Medical Waste Management for WASH Practitioners

# Incinerators and Sharps Management

This document outlines why proper incinerators are needed for effective waste management in health facilities. Construction of waste management facilities is increasingly the responsibility of WASH practitioners who may be unfamiliar with best practice. This document summarises the key issues to consider and signposts the main guidance available.

## Overview

Few medical waste disposal methods are available, affordable or appropriate in remote areas of low-income countries. Burning in an incinerator often remains the most suitable treatment method for infectious waste, and most Ministries of Health require incinerators at medium-sized facilities. This note recommends the construction of De Montfort Incinerators (Mark 8a) or other recognised high temperature incinerators in such contexts[i]. During emergencies, a temporary volume reducer (converted oil drum) can be used as an interim solution, but this will produce a higher level of toxic gases, heavy smoke and will not effectively decontaminate the waste.

Figure 1: De Montford Incinerator

## Waste Classification and Disposal

Correctly built and operated incinerators effectively control infectious waste and can also manage general waste. Table 1 summarises WHO guidelines for the management of medical waste, including recommendations for classification, collection and disposal. Note that MSF doesn't make a distinction between Infectious and non-infectious General Waste, as it is often difficult to distinguish - they classify both as 'Soft' and incinerate this (always verify the MoH position in country; if this is unclear, adopt the MSF position). Sharps are considered the most hazardous waste generated at health facilities. They are a potential source of tetanus and hepatitis B (which survives several weeks in the ambient environment) and injuries produced by sharps are entry points for other infections (especially when handling highly contaminated dressings, fluids or body parts). Sharps can either be incinerated or disposed of in a sealed pit – options are discussed further below, and Table 2 details the infrastructure required for each. Note that MSF's position is to only dispose of sharps in a pit, limiting the manipulation of needles and risk of injury (direct disposal should be the default practice unless burning is promoted by the MoH). The monitoring of the waste management chain is the responsibility of the MoH (often supported by health actors); however, WASH practitioners should be aware of the correct segregation, storage, treatment and disposal options and ensure programming reflects these protocols.

**Table 1:** Summary of WHO recommended waste classification, collection and disposal methods

| Classification | Definition | Collection | Disposal |
|---|---|---|---|
| Sharps | Needles, scalpels, ampoules, broken glass/vials | Puncture-resistant container marked SHARPS | Direct disposal or burnt[ii] |
| Organic/ Anatomical | Human tissues, organs or fluids; body parts; foetuses | Yellow plastic container with lid (puncture resistant, leak proof) | Disposed daily into placenta pit |
| Hazardous/ Chemical | Waste managed on case by case basis. Follow specific in-country guidelines and advice of specialist | | |
| Infectious (MSF class as Soft) | Waste contaminated with blood and other bodily fluids; cultures and stocks of infectious agents from laboratory | Yellow plastic container with lid (puncture resistant and leak proof) | Burnt at 900 $^{0}$C |
| General Waste (MSF class as Soft and handle as per Infectious waste) | Waste that does not pose any particular biological, chemical or physical hazard (accounts for 85% of facility waste) | Black coloured containers | Recycled/burnt/ buried |

**Table 2:** Waste zone infrastructure required for a) sharps disposed of in sealed pit or b) when sharps are incinerated

| Sharps disposed of directly in Sharps Pit | Sharps incinerated[i] |
|---|---|
| De Montfort Incinerator (for management of infectious waste) | De Montfort Incinerator (for management of infectious waste and sharps containers) |
| Sharps pit (ensure volume matches generation rate). If a high volume of safety boxes are used, consider construction of a volume reducer. | Combined Ash and Sharps pit (a pit of 7.5m$^3$ stores ash from the burning of approximately 300 sharps containers per month over a period of twelve years) |
| Ash pit (for ash from burnt infectious waste) | |
| Glass Vials (intact or broken) can be disposed of in sharps container | Whole Glass Vials cannot be incinerated in sharps boxes (unless already broken); should be disposed of directly into a combined Ash and Sharps pit |
| Pressurised containers, polyvinyl chloride (PVC) plastics (intravenous sets, catheters and PVC containers for sharps), vials of vaccines, mercury thermometers (preferably collect for mercury recovery) will also be disposed of in the Sharps Pit. Note that all pits need to be sealed (water tight) and a minimum of 2 m above the water table to avoid contamination | |
| Placenta/Organic Pit with vent for anatomical waste (vent should be at 2.5 m above ground level) | |
| A waste store to securely accumulate waste to be incinerated, and to store tools, records and protective equipment | |
| An enclosure with a lockable door to prevent access by children and unauthorised persons, scavenging animals and birds | |

## The Problem with Low Quality Incinerators

Safe incinerators need to maintain a temperature above 900ºC and have a gas residence time > 1 second, which significantly reduces the volume of waste (>90%), converting it to incombustible matter. However, incinerators are frequently poorly constructed, use inappropriate materials and are incorrectly operated; the result is incinerators that burn too cold. Typical construction problems include: oversized incinerators, no secondary chamber, cracked brickwork or metal, construction without heat proof cement or blocks. Waste burnt at lower temperatures can result in the following:

- Incinerator produces smoke emissions containing pathogens and hazardous by-products (e.g. fly ash, heavy metals, dioxins, furans[iii])
- Incinerator emits heavy smoke[iv] (rarely acceptable with local residents)
- Incinerators do not completely sterilise waste and produce hazardous ash containing contaminated toxic residuals (leachable metals, dioxins and furans that pollute soil and water)
- Incomplete combustion increases the volume of residue produced

## De Montfort Incinerator Construction

The De Montfort Incinerator is relatively low cost (<$2000) and, built correctly, reaches temperatures above 900ºC. It consists of a double combustion chamber, which increases both the residence time of the (flammable) gases and turbulence, resulting in better combustion. The high temperatures attained ensure full combustion and sterilisation of used needles. The remaining ash and waste material must then be buried. The incinerator needs to be constructed by a skilled technician using refractory bricks (fire proof blocks: weight >4.5 kg per block, $Al_2O_3$ >60%, low iron content), which increase the incinerator's temperature and lifetime, and refractory cement ($Al_2O_3$ content >40%, $SiO_2$ <5%). To ensure quality it is recommended to import refractory bricks and cement; anticipate 3-6 months for this. The cement mortar needs to be thin (2-3mm). The outer bricks can be locally sourced and the incinerator should be

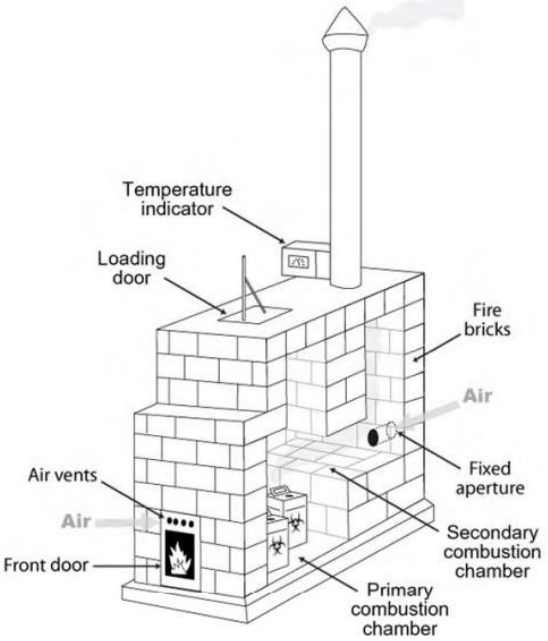


Figure 2: Incinerator Schematic

sheltered. Ideally, the metal components (door and lid) should be machine-made and the paint and rustproofing of the metal needs to be heat proof. Before use, the cement needs to cure for 21 days (7 days in an emergency) and then the incinerator needs to be cured (slowly heated to remove any water in bricks over 1-2 days; if done poorly, this results in cracked brickwork – the process is outlined in MSF, 2012).

### Alternative Incinerator Options

The Humanitarian Innovation Fund is funding a design challenge to develop a low cost incinerator using local materials. The results are not yet available, but should be monitored for an alternative design that uses local materials. In an emergency, an incinerator can be made with local refractory bricks and skimmed inside with refractory cement. In Burkina Faso, ACF have been working with the GWABA incinerator. This is a single chamber incinerator constructed with cement and heat proof additives (see Reference section for further guidance). It burns up to 650°C. It could be considered in locations where importing bricks is challenging.

### De Montfort Incinerator Operation

The resources listed in the References section of this note provide clear instructions on the operation and maintenance of De Montfort incinerators. However, practitioners need to ensure there are effective training protocols and accessible materials available, and support in training, refresher training and monitoring for operators and supervisors. The following is a summary of the key guidelines to respect when operating the incinerator:

- A De Montfort can run almost entirely on infectious waste, with no other fuel apart from in the preheating phase, the final burning phase or if the waste is extremely wet. Generally, preheating is undertaken using non-hazardous waste. Infectious waste should be added once there is a fire in the second chamber (verified using the peep hole). To ensure complete burning, an additional 1-2 kg of non-medical waste is added 8-10 minutes after the entire medical waste has been loaded.
- If using a stovepipe thermometer, the temperature should be maintained between 600ºC and 900ºC by controlling the waste-loading rate.[v] Robust flames in the secondary combustion chamber (via peep hole) and a roaring noise are good indicators of a sound fire/combustion.
- If you are burning sharps in safety boxes, the recommended rate of destruction is 1 safety box every 8-10 minutes (6-7 kg per hour). If using a stovepipe thermometer[vi], the incinerator is first heated to 600ºC (pre-heating phase) and then the safety boxes can be added one at a time.

### Glass Vial Disposal

The heat generated in an incinerator is enough to explode glass objects like vials. This can harm the operator and/or damage the incinerator. Therefore, if using an incinerator to burn sharps, then extra attention is also required at waste segregation points, ensuring whole vials are not put in the sharps boxes. If whole vials need to be burnt, they need to be smashed first (using a glass crusher). Refer to Table 2 for items that should not be burnt.

### Sharps Disposal Options

There are 3 options for sharps disposal, as listed below. When identifying the most appropriate option, a decision needs to be taken on whether to prioritise a) minimising handling of blunted needles (in which case, opt for direct disposal) or b) decreasing the volume of sharps waste (opt for incineration - note that the sharps themselves won't reduce in volume, except AD syringes which have the needle integrated in the plastic syringe). MSF, who favour direct disposal, separate needles from normal syringes to reduce the volume in the sharps container and sharps pit, and the plastic syringe then helps to incinerate the

soft waste that doesn't burn very well. In addition, sharps management needs to mitigate the dangers of unintentional accessibility leading to inappropriate, illegal and unsafe recover and reuse.

- **Direct Disposal:** To minimise handling of sharps, MSF recommends the use of a sealed sharps pit. This involves disposing of sharps immediately when they enter the waste zone, in their sharps container, into a pit (and capping the pit with concrete when nearly full). This is a simple, cheap, efficient and safe tool for final disposal, but it does not reduce volume. A $1m^3$ pit has capacity for 1 million needles or 30,000 syringes.
- **Incineration**: To reduce the volume of space needed for disposing of waste, it is possible to incinerate sharps boxes in a non-industrial incinerator and carefully dispose of the ash in an ash pit. A De Montfort incinerator will reduce the volume of syringes and containers and will blunt and decontaminate sharps, but will not melt them[vii].
- **Safety Box Reducer:** If a large volume of safety boxes are produced, MSF recommend construction of a safety box reducer directly above a sharps pit. The reducer design is a single chamber volume reducer which is only used for sharps boxes that are burnt with kerosene. After burning, the ash falls directly into the pit. MSF have 2 models, a drum model used during mass vaccination campaigns and a refractory brick model (photo next page) used for enlarged programs of immunization (for long-term health structures). Note the safety box reducer is only for safety boxes and is in addition to a De Montfort Incinerator used for soft waste.


**Figure 3:** MSF Safety Box Reducer over a Sharps pit

This note recommends clarifying the MoH position in-country for the management of sharps, then ensuring facilities are designed accordingly, and completing training and monitoring visits that promote appropriate operation[viii]. For example, in Sierra Leone the Waste Manager for many of the health facilities is a voluntary caretaker. ACF needs to work with the caretaker and the facility staff to ensure everyone is clear on the waste management protocol and the health and safety considerations. If sharps are being directly disposed of in a sharps pit, ensure the pit is large enough (estimate the volume of boxes produced per month). Also, verify that sharps boxes are only disposed of when ¾ full to avoid unnecessary disposal. If burning sharps, verify the operators have necessary PPE and inoculations and ensure the operator and supervisor have a clear understanding of the risks. Practitioners should also support ongoing monitoring and periodic inspection of record keeping, increasing vigilance in respecting protocols for the safe management of waste.

## Key References


- MMIS (2010) The Incinerator Guidebook: Practical guide for selecting, purchasing, installing, operating, and maintaining small-scale incinerators in low-resource settings
- MSF (2010) Public Health Engineering in Precarious Situations, 2nd edition: Excellent overview of waste management, construction and best practice
- MSF (2012) Incineration in Health Structures of Low-Income Countries; Construction & Operation of the De Montfort Incinerator, 22/10/12: Step by step guide to construction and operation of De Montfort
- Montfort Medical Waste Incinerator: Website detailing the construction of the De Montfort
- WHO (2005) Managing Health Care Waste Disposal: Guidelines on how to construct, use and maintain a waste disposal unit: Overview of incinerators used for burning sharps. Includes training resources, checklists and drawings

- WHO (2005) Management of Solid Health-Care Waste at Primary Health-Care Centres *A Decision-Making Guide*: Presents the pros and cons of different options and appropriate methods for urban/peri-urban settings
- MSF (2003) DIRTY AND DANGEROUS: Health Care Waste Management within MSF settings: General overview of waste management in health centres
- WHO (2016) Guidance for healthcare waste management in LICs: Broad overview of waste management. Good review of different technologies
- WHO (2008) Essential environmental health standards in health care: WASH standards for health facilities
- WHO (2014) Safe management of wastes from health-care activities: Comprehensive overview of waste management, but targeting high income countries (not adapted for low income country settings)
- GWABA Incinerator: Outlines technical specification of concrete-based incinerator that reaches 600°C (in French)
- Humanitarian Innovation Fund - Incinerator Challenge: Innovation challenge for design of incinerator using local materials relevant to emergencies

*This Practice Note was prepared by ACF. Review inputs were provided by Andy Bastable, Jamie Bartram, Joos Van Den Noortgate and Jim Picken. Version 1, May 2017.*

[i] The waste management methodologies in this note are for general health facilities - they are not suited for an Ebola Treatment/ Management Centre.

[ii] MSF does not burn sharps in an incinerator. If sharp boxes are burnt, they use a safety box burner. This document presents both options as the practice is carried out in some countries. National Ministry of Health guidelines on sharps disposal should be used by default.

[iii] A WHO (2004) study reported that a properly operated and maintained incinerator limits emissions to 10 ng TEQ/Nm, whereas incinerators with a secondary combustion chamber incorrectly used/designed produce emissions with an average 500 ng TEQ/Nm. Incinerators without a second chamber produce on average 4000 ng TEQ/Nm.

[iv] Black smoke is also produced if the incinerator is incorrectly used and plastic waste is added faster than the flames can consume it.

[v] Temperatures above 900ºC increase velocities and burning in the chimney, which induces dense black smoke and reduces gas residency time. Temperatures below 600ºC increase toxic emissions (dioxins and furans). When waste (e.g. plastic) is added faster than it can burn, it will give black smoke due to release of unburnt carbon.

[vi] If available in country, consider installing a stovepipe thermometer – however, breakdowns are common, so this is not essential.

[vii] To melt sharps requires an industrial incinerator, which burn above 1400ºC. However, these are very expensive to build, operate and maintain (requiring electricity, fuel and trained personnel to operate).

[viii] All monitoring and supervision should be done in close collaboration with the MoH. They are responsible for Infection Prevention Control. However, their supervisors often lack the means to undertake monitoring visits.