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Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
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Item 4 (a) (ii) of the provisional agenda**

Matters related to the implementation of the Convention: strategic issues: follow-up to the Indonesian-Swiss country-led initiative to improve the effectiveness of the Basel Convention

Revised draft factsheets on specific waste streams

Note by the Secretariat

As referred to in the note by the Secretariat on follow-up to the Indonesian-Swiss country-led initiative to improve the effectiveness of the Basel Convention (UNEP/CHW.13/4), the annex to the present note sets out revised draft factsheets on specific waste streams, prepared by the expert working group on environmentally sound management on the basis of the comments received from Parties and others. The present note, including its annex, has not been formally edited.

* Second reissue for technical reasons (20 April 2017).

** UNEP/CHW.13/1.

Annex

Revised draft fact sheets on specific waste streams

Contents

GENERAL INFORMATION: IMPLEMENTATION OF ESM OF WASTES

This is the first of a series of technical fact sheets to support the implementation of environmentally sound management (ESM) practices for hazardous wastes or other wastes in accordance with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. This fact sheet provides general information that is common to ESM of different waste streams. Other fact sheets in the series, each tailored for a different target audience (e.g. recyclers or governments), provide more information for specific waste streams, namely e-waste, waste vehicles, healthcare or medical waste, waste lead-acid batteries, waste oils, and waste pneumatic tyres.

The factsheets are intended to serve as a low-threshold document providing the respective target groups with a quick overview of the most important aspects related to ESM of the particular waste streams. They should not be used as the sole source of information, but rather as a starting point to assist the target audience in understanding the issues involved and as a guide to additional and more comprehensive information, if needed. The fact sheets should help raise awareness and increase the use of existing guidance documents in view of a better implementation of ESM on the ground. More detailed information in the form of technical guidelines and guidance documents with respect to the ESM of various waste streams and disposal operations is available on the Convention website(19).

What is waste under the Basel Convention?

"Wastes", as defined by the Convention, are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. Annex I to the Convention, as further clarified in Annexes VIII and IX, lists those wastes that are classified as hazardous and subject to the control procedures under the Convention. Annex II to the Convention identifies those wastes that require special consideration (known as "other wastes", which primarily refers to household wastes). Wastes other than those listed in Annexes I and II to the Convention that are defined or considered as hazardous wastes under the national legislation of a Party of export, import or transit also fall under the Convention.

"Disposal", as defined by the Convention, refers to operations specified in Annex IV to the Convention, and includes final disposal operations in Annex IVA and recovery operations in Annex IVB.

Further guidance on certain terms used in the Convention, including the terms "waste" and "disposal", is available in the glossary of terms [adopted by the Conference of the Parties(21)]. In case of doubt as to whether the Basel Convention control procedure should apply to a particular transboundary movement, the national competent authority should be contacted for guidance(20).

Environmentally sound waste management

Environmentally sound management (ESM) of hazardous wastes or other wastes, as defined in the 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.

Managing hazardous or other wastes in an environmentally sound manner is a fundamental obligation of Parties to the Basel Convention. The framework for the ESM of hazardous wastes and other wastes, developed to improve the effectiveness of the Convention, establishes a common understanding of what ESM encompasses, identifies tools to support and promote its implementation, and identifies strategies to implement ESM of wastes(1). General guidance on ESM has also been developed by the OECD(2).

Source : Joost Meijer

To ensure that wastes are managed in an environmentally sound manner, governments should foster continual improvement within the waste management sector, including the development and implementation of measures to ensure facilities operate according to ESM practices. This can be in a step-wise manner, taking into consideration the protection of the environment and the technical, operational and economic feasibility of doing so, while working toward continually improving environmental performance.

A number of technical guidelines have been adopted under the Basel Convention for the ESM of specific waste streams, such as biomedical and healthcare waste, waste lead-acid batteries, waste oils and used and waste pneumatic tyres. Technical guidance for the use of Best Available Techniques (BAT) in waste treatment industries and waste incinerators has been published by the European Commission in the form of "BAT Reference Documents" (BREFs)[3,4]. In addition, BREFs covering specific industrial sectors contain information on relevant aspects of waste treatment (e.g. non-ferrous metal processes). BREFs are a useful tool to identify BAT, their performance, and costs (investment and operating costs). Guidance has also been developed under the Stockholm Convention on Persistent Organic Pollutants on how to reduce or eliminate unintentionally produced Persistent Organic Pollutants (POPs) by using BAT and Best Environmental Practices (BEP)[5]. Among other source categories, the BAT/BEP guidance addresses emissions from waste management installations such as waste incinerators, secondary metal production, shredder plants for the treatment of waste vehicles, cement kilns firing hazardous waste, and waste oil refineries.

Source: http://www.electronicstakeback.com/

Policy instruments

A variety of policy instruments can be used to promote ESM of hazardous wastes and other wastes. These include extended producer responsibility; unit based pricing (pay-as-you-throw, waste volume charges); landfill bans and taxes; removal of virgin material subsidies; materials, product and chemical bans and restrictions; eco-labelling; green government purchasing; marketable permits; and recycling credit programmes.

The OECD database on instruments used for environmental policy and natural resources management provides information on environmentally related taxes, fees and charges, tradable permit systems, deposit refund systems, environmentally motivated subsidies and voluntary approaches used in environmental policy in various countries[8].

Extended Producer Responsibility

Extended producer responsibility (EPR) extends a producer's responsibility for a product to the post-consumer stage of its life cycle. Policy approaches based on EPR can be used by governments to encourage environmentally sound recycling schemes. Practical manuals on EPR and financing systems for ESM are being developed by the expert working group on environmentally sound management [23]. The OECD[6] and the European Commission have also published guiding principles on EPR[7].

There are four basic categories of EPR instruments: take-back requirements (product take-back); economic and market-based instruments (deposit/refund schemes, advanced disposal/recycling fees, material taxes, upstream combination of taxes/subsidies); regulation and performance standards (minimum recycled content); and accompanying information-based instruments . Take-back requirements and economic instruments can be used to meet policy objectives by assigning responsibility for the management of products that have become waste. In addition, performance standards can be established to specify a particular percentage of recycled materials to be used in a product.

Clear policy goals (e.g. source reduction, waste prevention) and programme objectives (e.g. reducing the amount of waste going to final disposal) should be established for designing an effective EPR scheme. Products, product groups or waste streams should be matched with the most appropriate EPR policy mechanism, and decisions on whether to make the programme voluntary or mandatory, or to use a combination of the two (e.g. negotiated agreements), should be made early on. Targets for collection, reuse, recycling, and recovery may be set. Any EPR programme needs to address "free-riding", "orphan" and "existing" products.

Capacity

Parties are required to ensure the availability of adequate disposal facilities for the environmentally sound management of hazardous wastes and other wastes to the extent possible, located within their own territory. Building sufficient domestic infrastructure and capacity to ensure availability of adequate facilities to undertake waste management operations allows wastes to be managed in close proximity to where they are generated, minimising the need for them to be exported. The Basel Convention is based on the principle that transboundary movements of wastes should be reduced to a minimum consistent with the

Source: http://www.dep.wv.gov/

environmentally sound and efficient management of such wastes.

In order to develop an understanding of waste management and disposal capacity needs, governments should prepare and maintain an inventory of hazardous and other wastes, including of recovery and disposal capacity.

As provided for by Article 13, paragraph 3, of the Basel Convention, Parties are required to inform each other of disposal options operated in their territories. This information can be found in the Convention's online reporting database.

Permitting, Licensing or Authorising

Permitting, licensing or authorising, and control of installations and activities by designated authorities is essential for ensuring the ESM of hazardous wastes and other wastes. Waste management facilities should hold a licence, permit or other authorization and practice ESM. By requiring facilities to operate in an environmentally sound manner, permits, licenses or authorisations help protect human health and the environment, as well as ensure that facility operators or enterprises adopt and pay for their pollution control measures.

Some facilities and activities could be exempt from the requirement for an environmental permit, license or authorization, subject to compliance with certain requirements including registration. Likewise, simplified permitting, licensing or authorization processes could be considered for small and medium sized enterprises (SMEs) that cause negligible environmental impacts. A tiered approach based on the potential risk to the environment and human health of the proposed activities is used by some countries[(9)].

Integrated permitting is considered more effective than media-specific approaches (e.g. permits that only address air pollution or only address protection of surface water) in linking long-term environmental strategies for reducing pollution and making economic growth environmentally sustainable[(10)]. Integrated permitting means that regulators must set permit conditions so as to achieve a high level of protection for the environment as a whole. These conditions are commonly based on use of the concept of BAT, which balances the benefits to the environment as a whole against the costs to the operator. By way of this concept, integrated permitting attempts to prevent waste generation and emissions and, where that is not feasible, to reduce them to acceptable levels[(11)].

Setting the right conditions within permits, licenses or authorizations, and taking into account technical, legal and practical aspects of the particular waste management facility is of utmost importance to ensure its operation while still protecting human health and the environment. Permits, licenses or authorizations may cover: construction requirements; permitted waste types; waste acceptance procedures; pre-treatment requirements; storage requirements; closure and aftercare requirements; emission limits; emission control; emission monitoring; alert system; emergency plan; employee training; records maintenance; offences and penalties; inspections; third-party auditing and certification; proof of financial standing; financial guarantee[(12)].

Certification and Auditing Systems

Environmental management systems (EMS) can help organisations identify and manage their environmental impacts as well as their compliance with environmental legislation. Companies 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 wastes. 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.

Enforcement

ESM of wastes requires a regulatory and enforcement infrastructure that ensures compliance with applicable laws, measures and regulations[(22)].

Environmental enforcement programmes should utilize a balance of strategies: education and assistance; compliance incentives (e.g. recognition programmes); monitoring and inspections; and fair and differentiated non-compliance responses[(13)].

Inspections are the backbone of most enforcement programmes. By standardizing inspection procedures, enforcement officials can help ensure that all facilities are treated equally and that all the appropriate information is gathered. Effective environmental enforcement deters illegal traffic, including the use of penalties that make non-compliance costlier than compliance[(13)].

Specific guidelines and criteria are needed to distinguish compliance from non-compliance, to help ensure that all members of the regulated community are treated consistently and that enforcement is perceived as fair. Fairness, and perception of fairness, is critical to the credibility of an enforcement programme[(13)].

Competent authorities should have access to adequate physical, technical, and financial resources for their mandate and scope of work. Inspectors require training in a broad range of skills, including legal, technical, administrative and communication[(13)].

Transboundary Movements

Appropriate legal, administrative and other measures need to be taken to implement and enforce the provisions of applicable international and regional instruments in relation to the transboundary movement (TBM) of wastes, including the Basel Convention. Legislation should be introduced to prevent and punish illegal traffic.

Parties have an obligation to ensure that TBMs are reduced to a minimum consistent with environmentally sound and efficient management. Hazardous wastes or other wastes should be exported only if the state of export does not have the technical capacity and facilities to dispose of them in an environmentally sound manner or the wastes in question are required as raw material for recycling or recovery in the state of import. TBMs should not be allowed to occur when there is a reason to believe that the wastes in question will not be managed in an environmentally sound manner[(14,15)]. To this end, the Basel Convention requires the exporter and disposer to conclude a contract specifying environmentally sound management of the wastes in question. Prohibitions or restrictions in place in states of export, transit and/or import should be respected[(16)].

When competent authorities consent to a TBM, it should be conducted in a manner to protect human health and the environment. Packing, labelling and transport of the wastes should be in conformity with generally accepted and recognised international rules and standards[(17)].

TBMs must not commence from the state of export until the written consent of the state of import is received and confirmation of the existence of a contract specifying the ESM of the wastes in question. The disposer is required to inform the exporter and competent authority of the state of export of receipt of the wastes and completion of the disposal as specified in the notification[(18)].

References

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(3) European Commission (2006) Reference Document on Best Available Techniques for the Waste Treatments Industries. http://eippcb.jrc.ec.europa.eu/reference/

(4) European Commission (2006) Reference Document on Best Available Techniques for Waste Incineration. http://eippcb.jrc.ec.europa.eu/reference/

(5) Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices Relevant to Article 5 and Annex C of the Stockholm Convention on POPs. http://chm.pops.int/Implementation/BATBEP/BATBEPGuidelinesArticle5/tabid/187/Default.aspx

(6) OECD (2001) Extended Producer Responsibility: A Guidance Manual for Governments. http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

(7) European Commission (2014) Development of Guidance on Extended Producer Responsibility http://ec.europa.eu/environment/waste/pdf/target_review/Guidance%20on%20EPR%20-%20Final%20Report.pdf

(8) Database on Instruments Used for Environmental Policy and natural resources management http://www2.oecd.org/ecoinst/queries/

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(10) OECD (1999) Environmental Requirements for Industrial Permitting. Volume 1: Approaches and Instruments. http://www.oecd-ilibrary.org/environment/environmental-requirements-for-industrial-permitting_9789264172586-en

(11) OECD (2005) Integrated Environmental Permitting Guidelines for EECCA Countries. https://www.oecd.org/env/outreach/35056678.pdf

(12) European Commission (2012) Guidance on Permitting and Inspection of Waste Management Operations.

http://ec.europa.eu/environment/waste/framework/inspections.htm

(13) INECE (2009) Principles of Environmental Compliance and Enforcement Handbook. http://inece.org/resource/principles/

(14) Guidance Elements for Detection, Prevention and Control of Illegal Traffic in Hazardous Waste. http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

(15) Instruction Manual on the Prosecution of Illegal Traffic of Hazardous Wastes or Other Wastes. http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

(16) Notifications of decisions to prohibit or restrict import or export of hazardous or other wastes. http://www.basel.int/Countries/ImportExportRestrictions/tabid/1481/Default.aspx

(17) United Nations Recommendations on the Transport of Dangerous Goods; International Maritime Dangerous Goods Code.

(18) Guide to the Control System. http://www.basel.int/Implementation/Publications/GuidanceManuals/tabid/2364/Default.aspx

(19) www.basel.int

(20) A database of country contacts is maintained on the Basel Convention website: http://www.basel.int/Countries/CountryContacts/tabid/1342/Default.aspx

(21) The Glossary of terms [was adopted by the thirteenth meeting of the Conference of the Parties (BC-13/...). http://www.[...]]

(22) For general guidance on the enforcement of environmental legislation you may for example refer to:
- UNEP (2006) Manual on Compliance with and Enforcement of Multilateral Environmental Agreements. http://www.unep.org/delc/portals/119/UNEP_Manual.pdf
- UNEP (2005) Judicial Handbook on Environmental Law. http://unep.org/delc/Portals/119/publications/Judicial-Handbook-Environmenal-Law.pdf

(23) Draft practical manuals on EPR and financing systems for ESM available in document UNEP/CHW.13/INF/8. http://www.basel.int/TheConvention/ConferenceoftheParties/Meetings/COP13/tabid/5310/Default.aspx

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)[1,2,3].

Classification

The classification of e-waste according to Annexes I, III, VIII and IX of the Basel Convention, is presented in Table 1 below[3]. 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[13].

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/)

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(6).

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(3). 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.

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[12, 13].

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[6].

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[11].

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[14, 15].

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[19].

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[13].

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(16).

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(17).

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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WASTE VEHICLES

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 waste vehicles, also sometimes referred to as "end-of-life vehicles". It is primarily intended for use by dismantlers and recyclers.

Other fact sheets in the series provide related information on waste oils, waste lead acid batteries, waste tyres and electrical and electronic waste. Technical guidelines have been developed under the Basel Convention for the environmentally sound management of used and waste pneumatic tyres(1), waste oils(2), and waste lead-acid batteries(3), among others.

Classification

Waste vehicles that have been drained of fluids (e.g. engine oil) and are free of other hazardous components (e.g. lead acid batteries) are classified under entry B1250 of Annex IX to the Basel Convention, when subject to transboundary movement. Table 1 indicates fluids and components that are generally removed from waste vehicles during dismantling(4-12) and their classification under Annexes I, III, VIII and IX of the Basel Convention. Also identified therein is the applicable hazard class or division under the United Nations Model Regulations(13).

Storage

Waste vehicles should be stored in properly licensed, permitted or authorised facilities. Storage of vehicles, even temporarily, should be undertaken on an impermeable surface with spill containment. Spillage collection facilities should include a sealed drainage system as the primary means of containment, however, spill kits to deal with spillages of oils, fuels and acids should be provided and used as appropriate(6). Devices such as silt traps and oil separators should be provided for the treatment of storm water runoff. If engines or greasy parts are exposed, they should be covered with a tarpaulin or other covering to prevent rain and snow contact(9).

Storage sites should be secured in order to prevent unauthorised access, and to ensure that no material can escape(6). An inventory should be kept of the waste vehicles stored at the facility. The make, model, and year of each vehicle, the date the vehicle arrived, the date it was last inspected for leaks, and other information needed to control the flow of the inventory, should be recorded(9).

Environmentally sound waste management

Waste vehicles should only be handled in properly licensed, permitted or authorised facilities that employ environmentally sound management (ESM) practices.

When waste vehicles first arrive at a facility, they should be inspected for leaks and unwanted materials that could have been placed in the vehicle(9,14). Any oil or fluid leaking from the vehicle should be collected immediately using drip trays. Vehicles that are leaking should be moved immediately to the dismantling area and processed(8).

> 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.

Runoff management is an important consideration for waste vehicle dismantlers. Best practices to prevent or minimise pollutants from entering storm water runoff and/or reduce the volume of storm water requiring management include, among others, regular clean-up, collection and containment of debris in storage areas, and other housekeeping practices, spill control, and employee training(14). Best practices for minimising exposure of potential pollutant sources to precipitation include covering materials or activities with temporary covers (e.g., tarpaulins) or permanent covers (e.g., roofs).

Examples of waste categories	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
Waste lead-acid batteries	Y31,Y34	H8, H11, H12, H13	A1160	Waste Battery, Wet, Filled with Acid, UN2794, Class 8 -or- Waste Battery, Wet, Non-spillable, UN2800, Class 8
Waste lead-acid batteries, drained	Y31	H11, H12, H13	A1160	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Waste battery electrolyte	Y34	H8	A4090	Waste Battery Fluid, Acid, UN2796, Class 8
Waste lithium batteries	Y19	H13	A1170	Waste Lithium Ion Batteries, UN 3480, Class 9
Waste tyres	-	-	B3140	-
Waste mercury switches	Y29	H11, H12, H13	A1030, A1180	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Waste oils	Y8	H11, H12, H13	A3020	Environmentally Hazardous Substances, Liquid, N.O.S., UN3082, Class 9
Petrol (fuel)	Y9	H3, H11	A4060	Petroleum Products, N.O.S., UN1268, Class 3
Waste antifreeze	Y42	H11	A3140	Environmentally Hazardous Substances, Liquid, N.O.S., UN3082, Class 9
Waste catalytic converters that contain refractory ceramic fibre (RCF)	-	H11	-	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Waste electrical and electronic assemblies or equipment (e-waste)	Various (e.g., Y31, Y20, Y27, Y45)	H11, H12, H13	A1180	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Non-hazardous waste electrical and electronic assemblies	-	-	B1110	-
Non-deployed airbags	Y15	H1	-	Safety Devices, Pyrotechnic, UN0503, Division1.4G -or- Safety Devices, Electrically Initiated, UN3268, Class 9
Waste brake pads containing asbestos	Y36	H11	A2050	Waste Asbestos, Chrysotile, UN2590, Class 9
Metal and metal-alloy wastes	-	-	B1010	-

H1=Explosive; H3=Flammable liquids; H8=Corrosives; 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 components of waste vehicles

Contaminated runoff should be treated prior to discharge with devices such as oil-water separators[14]. Oil-water separators should be cleaned out on a regular basis (twice a year at a minimum)[8].

Dismantling

Any dismantling involving the engine, transmission or hydraulic systems should take place on impermeable surfaces with a sealed drainage system as a primary means of containment. However, spill kits to deal with spillages of oils, fuels and acids should be provided and used as appropriate. Waste vehicles may be dismantled on hard-standing surfaces only if the dismantling is of parts not associated with, and the dismantling activity will not disturb, the engine, transmission or hydraulic systems[6]. Oil-water separators should not be used as part of the spill control strategy[8].

De-pollution activities should be conducted using tools and equipment designed specifically for carrying out the required operations. The use of such equipment is generally considered to yield the best results as it ensures that a high level of de-pollution can be achieved in a relatively short time frame, generally 20-30 minutes[5].

Dismantling operations include parts removal and vehicle de-pollution (the removal of fluids and hazardous components prior to crushing or shredding) to various degrees. In order to de-pollute a waste vehicle, a number of operations have to be conducted, the sequence of which may vary depending on the vehicle. A possible sequence (developed from practical trials using one specific make of vehicle) is presented in Figure 1[5]. Model-specific information (such as airbag deployment instructions, identification of mercury-containing components, and information about potentially reusable parts and components) should be obtained from vehicle manufacturers (e.g. IDIS[15]).

After de-pollution, all gravity-drained holes should be plugged, either with their own drain plug or a suitable plastic bung, to prevent any residual leakage[5].

Fluid storage should be confined to designated areas that are covered and have adequate secondary containment. Containers should be kept closed, except when adding or removing fluids, and they should be inspected regularly to check for leaks, cracks, or structural deficiencies[11].

Fluids of differing types should be stored in separate containers prior to being collected and treated by specialist disposal companies[5]. Fluids should be properly segregated and stored to promote their recovery. Waste vehicle dismantlers should check with the recycler to determine what materials may be mixed (so as not to restrict the possibilities for recycling). Generally, waste oils (e.g. lubricating, transmission, power steering and shock absorber oils) can be mixed together and stored in the same container. Waste oils should not be mixed with waste solvents or products that contain halogen compounds. At a minimum, for fuels (petrol and diesel), oils, brake fluids and antifreeze should be kept in separate containers[5].

Waste oils and waste antifreeze should be stored in steel drums[8]. Although plastic containers are acceptable, the plastic deteriorates over time and will eventually fail. Also, plastic containers are more susceptible to puncture.

Fuels should be stored in a separate, well-ventilated area. Consideration should be given to the installation of a suitable storage tank (designed and constructed to an appropriate national or international standard) if the amount of petrol to be stored is more than 1000 litres of petrol[16].

Mercury-containing convenience lighting assemblies (or mercury switch capsules) and ABS sensor modules should be stored in plastic containers with airtight lids[11,17]. Containers should be kept closed, except when adding an assembly or pellet. All employees who remove and/or manage mercury-containing switches should be are aware of proper handling methods and emergency procedures for containing and cleaning up mercury spills and leaks. It is recommended that all facilities have a mercury spill kit.

Asbestos-containing brake shoes or clutches should be removed using specially designed, low-pressure spray equipment that wets down brake or clutch dust and properly catches the runoff to reduce the chance of asbestos being released into the air.

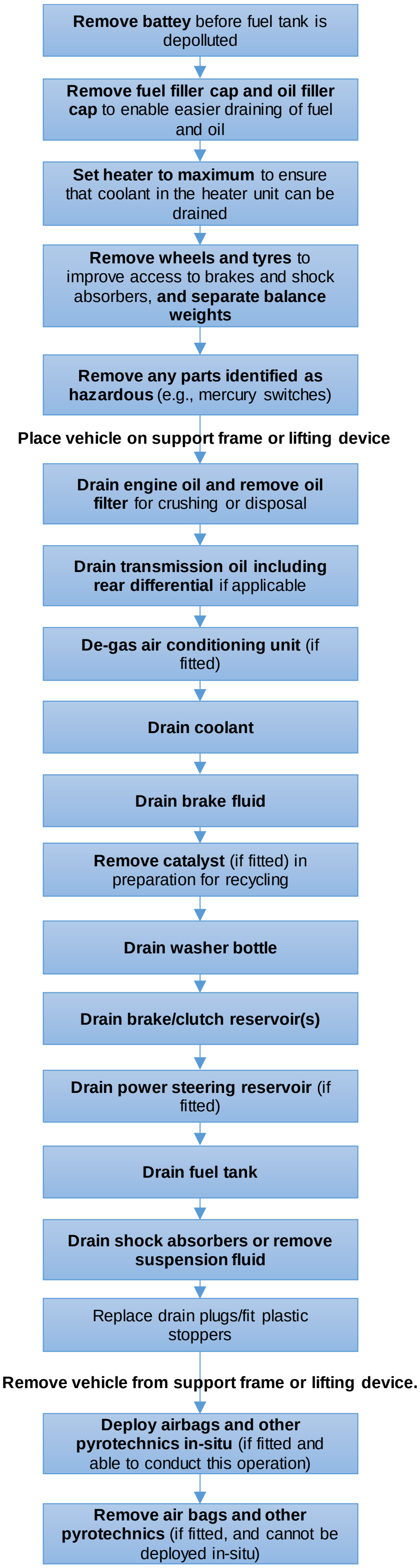

Figure 1. Example of the de-pollution process[6]

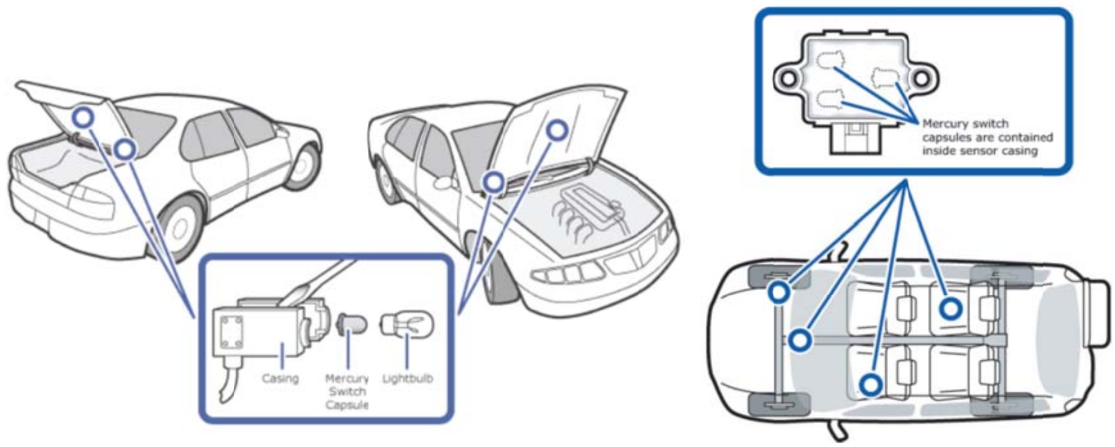

Figure 2. Location of mercury convenience lighting switches and ABS sensor modules (Source: www.switchout.ca)

The use of a high-efficiency particulate arrestance (HEPA) filter vacuum cleaner should be considered. Asbestos-containing brake shoes and clutches should be placed in a heavy plastic bag, double tied, and stored in a leak proof, airtight container designated for asbestos waste(19). Appropriate containers should be provided for any other hazardous components identified and removed from waste vehicles.

It is recommended that, where possible, airbags be deployed in-situ by trained technicians and using appropriate safety protection. Airbags can be deployed safely by using vehicle manufacturer information on airbag management. Non-deployed airbag units should be removed and not go through the shredding process. Seatbelt pre-tensioners that contain explosive devices also need to be deployed as part of the de-pollution procedure(5). Non-deployed air bag modules and inflators removed from vehicles should be managed in a manner that prevents them from being accidentally deployed. They should be stored in a cool dry location with appropriate fire protection. Airbag modules should be stored cover side up and not stacked(18).

Catalytic converters, metal parts containing copper, aluminium or magnesium, tyres, glass and large plastic components (e.g., bumpers, dashboard) should be removed for recycling in the dismantling stage, if they cannot be segregated in the shredding process in such a way that they can be effectively recycled(4). Catalytic converters that contain refractory ceramic fibre (RCF) should be stored in a manner that does not result in the metal casing being pierced or breached (e.g., stored in a rigid container).

Storage should be carried out in such a way as to avoid damage to components which contain fluids or to recoverable components and spare parts. Engines, transmissions and other oily parts should be stored under a tarpaulin, roof, or other temporary or permanent cover and on an impermeable surface, or in a covered weather-proof container such that there is no contact with rainfall and surface drainage(11). Parts removed for resale should be stored on racks where practical. Prevention of fire hazards and of excessive stockpiling should be considered when storing used tyres. Generally, no more than 2 vehicle loads of tyres should be stored(6).

Engines and parts should only be washed if absolutely necessary. Solvent cleaning of parts should be conducted in a solvent-based parts washer(21). Cleaned parts should be drained for at least 15 seconds, or until dripping ceases, whichever is longer; parts should be covered during drainage(20). To prevent evaporation washers should be covered when not in use and circulating sinks should be turned off(19,22). To keep the solvent cleaner longer, the use of parts washers equipped with filters and other separation and treatment options should be considered. Also, segregating cleaning into two stages, each having a dedicated washing unit, can extend the usefulness of the solvent(19). An on-site distillation unit to recycle waste solvent may be considered to further reduce solvent use and waste(19,21). Waste solvent should be stored in covered containers; solvents and degreasers should not be mixed with oils or with fuels.

Crushing

Vehicle crushers and drain racks should be situated on a bunded or self-contained impermeable surface, preferably under a roof and protected from the weather. The floor surface should be sloped to contain fluids. Mobile crushers should always be situated on an impermeable surface. Containers designed to be fitted to the crusher can help capture fluids(19,20).

Waste vehicles should be adequately drained prior to crushing. The fluids that drain from the crusher reservoir should be collected and disposed of properly.

Shredding

Shredding involves the actual shredding of materials into smaller pieces as well as the separation and sorting of the material once shredded for acceptance by other operations like a steel mill for metal recycling.

To reduce potential emissions, which may include POPs released from materials that were not properly removed during de-pollution, systems for dust suppression (e.g. wet shredding) or dust collection (e.g. cyclones) should be considered.

The amount of auto shredder residue (ASR) that would eventually need to be finally disposed of can be reduced significantly by separation and recovery of materials from the shredder residue, primarily plastics, rubber, and residual metals, including the reprocessing of the finer fraction. The non-combustible fraction can also be reduced by separating and recovering the metals and their oxides and perhaps the glass.

For the treatment of ASR, several options are available e.g. post shredder technology that separates materials from ASR for recycling. Specific attention should be paid to plastics as these may be contaminated with POPs. ASR may be incinerated and in such cases, incineration should take place in facilities that practice ESM. If incineration is not available, ASR may also be disposed of in a controlled (engineered) landfill.

Extended Producer Responsibility

Extended producer responsibility (EPR) extends a producer's responsibility for a product to the post-consumer stage of its life cycle. Effective EPR implementation depends on the participation of all the actors in the product chain. Dismantlers and recyclers who participate in an EPR programme and follow its requirements are generally required to meet certain standards or use best management practices for handling products and materials.

All waste vehicles should be managed according to ESM practices, whether or not they fall under an EPR scheme (e.g., waste vehicles being sold directly to a recycler).

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 waste vehicles. 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 reference section for general guidelines and recommendations to help small and medium-sized businesses develop an EMS[24].

Transboundary Movements

Transboundary movements of waste vehicles that are hazardous wastes 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, waste vehicles may be subject to additional restrictions and control procedures in certain countries. In some cases, it may be difficult to distinguish used vehicles from waste vehicles[25]. Contact should be made with the relevant competent authorities for further information.

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HEALTHCARE OR MEDICAL WASTE

This fact sheet is part of a series of fact sheets to support the implementation of the environmentally sound management 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 (ESM) of healthcare waste, also sometimes referred to as medical waste. This fact sheet is primarily intended for use by waste managers at facilities generating or disposing of healthcare waste, but also contains information useful to transporters and collectors.

In addition, the reader should take due account of the **Technical Guidelines on the Environmentally Sound Management of Biomedical and Healthcare Wastes (Y1; Y3)**, developed under the Basel Convention[(1)].

Facilities generating and disposing of healthcare waste should appoint a waste management officer who should have overall responsibility for developing a waste management plan for the facility, and for the day-to-day operation and monitoring of the waste management system. The waste management plan should address, among others, responsibilities, waste management procedures, monitoring and training[(2)]. Minimisation of waste through a purchasing policy that includes product substitution, product changes, procedural changes, replacing disposable items with reusable items, and encouraging extended producer responsibility, should be considered.

Classification

Classifying wastes into groups that pose similar risks to the environment and human health facilitates their management and the collection of information for monitoring and reporting purposes.

Table 1 below shows how various categories of healthcare waste may be classified under Annexes I, III, VIII and IX of the Basel Convention (required for transboundary movements of waste). The applicable hazard class or division under the United Nations Model Regulations[(3)], which serves as a basis for most national regulations governing the transport of dangerous goods, is identified for selected wastes within those categories.

Segregation

Introducing waste segregation is the first step in implementing a facility-wide waste management plan. Segregation should be carried out as close as possible to the place of generation. Waste that has been poorly

Figure 1. Sharps containers

segregated should not be re-sorted; if non-hazardous and hazardous wastes are accidentally mixed, the mixture should be managed as hazardous waste. Corrective action should be taken to ensure that waste is segregated properly in the future[(4)]. Many countries have national measures that prescribe the waste segregation categories to be used and a system of colour coding for waste containers. Where there is no national measure in place, a World Health Organization (WHO) scheme is available[(4)], as detailed in Table 1. Colour coding makes it easier for medical staff and hospital workers to put waste items into the correct container, and to maintain segregation of the wastes during transport, storage and disposal. Colour coding also provides a visual indication of the potential

Source: http://www.gefmedwaste.org/

Figure 2. Standard wheeled container with colour-coded bag and biohazard label

risk posed by the waste in that container[(4)].

WHO-recommended waste segregation categories[4]	WHO-recommended type, colour and labelling of containers a/	Y-code, annex I of Basel Convention	H-code, annex III of Basel Convention b/	A-code, annex VIII of Basel Convention	United Nations shipping name, number, and hazard class or division
Highly infectious waste (e.g. diagnostic laboratory samples; waste from infectious patients in isolation)	Yellow, autoclavable, leak-proof plastic bags/containers with biohazard symbol, marked "HIGHLYINFECTIOUS"	Y1	H6.2	A4020	Regulated Medical Waste, UN3291, Division 6.2
Other infectious waste and pathological waste (e.g. waste contaminated with blood and other body fluids; laboratory cultures and microbiological stocks; human tissues, organs or fluids; body parts; foetuses; unused blood products)c/	Yellow leak-proof plastic bags/containers with biohazard symbol	Y1	H6.2	A4020	Regulated Medical Waste, UN3291, Division 6.2
Sharps waste (e.g. hypodermic, intravenous or other needles; scalpels; broken glass)d/	Yellow puncture-proof containers with the biohazard symbol, marked "SHARPS"	Y1	H6.2	A4020	Sharps Medical Waste, UN3291, Division 6.2
Pharmaceutical and cytotoxic waste (e.g. expired pharmaceuticals; waste containing cytostatic drugs; genotoxic chemicals)	Brown plastic bags/rigid containers with appropriate hazard symbols	Y3	Various, see Safety Data Sheets (e.g. H3, H6.1, H11, H12)	A4010	Various, see Safety Data Sheets (e.g. waste medicine, liquid, toxic N.O.S., UN 1851, Division 6.1; waste medicine, solid, toxic N.O.S., UN 3249, Division 6.1; waste medicine, liquid, flammable, toxic N.O.S., UN 3248, Class 3)
Chemical waste (e.g. laboratory reagents; film developer; expired disinfectants; solvents; broken thermometers)	Brown plastic bags/rigid containers with appropriate hazard symbols	Various (e.g. Y16, X-ray fixer and developer; Y29, dental amalgam)	Various, see Safety Data Sheets (e.g. X-ray fixer and developer - H8, H11, H13; dental amalgam - H6.1, H12, H13)	Various (e.g. dental amalgam - A1030)	Various, see Safety Data Sheets (e.g. X-ray fixer - environmentally hazardous substance, liquid, N.O.S., UN 3082, Class 9; dental amalgam - waste mercury compound, solid, N.O.S., UN 2025, Division 6.1)
Radioactive waste (e.g. urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources)	Shielded container with radiation symbol	Not applicable	Not applicable	Not applicable	Various, dependent on the radionuclide and activity level[5](e.g. Tc 99m generator - waste radioactive material, type A package , UN 2915, Class 7)
General healthcare waste (non-hazardous waste)	Black plastic bags	Not applicable	Not applicable	Not applicable	Not applicable

a/ The use of other colour coding in a country is possible.
b/ H3= Flammable liquids; H6.1= Infectious substances; H6.2= Poisonous (acute); H8= Corrosives; 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
c/ In certain circumstances, human or animal tissue waste will arise where there is sufficient knowledge to classify it as non-infectious.
d/ In some circumstances certain sharps that are not contaminated with body fluids may not be infectious.

Table 1. Classification of healthcare waste according to the WHO-recommended segregation scheme

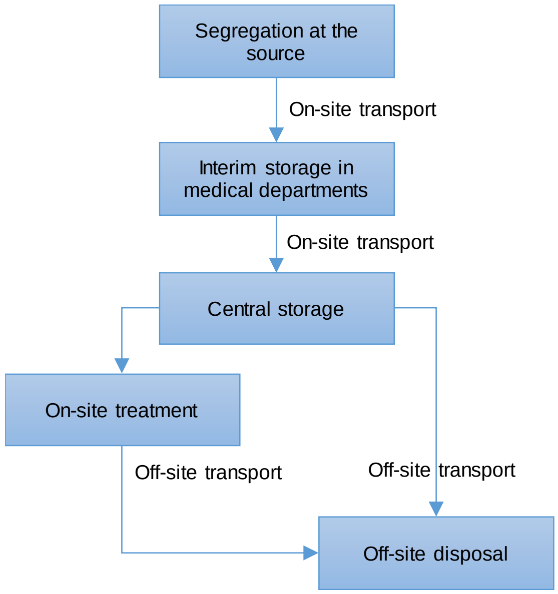


Figure 3. Basic elements of healthcare waste management

Containers should not be allowed to accumulate in places accessible to unauthorised personnel or the public. Containers and bags should be filled to no more than three quarters of their capacity and then sealed. Containers and bags should be labelled with the type of waste, point of generation, date and where possible, weight. Segregated waste should be regularly removed and safely stored to reduce the risk of transmission of pathogens and improve general standards of cleanliness and hygiene in medical areas.[4]

Storage

Interim storage in medical departments

Where possible, hazardous waste generated in medical areas should be stored in locked utility rooms. In this way, the waste can be kept away from patients before removal, then collected and transported to a central storage facility. If utility rooms are not available, waste can be stored at another designated locked location near to a medical area but away from patients and public access. Another possibility for interim storage is a closed container stationed indoors, within or close to a medical area. A storage container used for infectious waste should be clearly labelled and preferably lockable[4].

Central Storage

Central storage areas are places where different types of waste are brought for safe retention until collection for transport off-site or until further disposal. General guidance for storage facilities includes: (1) an impermeable, well-drained hard-standing floor, that is easy to clean and disinfect; (2) a water supply for cleaning purposes and washing facilities readily available for the staff; (3) to be lockable to prevent access by unauthorized persons; (4) to be secure from entry by animals and free from insect or rodent infestations; (5) to be well-lit, ventilated and sheltered from the sun; (6) to be sited away from food preparation and general storage areas; (7) have spillage containment equipment[4]. A supply of cleaning equipment, protective clothing and waste bags or containers should be located conveniently close to the storage area.

Infectious and pathological waste

Store infectious and pathological waste separately from other hazardous waste, at a temperature no higher than 8°C, to prevent putrefaction. If refrigerated storage is not available, storage times should not exceed 24 or 48 hours during the hot or cool seasons in warm climates, and 48 or 72 hours during summer or winter in temperate climates[4]. Floors and walls should allow easy disinfection. The storage area should be identified using the biohazard sign.

Chemical waste

The storage place should be an enclosed area and separated from other waste storage areas. To ensure the safe storage of chemical wastes, the following separate storage zones should be available to prevent dangerous chemical reactions: explosive waste, corrosive acid waste, corrosive alkali waste, toxic waste, flammable waste, oxidative waste, halogenated solvents, and non-halogenated solvents[4]. Liquid and solid waste should be stored separately. Cytotoxic waste should be stored separately in a designated secure location. Mercury waste should be kept segregated from other types of waste. The storage areas should be labelled according to their hazard class. Pharmaceutical waste with non-hazardous characteristics can be stored in a non-hazardous storage area. The storage area itself should have adequate lighting and good ventilation to prevent the accumulation of toxic fumes. A sample design of a storage room for waste is presented in Figure 4.

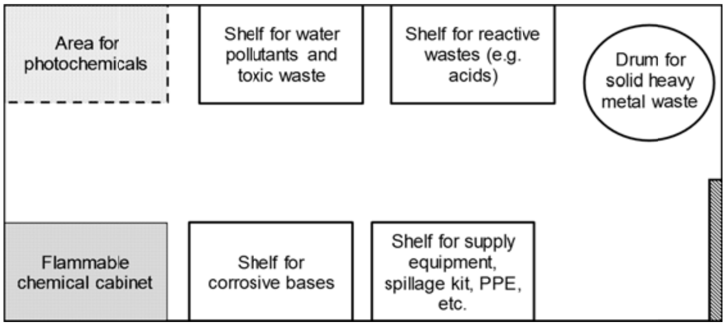


Figure 4. Sample outline of chemical storage room[4]

Low-level radioactive waste

Store for decay in a shielded container, in accordance with national law. The storage area should be identified using the radiation warning symbol (trefoil).

Transport

On-site transport of waste

On-site transport should take place during less busy times and using set routes to prevent the exposure of staff and patients. Hazardous and non-hazardous waste should be transported separately; infectious waste should not be transported together with other hazardous waste. Separate hazardous and non-hazardous routes should be planned and used. In general, a waste route should follow the principle “from clean to dirty”. Collection should start from the most hygienically sensitive medical areas (e.g. intensive care) and follow a fixed route around other medical areas and interim storage locations. Infectious waste should be collected at least daily. The use of waste chutes is not recommended[4].

Source: http://www.epd.gov.hk/

Figure 5. On-site transport

Equipment used to transport waste should be able to contain any leak and be easy to clean and drain; it should be cleaned and disinfected daily. Waste should not be transported by hand due to the risk of accident or injury from infectious material or incorrectly disposed sharps that may protrude from a container. Persons performing this work should wear adequate personal protective equipment, including heavy-duty gloves, safety shoes or industrial rubber boots, industrial aprons, overalls and face masks.

Off-site transport of waste

Off-site transport of waste should be carried out by a licensed, permitted or authorised carrier, in a vehicle used exclusively to transport medical waste, and labelled accordingly. The vehicle registration used to carry waste should be listed on the permit. Vehicles should be fully enclosed with an internal finish that allows for disinfection. Refrigerated containers could be used if the storage time exceeds the recommended period or if transportation times are long.

Information should be provided to the waste service provider on safe working procedures on-site and any temporary hazards associated with the collection and handling of the waste concerned. Emergency response information (e.g. European Chemical Industry Council’s ERICards) and hazardous waste tracking documents, as required by national law, should accompany each movement of hazardous waste. National legislation may require that such documents be retained for a certain period. The applicable hazard class or division under the United Nations Model Regulations[3] is identified for selected wastes in Table 1.

The vehicle should carry plastic bags, suitable protective clothing, cleaning equipment and disinfectant, together with special kits for dealing with liquid spills.

Transboundary Movement

Transboundary movement of healthcare wastes that are hazardous wastes 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, healthcare waste may be subject to additional restrictions and control procedures in certain countries.

Environmentally Sound Waste Management

Waste management should respect the waste hierarchy, with prevention being the preferred option. By not generating wastes and ensuring that those generated are less hazardous, the need to manage wastes and/or the associated risks and costs are reduced.

Where waste avoidance is not possible, management can be done on-site or off-site. When treating on-site, the technology should be carefully selected based on waste characteristics, technological capability and requirements, environmental and safety factors, and costs(4). Implementing rigorous segregation practices can avoid over-sizing of equipment and result in cost savings.

Table 2 provides an overview of disposal methods suitable for hazardous and radioactive healthcare waste. Infectious healthcare waste should be rendered safe by reducing the number of infectious organisms present in the waste to a level that no additional precautions are needed to protect workers or the public against infection by the waste. Pathological and anatomical waste should be rendered unrecognisable as may be required. Sharps should be rendered unusable and unrecognisable.

For infectious waste, suitable treatment technologies should be able to achieve, as a minimum, inactivation of vegetative bacteria, fungi, lipophilic/hydrophilic viruses, parasites, and mycobacterium at a 6 $\log_{10}$ reduction or greater, and inactivation of *Geobacillus stearothermophilus* (formerly *Bacillus stearothermophilus*) spores and *Bacillus atrophaeus* (formerly *Bacillus subtillis var. niger*) spores at a 4 $\log_{10}$ reduction or greater.

For cultures of pathogenic microorganisms, microbial inactivation of vegetative bacteria, fungi, lipophilic/hydrophilic viruses, parasites, mycobacteria and *Geobacillus stearothermophilus* spores at a 6 $\log_{10}$ reduction or greater, should be achieved(6). For most technologies, except incineration, it should be possible to demonstrate that the process meets disinfection requirements through “validation testing”(11). The ability to achieve required microbial inactivation criteria should be demonstrated under “worst case” load conditions(6). “Challenge testing” or quality control can be conducted through the use of either parametric monitoring or biological indicators provided that parametric monitors have been validated with indicators through efficacy testing and are revalidated at regular intervals as determined through discussions between regulators and vendors(12). Waste that has been appropriately treated is no longer considered infectious for handling and disposal purposes. Where appropriate, priority consideration should be given to non-combustion treatment technologies which avoid the release of persistent organic pollutants (POPs)(7).

Several options exist for small quantities of

Waste categories	**Incineration using BAT**	**Chemical disinfection**	**Autoclave**	**Microwave**	**Encapsulation**	**Specially engineered landfill a/**	**Discharge to sewer systems**	**Other method**
Infectious waste	Yes	Small quantities	Yes	Yes	No	No	Only urine and faeces c/	
Pathological waste	Yes	No	No	No	No	No	No	
Sharps	Yes	Yes	Yes	Yes	Yes	No	No	
Pharmaceutical waste	Yes	No	No	No	Yes	Small quantities	No	Return to supplier
Cytotoxic waste	Yes	No	No	No	No	e/	No	Return to supplier
Chemical waste	Small quantities	No	No	No	No	e/	Small quantities b/	Return to supplier
Radioactive waste d/	Low-level radioactive waste	No	No	No	No	No	Low-level radioactive waste	Decay in storage; return to supplier

a/ In accordance with rational regulations and policies, landfilling may be prohibited in some countries
b/ Not the preferred method
c/ There could be cases where the disposal option could be used provided a number of safeguards are in place (1)
d/ Only if the clearance levels set by the International Atomic Energy Agency are met
e/ In exceptional cases if special requirements (e.g. encapsulation in the case of cytotoxic waste) are met(1)

Note: Entries in bold indicated preferred methods

Table 2. Overview of disposal methods suitable for hazardous and radioactive healthcare waste

pharmaceutical waste: return of expired pharmaceuticals to the supplier; encapsulation and burial in a sanitary landfill; chemical decomposition in accordance with the manufacturer‘s recommendations if chemical expertise and materials are available; and dilution in large amounts of water and sewer discharge into a sewer for moderate quantities of relatively mild pharmaceuticals, such as solutions containing vitamins, cough syrups, intravenous solutions and eye drops. Antibiotics or cytotoxic drugs should not be discharged into municipal sewers or watercourses. For cytotoxic waste, treatment options include: return to the supplier; incineration at 1200°C and a minimum gas residence time of 2 seconds in the second chamber; and chemical degradation in accordance with the manufacturer's instructions[4].

Low-level radioactive waste that has been stored for decay until no appreciable radioactivity is detectable can be safely disposed of as general waste (if it presents no other hazard), in accordance with national law.

Source: http://www.gefmedwaste.org/

Figure 6. Dual autoclaves in Senegal

Steam treatment technologies

Autoclaves should be rated to operate between 100 and 200 kPa gauge pressure or higher. The most important factor for safe and effective disinfection is a well-carried out waste segregation system, to prevent mixing of hazardous chemical waste with waste to be autoclaved; if waste streams are not properly segregated contaminants will be released into the air, as a condensate, or in the treated waste, and possibly damage the equipment. Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste and radiological waste should not be treated in an autoclave. Large and bulky bedding material, sealed heat-resistant containers and other waste loads that impede the transfer of heat should be avoided. Autoclaves are generally not used for large anatomical remains, because it is difficult to determine beforehand the time and temperature parameters needed to allow full penetration of heat to the centre of the body; disinfection of human anatomical waste is also limited due to ethical concerns. Treated waste from an autoclave retains its physical appearance. If desired, a mechanical process such as a shredder or grinder can be used after treatment to make the waste unrecognizable.

The operation of autoclaves requires the proper combination of temperature/pressure and exposure time to achieve disinfection. Where prions (which cause Creutzfeldt-Jakob disease) are present, a cycle of 60 minutes at 134°C is recommended, because of their exceptional resistance. For these reasons, validation tests should be conducted using waste samples that are representative of actual waste produced in the facility[8,9]. The established time-temperature standards should be greater than those identified during testing, to provide a margin of error[10]. After the initial tests, regular challenge tests using biological indicators (e.g. *Geobacillus stearothermophilus*), should be performed at periodic intervals[4,6,11]. As an added check, colour-changing chemical indicators can be used with each waste load to document that the required temperature has been achieved[4]. The temperature within the chamber should be continuously monitored in various locations to detect thermal problems and inconsistencies[10]. Autoclave performance should be checked annually using independent thermocouple tests[6].

Record-keeping is a critical component of autoclave maintenance[10].

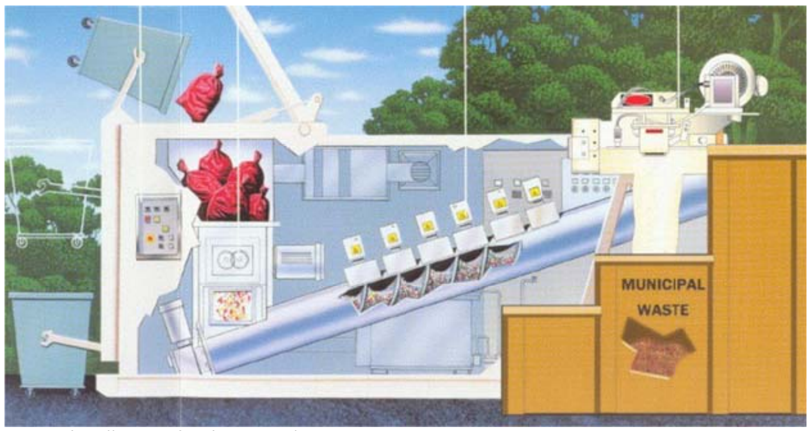
Methods other than steam-based disinfection (i.e. wet thermal) should be selected only if this is impracticable or inappropriate[1].

Microwave treatment technologies

Microwave disinfection uses radiant energy to heat moisture within the waste and/or heat water that is added to the waste. Microwave units with internal shredders, can theoretically be used for pathological waste, just like hybrid autoclaves and continuous steam treatment systems with internal shredders, however, legal, cultural, religious, aesthetic, and other considerations may preclude their use[9]. Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste and radiological waste should not be treated in a microwave[4]. Needles and other sharp metal objects should be in puncture-safe needle containers. Sharps containers should not be hermetically sealed to allow steam penetration[9]. If waste streams are not properly segregated to prevent hazardous chemicals from being fed into the treatment chamber, contaminants will be released into the air, condensate, or in the treated waste. Microbial inactivation tests (using for example *Bacillus atrophaeus*) should be carried out on a regular basis.

Chemical treatment technologies

Commercial, self-contained and automatic systems have been developed for healthcare waste treatment. Manual systems using chemical disinfection are not regarded as a reliable method for treating waste[4]. Chemical disinfection is most suitable for treating liquid waste such as blood, urine, stools or hospital sewage. Shredding of solid waste before or during disinfection is necessary to ensure good contact between the disinfectant and waste surfaces, however, this should be done in a closed system to avoid release of pathogens into the air. Thermal disinfection (e.g. autoclaving) should be given preference over chemical disinfection for reasons of efficiency and environmental considerations[1].



Source: http://www.gefmedwaste.org/

Figure 7. Continuous microwave system

Microbial inactivation tests (using for example *Bacillus atrophaeus*) are important to ensure that the concentrations and exposure times sufficient. The chemical agent selected should be compatible with other substances or material that may be present in the waste load so that its efficiency is not reduced, and also to ensure that hazardous products are not thereby formed or released. Users should wear protective clothes, including gloves and protective eye glasses or goggles. Formaldehyde and ethylene oxide are no longer recommended for waste treatment due to significant hazards related to their use[4].

A special case of a chemical treatment is alkaline hydrolysis. Primarily designed for pathological waste, it can also treat biological stocks, cultures, liquid blood, body fluids, and other types of infectious waste. Moreover, the process has been shown to degrade aldehydes, such as formaldehyde and glutaraldehyde waste which are commonly used in healthcare and may be found in pathological wastes.

Some small-scale chemical treatment processes also include encapsulating or solidifying compounds that can solidify sharps, blood or other body fluids within a solid matrix prior to disposal. Encapsulation alone is not recommended for non-sharps waste, but may be used in combination with treatment of such waste[4].

Incineration

Infectious, sharps and pathological wastes may be treated by incineration using best available techniques (BAT) and best environmental practices (BEP)[7]. Incineration technologies considered BAT/BEP include pyrolysis plants, rotary kilns, grate incinerators, fluidized bed incinerators, and modular systems. Incineration should only be carried out in dedicated plants or in larger incinerators for hazardous wastes (with a separate charging system for infectious wastes). Combustion temperature should be raised (after the last injection of combustion air) to 1100°C for hazardous waste with greater than 1% halogenated organic substances (as is generally the case for healthcare waste) or 850°C for all other wastes, for at least 2 seconds and 6% O_2. Auxiliary burners should be provided to ensure that the operating temperature is maintained at all times as long as unburned waste is in the combustion chamber (during start-up and shut-down operations). Bottom ash, fly ash and scrubber residuals should be handled in a manner that prevents releases and disposed of as hazardous waste. Materials containing chlorine such as PVC products or heavy metals such as mercury should not be incinerated. Carbon monoxide, oxygen in the flue gas, particulate matter, hydrogen chloride, sulphur dioxide, nitrogen oxides, hydrogen fluoride, airflows and temperatures, pressure drops and pH in the flue gas should be routinely monitored according to national laws and manufacturers' guidance[4,7].

Off-site disposal

Waste generators have a responsibility to ensure that waste sent off-site is managed in an environmentally sound manner, and in facilities that are properly licensed, permitted or authorised to deal with the waste stream involved. To ensure the waste will be managed in ESM, it is important to know how the waste and any residues from the treatment (e.g. incinerator ash) will be managed. If the waste is to be managed by more than one facility, the compliance and operating status of both should be considered.

Documentary proof of waste transfer, receipt and recovery or final disposal by the waste service provider(s) involved, should be obtained. Detailed records should be kept for the length of time required by national laws or other measures.

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WASTE LEAD-ACID BATTERIES

This fact sheet is part of a series of fact sheets to support the implementation of the environmentally sound management of hazardous wastes and other wastes, as required under 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 waste lead-acid batteries, also sometimes referred to as “spent lead-acid batteries” or “used lead-acid batteries”. It is primarily intended for use by collectors of waste lead-acid batteries, transporters and operators of facilities that store, recycle or otherwise dispose waste lead-acid batteries.

This fact sheet should be read in conjunction with the **Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries,** previously developed under the Basel Convention(1).

Classification

The classification of waste lead-acid batteries according to Annexes I, III, VIII and IX of the Basel Convention is presented in Table 1.

Collection and storage at collection points

Waste lead-acid batteries should be collected with proper care, in order to avoid adverse health effects and environmental contamination.

Batteries should be stored whole at collection points and should not be drained, dismantled or broken to remove lead plates or electrolyte. Draining should be handled at licensed, permitted or authorised dismantlers or smelters, who have proper procedures in place to collect and manage the acid.

The storage area should be located away from heat sources, be sheltered and well ventilated, and have an impermeable surface with sufficient curbing/bunding, including a collection sump, to contain any spills. The storage area should also have restricted access and be identified with the appropriate corrosive warning sign(1).

Source: http://www.ppesrl.eu/

Figure 1. Collection container

Waste lead-acid batteries should be stored inside acid-resistant containers or placed on pallets. Where possible the collection container should be used as the transport container to minimize the risk of accidental spillage(1).Waste lead-acid batteries should be stacked in an upright orientation with all the vent and inspection caps firmly in place. If caps are missing, they should be replaced; if replacement is not possible, vent holes should be sealed with foam. To prevent short circuits, terminals should be protected with tape or other insulating material (e.g. cardboard, waffleboard).

Spill control equipment should be available to

Waste categories	Y-code of Annex I	H-code of Annex 3	A-code of Annex VIII (or B-code of Annex IX if applicable):	UN Shipping name, number, class
Waste lead-acid batteries	Y31,Y34	H8, H11, H12, H13	A1160	Waste Battery, Wet, Filled with Acid, UN2794, Class 8 -or- Waste Battery, Wet, Non-spillable, UN2800, Class 8
Waste lead-acid batteries, drained	Y31	H11, H12, H13	A1160	Environmentally Hazardous Substances, Solid, N.O.S., UN3077, Class 9
Waste battery electrolyte	Y34	H8	A4090	Waste Battery Fluid, Acid, UN2796, Class 8

H8=Corrosives; H11=Toxic (delayed or chronic); H12=Ecotoxic; H13=Capable, by any means, after disposal of yielding another material which possesses any of the hazardous characteristics listed in Annex III

Table 1. Classification of waste lead-acid batteries

neutralise any electrolyte release, including, at a minimum, neutralizer (e.g. soda ash, sodium bicarbonate or lime), absorbent (e.g., sand, inert material or vermiculite), shovel or scoop, and polyethylene disposal bags. Personnel should wear **appropriate personal protective equipment (PPE)**, including acid-resistant clothing, safety footwear, gloves, face and eye protection. Safety data sheets should be readily available to all workers.

Waste lead-acid batteries should be stored at **collection points** solely for the purpose of accumulating a sufficient quantity for cost effective transportation to the recycling facility. Collection points should not store a large number of waste lead-acid batteries, or for long periods of time, as this increases the risk of accidental spills or leakage of electrolyte(1). The collection point may be required to be **licensed or permitted** as a hazardous waste storage facility under national law.

Collectors should not sell their batteries to unlicensed lead smelters(1).

Packaging

Prior to packaging, waste lead-acid batteries should be inspected for damage; this should be done while wearing the appropriate PPE (i.e. acid-resistant clothing or plastic apron, safety footwear, gloves, eye protection).

Depending on the type of waste lead-acid batteries, different packaging requirements apply(2,3,4,5). Batteries (except for non-spillable stationary cells) should be kept upright at all times, and batteries with terminals on the side must be stacked so the posts are facing away from each other. Waste lead-acid batteries should generally be stacked up to a height not more than 1.5 times the load width(6). Automotive and small sealed standby (stationary) batteries should be stacked not more than 3 layers high on pallets(2,3), with the largest on the bottom. Large sealed standby batteries should only be stacked up to a maximum of 2 layers(2). Forklift (motive) battery cells and large flooded standby batteries should not be stacked higher than one layer(2,4,5).The weight capacity of the pallet must be adequate for the load(2); it should be constructed with a minimum of three bottom runners(6). Thick corrugated cardboard should be placed on pallets and between each layer of waste lead-acid batteries (as well as on the top layer) to prevent them from sliding off, to minimise the potential for short circuit and to prevent protruding battery terminals from puncturing other battery cases. Waste lead-acid batteries should be secured to the pallet with clear stretch wrap. The pallet should be wrapped as many times as necessary to stabilize the load, and strapped under tension with plastic tape on all four sides. Waste lead acid batteries should not be packaged with waste non-lead-acid batteries.

Waste lead-acid batteries that are damaged and have the potential for leakage should either be transported in compatible (e.g. polyethylene) salvage drums/packaging, or repaired and/or packaged in such a manner that leakage of electrolyte is not likely to occur under normal conditions of transportation. Drainage of electrolyte as a means to eliminate the potential for leakage during transportation should be avoided. Damaged batteries that are not visibly leaking may be packaged separately in heavy weight polyethylene plastic bags (minimum 0.15 mm thick), closed securely with an adjustable plastic tie and placed in the middle of the top layer of stacked batteries(6).

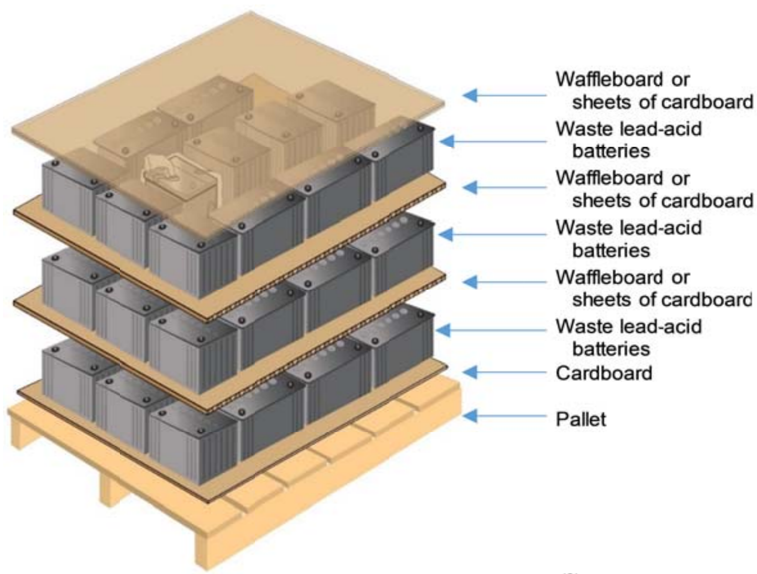

Figure 2. Stacking Waste Lead-Acid Batteries on Pallets(3)

Transport

Transport should be carried out by a licensed,

Source: http://batterycouncil.org/?Transportation

Figure 3. Damaged batteries that are not visibly leaking electrolyte must be put in heavyweight polyethylene plastic bags

permitted or otherwise authorised carrier, according to the applicable laws and regulations. The United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations[7] contains provisions for the packing, marking, labelling and placarding of dangerous goods, which may be considered in cases where there is no specific legislation. Transport vehicles should have visible Class 8 (corrosive) placards identifying the contents.

Source: http://batterycouncil.org/?Transportation

Figure 5. Securing pallets to prevent shifting of the load during transport

When transporting waste lead-acid batteries, routes should be chosen so as to minimise the impact of a potential spill[6]; routes should avoid heavily populated or congested areas, and sensitive environmental areas.

Containers and pallets must be properly blocked, braced, or otherwise secured in the trailer to prevent shifting of the load during transport.

Emergency response information (e.g. European

Source: http://batterycouncil.org/?Transportation

Figure 4. Batteries secured to the pallet with stretch wrap

Chemical Industry Council's ERICards) and hazardous waste tracking documents, as required by national law, should accompany each shipment of waste batteries. National legislation may require that such documents be retained for a certain period. Vehicles should be outfitted with the equipment necessary to neutralize small spillages (e.g. acid neutralizer or absorbent, nitrile gloves, polyethylene apron, shoe covers, safety goggles, scoops, disposal bags and ties, and labels). Transporters should be trained in emergency procedures; in the event of a spill, the transporters should contain the release and notify local emergency authorities.

Transboundary Movement

Transboundary movements of waste lead-acid batteries 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, waste lead-acid batteries may be subject to additional restrictions and control procedures in certain countries.

Environmentally Sound Waste Management

Waste lead-acid batteries should only be recycled in facilities that are properly licensed, permitted or authorised, and that practise environmentally sound management (ESM). A facility-wide Environmental Health and Safety Management System should be implemented[6].

Non-lead-acid batteries should be identified and segregated to ensure they do not enter the smelter[1,6].

To **prevent contamination of soil and groundwater** from battery storage, crushing, screening and classifying operations, acid-resistant flooring with a spill collection system should be used. To **prevent or**

reduce diffuse emissions from battery crushing, screening, and classifying operations, enclosed equipment with a gas extraction system should be used.

To **recover the sulfuric acid**, one or a combination of the following techniques should be used: as pickling agent or raw material in a chemical plant, regeneration by cracking, production of gypsum and/or sodium sulphate.

At the recycling facility the acidic spent electrolyte is generally neutralized (pH adjusted), often with magnesium hydroxide ($Mg(OH)_2$), to precipitate out contaminants in the form of a filter cake. The pH adjustment reaction is exothermic (produces heat) and therefore the best practice is for this process to occur in fiberglass tanks, rather than polyethylene tanks. This neutralization process produces a sulfate filter cake, which, depending on the results of leachate testing carried out at a certified laboratory, is either landfilled as a non-hazardous waste or is sent for further treatment as a hazardous waste.

Materials that cannot be recycled should be properly disposed of in accordance with the waste management hierarchy (e.g. prioritise incineration with energy recovery over landfilling).

Work practices to minimise workers' and the surrounding community's exposure to lead should be applied, including the following: do not smoke; segregate work and eating areas; keep eating area clean; wash hands before eating; shower daily at the end of the workday, before going home; change workwear (change out of work clothes before going home); change and launder workwear daily; check and clean respirators daily; wear respirators; wear work clothes; install mechanical controls to reduce employee exposure to lead dust in air; keep homes, vehicles, and personal property clean(6).

Extended Producer Responsibility

There are a number of countries that have implemented extended producer responsibility (EPR) schemes covering waste lead-acid batteries. See the reference section for examples of existing EPR schemes(9). All waste should be managed according to ESM practices, whether or not it falls under an EPR scheme.

Capacity and Feasibility

The International Lead and Zinc Study Group publishes an online mine and smelter database, the latest of which lists a total of 275 primary and secondary lead smelters (spread over 66 countries)(10). Additional information on facilities authorized, permitted or registered to operate in the territories of the Parties to the Basel Convention can be found in the Convention's online reporting database(11).

Certification and Auditing Systems

Environmental management systems (EMS) can help organisations identify and manage their environmental impacts as well as compliance with environmental legislation. Collectors 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 waste lead-acid batteries. 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 if properly designed and implemented. General guidelines and recommendations to help small and medium-sized businesses develop an EMS have been published by the European Environment Agency(12), the U.S. Environmental Protection Agency(13), and the Bureau of International Recycling(14), among others.

References

(1) Technical Guidelines for the Environmentally Sound Management of Waste Lead-acid Batteries (2003). http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

(2) Australian Battery Recycling Initiative (2013) Packaging Standard for Used Lead Acid Batteries (ULAB). http://www.batteryrecycling.org.au/wp-content/uploads/2013/11/ULAB-packaging-standard-2013-final2.pdf

(3) Battery Council International (2010) Stacking and Wrapping Used Batteries on Pallets. http://batterycouncil.org/?Transportation

(4) Battery Council International (2010) Packaging and Securing Used Stationary Batteries/Cells. http://batterycouncil.org/?Transportation

(5) Battery Council International (2010) Packaging and Securing Used Motive Batteries/Cells. http://batterycouncil.org/?Transportation

(6) Commission for Environmental Cooperation (2016) Environmentally Sound Management of Spent Lead-acid Batteries in North America. http://www3.cec.org/islandora/en/item/11665-environmentally-sound-management-spent-lead-acid-batteries-in-north-america

(7) United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations. http://www.unece.org/?id=3598

(8) Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices Relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants. http://chm.pops.int/Implementation/BATBEP/BATBEPGuidelinesArticle5/tabid/187/Default.aspx

(9) For further information on extended producer responsibility see:

- Canadian Battery Association, http://www.canadianbatteryassociation.ca
- Australian Battery Recycling Initiative, http://www.batteryrecycling.org.au/home
- BlyBatteriRetur, http://blybatteriretur.se/english/
- OECD, http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

(10) International Lead and Zinc Study Group. Mine and Lead Smelter Database. http://www.ilzsg.org/

(11) Online Reporting Database, Basel Convention. http://www.basel.int/Countries/NationalReporting/ReportingDatabase/tabid/1494/Default.aspx

(12) European Environment Agency (1998) Environmental Management Tools for SMEs: A Handbook. http://www.eea.europa.eu/publications/GH-14-98-065-EN-C

(13) U.S. Environmental Protection Agency Environmental Management Systems (EMS) https://www.epa.gov/ems

(14) Bureau of International Recycling (2006) Tools for Environmentally Sound Management for an ISO compliant Environmental Management System that includes OECD Core Performance Elements for the World’s Recycling Industries http://www.bir.org/publications/esm-tools/

WASTE OILS

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 ESM of waste oils, also sometimes referred to as "used oils" or "spent oils". It is primarily intended for those involved in the collection and management of waste oils.

This fact sheet should be read in conjunction with the **Technical Guidelines on Waste Oils from Petroleum Origins and Sources (Y8)**, and the **Technical Guidelines on Used Oil Re-Refining or Other Re-Uses of Previously Used Oil (R9)**, developed under the Basel Convention(1,2).

Classification

Waste oil belongs to category Y8 in Annex I of the Basel Convention, and is further classified as A3020 in Annex VIII.

Waste oils are generally considered to possess hazard characteristics H11, H12 and H13 in Annex III. Waste oil commonly contains carcinogenic polycyclic aromatic hydrocarbons (PAHs); used motor oil, in particular, also contains heavy metals from certain additives and metal particles from engine wear.

It is worth noting that for the environmentally sound management of waste oil containing or contaminated with PCB, technical guidelines have been developed under the Basel Convention which in particular address waste oil with a PCB concentration above 50mg/kg[1](30,31). Some countries have established stricter provisions. Chlorinated compounds can lead to corrosion of equipment and present a health hazard when incompletely combusted(9, 10, 11).

Collection

A first step to implementing an effective collection system is undertaking a detailed assessment of existing collection practices and conditions (infrastructure, costs, legal framework, etc.). A situation and gap analysis could be used to help identify strengths and areas for improvement. Establishing clear goals and objectives (e.g. to increase the collection of waste oil; to promote investments in collection and processing infrastructure) aimed at solving these problems can help guide the subsequent planning process, and quantitative targets can be used to measure whether objectives have been met(3,4,5).

Policy instruments: An appropriate mix of policy instruments (regulatory, economic and information-based measures) should be adopted, taking into account the political, social, economic, legal and cultural context (e.g. existence of informal collectors)(3). Voluntary industry measures (e.g. take-back programmes) may be part of policy solutions(7).

Regulatory instruments refer to direct government regulations such as technology mandates and performance standards. A basic feature of any regulatory framework is authorisation of related activities to ensure an environmentally sound operation, operators are known and report to the government on quantities handled. To make it easier for small-scale collectors to comply, a simplified licensing process could be applied to collectors under a certain threshold size.

Economic instruments may be used to encourage desirable behaviour (e.g. through subsidies) or to discourage undesirable behaviour (e.g. through taxes or charges), to guide actions towards sustainable production and consumption(6). When planning economic instruments, the market realities should be carefully considered(3). For economic instruments to work effectively, regulations need to be clear and the compliance enforcement capacity adequate(3). Economic instruments could include: product taxes; advance recycling fees; subsidies; tax differentiation; extended producer responsibility; deposit/refund schemes; green public procurement (giving preference to lubricants that do not contain certain hazardous substances).

> Approximately 40 to 50% of the lubricants sold are consumed or lost during use; the remaining 60 to 50% of the oil is potentially recoverable(12).

Information-based policy instruments aim to raise the awareness by providing information e.g. practical guidelines for the environmentally sound storage, collection, transport, recycling and final disposal of waste oil could be developed. The awareness of the stakeholders should be raised about the risks of inappropriate disposal of waste oils, good management practices, the value of waste oil if not mixed with other fluids, collection options, and penalties for non-compliance with regulations(3).

[1] Provisional low POP content level established under the Stockholm and Basel Conventions above which destruction or irreversible transformation of the persistent organic pollutant content is required.

Source:http://www.ci.sauk-rapids.mn.us/

Figure 1. Public used oil and filter drop site at the City of Sauk Rapids, U.S.A.

Methods for collection

The more convenient and accessible the collection system, the more waste oil will be returned for recovery. Waste oil can be collected by commercial, private collectors and/or recyclers directly from the "point-of-generation" or it can be taken by the user to a drop-off location (e.g., retail stores, service stations, recycling centres, oil banks). Collecting used oil from non-industrial sources and local/small generators is very difficult and requires a well-established and efficient infrastructure to accomplish the task[2,8].

In general, drop-off programmes consist of permanent tanks located at publicly accessible locations. The oil brought to these sites is poured into the tanks for later collection by a licensed hauler. Proper drop-off site management should include used oil acceptance protocols for contamination prevention. The use of a (handheld) halogen detector is suggested. As an extra precaution against contamination, some programmes require users to sign a log when they drop off their waste oil[13].

Kerbside programmes generally allow residents to set used motor oil in sealed, non-breakable containers at the kerbside next to regularly collected garbage or recyclables. The waste oil obtained on the collection route is typically transferred to an intermediate holding tank at a central location, where it is tested for contamination before being transferred to a large aggregation tank for later collection, transportation, and processing.

Storage

Storage of waste oil above certain threshold quantities should require a licence, permit or authorisation. Tanks and containers should be under regular inspection and maintenance to keep them in good condition. Secondary containment systems for single storage tanks should have a volumetric capacity of not less than 110% of the tank volume. In cases where there is more than one tank within the bund, some environmental authorities require that the capacity should be at least sufficient to accommodate 110% of the largest tank's maximum capacity or 25% of the total maximum capacities of all tanks, whichever is greater[14,15].

Mixing waste oils with different characteristics, other wastes or substances should be prohibited in order not to compromise downstream treatment processes or prevent recovery; and stipulating allowable limit contents of chlorine and polychlorinated biphenyls (PCBs)[8].

Transport

Transport of more than a certain amount of waste oil in a given year should require a licence, permit or authorisation.

The United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations contains provisions for the packing, marking, labelling and placarding of dangerous goods, which may be considered in cases where there is no specific legislation. Wastes not otherwise subject to these Regulations but covered under the Basel Convention may be transported under Class 9[16]. Waste oil that does not meet the classification criteria of any other class (i.e., good practices were followed to prevent contamination) would be classified as Class 9, UN 3082, waste environmentally hazardous substance, liquid, N.O.S.

Emergency response information (e.g., European Chemical Industry Council's ERICards) and hazardous waste tracking documents should be available with each shipment of waste oil (hard copy or electronic). In the event of a spill, the transporters should be required to contain the release and notify local emergency authorities.

Transboundary Movement

Transboundary movements of waste oils 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, waste oils may be subject to additional restrictions and control procedures in certain countries.

Environmentally Sound Waste Management

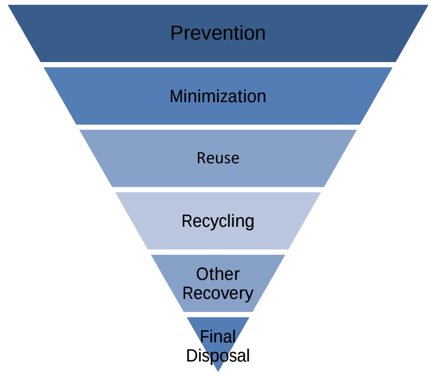

Figure 2. Waste management hierarchy

Waste oils should only be treated in facilities that are properly licensed, permitted or authorised, and that practise environmentally sound management (ESM).

Waste oils should be managed in accordance with the waste hierarchy, as shown in Figure 2, and preference should be given to options that deliver the best overall environmental outcome. Priority should be given to recycling and energy recovery over final disposal. The main disposal options for waste oils are recovery for use as fuel (including thermal cracking) and regeneration (re-refining) to base oil(2,13,17). Regeneration of waste oils and their use as fuel has comparable environmental impacts, therefore, a generic priority for any kind of regeneration technology is not necessarily compatible with the prioritisation of environmentally preferable technologies(18). If the policy objective is to minimise the risk of environmental damage, rather than preferring any one recycling route over another, the priority should be maximising the collection of the recoverable proportion of lubricants(12).

The regeneration of waste oil should achieve a yield higher than 60-65%(19,20) on a dry basis. Waste oils suitable for regeneration must have a low content of PCDD/PCDF, PCBs and chlorinated additives. The admitted POP content may, according to national legislation or guidance, need to be lower than the provisional low POP content level established under the Stockholm and Basel Conventions.

It has been recommended that the following be preferred for regeneration: engine oils without chlorine; hydraulic oils without chlorine; and non-chlorinated mineral diathermic oils(21). Thermal oxidation should be used to reduce VOC emissions(20). The base oil produced can be certified as meeting certain performance standards (i.e., certification that it meets the same high quality standards as oils from crude) to enhance its market acceptance(13). To implement regeneration as a priority, some form of subsidy may be necessary because intrinsic market forces are not sufficient to stimulate priority for regeneration(18).

The use of waste oil as fuel is generally done via two different routes, namely, direct burning without any pre-treatment or burning after some degree of pre-treatment. In all applications, emissions to air and the disposal of residual wastes should be considered carefully to ensure they are not harmful to human health and the environment. A quality assurance system should be in place to guarantee the characteristics of the waste fuel produced (e.g., measurement of the chlorine content to prevent the introduction of PCB-contaminated waste oils)(20). Performance standards can be set for waste oils that are used as fuel to ensure that the proposed use does not result in equipment failures (e.g., erosion-corrosion) or in higher emissions(3). Waste oil specifications can be used to describe the quality, or specify the maximum levels of particular contaminants, in waste oil (e.g., U.S. "used oil specifications" in Table 1, see also (11)). Such specifications provide a high degree of certainty (i.e., if there is certainty over what goes into a burner, and the burner is operated and maintained correctly, the operator can be fairly sure of the content of the emissions). Properly controlled co-processing of waste oils in cement kilns can provide a practical, cost-effective and environmentally sound recovery option(23). Open burning of waste is listed as an inadvertent source of persistent organic pollutants in Annex C, Part III of the Stockholm Convention, and it should be prohibited(3,21). Open burning can also include incineration devices that do not control the combustion air to maintain an adequate temperature and do not provide sufficient residence time for

Constituent/Property	Allowable Level
Arsenic	5 ppm maximum
Cadmium	2 ppm maximum
Chromium	10 ppm maximum
Lead	100 ppm maximum
Flash Point	100 °F (~37,7°C) minimum
Total Halogens	4000 ppm maximum
PCBs	Less than 0.2 ppm

Table 1. U.S. waste oil specifications for energy recovery(22)

Waste oil that is not mixed or contaminated with hazardous waste and meets all specification levels, otherwise known as "on-specification used oil", is not subject to any restrictions when burned for energy recovery. In fact, "on-specification used oil" is comparable to product fuel in terms of regulations. "Off-specification used oil" may also be burned for energy recovery, but it is strictly regulated.

Environmentally sound management (ESM) of hazardous wastes or others wastes (as defined in the 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.

complete combustion.

In some developing countries and in particular in rural areas, waste oils are being used for domestic uses including: polishing of new floors; animal skin treatment against ticks; use as herbicides to kill weeds; use for rust treatment; suppressing of dust on floors or roads; waterproofing and treatment of termites within wooden fences and gates posts. These uses are largely inappropriate from an environmental perspective and should be discouraged[(3)].

Extended Producer Responsibility

Extended producer responsibility (EPR) extends a producer's responsibility for a product to the post-consumer stage of its life cycle. There are a number of countries that have implemented EPR schemes covering waste oil; see reference section for examples of existing schemes[(24,25,26)].

Certification and Auditing Systems

Environmental management systems (EMS) can help organisations identify and manage their environmental impacts as well as compliance with environmental legislation. Facilities 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 waste lead-acid batteries. 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 if properly designed and implemented.

General guidelines and recommendations to help small and medium-sized businesses develop an EMS have been published by the European Environment Agency[(27)], the U.S. Environmental Protection Agency[(28)], and the Bureau of International Recycling[(29)], among others.

References

(1) Technical Guidelines on Waste Oils from Petroleum Origins and Sources (1994). http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

(2) Technical Guidelines on Used Oil Re-Refining or Other Re-Uses of Previously Used Oil (1995). http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

(3) Africa Institute (2013) Regional Policy Guidelines: Economic Instruments for the Environmentally Sound Management of Waste Oil. http://africainstitute.info/download/regional-policy-guidelines-for-waste-oil/

(4) U.S. Environmental Protection Agency (1989) How to Setup a Local Program to Recycle Used Oil (EPA-530-SW-89-039A). http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=100019FN.TXT

(5) UNEP- IETC (2013) Guidelines for National Waste Management Strategies. Moving from Challenges to Opportunities. http://cwm.unitar.org/publications/publications/cw/wm/UNEP_UNITAR_NWMS_English.pdf

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(8) Speight, J.G. and Exall, D.I. (2014) Refining Used Lubricating Oils. CRC Press, Taylor & Francis Group, Boca Raton, Florida.

(9) European Commission (2001) Critical Review of Existing Studies and Life Cycle Analysis on the Regeneration and Incineration of Waste Oils. Final Report. http://ec.europa.eu/environment/waste/studies/waste_oil.htm

(10) As an example, in Netherlands, the maximum permissible organohalogen and PCB content in waste oil that is intended for regeneration (re-refining) is set at 1000 mg/kg (calculated as chlorine) and 0.5 mg/kg per congener (PCB-28, 52, 101, 118, 138, 153 or 180), respectively; waste oils with higher organohalogen levels can only be used for energy recovery, provided the PCB concentration remains below 0.5 mg/kg per congener.

Ministry of Infrastructure and the Environment (2014), National Wastes Management Plan 2009-2021, Appendix 6. http://www.lap2.nl/sectorplannen/ (available only in Dutch)

(11) In Germany, waste oils with concentrations of PCB in excess of 20 mg/kg or a total halogen content of more than 2000 mg/kg cannot be regenerated according to the German waste oil ordinance.

http://www.gesetze-im-internet.de/alt_lv/ (available only in German)

(12) OECD (2006) Improving Recycling Markets. http://www.oecdbookshop.org/browse.asp?pid=title-detail&lang=en&ds=&ISB=9264029575

(13) UNEP-IETC (2012) Compendium of Recycling and Destruction Technologies for Waste Oils. http://apps.unep.org/publications/index.php?option=com_pub&task=download&file=010731_en

(14) New Zealand Environmental Protection Authority (2012) Secondary Containment Systems (HSNOCOP 47).

http://www.epa.govt.nz/Publications/HSNOCOP%2047.pdf

(15) EPA South Australia (2012) Bunding and Spill Management. http://www.epa.sa.gov.au/files/47717_guide_bunding.pdf

(16) United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations. http://www.unece.org/?id=3598

(17) ICS-UNIDO (2003) Compendium of Used Oil Regeneration Technologies. https://institute.unido.org/wp-content/uploads/2014/11/95.-Compendium-of-Used-Oil-Regeneration-Technologies.pdf

(18) European Commission (2005) Commission Staff Working Document - Annex to the Proposal for a Directive of the European Parliament and of the Council on Waste and Communication from the Commission Taking Sustainable Use of Resources Forward : A Thematic Strategy on the Prevention and Recycling of Waste - Impact Assessment on the Thematic Strategy on the Prevention and Recycling of Waste and the Immediate Implementing Measures {COM(2005) 666 final} {COM(2005) 667 final} http://eur-lex.europa.eu/legal-content/EN/NOT/?uri=CELEX:52005SC1681

(19) UNEP Mediterranean Action Plan (2015) Regional Meeting to Review the Used Lube Oil ESM Guidelines and Best Practices Towards Sustainable Tannery Sector in the Mediterranean. Barcelona, 22-24 July 2015 (UNEP(DEPI)/MED WG.419/3)

(20) European Commission (2006) Reference Document on Best Available Techniques for the Waste Treatments Industries. http://eippcb.jrc.ec.europa.eu/reference/

(21) Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices Relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants. http://chm.pops.int/Implementation/BATBEP/BATBEPGuidelinesArticle5/tabid/187/Default.aspx

(22) Title 40 of the Code of Federal Regulations (CFR) Part 279, Standards for the Management of Used Oil. http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr279_main_02.tpl

(23) Technical Guidelines on the Environmentally Sound Co-processing of Hazardous Wastes in Cement Kilns. http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

(24) European Commission (2014) Development of Guidance on Extended Producer Responsibility (EPR). Final Report. http://ec.europa.eu/environment/archives/waste/eu_guidance/index.html

(25) In the European Union, waste oils are mostly managed through EPR schemes where the responsibility of waste management is left to municipalities and the financial responsibility is left to producers. The role of Producer Responsibility Organisations (PROs) is mainly data aggregation, both from producers and waste operators. Whenever costs are not covered by the secondary oil market value, PROs reimburse collection costs based on a declaration presented by licensed operators [(24)].

(26) For further information on extended producer responsibility see:

- UOMA, http://usedoilrecycling.com/
- California Used Oil Recycling Program, http://www.calrecycle.ca.gov/usedoil/Recycle.htm
- Australian Product Stewardship for Oil Program, http://www.environment.gov.au/protection/used-oil-recycling/product-stewardship-oil-program
- Ecopneus, http://www.ecopneus.it/
- The Rose Foundation, http://www.rosefoundation.org.za/
- OECD, http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm
- Environmental Permitting (England and Wales) Regulations 2010

(27) Environmental management Tools for SMEs: A Handbook. http://www.eea.europa.eu/publications/GH-14-98-065-EN-C

(28) U.S. Environmental Protection Agency Environmental Management Systems (EMS). https://www.epa.gov/ems

(29) Bureau of International Recycling (2006) Tools for Environmentally Sound Management for an ISO compliant Environmentally Management System that includes OECD Core Performance Elements for the World's Recycling Industries. http://www.bir.org/publications/esm-tools/

(30) Updated general technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants [was adopted by the thirteenth meeting of the Conference of the Parties (BC-13/...). http://www.[...]]

(31) Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with polychlorinated biphenyls, polychlorinated terphenyls, polychlorinated naphthalenes or polybrominated biphenyls including hexabromobiphenyl [was adopted by the thirteenth meeting of the Conference of the Parties (BC-13/...). http://www.[...]]

WASTE PNEUMATIC TYRES

This factsheet is part of a series of fact sheets to support the implementation of the environmentally sound management 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 waste pneumatic tyres (hereafter “waste tyres”), also sometimes referred to as “end-of-life tyres” or “scrap tyres”. It is primarily intended for use by waste tyre transporters, collectors, and operators of facilities that store, recycle or otherwise dispose of waste tyres.

This fact sheet should be read in conjunction with the **Revised Technical Guidelines for the Environmentally Sound Management of Used and Waste Pneumatic Tyres**, developed under the Basel Convention[1].

Source: https://www.aliapur.fr/fr

Classification

Waste tyres are considered non-hazardous waste and are classified under entry B3140 of Annex IX to the Basel Convention. Tyres cannot be identified under any category of waste streams in the first part of Annex I (categories Y1-Y18), but waste tyres contain some constituents listed in Annex I to the Convention, namely copper, zinc, cadmium and lead compounds, stearic acid and halobutyl (under entries Y22, Y23, Y26, Y31, Y34 and Y45, respectively)[1]. These are however usually not present to an extent causing waste tyres to exhibit an Annex III hazardous characteristic.

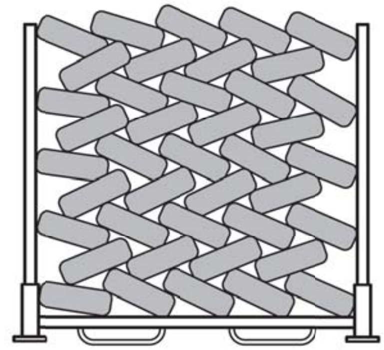

Figure 1. Typical laced storage[3,4]

Storage

Waste tyres can be stored temporarily in outdoor piles in an orderly manner. Tyre storage should preferably be on a level area of concrete or hard packed clay. Tyres should not be stored on wetlands, flood plains, ravines, canyons or steeply graded surfaces, nor should piles be located beneath power lines[2,3,4].

The storage capacity should allow the accumulation of a truckload of tyres for optimum hauling efficiency plus a limited additional scheduling buffer[5] and storage periods limited to the shortest time possible[1]. Moreover, depending on national law and practice, storage of waste tyres above certain threshold quantities may need to be licensed, permitted or authorised. Storage facilities should maintain daily operating records including the numbers of tyres received and removed from the site and its access should be

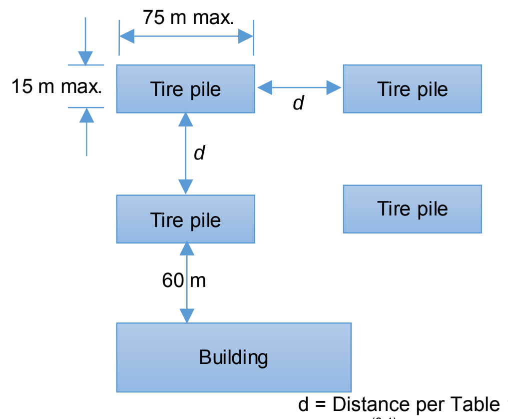

Figure 2. Pile geometry and spacing[3,4]

controlled through the use of fences or other means.

Maximum height of outdoor piles should be 6 m, maximum pile width should be 15 m, and maximum

Exposed face dimension (m)	Pile eight (m)					
	2.4	3.0	3.7	4.3	4.9	5.5
7.6	17.1	18.9	20.4	22.3	23.5	25
15.2	22.9	25.6	28.3	30.5	32.6	34.4
≥ 30	30.5	35.4	39	41.8	44.5	47.2

Table 1. Representative minimum exposure separation distances, in metres[1,2,3,4]

length should be 75 m[1,2,3,4], or as otherwise required by local fire codes. Minimum separation distances between adjacent piles should be observed in accordance with Table 1 and Figure 2. These are also are also recommended between tyre piles and buildings.

Suitable firebreaks of at least 18 m should be maintained to reduce the spread of a fire. Appropriate fire safety practices should be put in place and strictly adhered to, taking precautions to assure ignition sources are not present (e.g. prohibition of open burning, smoking and operation of cutting devices). A water system should be provided to supply a minimum of 3780 L/min for piles less than 1416 m^3, or 7560 L/min for larger piles for a duration of 6 hours[1,3,4]. Indoor storage of waste tyres may require an automatic sprinkler system, fire walls or column fireproofing depending upon the number of tyres to be stored. Facilities should be constructed to provide protection to bodies of water from runoff of pyrolytic oil resulting from a potential fire. Facilities should also have communication capabilities to immediately summon fire, police, or other emergency service personnel in the event of an emergency.

When stored improperly, waste tyres can harbour mosquitoes which may spread yellow fever, dengue fever or Zika virus, among other diseases. To prevent breeding and habitation of these and other vectors, conformance with a vector control plan which has been approved by the local vector control authority or health department should be instituted (e.g. chemical control of *Aedesaegypti* mosquitoes can include application of larvicides as part of a routine control strategy[6]), unless the piles are covered with impermeable barriers other than soil to prevent entry or accumulation of precipitation[7]. In addition, waste tyres received for storage should be drained of water within 24 hours of receipt.

Covering the waste tyres may also be required to reduce the potential for leachate generation and avoid possible contamination of soil, surface water and ground water[1]. To minimise the amount of water runoff from the tyre piles a suitable storm water collection system should be installed.

Collection and Transport

Waste tyres should be handled so as not to create a nuisance, a fire hazard, or a hazard to public health or safety.

Careful consideration should be given to travel distance, volume and frequency of tyre collection, and loading techniques to determine optimal equipment usage. Waste tyres can be collected on scheduled intervals or an as-needed basis. For improved transportation efficiency a trailer or other suitable container can be used to facilitate accumulation of tyres and collection can be requested when the trailer is full. Transportation of whole waste tyres depends heavily on the proper lacing of the tyres into the trailer; the more uniform the type of waste tyre the greater the volume of waste tyres that can be loaded into the trailer[5].

Once collected, waste tyres should be sorted so that those suitable for direct reuse and those suitable for reuse following retreading are separated from those that have to be otherwise disposed of[1]. It is noted that also used tyres (that are not waste) may undergo retreading.

Carriers should maintain records of waste tyres transported. Depending on national law and practice, the transportation of waste tyres above a certain threshold quantity may need to be licensed, permitted or otherwise authorised.

Transboundary Movement

Transboundary movements of waste tyres are not subject to the Basel Convention control procedure. To prevent the accidental introduction of invasive mosquitoes, which may be transported with waste tyres in various stages of development, some countries have adopted measures to restrict waste tyre imports (e.g. Chile, Argentina).

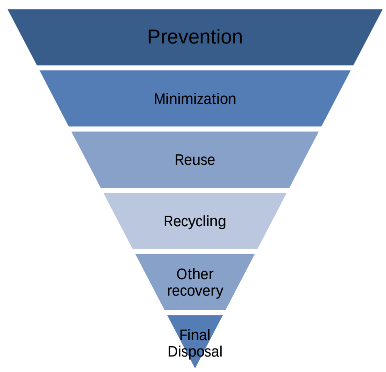

Figure 3. Waste management hierarchy

Environmentally Sound Waste Management

Waste tyres should only be disposed of in facilities that are properly licensed, permitted or authorised, and that practise environmentally sound management (ESM). Uncontrolled burning of waste tyres does not constitute ESM.

> Environmentally sound management (ESM) of hazardous wastes or other wastes, as defined in the 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.

Waste tyre management should be viewed in the context of the waste hierarchy, as shown in Figure 3. The waste hierarchy accords priority to waste prevention (e.g. appropriate tyre maintenance) and reuse (e.g. direct reuse of partly worn tyres), followed by recycling and then energy recovery in preference to final disposal (landfilling). To encourage higher rates of recycling and recovery a number of countries have enacted bans on the landfilling of waste tyres (excluding tyres used as engineering material).

Retreading is placed higher on the waste hierarchy than recycling and other recovery operations because it extends the useful life of the tyre(1). Retreading is a preferred option provided that the casings are of good quality and meet applicable safety standards.

Recycling generally involves cutting, shredding, chipping and grinding—ambient and cryogenic size reduction are the most common technologies—to produce various categories of tyre materials, ranging from large cuts greater than 300 mm, which include all the steel and textile components of the original casings, down to fine rubber powders (below 500 µm), which can be virtually free of those components(8, 16). These tyre materials can be used directly or further processed to modify one or more characteristics by means of treatments such as rubber reclaim and de-vulcanisation. Even though general application practice suggests that there is a low likelihood of leaching from unbound tyre-derived materials, where shredded or crumbed materials are to be applied in the form of loose fill in close proximity to aquatic receptors (including rivers, streams, lakes, ponds and groundwater), the following good practice should be adhered to: materials should not be applied in a way that may potentially cause environmental pollution (e.g. do not spread directly next to watercourses); where practical, all loose tyre-derived materials should be contained by appropriate barrier methods (e.g. lining, kerbing); materials should not be used in areas with very high pH (e.g. pH 8 or above) or very low pH (e.g. pH 5 or below) as there is greater potential for metal/organic mobilisation; materials should not be used for high load bearing applications as their ability to leach chemicals increases; records should be maintained detailing quantities used, application rates, location and date of spreading(9,10). Tyre recycling does not include energy recovery or reprocessing into materials for use as fuels or in backfilling operations(1).

Whole or partially size-reduced tyre-derived rubber materials can be used as an alternative fuel source in energy intensive industries. In addition, when whole tyres are co-processed in cement kilns, the steel belting becomes a component of the clinker, replacing some or all of the iron required by the manufacturing process(11). With the exception of zinc emissions, potential emissions from tyre derived fuel are not expected to be very much different from other conventional fossil fuels(12). However, this needs to be considered on a case by case basis as it is dependent on good operating practice as well as the particular characteristics of the tyres used and the kiln(1).

Piles of tyre-derived rubber materials may be at risk from fire and spontaneous heating(9,13). Accepted practices for mitigating this risk include: minimising pile size; controlling moisture levels; managing stock to prevent piles being left for long periods; monitoring sub-surface temperature; turning piles at risk of spontaneous heating; minimising external heating (e.g. shading from direct sunshine); and controlling ventilation by enclosure if possible(9).

Extended Producer Responsibility

There are a number of countries that have implemented extended producer responsibility (EPR) schemes covering waste tyres. Under EPR, producers take responsibility for the management of waste tyres, for example by creating a Producer Responsibility Organisation (PRO) to achieve EPR goals. See the reference section for examples of existing EPR schemes(14).

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. Collectors 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 waste tyres. 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.

General guidelines and recommendations exist to help small and medium-sized businesses develop EMS(15).

References

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(8) PAS 107:2012 Specification for the Manufacture and Storage of Size Reduced Tyre Materials. http://tyrerecovery.org.uk/specification/pas-107/

(9) Quality Protocol: Tyre-derived rubber materials, End of waste criteria for the production and use of tyre-derived rubber materials https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/321419/LIT_8273.pdf

(10) ASTM 6270/1998 use of scrap tyres in civil engineering applications

(11) Technical Guidelines on the Environmentally Sound Co-Processing of Hazardous Wastes in Cement Kilns. http://www.basel.int/Implementation/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

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(14) For further information on extended producer responsibility see:
- Recytyre http://www.recytyre.be/
- Aliapur https://www.aliapur.fr/
- Ecopneus http://www.ecopneus.it/
- Signus http://www.signus.es/
- Tire Stewardship BC http://www.tsbc.ca/
- OECD http://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm

(15) For further information on environmental management systems see:
- European Environment Agency (1998) Environmental Management Tools for SMEs: A Handbook. http://www.eea.europa.eu/publications/GH-14-98-065-EN-C
- U.S. Environmental Protection Agency Environmental Management Systems (EMS) https://www.epa.gov/ems
- Bureau of International Recycling (2006) Tools for Environmentally Sound Management for an ISO compliant Environmental Management System that includes OECD Core Performance Elements for the World's Recycling Industries http://www.bir.org/publications/esm-tools/

(16) For an example of national experiences in environmentally sound management of tyres, see Resolution 523/2013 on sustainable tyre management (Argentina) http://www.ambiente.gob.ar/?idarticulo=12730