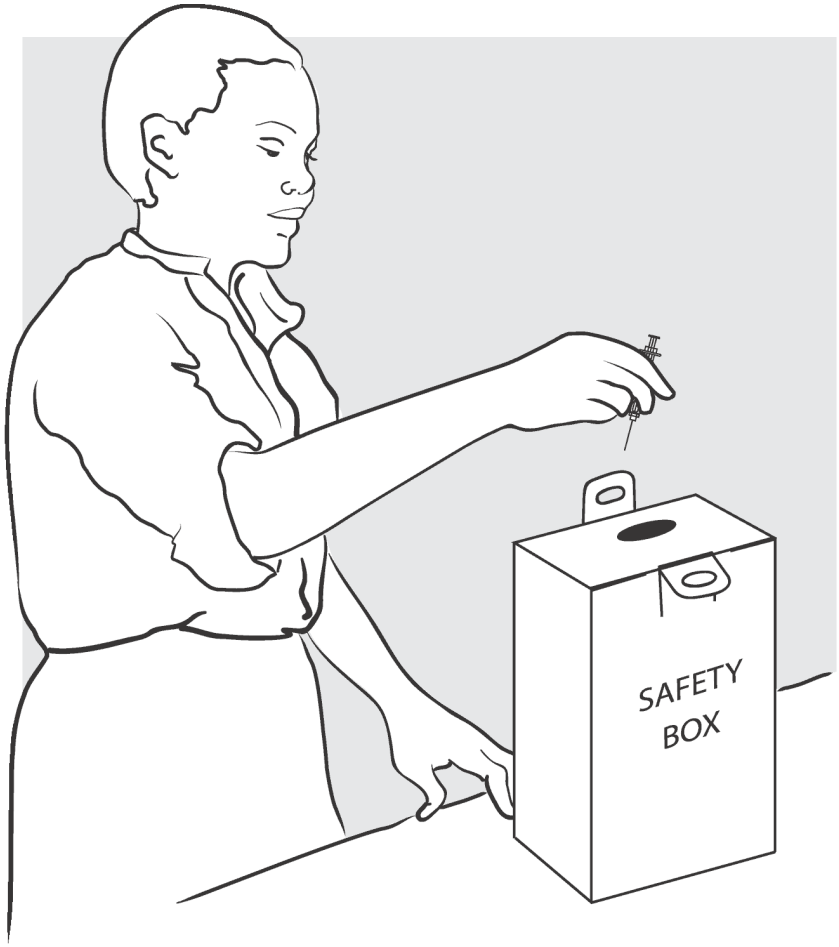

Designing Safe Syringe Disposal Systems for Immunization Services

A Guide for Program Managers

Children's Vaccine Program

path
Program for Appropriate Technology in Health

Training Resource Series, October 2003

Acknowledgements
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Designing Safe Syringe Disposal Systems for Immunization Services
Children's Vaccine Program at PATH—October 2003

Table of Contents

Introduction

There are three sources of risk from unsafe injections:

1. Patient-to-patient transmission of infection due to the reuse of syringes.
2. Patient-to-health worker transmission due to needle-stick.
3. Patient-to-community transmission due to unsatisfactory final disposal.

Auto-disable (AD) syringes have been introduced as a standard for all immunization injections to eliminate the first and greatest risk, patient-to-patient transmission.

Safe syringe waste disposal systems, which are the focus of this guide, are needed to eliminate the second and third sources of risk. In primary health facilities, there is an urgent need for better waste disposal systems, especially in countries where resources are scarce and the infrastructure to handle waste does not exist.

This document describes the various options available for collection and final destruction of sharps waste. In most situations, a manager will use a variety of these options, depending on the amount of waste generated at each health center and proximity to incinerators.

Once you are familiar with these options, you can begin to map out the needs of your health centers and decide the best mix of options for your district.

The Safe Syringe Disposal Planning Process

This guide will help you through the six important steps below. Each step is discussed in detail later in this manual.

Step 1: Review your options.

Learn more about your choices for
- Collecting used syringes immediately after injection.
- Method of final destruction of syringes.
- Location for final destruction of syringes.
- Monitoring safe disposal of syringes.

Step 2: Collect data and map your district.

Create a map of all the health facilities in your area.

Step 3: Identify health facilities with access to incineration now.

Which facilities have incinerators? Note this on the map.
And which are close to existing incinerators? Note this on the map as well.

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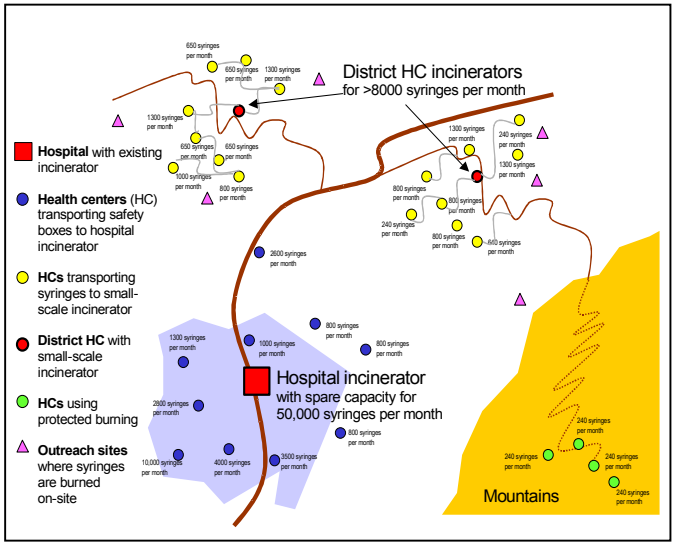
Step 4: Identify strategic locations for new incinerators.

Which facilities can efficiently and effectively use a new incinerator? Make a note on the map.



A "disposal system map" showing all the health and incineration facilities in each district is useful for planning safe syringe disposal.

Step 5: Determine the best disposal systems for remaining health facilities.

What is the best disposal method for each facility that cannot use an incinerator? Label the map.

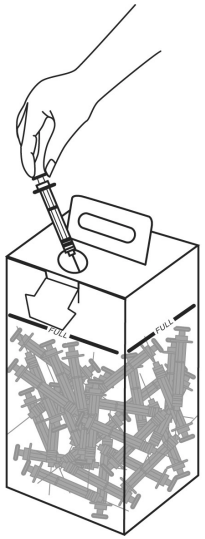
Step 6: Calculate needs and the cost of the plan and implement it!

Step 1: Review your options.

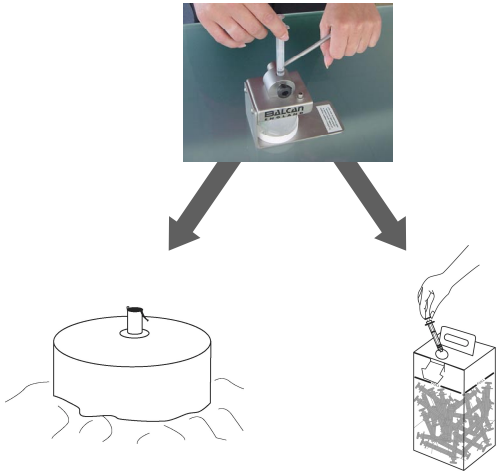
Options for collecting used syringes immediately after injection

There are two generally accepted methods of collecting used syringes in a safety box immediately after the injection:

Option 1
Place needles and syringes in a safety box immediately after use.



Option 2
Using a needle remover, separate needles from syringes before placing the syringe in a safety box. Put the separated needles in a secure pit.

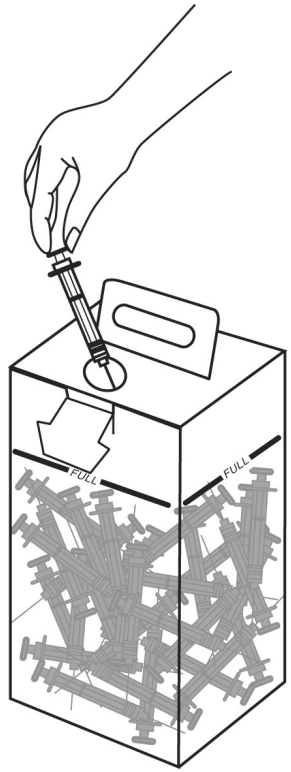


Both options are discussed in detail, beginning on the next page.

Collection option 1: Place needles and syringes in a safety box immediately after use.

The most common method of collecting used syringes is to place the syringe and needle in a safety box immediately after use, without recapping.

The needle is **not** separated from the syringe.



Advantages:
• The safety box is designed so that the needle usually will not penetrate the box wall. • Once safety boxes are purchased, no additional equipment is necessary. • The safety box arrives packed flat, so it is easy to transport empty. It is assembled at the point of use. • The outside wall of the box presents an opportunity for the Ministry of Health to print messages about injection safety.
Disadvantages:
• Needle-stick injuries remain a hazard during waste handling and transport. • Syringes with needles are bulky to store and transport because the needles prevent close packing (only about 150 syringes fit in each 5-liter box). • There is a needle-stick risk if too many syringes are packed in the box (if it is more than ¾ full). • In situations where many injections are given, safety boxes accumulate very quickly. • Most boxes manufactured for the international market are water resistant, but they disintegrate if they become wet. • Needles emit a toxic gas (Chrome-6) if they are burned in high temperature incinerators.

Collection option 2: Separate needle from syringe with a needle remover before placing the syringe in a safety box. Put the separated needles in a secure pit.

This option encourages the health worker to safely remove the needle from the syringe before disposal. Immediately after the injection, the health worker uses a needle removal device that cuts or extracts the needle from the syringe (see Annex 2). After removing the needle from the syringe, the body of the syringe is discarded in a safety box (see Annex 1) and the needles are disposed of in a protected sharps pit (see Annex 3).

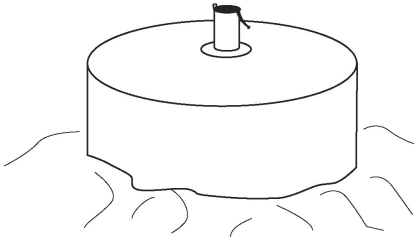
Advantages:

- A syringe without the needle is no longer a hazard so there is less risk of needle-stick during handling and transport.
- The volume of sharps waste is reduced by 20%-60% when needles are removed.
- Many years worth of needles will fit in a protected sharps pit.
- Without needles, more syringes can be put in each safety box.

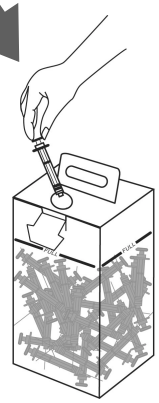
Disadvantages:

- The needle remover costs between US$14 - $70 per device.
- A specially constructed, protected sharps pit must be built (see Annex 3).
- A needle remover is needed for each person giving injections, wherever the injection is given.

A needle remover is used to collect needles in a secure container.



Then the needles are dumped from the container into a protected pit…



and the syringe bodies are put in a safety box.

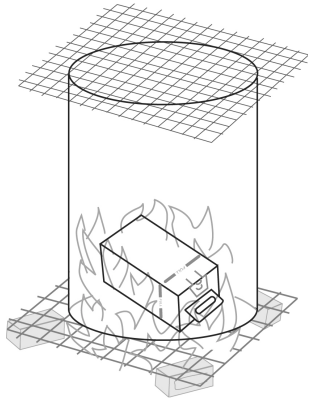
Options for <u>method of final destruction of syringes</u>

Filled safety boxes should be brought back to the health facility and kept in a secure, well-ventilated, dry storeroom until they can be destroyed. Safety boxes should be destroyed within a week, if possible, and should never be stored longer than a month.

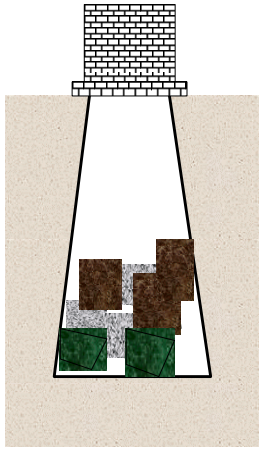
Sometimes companies buy waste plastic for recycling. This is the best environmental option for destroying used syringes without needles but is not always available or affordable. Fortunately you have other options:

Incinerating filled safety boxes
(best method)

Burning safety boxes in a drum, protected hearth, or pit
(next best method)



Burying safety boxes in the ground
(least safe method)



Destruction option 1: Incinerating filled safety boxes (best method).

If possible, syringes in safety boxes should be completely destroyed in a special incinerator. An incinerator operates at much higher temperatures than an open fire, so the plastic is destroyed completely, and the smoke emission is less. Large hospital incinerators should be used if they are available. If not, consider purchasing small-scale incinerators (SSIs) or building them from materials purchased locally (see Annex 6).

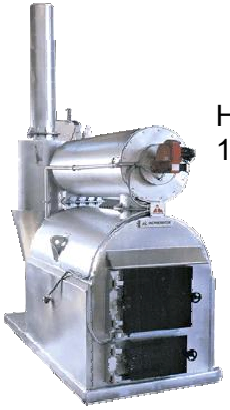
Advantages:

- SSIs may be built on site (see De Montfort below) or purchased.
- Provides complete and efficient destruction of syringes because temperatures are high (600°-1300°C).
- Consistent with standard hospital policy and practice.
- Can be used to destroy other infectious waste.
- Lower environmental emission hazard.
- Less smoke during operation.

Disadvantages:

- Cost is between US$1,000-$12,000 installed.
- If the incinerator is not close to the place where injections are given, the filled safety boxes must be transported to the incinerator.
- Training and supervision is required for proper use and maintenance.
- SSIs require fuel or wood. Large incinerators need electricity.
- Incinerators are only feasible far from buildings. Smoke and noxious emissions may not be tolerated in urban areas.
- Potential for needle-stick injury if needles are not removed.
- To avoid toxic emissions, the health worker needs to carefully control the kinds of waste incinerated.

De Montfort small-scale incinerator 600-800°C



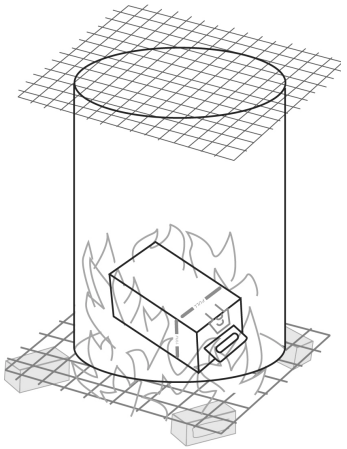
Hospital incinerator 1,000-1,300°C

SICIM district incinerator 700-900°C

Destruction option 2: Burning safety boxes in a drum, protected hearth, or pit (next best method).

If syringes in safety boxes cannot be taken to an incinerator, they may be burned in a drum, protected hearth, or an open pit.
Drum burning is preferred to open pit burning because combustion is better and temperatures are higher.
See Annex 5 for details on options for open or protected burning.

Advantages:
• Materials are available locally. • Low cost.
Disadvantages:
• Requires supervision for proper usage. • Does not burn as cleanly as a special incinerator—there may be smoke and environmental emission hazards. • Fuel is required. • Needles will not be destroyed, so residual metal and ash remain a hazard (though they are not infectious after burning). • Hot, molten plastic is a serious hazard. • Burning pits may not work well in the wet season.



While not as good as incinerators, oil drums can be transformed into acceptable burners. And they are much better than open pits.

Burning pits don't work in the wet season!

Destruction option 3: Burying safety boxes in the ground (least safe method).

If for some reason safety boxes cannot be burned, you can dig a pit 3 to 5 meters deep and 2 m² wide, then place the used safety boxes in the pit.

Once the pit is ⅔ full, cover it with earth or concrete (see Annex 4).

Advantages:

- No additional equipment required.
- No smoke.
- No fuel is required.
- No maintenance is needed.
- Low cost.

Disadvantages:

- Digging deep pits and covering them places enormous burden on staff. It is a lot of work!
- Syringes can be unearthed accidentally (or on purpose).
- Pits cannot be used when the water table is near the surface because liquids leak into ground water and syringes may surface over time.
- Hard ground may make digging difficult.
- Safety boxes are bulky (5 meters cubed per 100,000 syringes) and syringes never degrade–much land is needed.
- The environmental cost is high.

This option should only be used when:

- **No incinerator is available and**
- **Burning is not acceptable or possible and**
- **Suitable land is available:**
  - **The land should be securely protected and not accessible to children and the community.**
  - **The water table should be at least 1.50 m below the base of the pit, even during the wet season.**
  - **The ground must not be too hard.**

Options for the location of final destruction

Once you have decided on the method of final destruction (incinerating, burning, or burying), determine a location for final destruction. The ideal location is as close as possible to the place where injections are given—this will reduce handling and the cost of transport.

Option 1: Final destruction at a location remote from the health center.

If incineration facilities do not exist at the health center, transport filled safety boxes to a place where they can safely be incinerated (see Annex 7 for more information about transporting filled safety boxes).

Advantages:	Disadvantages:
• Waste destruction may be centralized for efficient use of more costly but more effective incineration equipment.	• Cost and scarcity of transport.
• Ensures that destruction is supervised by trained waste management personnel.	• Increased handling of safety boxes.
	• Safety boxes must be kept away from sterile supplies.
	• Need to disinfect trucks used to transport safety boxes.

Option 2: Final destruction at the health center.

Syringes collected in safety boxes during outreach or fixed immunization sessions may be destroyed at the health center if there is an incinerator on site or if there is no available transport to a remote incineration facility.

Advantages:	Disadvantages:
• Need for transport minimized–only the return of safety boxes from outreach immunization.	• Cost of an incinerator or other burner and the possibility that it may be underused.
• Less handling of safety boxes so minimum risk to personnel.	• The community may resist open burning or burying.

Option 3: Final destruction at the immunization outreach site.

It may not be practical, or safe, to carry filled safety boxes long distances after outreach sessions, so you may decide to burn or bury filled safety boxes near the outreach site.

Advantages:	Disadvantages:
• No need to transport the safety boxes.	• May not be possible to protect the burning site adequately.
• Minimum handling of safety boxes so minimum risk to personnel.	• It will be more difficult to monitor the number of filled boxes if they are **not** brought back to the health facility.
• Immunization staff are available to supervise the burning.	• Community members may object to open burning or burying.

Options for monitoring safe disposal of syringes

Used syringes, particularly disposable syringes, may be lost or stolen en route to final disposal.

For this reason, the security of the disposal system should be monitored to check that all used syringes are safely destroyed.

One good indicator for monitoring safe disposal is:

The number of syringes destroyed in safety boxes as a percentage of the total number of syringes used for all injections

Target = 100% of syringes destroyed in safety boxes

There are two options for measuring this indicator:

Best method:

- Record the number of safety boxes filled with syringes.
- Multiply by 150.[1]
- Divide by the **total number of syringes supplied to the facility** in the same period.

Alternate method:

- Record the number of safety boxes filled with syringes.
- Multiply by 150.[1]
- Divide by the **total number of injections given for all purposes** in the same period

Go to the next page for further information and an example.

[1] 150 syringes with needles fill a 5-liter safety box; 300 syringes with needles fill a 10-liter safety box.

If you removed the needles: 300 syringes without needles fill a 5-liter safety box and 600 syringes without needles fill a 10-liter safety box.

Options for monitoring safe disposal of syringes (continued)

Best Method:

Record the number of safety boxes filled with syringes, multiply by 150, and divide by the total number of syringes supplied to the facility in the same period.

Advantages:	Disadvantages:
• It is easy to count filled boxes, both in storage and at the point of destruction.	• Some boxes may not be filled to the level printed on the box or they may contain material other than syringes, thereby reducing actual capacity and decreasing accuracy of your calculations.
• It is easy to count the number of syringes being drawn from stock for use in the health facility.	
• The capacity of boxes only needs to be estimated once; then that factor is used to calculate number of syringes in each box.	

Example:

- In the month of December, Beguin District dispatched 4,000 syringes of all sizes.
- Health centers later reported incinerating a total of 20 filled safety boxes.
- A total of 20 filled safety boxes X 150 syringes per box = 3,000 syringes incinerated/ 4000 syringes dispatched = 75% of dispatched syringes were incinerated. *This is a problem because not all the syringes were incinerated!*

Alternate Method:

Record the number of safety boxes filled with syringes, multiply by 150, and divide by the total number of injections given for all purposes in the same period.

Advantages:	Disadvantages:
• It is easy to count filled safety boxes, both in storage and at the point of destruction.	• The number of injections given is not always recorded in curative interventions.
• The capacity of boxes only needs to be estimated once, then that factor is used to calculate number of syringes in each box.	• Some boxes may not be filled to the level printed on the box or they may contain material other than syringes, thereby reducing actual capacity and decreasing accuracy of your calculations.

Step 2: Collect data and map your district.

To design the right disposal system for each health facility, collect data from all incineration and health facilities in your service area. You will also need to consider the constraints of your transport system. With this information, you can designate disposal options for different situations in the service area. A "disposal system map" (next page) can help you to minimize costs and maximize waste handling and treatment.

Small-scale incinerators have a minimum and a maximum capacity (see table below). To remain cost-effective, they must be used at least at minimum capacity. And to remain safe, they should not be used more than their maximum capacity.

For each **health facility** determine:

- The total number of injections, including immunization and curative, given at each location per week.
- The distance, time, and cost of transporting filled safety boxes to the nearest existing incineration facility.

For each **incineration facility** determine:

- Maximum capacity to burn used safety boxes per month (see below).
- Minimum monthly use that is cost-efficient (see below).

Incinerator Cost-Effectiveness, Monthly Capacity, and Hours of Use per Week

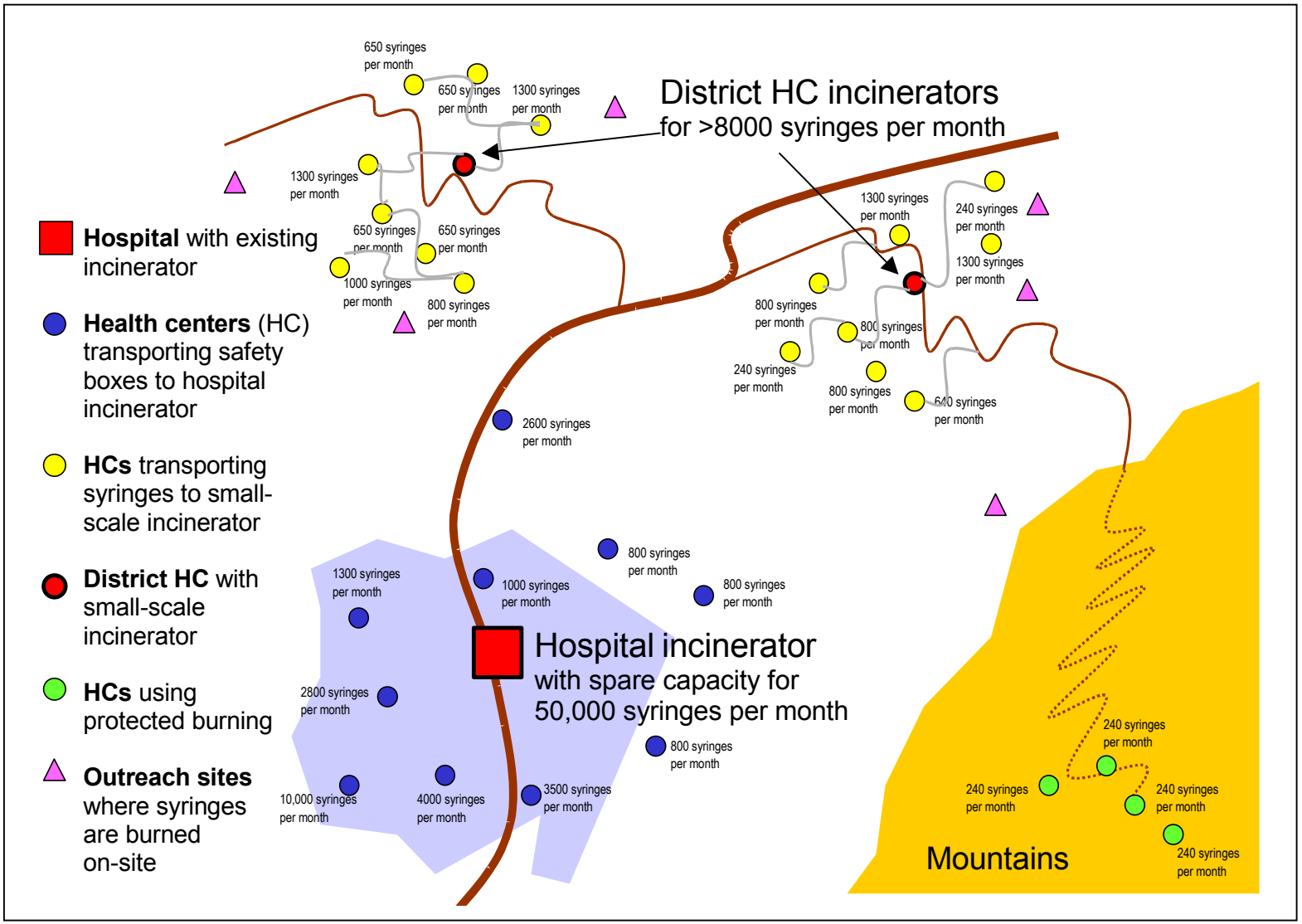
	SICIM Number of syringes per month	**De Montfort** Number of syringes per month	**Hours of use per week to destroy that many syringes**
Syringes with needles • Minimum cost-effective use* • Maximum capacity**	 24,000 240,000	 8,000 96,000	 3 hours per week 36 hours per week
Syringes without needles • Minimum cost-effective use* • Maximum capacity**	 32,000 320,000	 12,000 144,000	 3 hours per week 36 hours per week

* It is not cost-effective to use the incinerator to burn fewer than this number of syringes each month.

** This number assumes that the waste is mixed, i.e. it contains syringes plus other infectious waste.

Next, create a map something like this one, showing the various disposal requirements of each health center and outreach site and their proximity to existing or planned incinerators. Be sure to note how many syringes can be destroyed at each incineration site.

Sample Map for Safe Syringe Disposal System



Step 3: Identify facilities with access to incineration now.

Mark all health facilities that can be served by existing incinerators on your map.

Be sure to take incinerator capacity into account (see the chart in Step 2)!

Step 4: Identify strategic locations for new incinerators.

If existing incinerators cannot be used to destroy all used syringes from all health facilities, consider building more incinerators.

Use your map to plan where to locate new incinerators. Look for locations central to several unserved facilities.

- **Remember: incinerators may not be installed in urban areas or in locations close to occupied buildings.**
- Consider how you would transport filled safety boxes from the facility to the new incinerator.
- Think about the number of syringes that will be generated each week by each unserved facility. Do not overload your new incinerator!
- Plan for a suitable collection schedule to ensure that used syringes are collected each week.

Mark all the health facilities that can be served by new incinerators on the map.

Step 5: Determine the best disposal systems for the remaining health facilities.

Even after building new incinerators, some health facilities still may not have access to them.

Decide the best destruction option for each unserved facility (i.e. burning in a drum or pit or burying) and add that information to the map.

Step 6: Calculate needs and the cost of the plan and implement it.

Complete a planning chart like this, then make a budget, obtain funding, and implement your plan.

Sample Sharps Waste Disposal System Planning Chart for District A

Note: All health workers in our district must remove needles from used syringes before placing the syringe body in a safety box. Collected needles will be thrown into a secure pit. Most health facilities will incinerate safety boxes at District Office A or at Health Center B. But two remote health posts (B7 and B8) will burn their safety boxes in oil drums.

Name of facility delivering immunizations	Maximum # EPI injections per month*	Maximum total injections per month**	# of safety boxes filled per month***	# needle removers needed****	Type/location of final disposal *SSI=Small Scale Incinerator*	# needle pits needed/ # in place	Safety box transport (if needed) provided by?	Fuel (if needed) per month	Action plan
District Office A	0	0	0	5	SSI/On site	1/0	Not needed	10L kerosene	build needle pit & build incinerator
Health Center B	1,108	11,075	111	3	SSI/On site	1/0	Not needed	10L kerosene	build needle pit & build incinerator
Health Post A1	150	1,500	15	2	SSI/ Dist.Office A	1/0	District	50L gasoil	build needle pit
Health Post A2	335	3,350	34	2	SSI/ Dist.Office A	1/0	District		build needle pit
Health Post A3	820	8,200	82	6	SSI/ Dist.Office A	1/0	District		build needle pit
Health Post A4	860	8,600	86	2	SSI/ Dist.Office A	1/0	Health committee		build needle pit
Health Post A5	1,600	16,000	160	6	SSI/ Dist.Office A	1/0	District		build needle pit
Health Post B1	1,600	16,000	160	5	SSI/ Health Center B	1/0	Health Center		build needle pit
Health Post B2	1,800	18,000	180	6	SSI/ Health Center B	1/0	Health Center		build needle pit
Health Post B3	160	1,600	16	4	SSI/ Health Center B	1/0	Health committee		build needle pit
Health Post B4	200	2,000	20	2	SSI/ Health Center B	1/0	Health Center		build needle pit
Health Post B5	210	2,100	21	2	SSI/ Health Center B	1/0	Health committee		build needle pit
Health Post B6	240	2,400	24	2	SSI/ Health Center B	1/0	Health committee		build needle pit
Health Post B7	420	4,200	42	4	Drum burning/on-site	1/0	Not needed	Not needed	provide oil drum & build needle pit
Health Post B8	550	5,500	55	3	Drum burning/on-site	1/0	Not needed	Not needed	provide oil drum & build needle pit
TOTAL	**10,053**	**100,525**	**1,006**	**54**		**15/0**			

* From records of DTP, Hep B, TT, Measles, and BCG vaccine doses administered per month, or calculate EPI annual target X number of injections per year / 12 months.

** From records of all injections conducted per month or an estimate based on EPI injections X 10.

*** Assumption: 150 syringes per safety box.

**** One needle remover per health worker giving injections.

Good luck with your improved, safer syringe disposal system!

ANNEX 1: Syringe safety boxes

Safety boxes (also known as “sharps containers”) are puncture proof, impermeable containers for the safe and convenient disposal of used syringes and needles and other contaminated sharps.

- Safety boxes should be filled only once (to the full line if needles are attached).
- Filled safety boxes should be transported and stored upright. When they are used correctly, safety boxes can help prevent disease-spreading needle-stick injuries.
- Different safety boxes are assembled in different ways—instructions are usually printed on each box.
- Health workers must be trained to correctly assemble and use safety boxes.

Safety boxes are usually made in 5-liter or 10-liter sizes with the following syringe capacity and weight (figures are approximate as they depend on syringe type).

Approximate Capacity of Safety Boxes

	5 liter	10 liter
Number of syringes with needles	150	300
Number of syringes without needles	235	470
Weight, syringes with needles	0.5 kg	1.0 kgs
Weight, syringes without needles	1 kg	2 kgs

ANNEX 2: Needle removers

Needle removers separate used needles from their hubs (or from syringes if they are directly fixed). There are many different kinds of needle removers, but usually the needle drops into a small container after separation, then the syringe is discarded in a safety box. When the needle container is full, it is released from the needle remover and emptied into a protected sharps pit (See Annex 3).

Needle removers must be used immediately after each injection to minimize risk of needle-stick injuries. The needle remover must therefore be in direct reach of the person giving the injection, whether the injection is given in a clinic or at an outreach site.

Although the syringe is no longer sharp after needle removal and is no longer a direct hazard, it is best to discard the syringe body in a safety box because it will not be possible to guarantee that all syringes will be discarded without their needles. For this reason do not use a bag to collect the syringes; use a safety box.

WARNING! If the used syringes are collected at point of use and then carried to the needle remover, there is a high risk of needle-stick injury!

Every person giving injections should have their own needle remover close at hand.

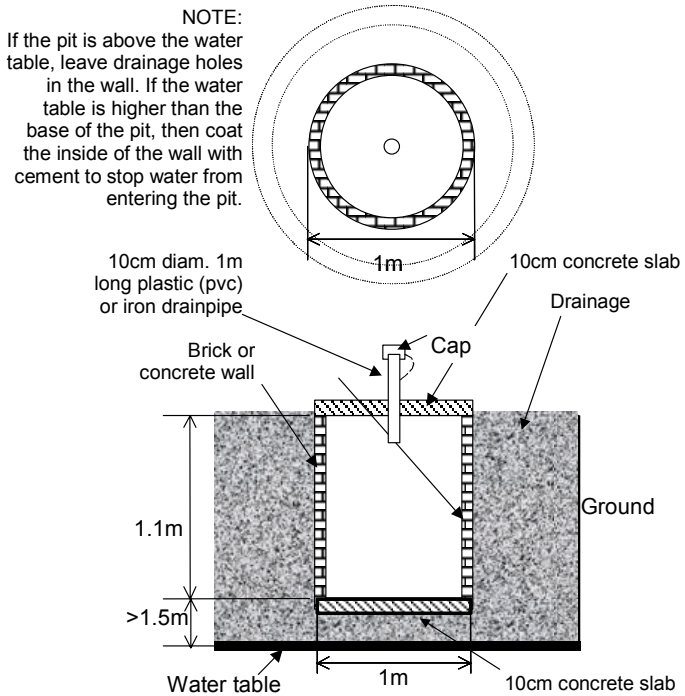
There are many kinds of needle removers on the market. The “Balcan Mini” is one of the most popular.

ANNEX 3: How to build a protected sharps pit

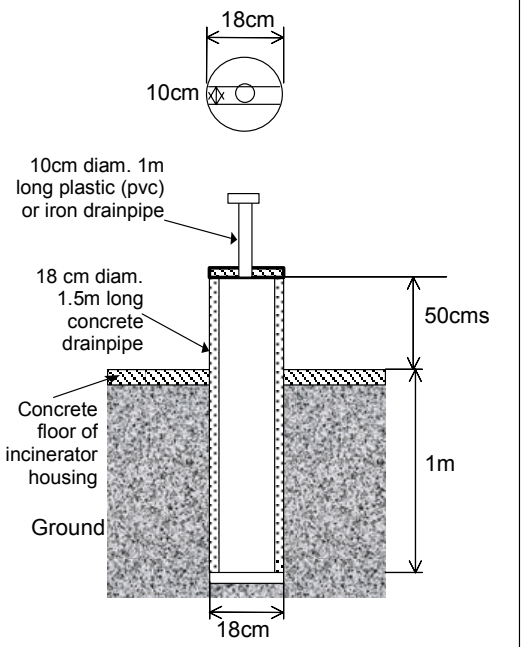
A protected sharps pit is a covered and lined pit used only for needles and other small sharps—not for bulky sharps such as syringes.

- One hundred needles occupy 106 cm,[3]*, so a pit of about 1 m^3 internal volume can hold about 1 million needles. The drawing below shows how to construct such a pit.
- A health center providing 200 immunization injections per month would provide at least 24,000 injections for all purposes in one year.
- In that facility, a pit of 1 m,[3] used exclusively for needles, would be sufficient for at least 42 years. If sharps with 5 times the volume of a needle are disposed, the pit will be sufficient for at least 8 years.

Protected sharps pit (MSF style)



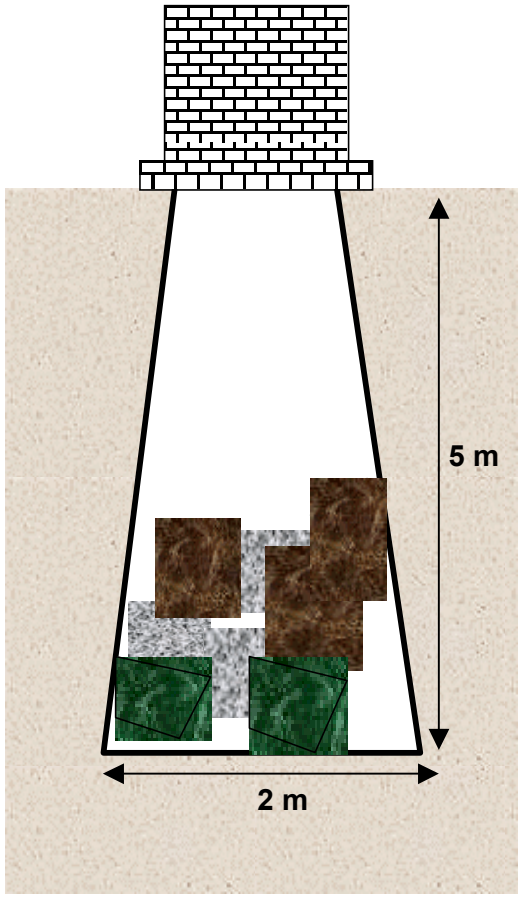
Protected sharps pit (Indonesian style)



* This figure is for needles cut from syringes. Needles pulled from syringes require five times more space than cut needles.

ANNEX 4: How to build an infectious waste burial pit

An infectious waste burial pit is easy to use and maintain, but there are some disadvantages. A pit of this size can be difficult to dig if the ground is hard, and waste pits are not appropriate where heavy rains or floods are common or where the water table is near the surface. And unlike incineration or burning, burying safety boxes in a pit does not reduce the volume of waste. However, if a burial pit is the best solution for your situation, this is the best way to construct the pit:



Materials needed for construction

- Tools (shovels, pickaxe.
- Concrete or corrugated iron rings.
- Cement or nuts and bolts.

Building the pit (this pit has a capacity of 20 m^3)

- Select a proper site for the pit:
  - Do not dig the pit close to water sources such as wells or spring water.
  - The ground should be of low permeability.
- Dig a hole approx. 2 m x 2 m x 5 m
  - Insert rings if necessary to reinforce the hole.
  - A fence should be put round the burial pit to avoid accidents and unauthorized access by humans or scavengers.
- The walls should have a negative slope (narrow at the top, wider at the bottom).
- Line the bottom of the pit with a material of low permeability, such as clay.

Using the pit

- Dump only non-anatomical waste in the pit.
- Seal the pit with soil and concrete **before** it is full of waste. Leave approximately 50 cm to properly seal off the pit.
- The abandoned pit must be marked with a warning so that it is not used in the future.

Source: World Health Organization, *www.healthcarewaste.org.*

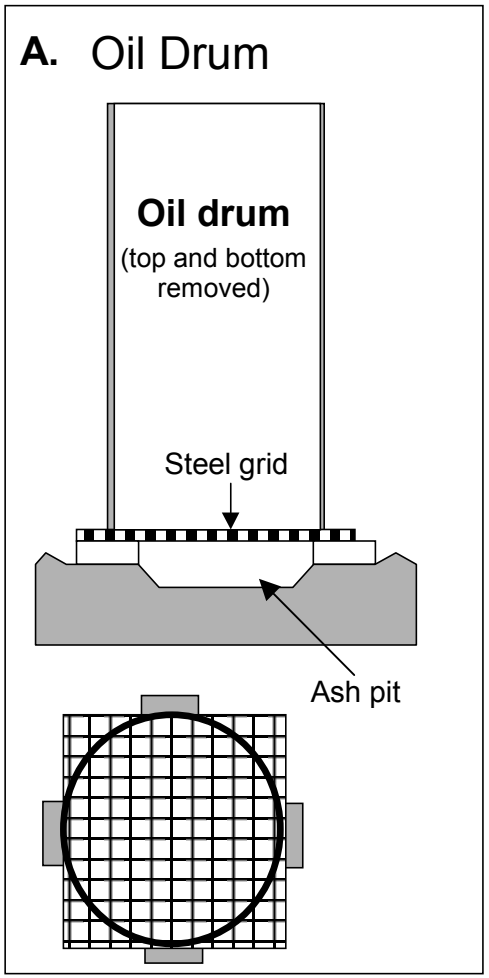
ANNEX 5: Options for protected and open burning

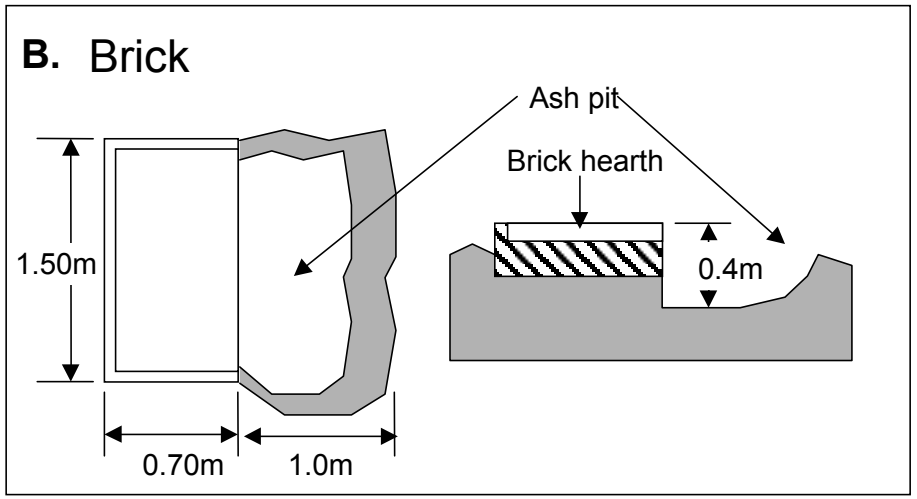
A. An open oil drum is the best solution for burning. The drum, with top and base removed, are placed on a steel grid which is raised off the ground with bricks to allow good air circulation.

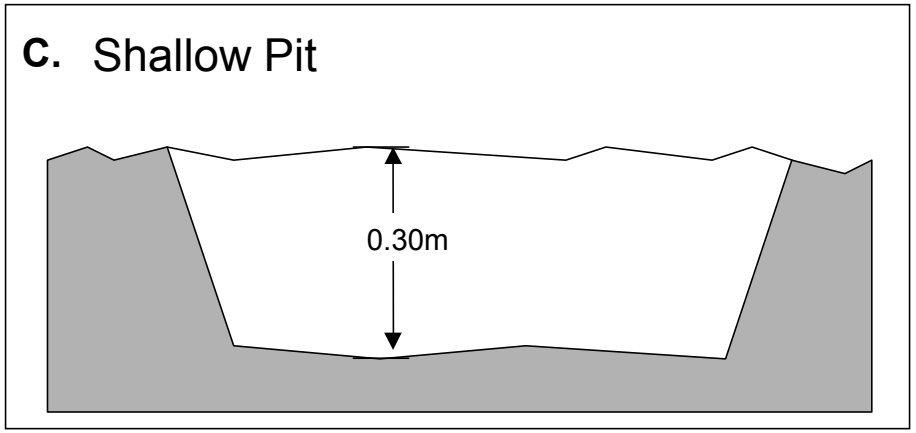
B. If a drum is not available, an open brick hearth can be used instead. Sweep molten plastic and ash into an ash pit behind the hearth.

C. If neither A nor B is feasible, burn waste in an open pit. Take care to ensure that all the syringes are burned because shallow pit burning is not very efficient.

Note: Burning waste should be protected so that wind does not blow hot ash and so that molten plastic cannot burn people near the fire.







ANNEX 6: Incinerator details

Two types of incinerator are described in this annex. Below is summary information, with further details on the following pages.

De Montfort Mark 8a auto-combustion incinerator

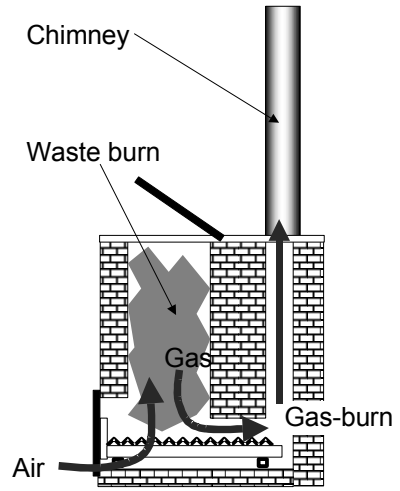
- The De Montfort incinerator costs from US$1,000–$3,000 installed and is constructed on site, using local materials.
- This incinerator takes time to start up.
- Once started, it should be run for several hours–destroying approximately 20 kgs of waste (approx. 1,200 syringes and other waste).
- This quantity of waste is likely to be generated by a primary health center in four months whereas the incinerator should be run at least once per 48 hours to ensure that infectious waste is not accumulated for too long and to make economic use of the equipment.
- The De Montfort is more suitable at the district level, where safety boxes from the district health center may be destroyed together with safety boxes collected from primary health centers nearby.

SICIM Pioneer AC01 auto-combustion incinerator

- This incinerator costs about US$2,800 and has been used nationwide in Cambodia and in some parts of Vietnam and the Philippines.
- A protective steel cage is needed because the surface of the incinerator becomes very hot.
- The incinerator uses paper or other easily burned waste to start up and requires no kerosene or other fuel—it is designed to operate on the combustion of the syringes themselves.
- The SICIM produces thick smoke at start up and during reloading so it should not be located near residential areas.

De Montfort Mark 8a auto-combustion incinerator: details

Model	Mark 8a
Description	Auto-combustion incinerator
Capacity (weight/volume)	12 kgs/0.7 m^3
Cycle time/loading	240 mins/ continuous
Temperatures low/high	600°C, 800°C
Energy source(s)	Kerosene, diesel, gas, wood
Energy consumption	**2 liters kerosene per cycle plus start-up paper**
Flue emission data	Flue height 4-6 m Particules: Bosche smoke 0.5 to 3.0 Trace elements: calcium, zinc, silicon, iron
Manufacturer	**Local manufacture with local materials** **De Montfort University, UK** **www.appsci.dmu.ac.uk/mwi/**
Approx. unit cost	US$700



ADVANTAGES

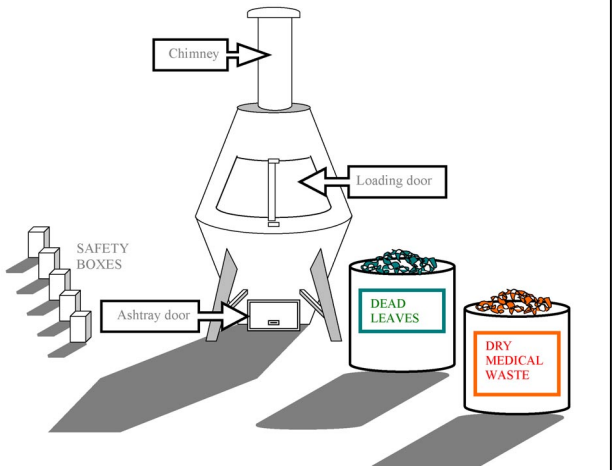
- The incinerator is built on site with materials available locally including refactory bricks; refactory mortar; mild steel door; frame; grates, and stack; and standard building bricks.
- The incinerator has a secondary combustion chamber to reduce harmful emissions. When residual combustible gases reach the secondary combustion chamber they encounter more air and undergo secondary combustion, raising the temperature even higher and reducing the gases to stable compounds such as carbon dioxide.
- The incinerator may be reloaded while in operation.
- The walls of the incinerator never become dangerously hot to touch, even during operation, because of the double walls and sand infill between the walls.

ISSUES

- The incinerator operates with natural draft, requires fuel to start, and takes time to reach operating temperature from cold. It is therefore best operated for long periods, not less than 3 hours at a time.
- The De Montfort is not suitable for operation in a closed room because smoke is emitted whenever the loading door is opened. A roof may be fitted to protect the operator from rain, but to ensure good ventilation there can be only minimal walls.
- Overloading the incinerator with syringes causes leakage of molten plastic into the ash box and out the ash door. When cooled, this plastic can block the door and cause it to break from the incinerator wall.

SICIM Pioneer AC01 incinerator: details

Model	Pioneer AC/01
Description	Auto-combustion incinerator
Capacity (weight/volume)	20-30 kgs/1 m^3
Cycle time/loading	180 mins/single load
Temperatures low/high	700°C, 900°C
Energy source(s)	Start-up paper
Energy consumption	None, auto-combustion
Flue emission data	Emissions not measured, but smoke and particulates were observed during field trials in Vietnam and Cambodia
Shipping weight/volume	250 kgs/3 m^3
Manufacturer	SICIM Spa. Via Aquileia, 94 34076 Romans d'Isonzo (GO), Italy Tel: (34) 0481 90188 Fax: (34) 0481 90332
Approx. unit cost	US$2,500



ADVANTAGES

- The SICIM auto-combustion incinerator is designed to burn mixed medical waste.
- It requires no fuel except paper, packaging, or leaves to start up.
- It has been widely used in Cambodia, Laos, and Vietnam.
- Stainless steel (3 mm DIN 304) is now used for the walls of the incinerator. This will extend its life significantly.

ISSUES

- The body of the incinerator becomes very hot during use and a protective fence is needed to restrict access.
- Dense smoke and particulates have been observed during start-up and reloading.
- The incinerator should be located far from occupied buildings.

ANNEX 7: Transporting filled safety boxes

Safety boxes are designed for safely storing, carrying, and transporting syringes. Once filled to the maximum fill line (¾ full of syringes with needles attached), these boxes may be transported by:

1. Hand carrying
2. Bicycle or motorcycle
3. Dedicated vehicle (eg. a truck used only for waste collection)
4. Dedicated trailer towed by a vehicle (i.e. a trailer used only for waste collection)
5. A supply vehicle (eg. a truck used both for supply and waste collection)
6. A personnel-carrying vehicle

IMPORTANT!!

If safety boxes are transported by a supply vehicle or a personnel-carrying vehicle, the following precautions should be observed:

- The safety boxes should be **kept dry** (otherwise they become weak and burst open, spilling contaminated syringes).
- The safety boxes should be **stacked upright**, standing on their bases, not on their sides (they are not strong enough to resist weight and they collapse when stacked on their sides).
- The safety boxes should be **loaded by their handles**, not held by their sides (there is a risk of needle-stick if the box has been punctured).
- The safety boxes should be stored in **vehicles without direct contact with drugs**, **vaccines or other medical supplies** (they may contaminate the packaging of clean supplies).
- After each journey carrying safety boxes, the vehicle interior should be **cleaned with surface disinfectant**, such as 1:20 diluted household bleach.

NOTES

More Training Resources from the Children's Vaccine Program at PATH

Visit the "**Training Materials and Clinical Information**" section of our website to download any of these materials:

www.ChildrensVaccine.org

- *Giving Safe Injections: Using Auto-Disable Syringes for Immunization*
- *Proper Handling and Disposal of Auto-Disable Syringes and Safety Boxes*—A Training Module
- *Immunizing Children Against* Haemophilus influenzae *type B*—A Training Module
- *Immunizing Children Against Japanese Encephalitis*—A Training Module
- *Immunizing Children Against Hepatitis B*—A Training Module
- *Hepatitis B Vaccine Introduction: Lessons Learned in Advocacy, Communication, and Training*
- *Training Vaccinators in a Time of Change*
- *Immunization and Child Health Materials Development Guide*
- *The Case for Childhood Immunization*
- *Advocacy for Immunization*
- *Helping Young People Become Youth Advocates for Immunization*

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