



# Healthcare or Medical Waste

## Basel Convention

on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

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<sup>(1)</sup>.

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<sup>(2)</sup>. 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<sup>(3)</sup>, 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 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<sup>(4)</sup>. 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<sup>(4)</sup>, 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

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maintain segregation of the wastes during transport, storage and disposal. Colour coding also provides a visual indication of the potential risk posed by the waste in that container<sup>(4)</sup>.

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.<sup>(4)</sup>

### 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<sup>(4)</sup>.

#### 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

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<sup>(4)</sup>. 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<sup>(4)</sup>. 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<sup>(4)</sup>. 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



Figure 1. Sharp containers



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

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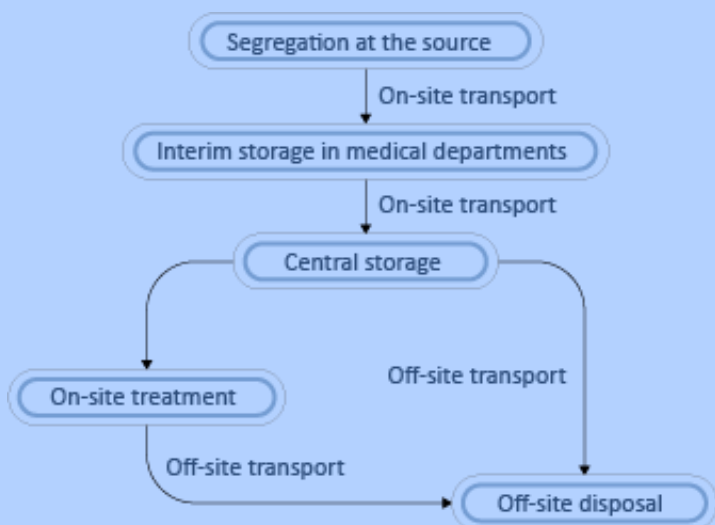


Figure 3. Basic elements of healthcare waste management

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.

### 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<sup>(4)</sup>.

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.

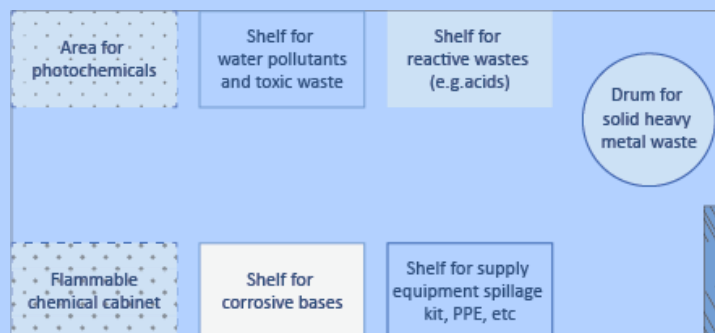


Figure 4. Sample outline of chemical storage room<sup>(4)</sup>

### 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<sup>(3)</sup> is identified for selected wastes in Table 1.



Figure 5. Off-site transport of waste

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WHO-recommended waste segregation categories <sup>(4)</sup>	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 "HIGHLY INFECTIOUS"	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; fetuses; 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.,
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,	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,
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 <sup>(5)</sup> (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**

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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<sup>(4)</sup>. 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<sub>10</sub> reduction or greater, and inactivation of *Geobacillus stearothermophilus* (formerly *Bacillus stearothermophilus*) spores and *Bacillus atrophaeus* (formerly *Bacillus subtilis* var. *niger*) spores at a 4 log<sub>10</sub> 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<sub>10</sub> reduction or greater,

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 national 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<sup>(1)</sup>

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<sup>(1)</sup>

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

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should be achieved<sup>(6)</sup>. For most technologies, except incineration, it should be possible to demonstrate that the process meets disinfection requirements through “validation testing”<sup>(11)</sup>. The ability to achieve required microbial inactivation criteria should be demonstrated under “worst case” load conditions<sup>(6)</sup>. “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<sup>(12)</sup>. 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)<sup>(7)</sup>.

Several options exist for small quantities of 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<sup>(4)</sup>.

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.

#### 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.



Figure 6. Autoclave

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<sup>(8,9)</sup>. The established time-temperature standards should be greater than those identified during testing, to provide a margin of error<sup>(10)</sup>. After the initial tests, regular challenge tests using biological indicators (e.g. *Geobacillus stearothermophilus*), should be performed at periodic intervals<sup>(4,6,11)</sup>. As an added check, colour-changing chemical indicators can be used with each waste load to document that the required temperature has been achieved<sup>(4)</sup>. The temperature within the chamber should be continuously monitored in various locations to detect thermal problems and inconsistencies<sup>(10)</sup>. Autoclave performance should be checked annually using independent thermocouple tests<sup>(6)</sup>.

Record-keeping is a critical component of autoclave maintenance<sup>(10)</sup>.

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

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#### 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<sup>(9)</sup>. Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste and radiological waste should not be treated in a microwave<sup>(4)</sup>. Needles and other sharp metal objects should be in puncture-safe needle containers. Sharps containers should not be hermetically sealed to allow steam penetration<sup>(9)</sup>. 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<sup>(4)</sup>. 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<sup>(1)</sup>.

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<sup>(4)</sup>.

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<sup>(4)</sup>.

#### Incineration

Infectious, sharps and pathological wastes may be treated by incineration using best available techniques (BAT) and best environmental practices (BEP)<sup>(7)</sup>. 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<sub>2</sub>. 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<sup>(4,7)</sup>.

#### 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.



The fact sheet was prepared by the Basel Convention expert working on environmentally sound management and welcomed by the Conference of the Parties in its decision BC-13/2 in 2017. It was slightly edited and formatted for the purpose of this publication.

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