lead and Zinc Study Group (ILZSG)¹¹ Study on Environmental and Health Controls on Lead listed in Table V.1 of Annex V shall apply.

In lithium-ion waste batteries treatment (NEW)

Releases of harmful gases shall be prevented by installing a ventilation system and filters.

Environmental health and safety procedures when treating and recycling lithium-ion batteries, in the absence of national or regional equivalent regulations, shall follow the European Directive 2010/75/EU on non-ferrous industry.

During the pyrometallurgical process (at high treatment temperatures between 1100 to 1500°C), safe operation shall be ensured.

The European Directive 2010/75/EU on non-ferrous industry sets the minimum requirements for safety and emissions control:

- Waste gases from smelting plants shall be discharged in a controlled way by means of a stack, containing one or more flues, the height of which is calculated in such a way as to safeguard human health and the environment (Directive 2010/75/EU Article 30).

¹¹ <http://www.ilzsg.org/static/introduction.aspx?from=1>

- The emissions of volatile organic compounds shall be controlled under contained conditions as far as technically and economically feasible to safeguard public health and the environment and shall not exceed the relevant emission limit values defined in Annex VII of Directive 2010/75/EU.
- Emissions of other pollutants including HF, SO₂, CO₂, dioxin etc. shall not exceed the limit values in Annex V to VI of Directive 2010/75/EU.
- PPE for workers

If the pyrolysis process treatment temperature is below 200°C, the electrolyte is evaporated to obtain a mixture of waste organic solvent which shall be further treated. In this process, emission of HF, P₂O₅, SO₂, CO, particulates of heavy metals and dioxin shall be controlled in accordance to Directive 2010/75/EU for a combustion plant.

During mechanical or hydrometallurgical based processed, waste-water treatment is an environmental aspect of concern. Sulphate acid, chloride acid, and alkaline have shall be handled carefully in order to prevent leakage to the environment and exposure to workers.

Graphite residue containing trace heavy metals and other organic or inorganic elements is the final residue after the leaching step. The residue shall be properly treated to avoid environmental damage. The operator may apply innovative technologies to recover the graphite or convert the residue into potential products.

The removal of impurities using solvent extraction generates a number of residues containing heavy metals, F, P and organic compounds. These shall be clearly labelled and classified as hazardous waste.

The residue during the solvent extraction stage, as a result of impurities removal, contains heavy metals of Cu, Ni, Mn etc. and trace organic compounds of the solvent. Since further R&D is needed to enable recovery, operators shall ensure that these residues are disposed of in safe manner.

For wastewater treatment, the same requirements shall be met as for the pyrometallurgical process.

The organic solvent mixtures produced during the mechanical recycling of lithium-ion batteries shall be treated as a hazardous substance. Further R&D is needed to separate these solvent mixtures and recover them as secondary materials.

During mechanical separation of different materials, emission of fine particulates of heavy metals as well as remaining organic materials shall be limited and the safe operational environment for the operators shall be ensured.

Wastewater from the pyrometallurgical process shall undergo proper treatment. The levels of COD, heavy metal contents, NH₃-N, Cl, F and PO₄³⁻, SO₄²⁻ shall comply with national regulations and limit values in Annex VI of Directive 2010/75/EU on the discharge point of wastewater treatment plants. Recycling plant should have proper wastewater treatment facilities or divert the wastewater to specific treatment plants.

The following measurements shall be carried out at the point of waste-water discharge:

- a) continuous measurements of pH, temperature and flow;
- b) spot sample daily measurements of total suspended solids or measurements of a flow proportional representative sample over a period of 24 hours;
- c) at least monthly measurements of a flow proportional representative sample of the discharge over a period of 24 hours of Hg, Cd, Tl, As, Pb, Cr, Cu, Ni and Zn; additional requirement on Co and Mn shall be placed for lithium-ion waste batteries recycling;
- d) at least every 6 months measurements of dioxins and furans; however, one measurement at least every 3 months shall be carried out for the first 12 months of operation.

Continuous: Emission control and technologies

European operators shall follow the requirements in the Industrial Emissions Directive and Best Available Techniques Reference documents (BREFs) for waste treatment plants. In some Member States the occupational exposure limits may be stricter than the EU regulations.

As a minimum, non-EU operators shall follow their national or local environmental regulations. However, to safeguard environmental protection, non-EU operators are encouraged to adopt European limit values when they are stricter than national or local regulations.

Discharges to the aquatic environment of waste-water resulting from the cleaning of waste gases shall be limited as far as practicable and the concentrations of polluting substances shall not exceed the emission limit values set out in Part 5 of Annex VI of Directive 2010/75/EU.

Any potentially harmful substance in the resulting fly ashes (e.g. F-dioxins) shall be captured and treated through an exhaust gas purification system such as a regenerative thermal oxidizer unit.

Monitoring shall be based on daily averages. The frequency of the emission measurements is determined by the competent licensing authority for the plant.

4.10.2.3 EMISSIONS CONTROL - MAGNETS TREATMENT ^(NEW)

Emissions controls, in addition to the ones established based on the health and safety risk assessment, are not required during the pre-treatment of waste magnets.

4.10.2.4 EMISSIONS CONTROL – PRINTED CIRCUIT BOARDS

TREATMENT ^(NEW)

During pre-treatment, specific care shall be taken to avoid emissions of heavy metals (Cu, Pb and Cd) that can undermine the environmental quality. These heavy metals can enter the environment through dust (during shredding and crushing) or metal ions in wastewater (also Sn, and Ni).

4.10.3 SOCIETY ^(NEW)

Pre-treatment and final treatment operators are encouraged to show openness to contribute with local and national authorities in the development and demonstration of educational technological programs that support the CEWASTE ultimate goal of improving the CRM recovery. This can contribute e.g. to expanding the availability of skilled labour force that is required for the implementation of sound WEEE and waste batteries treatment according to the CEWASTE requirements. Other parties such as entities responsible for collection may initiate similar initiatives.

5. TECHNICAL REQUIREMENTS

This clause describes the technical requirements that key CRM equipment and key CRM component shall follow. A graphic description is provided in **Figure 2** which also highlights the CEWASTE scope, the flows that are not part of it and where they should be delivered to. The aim of this figure is to help navigating throughout the clauses that apply to specific KCE and KCC.

These requirements exclude WEEE suitable for (preparation for) re-use which shall be separated from WEEE or waste batteries destined for recycling as early in the end of life supply chain as possible.

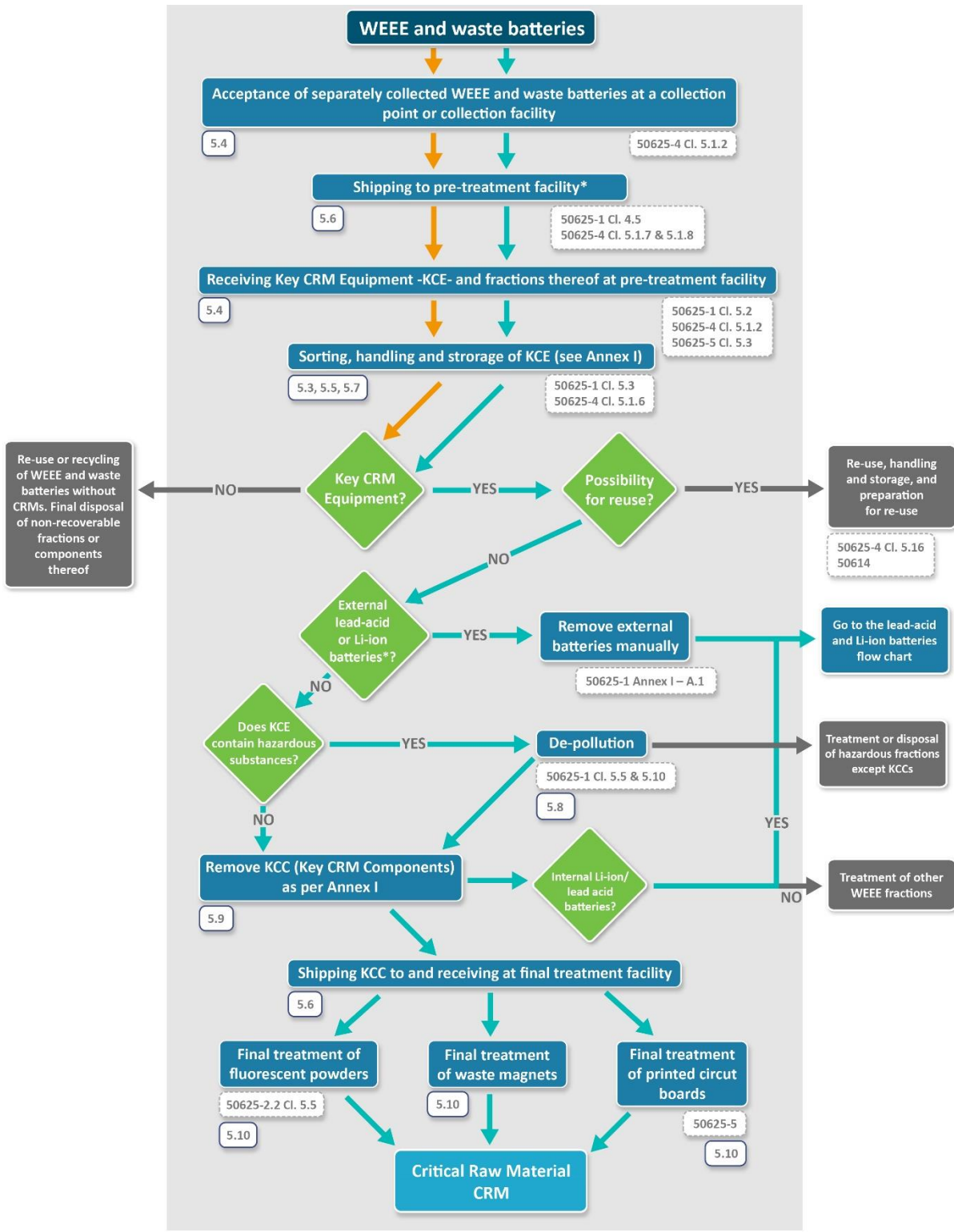
Separate collection – different to sorting - takes place at the collection stage in, collection facilities and shall allow the ones bringing their wastes (KCE for the purpose of CEWASTE) to dispose them of in different waste streams e.g. in different containers. ‘Separate collection’ is also expressed as ‘collected separately’. See details in 5.1.1.

Sorting of KCE collected occurs after separate collection and takes place at treatment facilities. Sorting bases on procedures for carefully handling by trained personnel. See details in 5.8.

NOTE: For example, this may result in sorting of non-NdFeB-magnets from NdFeB-magnets which came accidentally together.

Overall general guidance based on the waste hierarchy principles are in clause 5.10 of EN 50625-1:2014. Hierarchy principles follow the sequence of prevention, minimization, reuse, recycling, other recovery including energy recovery, and disposal.

Concerning the handling through treatment processes of lead-acid waste batteries and Li-ion batteries, they follow a simplified option (see **Figure 3**).



→ CRM Flows
 → Non-CRM Flows
 → Flows exiting the CEWASTE scope
X.X CEWASTE clause
50625-X Cl.1 – X.X CENELEC clause
Out of scope
CEWASTE Scope

Figure 2. Generic process flow diagram for the recovery of key CRM from WEEE and waste batteries

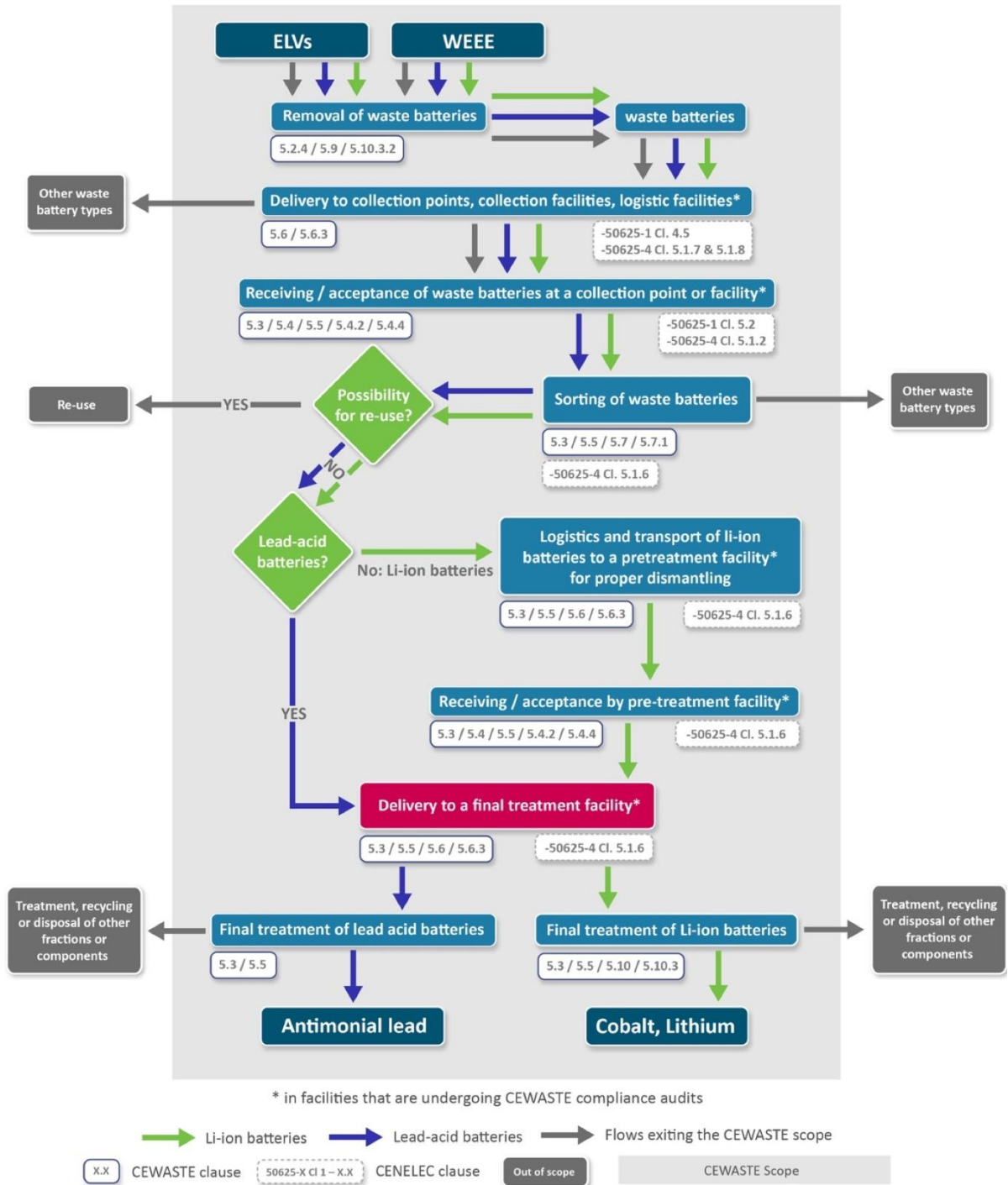


Figure 3. Flow of waste batteries, components and materials as well as requirements

5.1 GENERAL TECHNICAL REQUIREMENTS (EN 50625-1)

General technical requirements focus on the sorting, pre-treatment and treatment of WEEE and waste batteries containing CRM and valuable materials (see clause 5.1 of EN 50625-1:2014).

Refer to clause 5.1 of EN 50625-1:2014

5.1.1 COLLECTION OPERATORS AND LOGISTICS OPERATORS (CLC/TS 50625-4)

For the collection and logistics facilities, additional technical requirements are established in clause 5.1.1 of CLC/TS 50625-4:2017.

Refer to clause 5.1.1 (principles) of CLC/TS 50625-4:2017

5.1.1.1 WEEE COLLECTED IN STREAMS RELATED TO KCE (NEW)

WEEE received at collection facilities and logistics facilities shall be collected separately as per key CRM equipment (KCE listed in Annex I).

- CRT monitors and TVs (containing fluorescent powders)
- Fluorescent lamps (containing fluorescent powders)
- Laptops (hard disk drive - HDD), desktop computers (HDD), mobile phones, tablets and similar devices containing printed circuit boards and magnets
- External CDDs, ODDs, devices with internal CDDs/ODDs
- Lead-acid batteries from end-of-life vehicles and WEEE
- Li-ion batteries from laptops, mobile phones, tablets and BEV, (P)HEV

See in *Figure 4* the options for separated collection of KCE.

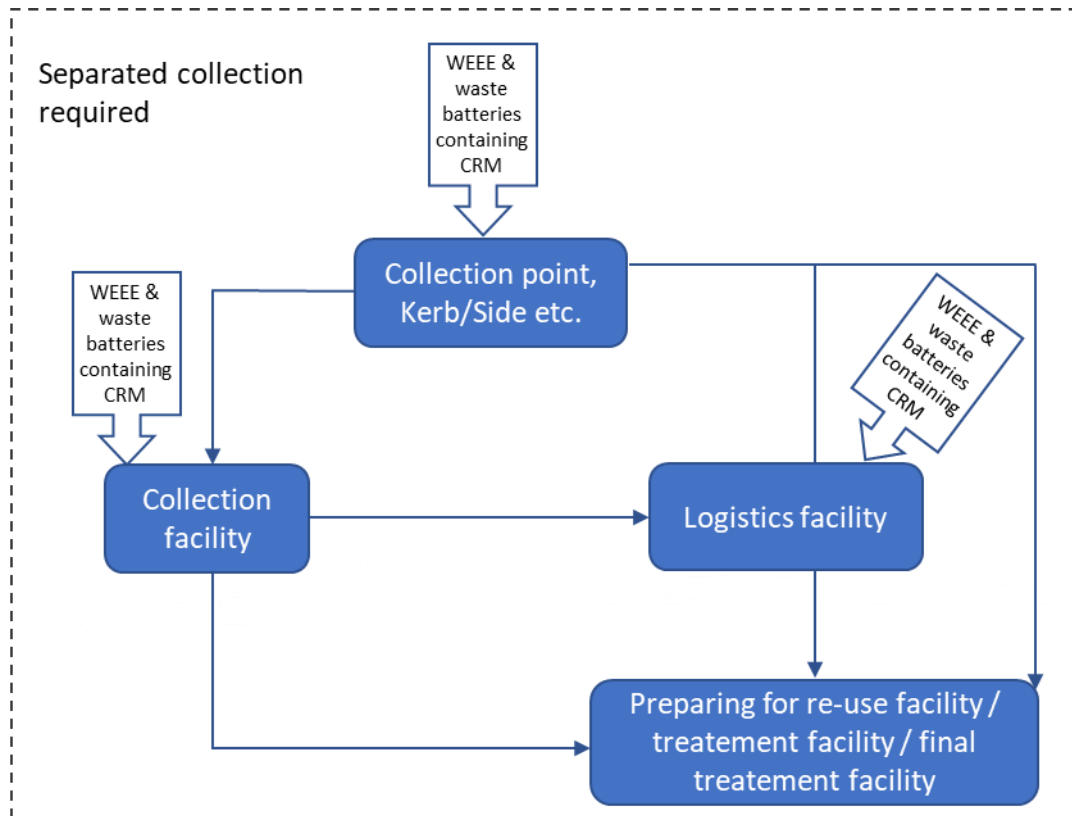


Figure 4. Separated collection at collection points and facilities (adapted from Fig.1 of CLC/TS 50625-4:2017)

5.1.1.2 COLLECTION POINTS AND FACILITIES (CLC/TS 50625-4)

The operator responsible for collection of WEEE from collection points shall ensure that the collection point is compliant with the technical requirements in clause 5.2 (of CLC/TS 50625-4:2017). Clause 5.1 of CLC/TS 50625-4:2017 applies to collection facilities.

Refer to clauses 5.1 and 5.2 (principles) of CLC/TS 50625-4:2017

In addition, the following shall be considered for collection points and facilities:

- Received loose batteries from notebooks, mobile phones and tablets shall be kept separate at collection facilities for further pre-treatment and final treatment.
- Collection point and collection facility operators shall not carry out any form of pre-treatment unless the site has the relevant permit or is permitted to undertake the activity according to local legislations. If the latter is the case, these operators shall work as treatment operators according to clause 5.1.4 of CLC/TS 50625-4:2017.
- Collection point operators shall not carry out any form of preparing for re-use

NOTE: Such treatment activities include any form of dismantling.

Refer to clause 5.1.4 of CLC/TS 50625-4:2017

The entity responsible for the collection shall ensure that WEEE not intended for re-use containing CRM as per the Annex I of this document are collected separately before treatment.

5.1.1.3 COLLECTION OF WASTE BATTERIES (NEW)

There are typically five collection routes for batteries collection with specific requirements:

- a. *Collection points for portable batteries.* These are collected separately and often mixed without differentiating the battery chemistry. Collection points for portable batteries are located for instance at supermarkets or other public places easily accessible by consumers.

Portable batteries shall be put in containers and transported, according to the requirements in clause 5.6.3, to sorting facilities.

- b. *Collections points and facilities for WEEE.* Most (lithium-ion) batteries are collected together with the WEEE in which they are embedded (e.g. notebooks, tablets, mobile phones, power tools). These may be collected at public collection points, collection facilities, retailers or repair shops.

WEEE (including the batteries) shall be taken in suitable transport containers to electronic waste treatment operators (ADR 2019 ECE/TRANS/275, 2019).

- c. *Collection of batteries from end-of-life vehicles.* These contain lead-acid or lithium-ion battery packs which follow a different waste regime and collection route than WEEE. Lithium-ion batteries shall be removed from end-of-life by trained personnel and transported to dismantling plants as dangerous goods.

While removing lithium-ion batteries from WEEE, operators shall prevent damage to the batteries.

- d. *Take-back schemes for industrial batteries¹².*

¹² Following the EU Batteries Directive (Directive 2006/66/EC), SLI (starting, lighting, ignition) batteries are defined as automotive batteries, whereas hybrid and electric vehicle batteries are categorised as industrial batteries.

- e. *Collection of (semi)industrial waste batteries.* Waste batteries from industrial sites such as forklift trucks, but also energy storage systems shall be collected separately at company sites and brought to collection facilities.

5.1.2 LAMPS TREATMENT OPERATORS (EN 50625-2-1)

Refer to clause 5.1 of EN 50625-2-1:2014

5.1.3 CRT DISPLAYS TREATMENT OPERATORS (EN 50625-2-2)

Refer to clause 5.1.1 of EN 50625-2-2:2015

5.2 TECHNICAL AND INFRASTRUCTURAL PRE-CONDITIONS

(EN 50625-1, CLC/TS 50625-4, EN 50625-2-1, CLC/TS 50625-5)

For pre-treatment and treatment facilities general technical and infrastructural pre-conditions are established in clause 4.2 of EN 50625-1:2014.

For final treatment of copper and precious metals contained in WEEE and fractions of WEEE, the relevant requirements of CLC/TS 50625-5:2017 apply in addition to the ones mentioned above.

Refer to clause 4.2 of EN 50625-1:2014 for pre-treatment and treatment facilities

Refer to clause 5.2 of CLC/TS 50625-5:2017 for final treatment of copper and precious metals contained in WEEE and fractions of WEEE.

In pre-treatment processes of targeted NdFeB magnets and waste batteries the operator shall not shred KCE and KCC containing these components.

5.2.1 COLLECTION OPERATORS AND LOGISTICS OPERATORS (CLC/TS 50625-4)

For the collection and logistics phase, the infrastructural pre-conditions are established in clause 4.1.2 of CLC/TS 50625-4:2017.

Refer to clause 4.1.2 of CLC/TS 50625-4:2017

5.2.2 LAMPS TREATMENT OPERATORS (EN 50625-1)

In case of lamps the following applies.

Refer to clause 4.2 of EN 50625-2-1:2014

5.2.3 FLUORESCENT POWDERS TREATMENT OPERATORS (NEW)

Facilities applying hydrometallurgical processing for the treatment of fluorescent powders (see Annex III) shall apply the following:

- Store sulfuric acid in appropriate containers and appropriately labelled. Sulfuric acid shall be stored in a cool, dry area away from direct sunlight and heat sources. Sulfuric acid should not be stored indoors in large quantities, to prevent the possible accumulation of vapours. Product containers shall be regularly examined for signs of damage or leaks.
- Facilities shall have a centralized aspiration consisting of cartridge filters for fluorescent powders and a scrubber unit for acid vapours.
- Facilities shall count with an automatic remote blocking system (to stop the process in case of an emergency).

5.2.4 WASTE BATTERIES TREATMENT OPERATORS (NEW)

Waste lead-acid and lithium-ion battery recycling plants should be situated in designated industrial zones and not adjacent to residential areas or rural populations.

Battery removal shall take place in a space separated from other operations. Collection and pre-treatment operators of targeted batteries shall not use shredding technologies for removal.

NOTE: Targeted batteries are Lead-acid and Li-ion batteries

Sites for treatment of lithium-ion and lead-acid batteries shall be equipped with Impermeable surfaces and waterproof covering for appropriate areas with the provision of spillage collection facilities and, where appropriate, decanters.

More specifically, sites for treatment of lithium-ion batteries shall be equipped with:

- Appropriate collection containers such as mesh boxes for disassembled and separated spare parts (casings, cables, electronics, etc.) of industrial lithium-ion batteries;
- Equipment for the treatment of water in compliance with health and environmental regulations determined by the competent licensing authority for the plant
- Balances to measure the weight of the treated waste.

In addition, the battery storage facilities shall be designed in a way that potential discharges of acid cannot contaminate soil, ground or surface water sources, and so that waste batteries are not mixed with waste from conductive or combustible materials.

5.2.5 NdFeB-MAGNETS TREATMENT OPERATORS (NEW)

Pre-treatment operators of KCE containing targeted magnets shall not use shredding technologies for removal of these magnets.

NOTE: Targeted magnets are NdFeB magnets from desktops and laptops

Pre-treatment operators removing targeted magnets from WEEE shall have non-magnetizable receptacles available for their storage to ensure the magnets can be easily cleared from the receptacles for further pre- or end-treatment steps.

5.3 HANDLING (EN 50625-2-1)

The handling of WEEE and waste batteries containing CRM and valuable materials, including the loading, unloading and transport shall apply the general requirements in clause 5.3 of EN 50625-1:2014.

Refer to clause 5.3 of EN 50625-1:2014

5.3.1 HANDLING AT COLLECTION FACILITIES (EN 50625-4)

In addition to the requirement in clause 5.1.4 of CLC/TS 50625-4:2017, consider the following:

- When batteries can be removed without tools, they shall be removed

Refer to clause 5.1.4 of CLC/TS 50625-4:2017

5.3.2 HANDLING OF FLUORESCENT LAMPS DURING TREATMENT (EN 50625-2-1)

Refer to clause 5.3 of EN 50625-2-1:2014

5.3.3 HANDLING OF CRT DISPLAYS EQUIPMENT DURING TREATMENT (EN 50625-2-2)

Refer to clause 5.3.1 of EN 50625-2-2:2015

5.4 RECEIVING AND ACCEPTANCE OF WEEE AND WASTE BATTERIES AT TREATMENT FACILITIES (EN 50625-1, CLC/TS 50625-4, EN 50625-2-1)

For receiving WEEE and waste batteries, clause 5.2 of EN 50625-1:2014 applies.

For acceptance of any KCE or KCC by collection and logistics facilities, requirements established in clause 5.1.2 of CLC/TS 50625-4:2017 shall be applied.

Requirements for receiving hazardous KCC (fluorescent powders and lead-acid waste batteries) are in 5.4.4.

For specific KCE and KCC, requirements exist in EN series (such as for fluorescent lamps and printed circuit boards) or have been newly developed (for lithium-ion batteries) as indicated in 5.4.1, 5.4.2 and 5.4.3 which shall be met by the respective waste fractions.

Additionally, for ensuring clear separation when receiving KCE or KCC and raise awareness, collection and logistics facilities shall provide visuals and descriptions that help identifying the types of WEEE and waste batteries and the locations for disposing them of.

Refer to clause 5.2 of EN 50625-1:2014

Refer to clause 5.1.2 of CLC/TS 50625-4:2017 for collection and logistics facilities

For traceability purposes, the operator should prevent mixing waste lead-acid batteries, printed circuit boards or their fractions originating from CEWASTE compliant operators with others.

5.4.1 RECEIVING OF FLUORESCENT LAMPS (EN 50625-2-1)

Refer to clause 5.2 of EN 50625-2-1:2014

5.4.2 RECEIVING OF LITHIUM-ION WASTE BATTERIES (NEW)

The state of lithium-ion waste batteries typically received by waste facilities fall in three types:

1. Whole batteries are complete and undamaged;
2. The cases are complete while inner short-cut may occur during transportation;
3. The cases or the batteries themselves are damaged possibly with leakage of electrolyte.

The 2nd and 3rd types are critical as these pose possible danger during transport and shall be distinguished from type 1 (non-critical).

When receiving damaged batteries (type 3), they shall be separated from batteries with complete cases. Appropriate safety measures shall be taken, such as storing them in a container with an appropriate absorption material. For the purpose of this requirement, collection facilities shall only remove external batteries where this is possible without tools unless they have a permit.

Portable type 1 lithium-ion batteries also from electric vehicles shall be received, sorted and kept separate and labelled based on their application or where known on their chemistry composition.

NOTE: Typical lithium-ion composition is as follows

- The cathode composition of lithium-ion waste batteries from electric vehicles typically include LiFePO₄ type battery, LiMnO₂ type battery, Li (Ni,Co,Mn)O₂ type battery, Li(Ni, Co, Al)O₂ type battery, LiCoO₂;
- NCM type lithium-ion waste batteries have different compositions e.g. NCM111, 523, 622, 811 etc.; there are also mixed lithium-ion waste batteries e.g. LiMnO₂ mixed with NCM, LFP mixed with LMO;
- Concerning the anode compositions most typical ones are graphite based; Li₄Ti₅O₁₂ based; Silicon-C combined and Si-O based.

5.4.3 AGREEMENT FOR ACCEPTANCE OF PRINTED CIRCUIT BOARDS AND FRACTIONS CONTAINING CU AND PRECIOUS METALS (CLC/TS 50625-5)

Refer to clause 4.4 of TS 50625-5 for final treatment operators

Arrangements for sampling of printed circuit boards shall be conducted as set out in 5.3 of CLC/TS 50625-5:2017.

5.4.4 AGREEMENT FOR ACCEPTANCE OF HAZARDOUS KCC: FLUORESCENT POWDERS AND WASTE BATTERIES (NEW)

Deliveries of fluorescent powders and waste batteries – hazardous WEEE streams – to a further treatment facility shall only occur once a written agreement is issued between the concerned operators (the supplier and the receptor). The minimum elements of the contract shall include:

- Description of material i.e. type of the waste (based on applicable waste codes such as the European Waste Catalogue (EWC) - Commission Decision 2000/532/EC or the Basel Convention codes), physical characteristics, and condition of the WEEE or component – functional/crushed/damaged or not;
- The delivery mode e.g. transport by road, ship or rail;
- Duration of the agreement;
- Agreed quantities;
- Mutually agreed specification of materials;
- Specification of authorized transport and logistics related requirements;

NOTE 1: Compliance with Waste Shipment Regulation - (EC) No 1013/2006 and European List of Waste - 2000/532/EC if required and compliance with the ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road) provisions if applicable.

- Packaging requirements;
- Arrangements for handling of 'off-spec material';
- Minimum specification on possible contaminants such as :
 - Permissible exposure limits of mercury (Hg);
 - Permissible exposure limits (PEL) of fluoride as LiPF₆;
 - Permissible exposure limits of beryllium (Be);
 - Declaration of check of volatile materials (dimethyl carbonate, ethyl carbonate);

NOTE 2

- Typical Hg acceptance level < 10 ppm.
- Typical PEL of LiPF₆ < 2.5 mg/m³.
- Typical Beryllium acceptance level < 200 ppm.
- In case of detection of any radioactivity, in which there should be generally a low tolerance level, while the evaluation of radioactivity and maximum content's threshold should be in accordance with 2003/122/Euratom or those of the equivalent competent authority whichever is the most stringent.

A procedure shall be in place to allow verification and compliance with the agreement for acceptance of materials. The procedure shall include the following:

- Inspection at reception;
- Each delivery shall be inspected to verify quality and respect of environmental requirements and compliance with the agreement for acceptance;
- Proof of inspection of transport documents and record of the origin;
- The results of the verification shall be documented.

5.5 Storage at collection and treatment facilities

(NEW, EN 50625-1, EN 50625-1, CLC/TS 50625-4, EN 50625-2-1, EN 50625-2-2)

Treatment logistics, and collection facilities operators shall take all necessary measures to ensure the proper and safe storage methods of WEEE, waste batteries, and CRM and fractions, particularly the separate storage of hazardous and non-depolluted fractions. General guidance can be also found in clauses 5.4 of EN 50625-1:2014 and 5.1.5 of CLC/TS 50625-4:2017.

Concerning lead-acid and Li-ion batteries, for properly and safely storing them, open batteries contacts shall be taped off. Loose wires shall be taped to the cells/batteries. Because batteries are a potential source of heat, in order to prevent short circuits they shall be uncharged and kept in sealed containers free of oxygen supply and water and with inert materials around the batteries such as sand.

Additional requirements are also provided for waste batteries storage in 5.5.1 and 5.5.2.

Refer to clause 5.4 and 5.8 of EN 50625-1:2014 for treatment facilities

Refer to clause 5.1.5 of CLC/TS 50625-4:2017 for collection and logistics facilities

Refer to clause 5.4 of EN 50625-2-2:2015 for displays treatment facilities

Refer to clause 5.4 and 5.8 of EN 50625-2-1:2014 for lamps treatment facilities

5.5.1 SOUND STORAGE OF LEAD-ACID WASTE BATTERIES (NEW)

Uncontrolled draining and leakage of sulfuric acid from lead-acid waste batteries at storage places and in the recycling plant shall be avoided.

To avoid environmental contamination, leaking batteries shall be stored in acid-proof containers compliant with the UN Recommendations on the Transport of Dangerous Goods (2017).

Lead-acid waste batteries shall be separately stored in such a way that waste batteries are not mixed with other wastes.

Lead-acid waste batteries shall be separated into not-damaged batteries and damaged batteries (for example, with an inner shortcut or broken casing).

5.5.2 SOUND STORAGE LITHIUM-ION WASTE BATTERIES (NEW)

Lithium-ion batteries shall be protected to prevent exposure to temperatures close to 100°C, water, or any crushing or physical damage during handling, sorting, and storage.

NOTE 1: Lithium is highly reactive and difficult to control.

NOTE 2: Batteries electrolytes usually contains flammable organic solvents some of which are volatile at modest temperatures (below 100 °C).

Lithium-ion waste batteries with different compositions shall be separately stored.

Damaged lithium-ion batteries shall be stored separately from undamaged ones.

Open contacts of lithium-ion waste batteries shall be taped off, and loose wires shall be taped to the cells/batteries.

Package batteries shall be stored in containers with an appropriate absorption material.

5.6 SHIPPING (NEW, EN 50625-1)

Requirements are established in clause 4.5 of EN 50625-1:2014. More specific requirements are provided for transport in general in clause 5.1.7 of TS 50625-4, and for transfers between operators in clause 5.1.8 of TS 50625-4.

Refer to clause 4.5 of EN 50625-1:2014

In the case of lead-acid waste batteries and lamps, they shall be transported as dangerous wastes.

NOTE: In the case of damaged lithium-ion batteries, stricter regulations apply to their transport.

Where shipment for further processing of WEEE and/or waste batteries, or fractions thereof, is to be undertaken, treatment operators shall ensure that receiving facilities comply with:

- the WEEE treatment requirements of European Directive 2012/19/EU or equivalent treatment requirements;
- the Regulation (EC) No 1013/2006 on shipments of waste;
- the Regulation (EC) No 1418/2007 on the export for recovery of certain waste listed in Annex III or IIIA to Regulation (EC) No 1013/2006;

- the Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures;
- the Directive (EURATOM)2006/117 on the supervision and control of shipments of radioactive waste; and
- national authorization procedures of the State where the facility is established.
- EERA, Technical Guidance Document, Safe Collection and Transport of Electronic Equipment with Lithium Batteries, 2019
- CEWASTE requirements

For the safe inland and international transport by road, rail or inland waterways of dangerous fractions (such as lithium batteries, fluorescent powders, among others) there shall be ensured compliance with the following European agreement and regulations.

- Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods
- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways – ADN (2017)
- European Agreement concerning the International Carriage of Dangerous Goods by Road – ADR (2019)

5.6.1 TRANSPORT (CLC/TS 50625-4)

Refer to clause 5.1.7 of CLC/TS 50625-4:2017

5.6.2 TRANSFER BETWEEN OPERATORS (CLC/TS 50625-4)

This covers the transfer from collection and logistic operators to treatment operators.

Refer to clause 5.1.8 of CLC/TS 50625-4:2017

Furthermore, for final treatment of CRM components or fractions thereof transfer shall be done to operators that self-declare undertaking CEWASTE audits (ergo, compliant with or in the phase of implementation of CEWASTE requirements).

5.6.3 SHIPPING OF WASTE BATTERIES AND FRACTIONS (NEW)

Shipment of lead-acid waste batteries across borders is subject to the requirements of the Basel Convention. More specific requirements are in 5.6.3.1 and 5.6.3.2.

5.6.3.1 LEAD-ACID WASTE BATTERIES (NEW)

Lead-acid batteries shall be collected and transported complete with acid.

For bulk transports of waste lead-acid batteries the requirements listed in the standards in Annex V, Table V.2 shall be fulfilled.

If the shipment of lead acid waste batteries crosses States' borders, 'shipment' is considered a 'transboundary movement' the requirements of the Basel Convention (UNEP, 2019) shall apply.

The transport of Waste Lead-Acid Batteries is subject to ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road – 2019). The criteria set out in ADR 7.3.3 VC1, VC2 and AP8 apply. Respectively for Transport on Inland Water, the newest version of ADN (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways) applies. For transport, WLABS have to be in compliance with the following criteria:

- packed and secured so they cannot slip, fall or be damaged;
- provided with carrying devices, unless stacked on pallets;
- free of any dangerous traces of acid on the outside;
- protected against short circuits.

Further detail is given in Annex V, Table V.2.

5.6.3.2 LITHIUM-ION WASTE BATTERIES (NEW)

For transports of lithium-ion waste batteries the requirements according to the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) as listed in Annex V, Table V.3 shall apply.

5.7 SORTING (CLC/TS 50625-4, NEW)

Key CRM equipment (KCE) (as in Annex I) collected separately at collection and logistics facilities (clause 5.1.1) and delivered to recycling facilities shall be sorted (e.g. from non-recoverable materials or components) at treatment facilities by properly trained personnel who shall know the sorting requirements.

KCE shall be sorted with the aim to:

- a. Avoid CRM mixing or dilution in the mass flow;
- b. Whenever feasible, avoid mixing sources that self-declare having implemented the CEWASTE requirements with unspecified ones;
- c. Improve the concentration of CRM in the output flows;
- d. Meet that requirements for further treatment or recycling.

If KCE has not been collected separately at the collection points or collection facilities, the treatment facility shall sort them.

As required in clause 5.1.6 of CLC/TS 50625-4:2017, WEEE containing CRM and valuable materials or their components that may be suitable for re-use shall be identified, separated at collection facilities and delivered to the corresponding processes out of the scope of CEWASTE for re-use.

Refer to clause 5.1.6 of CLC/TS 50625-4:2017

5.7.1 SORTING OF WASTE BATTERIES (NEW)

More specifically spent lead-acid batteries must be sorted from spent lithium-ion and NiMH batteries, and other types of waste batteries.

Note: Further technical details and recommendations for sorting lead-acid waste batteries are listed in the document in the Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (2003) (chapter 3.4 on sorting).

5.7.2 SORTING OF WASTE MAGNETS (NEW)

Separated NdFeB magnets shall not be mixed with non-NdFeB magnets.

NOTE: NdFeB-magnets are among the three main types of rare earth magnets (samarium cobalt, ceramic and NdFeB-magnets) and different to the others tend to rust for which they are coated - with a layer of nickel followed by a layer of copper and then nickel again, rubber, Polytetrafluoroethylene (PTFE), among others.

5.7.3 SORTING OF WASTE PRINTED CIRCUIT BOARDS ^(NEW)

At collection and logistics facilities, the operator shall sort and separate the following key CRM equipment containing printed circuit boards so they can easily be identified from other waste streams (e.g. by labelling containers) before delivering them to treatment facilities:

1. Desktop computers, tablets, laptops, mobiles phones;
2. External CDDs, ODDs and other devices with internal CDDs/ODDs.

5.8 DE-POLLUTION AT TREATMENT FACILITIES ^(EN 50625-1)

General requirements for de-pollution are in clause 5.5 of EN 50625-1:2014.

Any pre-treatment process of waste lead-acid batteries shall be considered as de-pollution and, hence, clause 5.5 of EN 50625-1:2014 shall apply.

Specific de-pollution requirements are in clause 5.5 of EN 50625-2-1:2014 for lamps, and in clause 5.5.1 of EN 50625-2-2:2015 for CRT displays.

Gas discharge lamps and components containing mercury shall be removed before the final treatment process that can cause damage to the item or shall be treated in such a way that the mercury can be removed and monitored to prove environmentally safe treatment.

Refer to clause 5.5 of EN 50625-1:2014

Refer to clause 5.5 of EN 50625-2-1:2014

Refer to clause 5.5 of EN 50625-2-2:2015

5.9 REMOVAL OF CRM-CONTAINING COMPONENTS ^(NEW)

Components containing CRM shall be removed from key CRM equipment as listed in Annex I.

Removal practices shall comply with health and safety requirements.

Removal of CRM-containing components shall be conducted by trained personnel by using the appropriate tools. If no trained personnel available or no appropriate tools in place, key CRM equipment shall be transported to dismantling plants.

Removal practices shall not release hazardous substances or CRM materials into the environment.

Removal practices shall ensure subsequent treatment of CRM containing components and recycling of the CRM is not hindered.

Key CRM components removed from WEEE shall be transferred for CRM recycling.

The operator shall record:

- the weight and/or number of incoming KCE and of components removed.
- the weight and/or number of components removed and handed over for further treatment.
- The identification of the treatment facility receiving separated KCE
- The mass in the case of NdFeB-magnets handed over for further treatment.

Removed key CRM components shall be forwarded to facilities that are designed for the recycling of CRM and that self-declare having implemented CEWASTE requirements.

5.9.1 REMOVAL OF PRINTED CIRCUIT BOARDS (NEW)

To recycle valuable metals (e.g. Au, Ag, Pd) and CRM (e.g. Pd), printed circuit boards shall be manually and/or mechanically removed from the key CRM equipment that were already sorted in the previous stage (see 5.8.3). The operators shall evaluate to what extent printed circuit boards are effectively removed. In addition, the operator shall estimate losses in relation to total input of KCE. The results can be used to improve the efficiency of the process.

It is recommended to determine the economic costs and benefits of printed circuit boards' removal.

NOTE: There are two types of removal:

1. Through non-damaging (selective) disassembly of high-grade printed circuit boards from equipment that is easy to dismantle, such as desktop computers. This method leads to better concentration of printed circuit boards (and thus less material losses) but is also more costly because it is labour-intensive.
2. Through shredding and mechanical separation of key CRM equipment that are difficult to take apart as well as low-grade printed circuit boards, such as BEV/(P)HEV (electro engine), CRT monitors and TVs. This method leads to higher losses of both valuable metals and CRM but is less costly. To increase the efficiency, safety and quality of printed circuit boards recycling, it helps to implement an inspection system for the localisation and recognition of components and key CRM as well as an automated system for a combination of selective disassembly and mechanical separation.

Through mechanical pre-treatment (e.g. shredding, cutting and grinding), printed circuit boards may be reduced in size to facilitate transport and further separation of the metallic and non-metallic fractions.

The metal fraction obtained after mechanical pre-treatment is a mixture of various metals and shall be refined further.

There are different techniques (e.g. physical, magnetic, and electrostatic) to separate the metal from non-metal fractions, based on differences of materials in physical characteristics (e.g. density, electric conductivity, magnetic properties, etc.).

Further screening and refining shall be performed to prepare a uniformly sized feed and to upgrade the metals contents.

Additional measures may be taken to increase the efficiency, safety and quality of (downstream) printed circuit boards recycling, e.g. advanced characterisation and control systems.

5.9.2 REMOVAL OF WASTE MAGNETS (NEW)

For removing magnets from electric engines (EV-PHEV) with interior permanent motors which are glued and fragmented, special procedures shall be considered.

NOTE: Since representative state-of-the art recycling performance data for rare earth elements recycling from NdFeB-magnets are not yet available, pre-treatment operators should explore the market at least every year for identifying final treatment operators of NdFeB-magnets with a better CRM recycling performance. If a better CRM recycling performance facility is identified, and NdFeB-magnets separated are still being transferred to a less-performance facility, pre-treatment operators should explain why.

5.10 FINAL TREATMENT FOR RECYCLING CRM FRACTIONS AND DISPOSAL OF WASTE FRACTIONS (NEW, EN 50625-1)

The separated fractions/components containing CRM shall be treated by facilities that are designed for the recycling of CRM and that self-declare having implemented CEWASTE requirements.

The final treatment concerns the priority CRM or alloys selected for recovery and the final processing technology identified.

The selection of priority CRM or alloys for recovery shall take into account the technological processing, thermodynamic and economic limitations. Hence, it is acknowledged since the start that not all CRM will be possibly recovered.

Lead-acid batteries and fluorescent lamps contain hazardous substances. Hence, as for general requirements for final treatment of lead-acid batteries refer to clause 5.7 of EN 50625-1:2014, and of fluorescent lamps refer to clause 5.7 of EN 50625-2-1:2014.

Refer to clause 5.7 of EN 50625-1:2014

Refer to clause 5.7 of EN 50625-2-1:2014

The operator shall record the following information once the final treatment process is completed:

- for fractions that have reached end-of-waste status, data on the composition shall be recorded;
- for fractions that are classified as hazardous, data on the mass, the composition, information on the first acceptor and the downstream acceptor(s) of the fractions, and the final treatment technologies;
- from the acceptor, name, address of treatment facility, treatment technology and permit issued by the authority.
- in the case of rare earth metals recycling from NdFeB-magnets, the mass of CRM (rare earth elements in magnets) recycled.
- in the case of magnet-to-magnet (MtM) recycling the mass of the NdFeB-magnets produced from these waste magnets and sold.

Final treatment operators shall assess their yield of CRM. In case of a process change that influences the result of the process, final treatment operators shall make a new assessment and apply for a new audit.

Additional specific requirements are in clauses 5.10.1 and 5.10.2 of EN 50625-2-2:2015 for CRT equipment and flat display panel equipment. Requirements for disposal of hazardous and non-hazardous fractions provided for the recovery of copper and precious metals from WEEE fractions including printed circuit boards, also apply for the recovery of other CRM as listed Annex I (see clause 5.5 of EN 50625-2-2:2015).

A plan for achieving maximum recovery of secondary materials instead of disposal shall be in place.

Refer to clause 5.10 of EN 50625-1:2014

Refer to clauses 5.5, 5.10.1 and 5.10.2 of EN 50625-2-2:2015

5.10.1 FINAL TREATMENT OF CRT EQUIPMENT (50625-2-2)

Refer to clause 5.10.1 EN 50625-2-2:2015

5.10.2 FINAL TREATMENT OF FLUORESCENT POWDERS (NEW)

The final treatment shall apply best available and cost-efficient technologies capable to recover CRM contained in fluorescent powders from lamps while preventing any adverse effects on the environment. See recommended process in Annex III.

NOTE: Final treatment of the CRM oxides consisting of hydrometallurgical recovery of metals requires two main steps:

- Leaching, in which the soluble fraction contained in a solid phase is removed as a solution. This step dissolves the metals of interest and, depending on conditions, other undesired constituents present in the material;
- Separation of the metals of interest from each other and/or from undesired elements present in solution using e.g. solvent extraction, ion exchange and/or precipitation.

Due to current Eu and Y prices, hydrometallurgical processes tend not to be economical.

5.10.3 FINAL TREATMENT OF WASTE BATTERIES (NEW)

5.10.3.1 LEAD-ACID WASTE BATTERIES (NEW)

Batteries shall be broken before they enter the smelter. Batteries shall not be broken manually, but through the use of state-of-the-art techniques such as automatic battery breaking.

NOTE 1: Respective technical options for battery breaking are in the EC JRC Best Available Techniques (BAT) - Reference Document for the Non-Ferrous Metals Industries (2017, chapter 2.5.1.4) and in the Waste Lead-acid Batteries (2003, chapter 4.1).

Batteries shall be drained in a designated area and the acid collected. The acid collection system shall be acid-resistant and sealed.

NOTE 2: If doable, lead-acid batteries can be also either prepared for re-use, converted to a saleable product or neutralized.

The operator shall follow the requirements in the EC JRC Reference Document for the Non-Ferrous Metals Industries (2017) regarding the recovery of lead from lead-acid batteries (chapter 5.1.3.1). A general diagram flow of the recovery process is in Annex V.

The operator shall follow the requirements on the sound collection and disposal of battery acid formulated in the EC JRC Best Available Techniques (BAT) - Reference Document for the Non-Ferrous Metals Industries (2017, chapters 2.5.1.4 and 5.1.3.1) and in the Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (2003, chapter 4.1).

Refer to EC JRC Reference Document for the Non-Ferrous Metals Industries (2017)

Refer to Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (2003)

For lead-acid batteries in countries with no recycling efficiency rates (e.g. some non-European countries), a recycling efficiency of 65% with a recycled lead content between 85 % and 100 % shall be achieved based on the successful experience of the application of the Batteries Directive (Directive 2006/66/EC) in Europe¹³.

Sound recycling of battery cases (NEW)

Plastic-cases of lead-acid batteries shall undergo at least three washing cycles, one of them using an alkaline solution, before they can be recycled or sold to the market for further processing.

The operator shall follow the requirements regarding the sound recycling of lead-acid battery cases are listed in chapter 5.2.4.2 (on 'Plastics from battery processing') of the EC JRC Best Available Techniques (BAT) - Reference Document for the Non-Ferrous Metals Industries (2017) and in chapter 4.1.3 (on 'Battery Breaking: Potential Sources of Environmental Contamination') of the UNEP Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (Basel Convention series/SBC No. 2003/9).

Sound smelting and refining of lead (NEW)

All furnace emissions shall be ventilated to a baghouse in order to avoid lead-contaminated fume and dust entering the workplace or the atmosphere. The furnace shall be ventilated properly, and the suction of the fume hood shall be monitored on a daily basis. The filtered

¹³ Waste statistics - recycling of batteries and accumulators (2019): <https://ec.europa.eu/eurostat/statistics-explained/pdfscache/66807.pdf>

dust is highly toxic and shall be captured in air-tight containers and either processed on site or disposed of in an environmentally sound manner.

Management of process waste, including filter dust and slags (NEW)

In normal cases, all lead-containing wastes shall be recycled within the facility with a view to prevent emissions of lead-compounds into the environment and to minimize process waste for disposal. If this is not possible, suitable disposal shall be undertaken. As for the latter, a written agreement with a suitable disposal facility for the environmentally sound disposal shall document this step.

5.10.3.2 LITHIUM-ION WASTE BATTERIES (NEW)

Batteries which are classified as critical (e.g. mechanically damaged, inflated by heating, high risk of short circuits) during the incoming inspection of the recycling plant shall be immediately put into a salt or alkaline bath for a longer period of time in order to prevent short circuits or thermal reactions. This solution will finally become waste- water containing F-, PO₄(3)-, and heavy metals of Ni, Co, Mn. This wastewater shall be treated properly to remove these hazardous substances.

Dismantling and discharge

After removal, lithium-ion batteries from electric vehicles shall be discharged (for example by using a discharge device) before being disassembled to separate the battery packs and modules.

Discharge of the pack to a safe voltage below 0.5V shall be carried out. As a minimum discharging shall be performed where there is a risk of batteries catching fire, e.g. when the batteries are damaged and with a SOC above 30%.

Requirements concerning further disassembly into cells vary depending on the type of final treatment: pyrometallurgical, hydrometallurgical or mechanical treatment

For entering into a pyrometallurgical processing, removed battery modules do not need to be dismantled further down to the level of the individual cells. The module or cells can be treated without further discharging.

For hydrometallurgical or mechanical processes, the module shall be disassembled into cells. The cells can then be shredded or thermally treated and then shredded.

After the module/cells are dismantled, further chemical/complete discharge may be required depending on the types of recycling technologies.

NOTE 1: For cells after disassembling from pack or module, chemical discharge using salt solution with a concentration of 1~10wt.% or higher is usually applied.

During physical discharge, it is important to ensure the safety with more than 380V DC current. At this stage, it is possible for a fire, leakage of electrolyte or explosion of the pack to occur. The condition of each cell in the pack shall be automatically monitored and recorded in the cloud of the device so that when a defective cell is detected in the pack, an alarm system can be activated.

The batteries shall be dismantled by either specially trained personnel with the aid of suitable equipment (e.g. cordless screwdrivers) or a disassembly robot. During this process the housing (or casing), protection circuit module and cooling system shall be removed and the cables are disconnected.

The following materials shall be separated: aluminium (from battery housing), copper cables, steel components, electronic components (battery management system, printed circuit board), screws and plastic components. These components shall be recycled in-house or transported to dedicated recycling plants.

The disassembly and recycling of lithium-ion batteries from electric vehicles may happen in one plant at the same location. When transported to another recycling plant, the pack or cell modules shall be safely packed, with sand or vermiculite.

Pyrometallurgical or hydrometallurgical process

For the final treatment step, lithium-ion waste batteries can be recycled through either pyrometallurgical or hydrometallurgical processes.

In pyrometallurgical processing, lithium-ion waste batteries packs or cell modules are processed in a smelter or furnace to reduce the metal oxides into a metallic phase or an alloy. The metal bullion is then further refined using a hydrometallurgical technology.

Nickel or cobalt sulphate shall be recovered.

Hydrometallurgical process requires thermal treatment and separation of different components before the active materials can be obtained. The active material is a powder containing both cathode and anode materials.

Active materials powder shall be further processed in order to recover CRM such as cobalt as well as salts or precursors.

Pyrometallurgical technology can also process active materials powder.

Slags or residues of the pyrometallurgical processes shall be treated. All process waste containing heavy metals shall be recycled within the system with a view to prevent environmental risks and to minimize process waste.

During the smelting/refining process smelting slag is generated: a CaO-SiO₂-Al₂O₃ based slag containing F, P, Li, trace Cu/Ni/Co, Mn, Mg, Fe and rare earth elements (In the event that NiMH batteries have also been introduced into the melt.). If technically and economically feasible, these elements (particularly valuable materials such as lithium, among others) should be recovered. Landfilling should be avoided as much as possible. Heavy metals that cannot be recovered shall be stabilised in the slag and not leached in nature conditions.

After stabilizing the heavy metals and F/P, the slag may be used as additive for construction materials. The heavy metal contents in the slag depends on BAT and requirements given in Annex I of Directive 2010/75/EU.

Wastewater must undergo proper treatment. Requirements for heavy metal content and monitoring are specified under 4.10.2.2. Operators shall follow the general requirements as formulated in the implementing decision of the European Commission (EU) 2016/1032 (BAT conclusions for the non-ferrous metals industries for emission control) or equivalent national legislations.

The yield of cobalt from lithium-ion battery recycling processes shall be at least 90%. Ambitious yields shall also be sought for nickel, copper and lithium.

NOTE 2: For example, the proposal for a new Batteries Regulation (COM(2020) 798/3, 2020/353 (COD)) requires yields of recycling processes such as 90%, 90%, 35% for nickel, copper and lithium, respectively.

In any case, yield here means the provision of cobalt compounds etc. in battery quality or suitable for an economically comparable application and needs to refer to the metals content in the battery cells, i.e. reflecting the entire recycling process chain.

A more detailed description including diagram flows is given in Annex IV.

5.10.4 FINAL TREATMENT OF NDFEB-MAGNETS (NEW)

NdFeB magnets shall be treated according to two options following different aims:

- Option A: to recycle the REEs contained.
- Option B: to produce new NdFeB-magnets from the waste magnets (magnet to magnet (MtM) recycling).

Option A (REE recycling):

The recycling performance shall be reassessed at least every two years, and after modifications in the recycling processes unless it is obvious that the changes do not affect the recycling performance.

Option B (MtM recycling):

The final treatment operator shall document:

- The weight of waste NdFeB-magnets received
- The average percentage of waste NdFeB-magnets used in newly produced magnets.

Final treatment operators shall provide the latest recycling performance assessment to CEWASTE-certified pre-treatment operators from whom they receive NdFeB-magnets.

Note: Example: 1000 tons magnets as input and 850 tons magnets as output in case of MtM recycling

5.10.5 FINAL TREATMENT OF PRINTED CIRCUIT BOARDS (NEW, CLC/TS 50625-5)

The operator shall aim to implement a recycling process that is efficient and has limited environmental impact.

Final treatment shall follow the requirements for printed circuit boards, as described in CLC/TS 50625-5:2017.

Refer to CLC/TS 50625-5:2017

Final treatment is focused on the recovery of gold, silver and palladium from the metal fractions obtained after pre-treatment of printed circuit boards.

6. DE-POLLUTION MONITORING

6.1 INTRODUCTION (EN 50625-1, CLC/TS 50625-3-1)

Clauses 5.6 of EN 50625-1:2014 and 4.1 of CLC/TS 50625-3-1:2015 provide an introduction to de-pollution monitoring requirements during collection, logistics and the overall treatment of WEEE which also apply to waste batteries.

Refer to clause 5.6 of EN 50625-1:2014

Refer to clause 4.1 of CLC/TS 50625-3-1:2015

6.1.1 GENERAL CONSIDERATIONS FOR LAMPS AND CRT (EN 50625-2-1, EN 50625_2-2)

More specifically, for lamps de-pollution monitoring requirements in clause 5.6 of EN 50625-1:2014 are replaced with requirements in clause 5.6 of EN 50625-2-1:2014.

In the case of CRT equipment monitoring, the requirements from clauses 5.6.1 and 5.6.2 of EN 50625-2-2:2015 are added to the requirements in clause 5.6 of EN 50625-2-1:2014.

Refer to clause 5.6 of EN 50625-1:2014

Refer to clause 5.6 of EN 50625-2-1:2014

Refer to clause 5.6.1 and 5.6.2 of EN 50625-2-2:2015

6.2 TARGET VALUE METHODOLOGY (CLC/TS 50625-3-1)

In order to assess the efficiency of de-pollution during batch processing of WEEE and waste batteries, target value(s) shall be established. Methodologies described in clause 4.2 of CLC/TS 50625-3-1:2015 are applicable for WEEE and waste batteries except for lamps.

Refer to clause 4.2 of CLC/TS 50625-3-1:2015

6.3 MASS BALANCE METHODOLOGY (EN 50625-3-1)

The approach to establish a mass balance to estimate the share of pollutants in the inputs and outputs is described in clause 4.3 of CLC/TS 50625-3-1:2015.

Refer to clause 4.3 of CLC/TS 50625-3-1:2015

6.4 ANALYSIS METHODOLOGY (CLC/TS 50625-3-1)

Results on the presence of existing pollutants are assessed against criteria and values previously established. Guidance for assessing the results are presented in clause 4.4 of CLC/TS 50623-3-1:2015.

Refer to clause 4.4 of CLC/TS 50623-3-1:2015

6.5 Overview of the applicable methodologies (CLC/TS 50625-3-1)

For each treatment process flow (CRT, lamps, etc.) methodologies for target values, mass balances and analysis are indicated in clause 5. of CLC/TS 50623-3-1:2015.

Refer to clause 5. of CLC/TS 50623-3-1:2015

Additional specific methodological aspects are established for lamps, CRT display appliances and batteries.

6.5.1 LAMPS (CLC/TS 50625-3-2)

Refer to clauses 4.4 and 9.2 of CLC/TS 50625-3-2:2016 (Analysis methodology)

6.5.2 CRT DISPLAY (CLC/TS 50625-3-1, CLC/TS 50625-3-3)

CRT display appliances- Target value methodology

Refer to clause 8.2 of CLC/TS 50623-3-1:2015 (Target value methodology)

CRT display appliances - Analysis methodology

Refer to clause 8.3 of CLC/TS 50623-3-1:2015 (Analysis methodology)

Refer to clause 4.4 of CLC/TS 50625-3-3:2017 (Analysis methodology)

CRT display and FPD appliances - Monitoring methodology

Refer to clause 4.101 of CLC/TS 50625-3-3:2017 (Monitoring methodology)

6.5.3 WASTE BATTERIES (CLC/TS 50625-3-1)

Waste batteries- Analysis methodology and target values

Refer to clause 11.3. of CLC/TS 50623-3-1:2015 (Analysis methodology)

Refer to clause 10.2 of CLC/TS 50623-3-1:2015 (Target value methodology)

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ANNEX I – CRM AND VALUABLE MATERIALS, KEY CRM EQUIPMENT AND COMPONENTS TARGETED. TABLE I.1

WEEE category (2012/19/EU), Annex III	Key CRM Equipment (KCE)	Key CRM Component (KCC)						(CRM + Ag and Au) contained															Main toxics contained (list is not exhaustive)					
		Fluorescent powder	Nd magnets in motors	Nd magnets in drives	Li-ion batteries	Lead-acid batteries	Printed circuit boards	Eu	Tb	Y	Ce	La	Gd	Nd	Dy	Pr	Pd	Co	Bi	Sb	Ag	Au	Li	Hg	Pb	H2SO4	BFR	
2	CRT monitors and TVs	X						X	X	X	X	X	X													X		X
3	Fluorescent lamps	X						X	X	X	X	X												X				
6	Desktop computers			X					X				X	X	X	X	X		X	X	X							X
6	Laptops			X	X				X				X	X	X	X	X		X	X	X		X					X
6	Mobile phones				X												X	X	X	X	X		X					X
6	Tablets				X												X	X	X	X	X		X					X
6	External CDD, ODD, devices with internal CDD, ODD																X		X	X	X							X
-	Lead-acid batteries from ELV and WEEE					X														X					X	X		
-	Li-ion batteries from WEEE and BEV, (P)HEV		X		X							X	X	X	X		X						X					

Annex I provides information on the identification and characterization of key CRM equipment (KCE). Starting on the left side, table 1 shows a list of devices with CRM components, such as fluorescent lamps, desktop computers or lead-acid batteries and assigns them to the respective WEEE category (Directive 2012/19/EU), where possible.

The second set of columns of table 1 under the heading 'Key CRM Component' list the key components containing CRM (KCE). These can be fluorescent powders, Nd magnets in motors, Nd magnets in drives, printed circuit boards, Li-Ion batteries and lead-acid batteries. The third set of columns (title with light green background) identifies the CRM as well as other valuable materials like gold and silver that are to be recycled from a type or class of products. Although lithium was not a CRM according to the EU (COM (2017) 490) (see Annex VII), this is increasingly becoming valuable materials and being recovered together with CRM. Lithium is considered a CRM by the EU since September 2020 (COM (2020) 474) (see Annex VIII).

In the fourth set of columns (title with grey background), the main toxics contained are presented. This list is not exhaustive and includes toxics such as mercury (Hg), lead (Pb), sulfuric acid (H₂SO₄) and brominated flame retardant (BFR) which are contained in each KCE or are released during the treatment. This list may guide the user in the risk assessment of potential emissions during the recycling of CRM.

This is the result of the CEWASTE assessment report (2019): Baseline and Gap/Obstacle Analysis of Standards and Regulations, Deliverable 1.1 of the CEWASTE Project¹⁴.

In order for a type or class of products to qualify as a valuable KCE suitable for CRM recovery, the following conditions had to be fulfilled:

1. The product contains a concentration of CRM that is technically relevant for recycling, at least higher than the minimum technical threshold concentration, or such a relevant concentration can be achieved by separating the CRM-containing component(s) from the product in pre-treatment;
2. An industrially feasible end-treatment technology is available or foreseeable, i.e. a technology readiness level (TRL; see description below) of at least 7, that facilitates

¹⁴ https://cewaste.eu/wp-content/uploads/2020/03/CEWASTE_Deliverable-D1.1_191001_FINAL-Rev.200305.pdf

the recycling of the CRM of this type or class of product, its component(s) or fractions thereof from pre-treatment;

3. Recovery of the critical raw material concerned makes economic sense.
4. The pre-treatment is technically capable to deliver the input needed for the end-process required for the recycling of the CRM;
5. The recycling of the CRM from the product does not impede the recycling of precious metals (PMs) from the product, its component(s), or fractions thereof;
6. The collection, transport, pre- and end-treatment required for recycling of CRM from a product may not (always) be economically attractive under the current conditions, but the costs should not be excessive and prohibitive.
7. WEEE and waste components containing CRM are market relevant due e.g. the amounts generated.
8. Severe environmental and social impacts (hotspots) associated with the handling and management of WEEE and waste components containing CRM.

Conditions 1 - 3 are sine-qua-non conditions, as recycling of CRM technically cannot happen from products containing concentrations of CRM that are below technical thresholds enabling the recycling, or if appropriate pre- and end-treatment for recycling is technically not feasible.

Condition 4 is based on economic and ecological considerations. PMs are the economic drivers of the recycling business. Recycling of PMs is highly desirable also from an environmental and resource perspective due to their scarcity and the related efforts for mining, as well as the resulting high energy consumption of mining and refining PMs as primary metals from ores. Interfering with PM recycling for the sake of CRM recycling would therefore adversely affect the entire recycling business and create additional environmental impacts. This approach excluded some electronic components with marginal concentrations of REEs. Tantalum capacitors could not qualify either as KCE because the end-treatment routes of PMs and tantalum are incompatible, which would result in losses of PMs. To enable a separate treatment, tantalum capacitors would have to be removed from the printed circuit boards. The tantalum capacitors contain, however, PMs as well, which would be lost in the tantalum

recycling process. Adding to this, these capacitors are very small¹⁵, so that their removal would require high efforts, thus be very costly, and would only yield small amounts of tantalum.

Condition 5 addresses the economic side of CRM recycling. When identifying KCE, the consortium tried to avoid cases where the ratio of costs and benefits are highly imbalanced, e.g. due to extremely low CRM concentrations in the products or in their components, or excessive pre-treatment requirements.

Conditions 6 and 7 emerged after revising the case of batteries. Lead-acid batteries present hotspots along the value chain which need to be addressed for improving the overall sustainability of their recycling; this is reflected in condition 7. This justifies their inclusion on the list of KCE. In the case of nickel metal hydride batteries, while these fulfil the conditions 1-5, their market share is very low (6% of all portable batteries in 2015) and is expected to continue decreasing as well as future related recycling activities. These batteries are being increasingly replaced by Li-ion batteries, hence, do not merit their inclusion in the KCE list.

Based on the conditions defined, other KCE excluded are photovoltaic panels, flat panel displays, small appliances as well as components such as plastic casing.

The final treatment concerns the priority CRM or alloys selected for recovery and the final processing technology identified.

Note: The selection of priority CRM or alloys for recovery should take into account the technological processing, thermodynamic and economic limitations. Hence, it is acknowledged since the start that not all CRM will be possibly recovered.

Note: The technology readiness levels are defined as follows¹⁶:

- TRL 1 – Basic principles observed
- TRL 2 – Technology concept formulated
- TRL 3 – Experimental proof of concept
- TRL 4 – Technology validated in lab

¹⁵ Example sizes are 1206 (3,2 mm x 1,6 mm), 0805 (2 mm x 1.25 mm), 06030 (1.6 mm x 0.8 mm), 0402 (1.02 mm x 0.5 mm), c.f. <http://www.avx.com/products/tantalum/high-reliability/medical/other-medical-applications/>

¹⁶ C.f. <https://enspire.science/trl-scale-horizon-2020-erc-explained/>

- TRL 5 – Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – System prototype demonstration in operational environment
- TRL 8 – System complete and qualified
- TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

ANNEX II – MANAGEMENT, MONITORING & EVALUATION PLAN (MM&E), PERFORMANCE INDICATORS AND TARGETS – EXAMPLE (INFORMATIVE)

B.1 GENERAL

This annex provides an example of the structure and content of an MM&E plan. It shows some standard pieces to be included in such a plan, gives options for additional detail and presents the user with guiding questions to facilitate the process of developing an MM&E plan.

It is adapted from various sources, such as:

- The monitoring and evaluation framework for the Global Strategy and Plan of Action on Public Health, Innovation and Intellectual Property at the World Health Organization (2011)[50];
- The Project Monitoring and Evaluation Plan Module developed by the Search for Common Ground (SCG), UKAID and United States Institute of Peace (2013)[45]; and
- Assessing the Impacts of Social and Environmental Standards Systems. ISEAL Code of Good Practice. Version 2.0. ISEAL Alliance (2014)[30].
- ISO 14001: 2015 Environmental Management System

An MM&E plan bases on a goal and target audience definitions.

A monitoring system includes the following steps:

- Pre-Assessment
- Internal audit (or external)
- Management review
- Handling of non-conformity
- Complaints
- Indicators
- Process performance

An MM&E plan could follow the table of contents proposed below. Description of more specific contents is also proposed.

Table of contents
Executive summary
Background
Goals/objectives
Target audience
Period and frequency
MM&E planning: process
The MM&E information matrix
Results
Conclusions
Recommendations
References

[List the names of the economic operators, their locations and the processes concerned. Make use of a table if this helps to create a clearer listing.]

Current countries of the economic operators are shown on the accompanying map.

[Insert the map here, with the geographical scope of the project pointing out to the areas where the economic operators are located.]

The baseline report was completed in [month/year].

The implementation is due to start (has started) in [month/year], and the activities will be terminating in [month/year].

B.2 GOALS/OBJECTIVES

The main goals/objectives of the CEWASTE requirements implementation in our value chain are:

Overall (or final goal): [Refer to the ultimate CEWASTE goal: Improved CRM recovery]

Specific (or intermediate goals):

a) [Refer to the specific objectives of the facility: All workers count on PPE]

b) _____

B.3 TARGET AUDIENCE

The target audience is composed of [Examples: auditors; shareholders] for [Examples: management, evaluation, investment] purposes.

B.4 PERIOD AND FREQUENCY

This MM&E plan proposes activities for the period [Indicate here starting month/year] – final [month/year. Please note that an average period of two to five years is foreseen].

The following frequency is considered [e.g. every six months].

B.5 MM&E PLANNING: PROCESS

During the preparation of the MM&E plan, the staff reached several critical decisions and identified essential strategies for MM&E in the project. The main debates and decisions included: [Describe here relevant assumptions, findings, agreements and key issues related to

objectives prioritized, key performance indicators selected, targets, actions, resources needed, feasibility, responsibilities, methodology for developing and monitoring indicators, etc.]

The participants in the planning were: [List the main participants in the planning.]

B.6 MM&E INFORMATION MATRIX

The MM&E information matrix (table) includes the objectives, indicators, actions, responsibilities, baseline, thresholds or targets and results per period.

Indicators and targets will be defined case by case. See Table II.

Table II.1: Example of indicators and linkages with one or more objectives and considerations

Objective	Key performance Indicator	Definition	Actions / Responsibilities	Resources needed	Baseline in year 0	Threshold or target, if any, for years 1, 2, 3, 4 and 5	Results /date of measurement	Remarks (e.g. reasons for deviation; limitations of indicator)
1.1 Enable safe and healthy workplaces	% of workers with PPE	For the activity of sorting and disassembling of waste lead-acid batteries, PPE includes gloves, masks, special glasses and clothes.	-Provision of training to workers concerned/ H6S department manager - Development of visuals and communication materials and dissemination in the working areas of the facility / communication officer	- PPE includes gloves, masks, special glasses and clothes. - Visual materials for training	5 %	Year 1: 50 % Year 2: 70 % Year 3: 90 % Year 5: 100 %	45% / 31 Dec year 1	
2.1 Increasing CRM recovery	% of CRM streams monitored of the total	Portion of streams with CRM content monitored in accordance to the CEWASTE requirements	-Provision of training to workers concerned / H6S department manager - Provision of required measurement devices / H6S department manager	- Measurement devices - Visuals for training	30 %	Year 1: 50 % Year 2: 80 % Year 3: 100 %	60% / 31 Dec year 1	
2.1 Increasing CRM recovery	% of recyclable units collected of the total	Portion of key CRM equipment collected which fulfils the quality goal established	-Training about quality risks and the quality goals of the operator -establishment of a system for records management of quality of inputs and outputs of key CRM component or equipment produced	- Measurement devices - Visuals for training	20 %	Year 1: 50 % Year 2: 80 % Year 3: 100 %	60% / 31 Dec year 1	

- Type of indicators: quantitative, qualitative
- Methods of data gathering
- Responsibilities for data collection
- Frequency of reporting
- Risks and assumptions]

B.7 RESULTS

The monitoring process was [appropriate/limited] with regard to the scope. [Provide also a brief statement about the adequacy of the methodology followed, including the frequency and scope of the monitoring.]

Highlights of results and deviations from and non-compliance with the objectives as well as related challenges include: [Provide a summary of highlights.]

[Summarize the main results per objective based on the MM&E information matrix developed and challenges faced.]

B.8 CONCLUSIONS

[e.g. include an average of progress made (10 %, 50 %, etc.) since the beginning, mention best-performing areas, add new relevant and unexpected findings that imply revision of the indicators, mention one or two main obstacles to overcome to succeed as planned.]

B.9 RECOMMENDATIONS

[E.g. about improving the process and the methodology to refine the indicators, about overcoming the main obstacles, about key messages to be internally and externally communicated.]

ANNEX III – FINAL TREATMENT OF FLUORESCENT POWDERS (INFORMATIVE)

Fluorescent powders contain CRM such as lanthanum, cerium, yttrium, europium, and terbium. Yttrium is the most abundant CRM in both lamp types.

Note: Straight fluorescent lamps, compact fluorescent lamps, fluorescent lamps, high intensity discharge lamps - including pressure sodium lamps and metal halide lamps, and low pressure sodium lamps contain mercury.

Final treatment of the CRM oxides consisting of hydrometallurgical recovery of metals requires two main steps:

- Leaching, in which the soluble fraction contained in a solid phase is removed as a solution. This step dissolves the metals of interest and, depending on conditions, other undesired constituents present in the material;
- Separation of the metals of interest from each other and/or from undesired elements present in solution using e.g. solvent extraction, ion exchange and/or precipitation.

Due to current Eu and Y prices, hydrometallurgical processes tend not to be economical.

The hydrometallurgical treatment for treating fluorescent powders includes a series of chemical-physical liquid-phase treatment techniques (leaching, solvent extraction, extraction with supercritical fluids, reverse osmosis, nanofiltration, ultrafiltration, etc.) which are efficient resulting in high-purity materials (rare earth oxides). The process is given in annex III (see generic flow diagram).

The rare earth oxides are further processed in a final treatment process to recover specific critical raw materials like Yttrium and Europium. Final treatment is not covered in the CEWASTE requirements.

The hydrometallurgical process for the recovery of CRM from fluorescent powders is a mature technology. To recover CRM from fluorescent powders may potentially also be achieved by pyro- and bio-metallurgical, however, so far these technologies have not gone beyond the proof of concept.

Facilities applying hydrometallurgical processing release solid wastes (filter cakes). Filter cakes from lamps-fluorescent powders may contain high levels of mercury and cakes from CRT-

fluorescent powders Cadmium, Lead and Zinc. The pressed filter cake after the first filtration (step 3) in the generic flow diagram given in Annex III has a very low pH, due to the leaching with sulphuric acid. The cake coming from CRT-fluorescent powders is hazardous due to the high content in lead and zinc. This pressed filter cake needs to be properly transported to authorized chemical-physical treatment plants for further treatment and disposal.

The residual solution after the second filtration is a liquid waste (step 5 in the generic flow diagram). This solution can be either reused in the process or be disposed of. In case of disposal as a liquid stream it needs to be neutralized prior to disposal.

The pressed filter cake after lime treatment (step 7 in the generic flow diagram) is non-hazardous and can be disposed of in an authorized landfill.

The following is a generic flow diagram of hydrometallurgical treatment of fluorescent powders originating from lamps and CRTs.

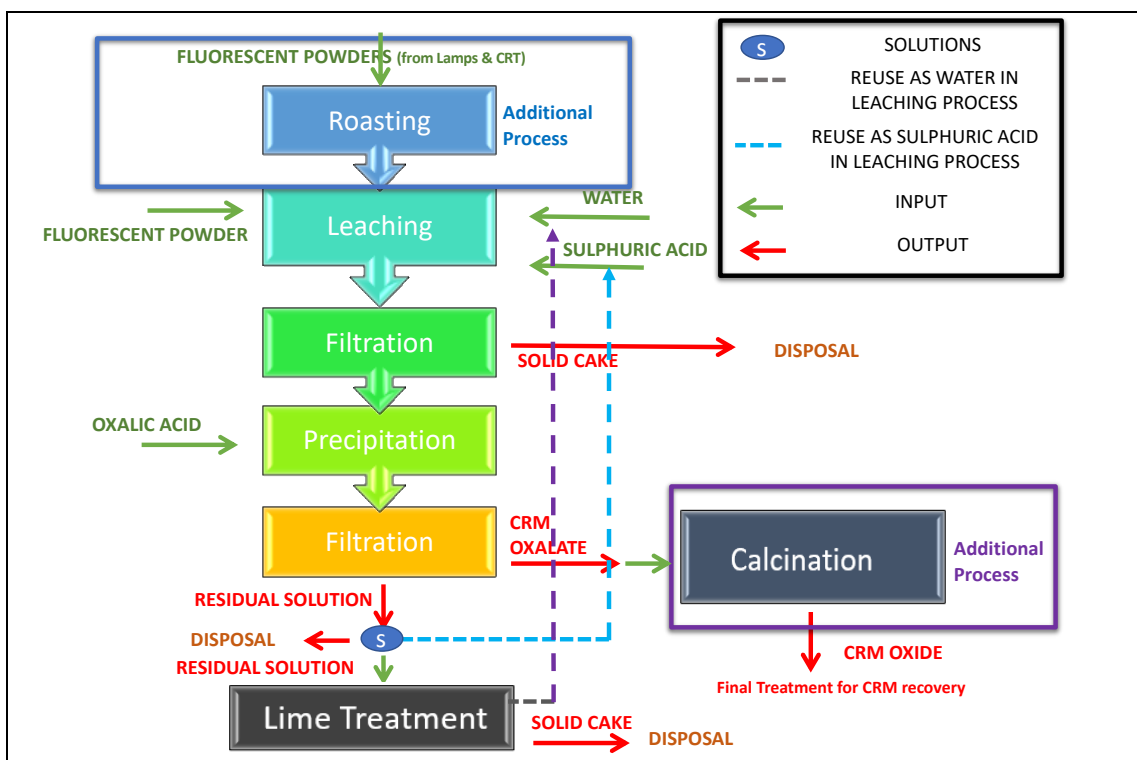


Figure III.1: Generic flow diagram of hydrometallurgical treatment of fluorescent powders

SOUND RECYCLING OF FLUORESCENT POWDERS (NEW)

With respect to CRM, Yttrium is the most abundant element in powders of lamps and CRTs. The typical CRM content in the oxide (oxalates) constitutes 85 % Yttrium and 10 % Europium.

The efficiency of the hydrometallurgical process in terms of % of rare earth elements, is closely linked to:

- the composition of the fluorescent powders mixture, which is supplied and treated, and
- the operating parameters of the process conditions (temperature, pH, reagent, etc.).

Note: Oxalates are a blend of REEs i.e. Lanthanum, Cerium, Europium, Gadolinium, Terbium and Yttrium). Typical composition of the product coming out of the Hydrometallurgical process is:

- Minimum content as REO (rare earth oxide) = 30%
- Maximum content of water = 40%
- Maximum content in oxalate: Hg = 20ppm and Fe = 50ppm

ANNEX IV – FINAL TREATMENT OF LITHIUM-ION WASTE BATTERIES (INFORMATIVE)

Pyrometallurgical process directly processes module or cell without further discharging. The lithium-ion waste batteries are processed in a smelter or furnace to reduce the metal oxides into metallic phase or an alloy. The metal bullion is then further refined using a hydrometallurgical technology. Nickel or cobalt sulphate can be obtained. Pyrometallurgical technology can also process active materials powder.

Hydrometallurgical process requires complete discharge, thermal treatment and separation of different components before the active materials can be obtained. The active material is a powder containing both cathode and anode materials. The mixture is further processed in order to recover critical metals as salts or precursors.

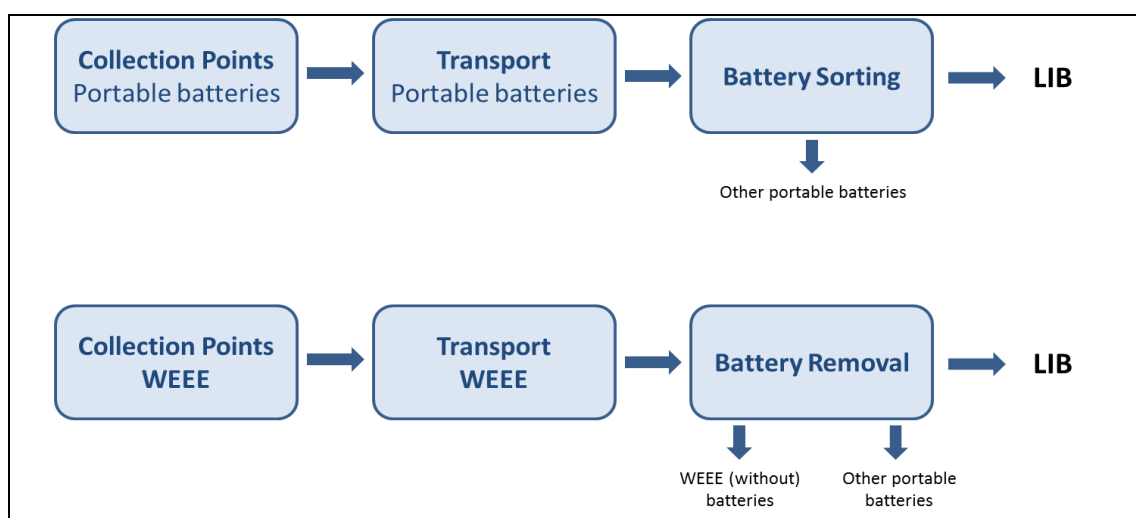


Figure IV.1. Pathways until sorting and removal of portable lithium-ion batteries (LIB) based on the collection modus

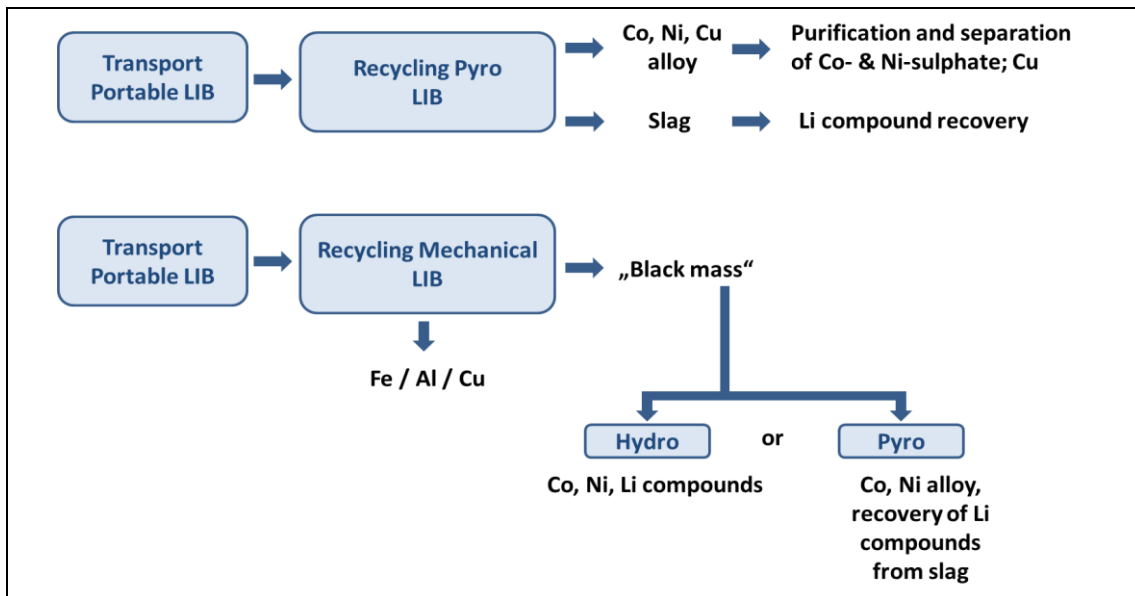


Figure IV.2. Pathways for the recycling of portable lithium-ion batteries

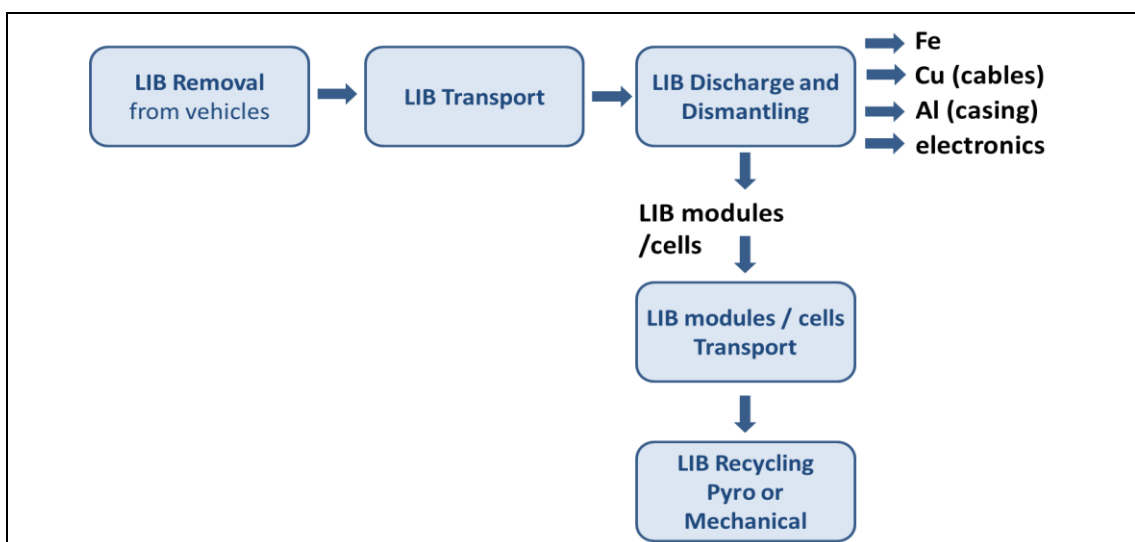


Figure IV.3. Pathway for the recycling of lithium-ion batteries from E-vehicles

Steps prior pyrometallurgical, mechanical or hydrometallurgical process

Lithium-ion waste batteries packs/modules/cells may need to be further shredded, thermally treated and separated to obtain an intermediate product, so-called black mass, depending on which technologies are used for the metal recycling.

In the mechanical/hydro-based route, the lithium-ion batteries are either shredded in a protective gas atmosphere or first thermally treated and then shredded¹⁷.

¹⁷ See for instance the process scheme of the Accurec process: <https://accurec.de/lithium>

The electrolyte, the organic separator and other organic materials are pyrolyzed depending on the operation temperature.

Pyrometallurgical process

Step I: smelting

The lithium-ion batteries modules or cells or active materials together flux oxides are fed into a furnace with pre-set conditions. In this step, it is important to prevent emission of particulate or dust of heavy metals as well as waste gases.

Step II – refining

When an alloy bullion containing CRM is obtained, it still has to be further refined using an electrochemical or hydrometallurgical process.

The alloy bullion is usually copper-based which means during electrochemical refining, pure copper is obtained on the negative electrode and nickel/cobalt is dissolved into the solution.

The solution is further treated to obtain nickel or cobalt sulphate.

The salts of critical metals can be used for further lithium-ion batteries precursor preparation.

Step III: Process waste treatment

Slags, residues and waste waters of the pyrometallurgical process may contain various heavy metals and thus undergo treatment.

Mechanical or hydrometallurgical based process

The “black mass” is treated by an acidic solution so that critical metals including nickel, cobalt are leached into the solution. The solution is further purified and solvent extraction is used to obtain a pure solution of Co sulphate and Ni sulphate or a mixture of Ni-Co-Mn sulphate. The solution is used either to prepare the corresponding salts or, directly, the precursor.

The operator may apply innovative technologies to recover the graphite.

Final products

After smelting in a pyrometallurgical process or solvent extraction in a hydrometallurgical process, the products can be metallic alloys, copper, Ni/Co sulphate, precursor or cathode materials.

The final products vary per company and specific recycling technology.

For quality assurance, operators follow internal or external quality requirements for either precursors and/or Ni/Co salts.

ANNEX V – FINAL TREATMENT OF LEAD-ACID BATTERIES

BATTERIES

Collection facilities are the first step of end-of-life processing of waste lead-acid batteries. Here, lead-acid batteries from different sectors and applications come together, including batteries from End-of-life Vehicles (ELVs), stationary power storage and uninterrupted power supply equipment. From there, waste lead-acid batteries are transported to recycling facilities, where they are broken and drained of acid. Different technologies are available for the separation of acid and plastic from waste batteries (see chapter 4.1 in UNEP (2003): Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (Basel Convention series/SBC No. 2003/9)). In a next step, different types of furnaces can be used for smelting (see chapter 4.2 in UNEP (2003)), resulting in reduced crude lead, slag and fume. The fume is ventilated into a baghouse, and the collected (lead containing) dust put back to the furnace. To increase the lead content of produced bullions and to achieve defined purities for industrial purposes, a refining process takes place (see chapter 4.3 in UNEP (2003)). The refining process results in highly concentrated lead and dross.

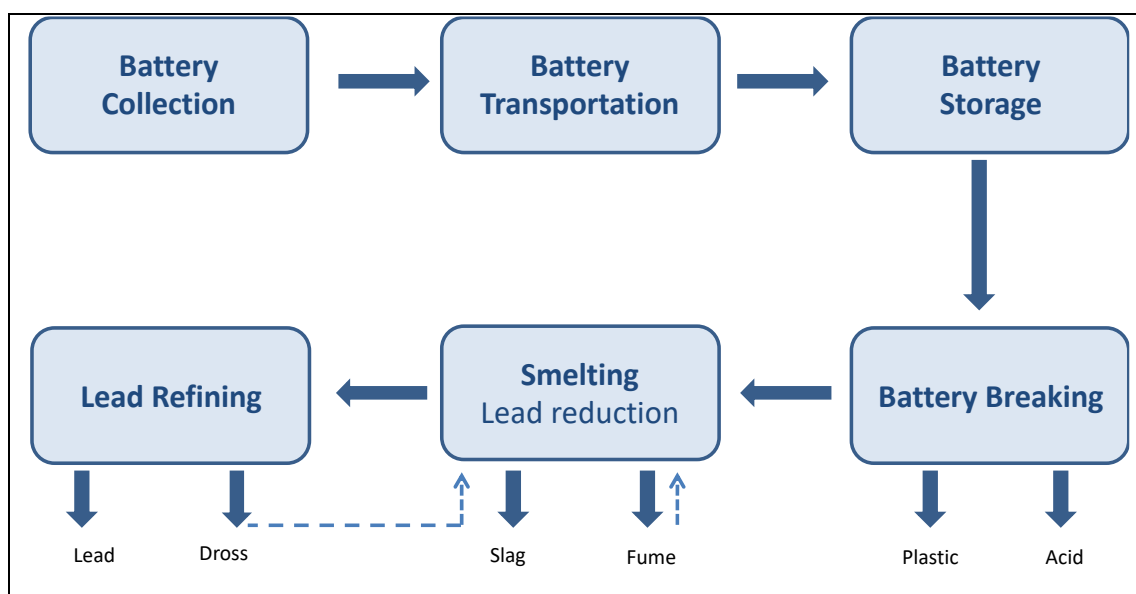


Figure V.1: Pathways for the recycling of lead-acid batteries

Table V.1: Applicable standards for emission control in lead smelters

Standard / Directive (Version / Date)	Requirements
EU Directive 2010/75/EU on Industrial Emissions (17.12.2010)	Annex VI - Part 3 – Section 1.3: Average emission limit value for lead in air emissions: 0,5 mg /Nm ³ (sampling period 30 min – 8 h) Annex VI - Part 5: Emission limit values for discharges of wastewater from the cleaning of waste gases: 0.2 mg/l total suspended solids as defined in Annex I of the Council of the European Communities Directive 91/271/EEC of 21 May 1991 (for unfiltered samples)
EU Scientific Committee on Occupational Exposure Limits (SCOEL) for lead and its organic compounds of January 2002	Workplace air levels should be maintained below 0.1 mg/ m ³ averaged over an 8-hour period (8 hr TWA)
International Lead and Zinc Study Group (ILZSG) Study on 'Environmental and Health Controls on Lead'	Water quality: Lead in water bodies: Max. Permissible Lead Level of 0.01 mg/L Effluent discharge: Lead in industrial effluents: Max. Permissible Lead Level of 0.5 mg/L at pH 7-9

Table V.2: Applicable standards for the transport of waste lead-acid batteries

Standard / Directive (Version / Date)	Requirements
European Agreement concerning the International Carriage of Dangerous Goods by Road – ADR (2019)	The transport of Waste Lead-Acid Batteries is subject to the criteria set out in ADR 7.3.3 VC1, VC2 and AP8. For transport, WLABS have to be in compliance with the following principles: <ul style="list-style-type: none"> packed and secured so they cannot slip, fall or be damaged; provided with carrying devices, unless stacked on pallets; free of any dangerous traces of acid on the outside; protected against short circuits.
European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways – ADN (2017)	Specifically, when transporting WLAB the vehicle can only carry one type of hazardous material. The WLAB can be transported in a leak proof UN approved plastic container or sealed skip. If not, the WLAB must be stacked upright on a wooden pallet with honeycomb cardboard between each layer, limited to three layers and shrink-wrapped to improve stability. A bill of lading with a description of the hazardous material is required together with the name of the company shipping the material and the name of the transport company.
International Carriage of Dangerous Goods by Rail (RID), 2019	Some wet sealed lead-acid batteries (Valve Regulated, Absorbent Glass Mat ¹⁸ and Gel Batteries) grouped under UN 2800 are exempt from Class 8. The battery manufacturer must declare how a battery is regulated on its associated Safety Data Sheet (SDS) and most AGM batteries can be shipped under the simpler UN 2800 directive. Different rules apply when shipping damaged batteries. A waste lead acid battery is considered damaged if the possibility of leakage exists due to a crack or if one or

¹⁸ https://batteryuniversity.com/index.php/learn/article/absorbent_glass_mat_agm

Standard / Directive (Version / Date)	Requirements
	<p>more caps are missing. Transportation companies may require draining the damaged batteries of all acid prior to transport. Place damaged batteries in an acid-resistant container and add soda ash to neutralize any acid that might spill.</p> <p>Damaged and intact waste batteries must be packaged separately.</p>

Further technical details and recommendations are listed in the document in the UNEP Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (Basel Convention series/SBC No. 2003/9) (chapter 3.3 on transporting).

There is no consensus on what blood level is required to guarantee the employee will be free from adverse effects of lead exposure. However, some scientific advisory bodies (e.g. American Conference of Governmental Industrial Hygienists - ACGIH) have advised that male employees blood lead levels should be maintained below 20 µg/100ml to avoid subtle but long-term health consequences.

Women of childbearing age are a sensitive subpopulation as lead can adversely impact the neurodevelopment of the unborn child and breastfeeding children.

ANNEX VI – FINAL TREATMENT OF WASTE

MAGNETS

The following text was mostly extracted from:

- the Report by the European Rare Earths Competency Network (ERECON): Strengthening the European Rare Earths Supply -Chain. Challenges and policy options (2015).
- The publication on ‘The use of hydrogen to separate and recycle neodymium-iron-boron-type magnets from electronic waste’ (A. Walton et al., 2015)¹⁹

The range of products and applications that use NdFeB magnets has expanded dramatically in recent years, particularly with regard to clean energy technologies.

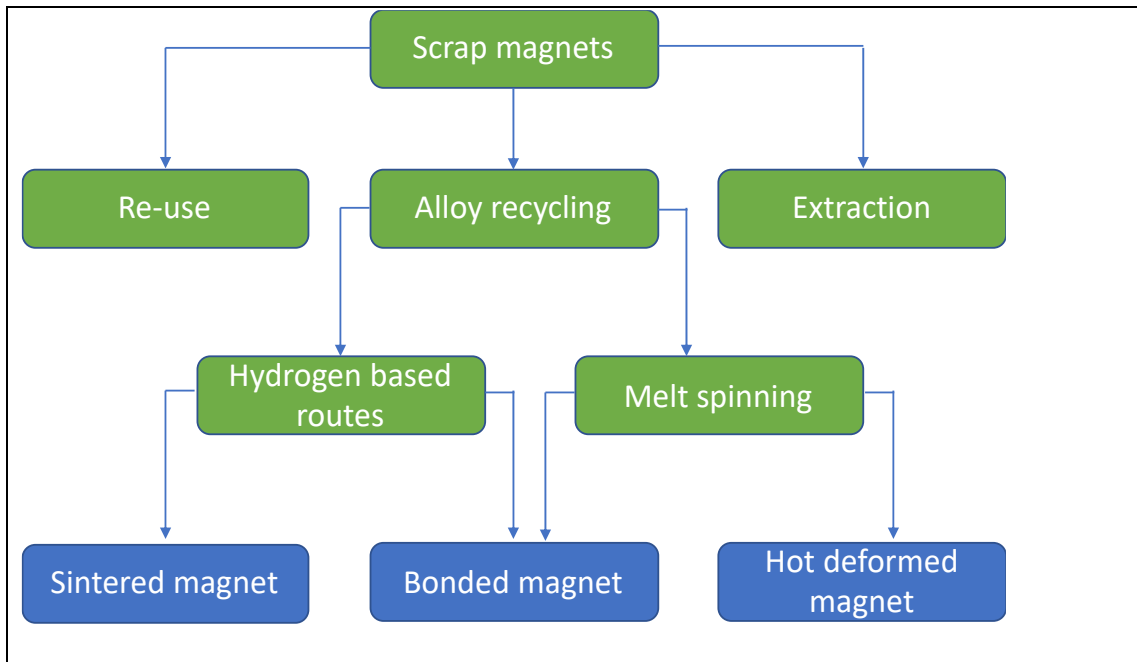
The magnets contained in WEEE (e.g., mobile phones, electric toothbrushes, shavers, drills, etc.) are often very small (up to 0.5g in a smartphone and considerably less in smaller mobiles) and come in the form of sintered or resin-bonded magnets. The sintered magnets are typically coated with nickel or a multilayer of Ni-Cu-Ni and then glued into position. The component itself forms part of a complicated architecture and is often in different positions within the product. All of these factors make mixed electronics less attractive as a recycling source. The bonded magnets present a particular challenge as they are made up of a rare earth alloy powder intimately mixed with a resin binder.

When they reach their end-of-life, many electronic goods are shredded in order to break the products into pieces that can be separated using standard recycling processes, such as magnetic and electrostatic separation. However, sintered REE magnets are very brittle and break apart when the product is shredded. The powder is still magnetic and tends to stick to the ferromagnetic components in the waste and to the shredder itself. Recovering the powder at this point becomes very difficult; moreover, the powder will be heavily oxidized, which will limit the downstream re-processing routes. Therefore, it is advantageous to remove the REE-containing components prior to crushing, if they are to be recycled. This often would require manual labour, which poses both technical and economic challenges.

¹⁹ A. Walton a, *, Han Yi a, N.A. Rowson b, J.D. Speight a, V.S.J. Mann a, R.S. Sheridan a, A. Bradshaw a, I.R. Harris a, A.J. Williams a
a School of Metallurgy and Materials, University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom
b School of Chemical Engineering, University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom

Once magnets are removed, recycling methods are mainly divided into three: extracting/recovering REEs by the smelting process, recycling as a magnetic alloy material, and the reuse of collected magnets for other uses. See following diagram.

Figure VI.1: Scientific overview of options for recycling of NdFeB magnets (Source: Roland Gauß, Oliver Diehl, Oliver Gutfleisch, Fraunhofer Project Group IWKS)



The most energy- and material-efficient way to recycle is to detach and simply re-use or refurbish the existing magnet. The major advantage of this approach is the cost savings in terms of labour and energy in comparison to employing more complex rare earth extraction and separation processes.

Overall, the major challenges to using such a ‘short-loop’ process derive from the quality of the scrap materials that is recycled. Newly designed machines and technologies usually require magnets with specific kinds of material properties (e.g. magnetic properties, corrosion resistance, and size) and scrap magnets may not always fulfil these requirements. In addition, one would have to define whether the scrap magnet material had undergone some kind of degradation due to corrosion prior to its reuse.

Another approach is to re-manufacture the magnets in alloy form. This can be achieved in a number of ways. Firstly scrap magnets can be melted down to a master alloy that can go back into the primary supply chain (pyrometallurgical technique).⁴¹ The advantage of this approach is that the magnet’s oxygen content can be reduced during the processing. Alternatively, the separated magnets can be processed using hydrogen-based routes to form sintered magnets or material suitable for bonded magnets.

Based on literature research, the Hydrogen Processing of Magnetic Scrap method (HPMS) – the Hydrogen Decrepitation (HD) process - is one option that allows the NdFeB-type magnets to be extracted without damaging the remainder of the device.

Manual separation of the sintered NdFeB magnets from the HDD would involve the removal of security screws. The magnets are also coated with Ni (and occasionally with Ni-Cu-Ni), and glued into position between the plates and they are in a fully magnetized state. At present, a large majority of HDDs are shredded in order to destroy any data on the disk. However, the magnets being extremely brittle, break up into granules/powder which remains permanently magnetized. Consequently, this powder is attracted to the other ferrous material including the shredder itself and is therefore very difficult to remove. The presence of this magnetized powder can adversely affect the operation of the shredder.

In the present work, hydrogen was employed, using the HPMS process, as a processing agent in order to extract selectively, NdFeB magnets from HDDs. Hydrogen is already used to process cast NdFeB in the Hydrogen Decrepitation (HD) process. The HD process is used extensively to reduce bulk (or strip) cast NdFeB ingots to friable, hydrogenated NdFeB granules/powder, prior to the production of jet milled powder which is then aligned, compressed and sintered to form fully dense sintered magnets (McGuinness et al., 1986). The hydrogen is then removed during the vacuum sintering process. Previous work at the University of Birmingham has shown that hydrogen can be employed to re-process uncoated scrap sintered magnets into powder, which was then re-sintered to produce aligned, fully dense sintered magnets (Zakotnik et al., 2009) or subject to further High density digital recording (HDDR) processing to produce bonded magnets (Sheridan et al., 2012, 2014).

ANNEX VII – LIST OF CRITICAL RAW MATERIALS FOR THE EU (COM (2017) 490)

Critical Raw Materials
Antimony
Baryte
Beryllium
Bismuth
Borate
Cobalt
Coking coal
Fluorspar
Gallium
Germanium
Hafnium
Helium
Indium
Magnesium
Natural graphite
Natural rubber
Niobium
Phosphate rock
Phosphorus
Scandium
Silicon metal
Tantalum
Tungsten
Vanadium
Platinum Group Metals
Heavy Rare Earth Elements
Light Rare Earth Elements

ANNEX VIII – LIST OF CRITICAL RAW MATERIALS FOR THE EU (COM (2020) 474)

Critical Raw Materials
Antimony
Baryte
Beryllium
Bismuth
Borate
Cobalt
Coking coal
Fluorspar
Gallium
Germanium
Hafnium
Heavy Rare Earth Elements
Light Rare Earth Elements
Indium
Magnesium
Natural graphite
Natural rubber
Niobium
Platinum Group Metals
Phosphate rock
Phosphorus
Scandium
Silicon metal
Tantalum
Tungsten
Vanadium
Bauxite
Lithium
Titanium
Strontium