

## ELECTRICAL AND ELECTRONIC WASTE (E-WASTE)

This fact sheet is part of a series of fact sheets to support the implementation of the environmentally sound management (ESM) of hazardous wastes and other wastes, in accordance with the obligations of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

The fact sheet provides information on the environmentally sound management of electrical and electronic waste (e-waste). It is primarily intended for use by waste recyclers.

In addition, the reader should take due account of the **Technical guidelines on Transboundary Movements of Electrical and Electronic Waste and Used Electrical and Electronic Equipment**, developed under the Basel Convention and adopted on an interim basis, as well as the guidance documents developed by the Mobile Phone Partnership Initiative (MPPI) and the Partnership for Action on Computing Equipment (PACE)<sup>(1,2,3)</sup>.

### Classification

The classification of e-waste according to Annexes I, III, VIII and IX of the Basel Convention, is presented in Table 1 below<sup>(3)</sup>. Also identified therein is the applicable hazard class or division under the United Nations Model Regulations.

### Storage

E-waste should be stored in a manner which minimises accidents, spills and breakages. Proper storage should maximise value for recovery, and be secure from unauthorised access. Appropriate containers should be used for storing different types of waste separately. Storage capacity should comply with all legal and regulatory requirements. Where such provisions are not available, it is recommended to consider that the maximum amount of e-waste stored should not exceed the amount of e-waste that can be treated within six months<sup>(13)</sup>.

Storage areas should be sheltered and have an impermeable surface with sealed drainage system with, where appropriate, provision of spillage collection facilities. Batteries, PCB/PCT-containing capacitors, mercury containing components and other hazardous components should be stored in dedicated, labelled and appropriate containers.

Special attention should be given to storage of lithium-ion batteries. Components which can be flammable or explosive, such as toners or batteries, should be stored in a manner that minimises risks of fire, away from sparks or heat. In the case of batteries, they should be

stored in a manner that protects battery terminals from contacting conductive materials and causing electrical discharges, explosions, or fires.

### Packaging

E-waste should be packaged in a manner that prevents breakage and the release of hazardous components to the environment, during transportation, loading and unloading. Special attention should be given to fluorescent tubes and mercury-containing lamps to prevent breakage.

All containers should be accurately labelled according to their contents, packaging type, hazard classification (if applicable).

Cathode ray tubes (CRTs) should be secured to pallets with shrink-wrap or similar wrapping. Broken CRT glass should be packed into containers that will not leak, such as drums or super-sacks. Smaller, dispersive fractions of shredded copper or circuit boards should be transported in properly closed containers with lining, if needed.

### Transport

Transport should be carried out by a licensed, permitted or otherwise authorised carrier, according to applicable laws and regulations.

Emergency response information (e.g. safety data sheets, ERICards) and hazardous waste manifests (consignment notes), as required by national law,



Figure 1: E-waste stacked in layers and shrink-wrapped (Source: <https://www.timaru.govt.nz/>)

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Examples of e-waste	Y-code, annex I of Basel Convention	H-code, annex III of Basel Convention	A-code annex VIII or B-code annex IX of Basel Convention	United Nations shipping name, number, and hazard class or division
E-waste, unsorted (i)	Various (e.g. Y31, Y20, Y27, Y45)	H6.1, H11, H12, H13	A1180	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Lead-containing glass from cathode ray tubes (CRTs) and imaging lenses	Y31	H6.1, H11, H12, H13	A1180, A2010	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Nickel-cadmium batteries and batteries containing mercury	Y26, Y29	H6.1, H11, H12, H13	A1170	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Selenium drums	Y25	H6.1, H11, H12, H13	A1020	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Printed circuit boards	Various (e.g. Y31, Y20, Y27, Y45)	H6.1, H11, H12, H13	A1020, A1180	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
PCB- or PCT-containing equipment	Y10	H11, H12	A1180, A3180	Waste Polychlorinated Biphenyls, Liquid, UN2315, Class 9 (5)
Plastic components containing brominated flame retardants, if applicable	Y45, Y27	H6.1, H11, H12, H13	A3180	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Mercury-containing fluorescent tubes and backlight lamps from liquid crystal displays (LCD)	Y29	H6.1, H11, H12, H13	A1030	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Other mercury-containing components, such as mercury switches, contacts and thermometers	Y29	H6.1, H11, H12, H13	A1010, A1030, A1180	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Components containing asbestos, such as cooking stoves and heaters	Y36	H11	A 2050	Waste Asbestos, UN 2590, Class 9
Non-hazardous waste electrical and electronic assemblies	Not applicable	Not applicable	B1110	Not applicable

H6.1=Poisonous (acute); H11=Toxic (delayed or chronic); H12=Ecotoxic; H13=Capable, by any means, after disposal of yielding another material which possesses any of the characteristics listed in Annex III

Table 1. Classification of e-waste

should accompany each shipment of e-waste.

Transport vehicles should be properly marked with placards identifying the fact that hazardous products are being transported. Personal protective equipment (PPE) should be provided for the transport personnel, who should also be trained in its emergency use. Transport vehicles should be outfitted with the equipment necessary to neutralize any simple spillage or leakage problems, and the transport personnel trained on how to use it. All releases should be immediately contained.

There may be specific prohibitions related to computing equipment and fractions thereof. For example, restrictions on the transportation of used lithium ion batteries prohibit transport by air and require that they are protected against short circuit to prevent fire hazards<sup>(6)</sup>.

## Transboundary Movement

Transboundary movements of hazardous e-waste are subject to the Basel Convention control procedure and should be reduced to a minimum consistent with

environmentally sound and efficient management and conducted in a manner which will protect human health and the environment. In addition, e-waste may be subject to restrictions and control procedures in certain countries. In some cases, it may be difficult to distinguish used electrical and electronic equipment from e-waste. Further guidance on transboundary movements of e-waste is available in Sections II and IV of the Technical guidelines on Transboundary Movements of Electrical and Electronic Waste and Used Electrical and Electronic Equipment<sup>(3)</sup>. In case of doubt, contact should be made with relevant competent authorities for further information on procedures and/or restrictions applying to the transboundary movement of e-waste.

## Environmentally sound waste management

E-waste should only be treated in facilities that are properly licensed, permitted or authorised, and that practice environmentally sound management (ESM). Open burning of e-waste is not environmentally sound. E-waste that has not been pre-treated should not be finally disposed of.

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Where appropriate, priority should be given to the reuse of equipment and/or components.

Environmentally sound management (ESM) of hazardous wastes or other wastes, as defined in the Basel Convention), means taking all practicable steps to ensure that hazardous wastes or 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.

E-waste that will not be reused is to be processed in several successive stages. E-waste processing consists of pre-processing (including sorting, dismantling, mechanical treatment), followed by end-processing (including refining and final disposal). Usually for each of these steps specialized operators/plants exist.

The operator should establish and maintain a procedure in order to identify legal requirements that are applicable to the environmental, health and safety aspects of all activities, services and processes undertaken at the facility<sup>(12, 13)</sup>.

A facility map should be produced and kept current, which shows the storage areas and their contents so that workers, and especially emergency responders, will know what materials and possible hazards and risks they are confronting<sup>(6)</sup>.

## Pre-processing

The first step towards recycling of e-waste is pre-processing. The aim of pre-processing is to liberate the materials and direct them to adequate subsequent treatment processes.

Hazardous substances should be removed and stored or treated safely while valuable components/materials should to be taken out for preparation for reuse or recovery. Removal practices should not damage or destroy components in a way that hazardous substances may be released to the environment or distributed to fractions, unless subsequent treatment of the hazardous substances is secured<sup>(11)</sup>.

Pre-processing of e-waste may be carried out manually or mechanically depending upon the scale of operations and the e-waste being handled. Manual dismantling should only be undertaken where there is no likelihood for direct contact with hazardous substances.

Removal prior to any further treatment is indispensable if at least one of the following conditions applies:

- (a) Hazardous substances or components cannot be controlled in subsequent treatment processes;

- (b) These substances or components otherwise disturb treatment processes of e-waste, fractions or materials thereof in operations of the initial or downstream operators thus compromising the quality of the recycled materials;
- (c) These substances or components otherwise end up in incineration or on landfill sites, which are not equipped to ensure ESM;
- (d) These substances or components otherwise end up in incineration or on landfill sites, even though recycling would be the environmentally preferred option.

Once removed, these need to be separated and properly stored in suitable labelled containers. For example, mercury should be removed from gas discharge lamps through a treatment process designed to prevent fugitive emissions of mercury vapour or dust. Batteries should be handled according to their specific characteristics and having regard to the potential fire risk associated with them. Gases that are ozone depleting substances (ODS), such as CFCs and foam containing CFCs, should be properly extracted and treated; refrigeration appliances should be presumed to contain ODS unless confirmed otherwise<sup>(14, 15)</sup>.

Hazardous waste should not be mixed, either with other categories of hazardous waste or with other waste, substances or materials unless the mixing operation is carried out by an operator which has obtained a permit or licence for such activity.

The removed substances, preparations, and components that cannot be recovered or recycled should be otherwise properly disposed of in accordance with the waste management hierarchy (e.g. prioritise incineration with energy recovery over landfilling). Appropriate measures should be implemented to safeguard occupational health and safety<sup>(19)</sup>.

## Incineration

Incinerators or other combustion units (preferably with energy recovery) should be operated to minimise the formation of furans and dioxins, as well as be equipped with state-of-the-art flue gas cleaning systems. Combustion ash, as well as materials from the processing of e-waste that cannot be recycled, should be disposed of in an environmentally sound and appropriately authorised landfill.

Materials containing mercury and beryllium should not be incinerated<sup>(13)</sup>.

## Landfill

Additional treatment should be considered to avoid long-term emissions from landfills; for instance the hazardous substances or preparations for disposal should be destroyed or immobilised prior to disposal in authorised landfills.



Figure 2: Manual dismantling of e-Waste (Source: <http://www.theepochtimes.com/>)

## Extended Producer Responsibility

There are a number of countries that have implemented schemes for extended producer responsibility (EPR) covering e-waste. See the reference section for further information on existing EPR schemes<sup>(16)</sup>.

All waste should be managed according to ESM practices, whether or not it falls under an EPR scheme.

## Certification and Auditing Systems

Environmental management systems (EMS) can help organisations identify and manage their environmental impacts as well as compliance with environmental legislation. Dismantlers and recyclers can become certified (e.g. using ISO, EMAS or industry standards) by demonstrating to an accredited, independent third-party auditor that they meet specific standards to safely manage e-waste. An organization can, however, achieve the same benefits from an EMS whether or not it pursues certification. Non-standardised systems can in principle be equally effective provided that they are properly designed and implemented.

See the reference section for certification schemes that are specific for e-waste<sup>(17)</sup>.

## References

- (1) MPPI (2013) Guidance document on the environmentally sound management of used and end-of-life mobile phones. <http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-EWASTE-GUID-PUB-MobilePhones-201302.English.pdf>
- (2) PACE (2013) Revised guidance document on the environmentally sound management of used and end-of-life computing equipment. <http://synergies.pops.int/Portals/4/download.aspx?d=UNEP-CHW.11-6-Add.1-Rev.1.English.pdf>

- (3) 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. For detailed information on the classification of e-waste according to Annexes I, III, VIII, IX, see in particular Section IV.B of the guidance. <http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW.12-5-Add.1-Rev.1.English.pdf>
- (4) Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065&from=EN>
- (5) International Programme on Chemical Safety Health and Safety Guide No. 68 Polychlorinated Biphenyls (PCBs) and Polychlorinated Terphenyls (PCTs) Health and Safety Guide. <http://www.inchem.org/documents/hsg/hsg/hsg68.htm>
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- (7) Woodhead Publishing Series in Electronic and Optical Materials: Number 30. Edited by Vanessa Goodship and Ab Stevels. Waste electrical and electronic equipment (WEEE) handbook. 2012.
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- (9) UNEP (2007) E-waste Volume II: E-waste Management Manual. [http://apps.unep.org/publications/index.php?option=com\\_pub&task=download&file=010747\\_en](http://apps.unep.org/publications/index.php?option=com_pub&task=download&file=010747_en)
- (10) Basel Convention. Updated technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs). <http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW.12-5-Add.5-Rev.1.English.pdf>
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- (12) WEEELABEX. WEEELABEX normative document on Logistics V9.0. 2011. [http://media.wix.com/ugd/968606\\_83239faa8af3d5ac0f589df6b81ed82c.pdf](http://media.wix.com/ugd/968606_83239faa8af3d5ac0f589df6b81ed82c.pdf)
- (13) WEEELABEX. WEEELABEX normative document on Treatment V10. 2013.

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- (14) WEEE Forum. Requirements for the Collection, Transportation, Storage, Handling and Treatment of Household Cooling and Freezing Appliances containing CFC, HCFC or HFC. 2007.  
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- (15) WEEE Forum. Requirements for the Collection, Transportation, Storage and Treatment of Cooling and Freezing Appliances containing Hydrocarbons (HC). 2006.  
[http://www.weee-forum.org/system/files/services/hc\\_treatment\\_specs1.pdf](http://www.weee-forum.org/system/files/services/hc_treatment_specs1.pdf)
- (16) For further information on extended producer responsibility see:
- Electronics TakeBack Coalition (ETBC), <http://www.electronicstakeback.com/promote-good-laws/about-producer-responsibility/>
  - OECD, <http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm>
- (17) For further information on certification and auditing systems see:
- WEEELABEX conformity verification (CV), <http://www.weeelabex.org/conformity-verification/>
  - UK Environment Agency WEEE evidence, <https://www.gov.uk/government/publications/weee-evidence-and-national-protocols-guidance>
  - UK PAS141:2011 Re-use – audits and UKAS approved certification. <http://www.wrap.org.uk/content/pas-141-re-use-standard>
  - EPEAT Conformity Assessment Protocols 4.6 End of life management, <http://epeat.net/documents/conformity-protocols/protocols-4.6-v1.3.pdf>
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