Disposal of Mass Immunization Waste Without Incineration

Executive Summary of the report *Waste Management and Disposal During the Philippine Follow-Up Measles Campaign 2004* (June 17, 2004), prepared for Health Care Without Harm (HCWH) and the Philippine Department of Health by Jorge Emmanuel, Merci Ferrer, and Faye Ferrer; copies of the full report are available from Firuzeh Mahmoudi of HCWH <Firuzeh@hcwh.org>.

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The adverse health and environmental impacts associated with incineration, and the entry into force of the Stockholm Convention on Persistent Organic Pollutants on May 17, 2004, have challenged health-care providers to seek non-incineration methods for treating medical waste. With the banning of incineration under the 1999 Philippine Clean Air Act, the Philippines became the first country to deal with waste from a nationwide vaccination program without resorting to incineration or open burning.

The Philippine Follow-Up Measles Elimination Campaign (PMEC) targeted an estimated 18 million children during the month of February 2004. In a little over a month, the PMEC generated an estimated 19.5 million syringes collected in 162,000 safety boxes, amounting to about 810,000 liters or 130,000 kg of sharps waste. Also produced were an additional 740,000 liters or 72,000 kg of non-hazardous waste (empty vaccine vials and ampoules, syringe wrappers, empty vitamin capsules, cotton swabs, syringe caps, and packaging). The measles campaign presented an opportunity to demonstrate and document waste management and disposal without incineration or open burning during a mass immunization campaign. This report is the result of collaboration between Health Care Without Harm and the Philippine Department of Health, with the cooperation of the World Health Organization.

The study examined waste management practices during the PMEC in 19 documentation sites representing a wide range of geographic, socioeconomic, and ethnic conditions: wealthy urban enclaves, urban poor ("slum") communities, rural agricultural areas, very poor remote villages, mountainous and difficult to access places, indigenous communities, coastal regions, islands, as well as areas at high risk due to armed conflict. The number of children vaccinated in the documentation sites ranged from 640 children in a small neighborhood, to 18,256 children in a large municipality, to 360,200 in a province. About 406,300 children were vaccinated in the 19 documentation sites.

Before the immunization phase of the campaign, the Philippine Department of Health issued a comprehensive national guidebook that included waste management guidelines. Local areas were required to develop microplans for the management of immunization waste. The guidebook recommended the collection of used auto-disable syringes in 5-liter safety boxes, and their treatment and disposal using one of the following methods:

- Treatment in an autoclave facility
- Treatment in a microwave facility
- Encasement in a concrete septic vault
- Burial in a waste pit.

The basic approaches using centralized treatment (autoclave or microwave technology) and burial (concrete vault or waste pit) are presented schematically in Figure A below.

Filled safety boxes were transported through unpaved dirt and gravel roads, mountain paths, plank bridges, bodies of water, asphalt streets, and concrete highways. Transportation methods included hand-carrying, bicycles with sidecars,

Figure B.
Carrying Multiple
Safety Boxes

motorcycles, motorcycles with sidecars, jeeps, minivans, vans, trucks, boats, horses, cars, ambulances, and vehicles used to deliver vaccination supplies. At the end of each day, the storage boxes were sealed with tape, labeled, and transported to temporary storage areas or central storage facilities. The transport and storage of safety boxes were conducted with little or no problems.

Many urban and rural areas that had access to centralized treatment facilities opted to use

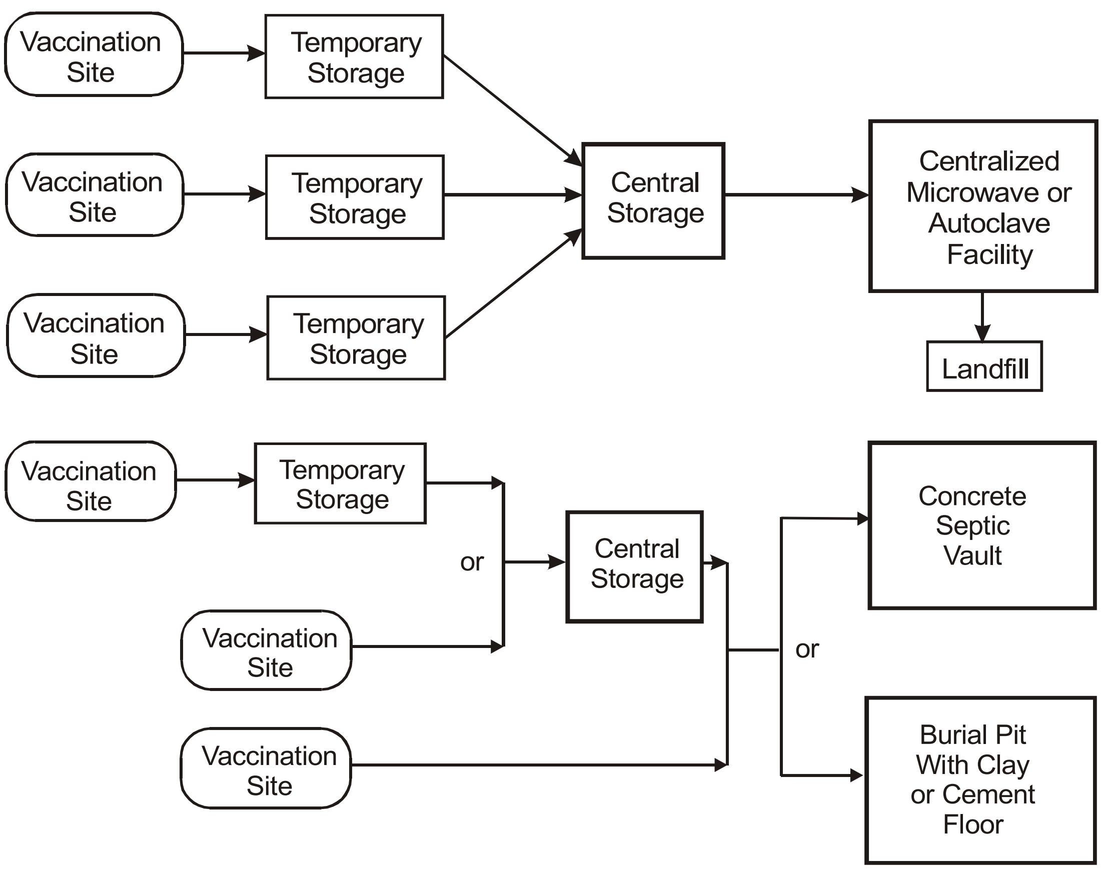

Figure A. Approaches to Waste Treatment and Disposal Used During PMEC

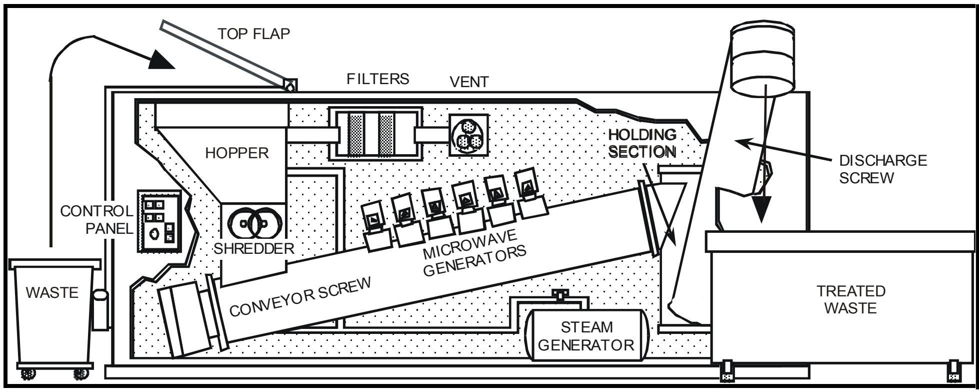

Figure C. Microwave Treatment System (Chevalier Environ Serives, Inc./Sanitec)

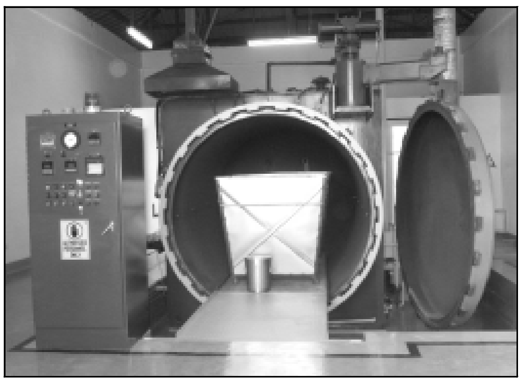

Figure D. Autoclave Treatment System (PAE Environmental, Inc.)

autoclave or microwave treatment. Illustrations of the microwave and autoclave systems are given in Figures C and D, respectively. The autoclave was a 1.5-meter diameter x 2.5-meter long steel chamber wherein sharps waste was sterilized using steam at 142 ºC for up to 90 minutes to destroy pathogens. The microwave technology used an internal shredder, conveyor screw, and a bank of six industrial microwave generators to produced steam and achieve high levels of disinfection.

Rural and coastal areas, as well as islands, used concrete vaults as recommended in the guidebook. Figures E1 and E2 show the design of a standard rectangular concrete septic vault and one being sealed. They were built at the back of health facilities, in landfills, or cemeteries. The vault openings were above the ground to prevent water intrusion. Some areas used other designs, such as cylindrical vaults, aboveground vaults, and vaults built into walkways.

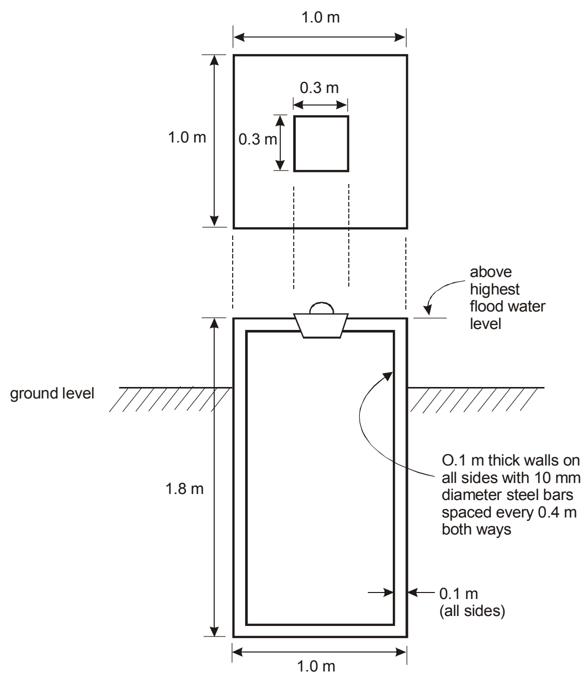

Figure E1. Concrete Septic Vault Design

Figure E2. Concrete Vault Being Sealed

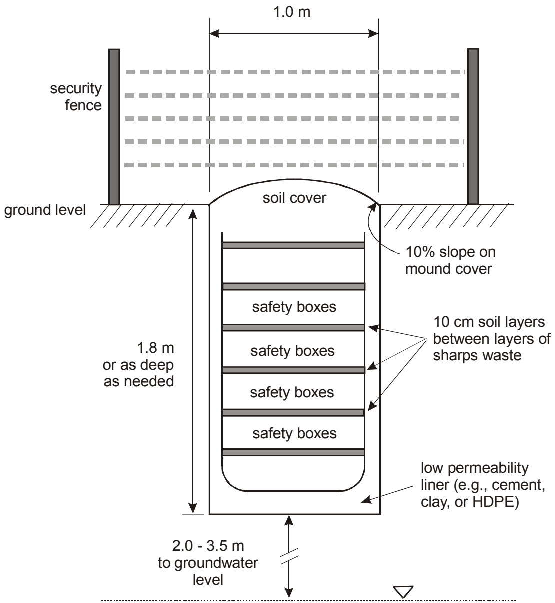

Figure F. Sharps Burial Pit

Poor communities in remote rural regions buried their waste in pits. Two basic burial pit designs were used: pits constructed with a cement floor and pits with bottom clay layers as shown in Figure F. The purpose of the cement or clay flooring was to minimize groundwater contamination. All vaults and pits were between 2 to 55 meters above the water table.

Two areas experimented with different approaches not mentioned in the guidebook. One city used electric needle destroyers, small portable devices that melted the needles and sliced off the hubs (see Figure G). A remote,

Figure G. Needle Destroyer

mountainous community decided to dispose of their safety boxes by depositing them in their communal latrine.

An analysis of costs showed that the simple clay-lined burial pits were the cheapest, followed by centralized treatment using autoclave or microwave technology. The most expensive methods were concrete encasement and burial pits with cement floors. The costs of treating 120 safety boxes (equivalent to immunizing about 12,100 children) are shown in Figure H. These costs include transportation and treatment costs for centralized treatment, and construction material and labor costs for vaults and pits.

For the purposes of planning, Table I provides cost estimates for different treatment and disposal methods per 1000 children and per syringe. Key data on waste generation from the PMEC are compared with estimates commonly used for planning purposes in Table II. The data reflect the fact that vaccination teams often reused mixing syringes and that some safety boxes were overfilled.

Since all vaults and pits were oversized, they will continue to be used by local health centers. The immunization campaign brought the added benefit of raising awareness about the dangers of sharps waste and providing local health facilities with concrete vaults, pits, or the experience

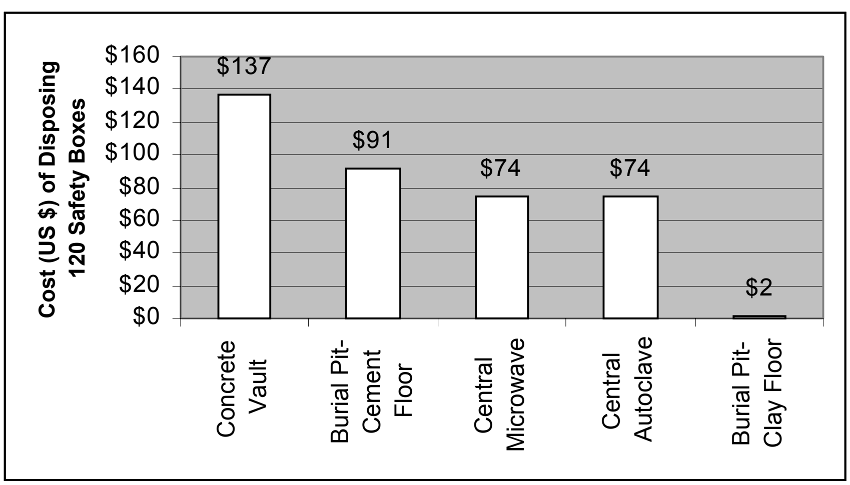

Figure H. Comparison of Costs for Treating 120 Safety Boxes
[Costs were converted from Philippine pesos at an exchange rate of $1:P55]

Table I. Cost Estimates for Treatment and Disposal *

Treatment and Disposal Method	Cost / 1000 Children (Dollars)	Cost / Syringe (Dollars)
Autoclave and Microwave Treatment Cost (including transportation)	9	0.008
Autoclave and Microwave Treatment Cost (excluding transportation)	4	0.004
Concrete Septic Vault Encasement	11	0.009
Burial Pit With Cement Floor	11	0.009
Burial Pit With Clay Floor	0.14	0.0001

* Autoclave and microwave treatment costs are based on regular prices charged per weight by existing treatment facilities and include the cost of transporting safety boxes. Concrete vault and burial pit costs are based on the cost of constructing a vault or pit of standard size (1m x 1m x 1.8m) to accommodate 120 boxes, corresponding to 12,100 children or 14,640 syringes.

of using centralized treatment so that good waste management practices could be sustained.

The new cardboard safety boxes proved to be durable, puncture-resistant, moisture-resistant, and easy to carry. Nine needle-stick injuries were documented in 18 of the documentation sites, corresponding to 56,070 children or 1.5 needle-sticks per 10,000 syringes used. The few accidents and needle-stick injuries reported were caused by improper handling of sharps waste or the use of old, less sturdy safety boxes. Recommendations were made including the need for more time to develop microplans, better training and coordination, ensuring secure transport and storage at all times, post-treatment shredding, waste tracking, accident and injury reporting, better personal protection, recycling of other wastes, and providing a wider range of treatment and disposal options.

Table II. Key Data on Waste Generation*

Parameter	Averages Based on PMEC Data	Estimates Used in Planning
# Syringes / 1000 Children	1,085	1,210
Syringe Wastage Factor (%)	7.1	10
# Syringes / Safety Box	123	100
# Safety Boxes / 1000 Children	9	12
Weight (kg) / Safety Box	0.8	0.7
Weight of Sharps Waste (kg) / 1000 Children	7	8
Weight of Other Wastes (kg) / 1000 Children	4	--

* Wastage refers to syringes that are broken and cannot be used. “Other wastes” refer to non-hazardous waste such as empty vials, syringe wrappers, and packaging.

Before and during the immunization campaign, various suggestions were explored, including the use of reusable (metal or hard plastic) sharps containers, post-treatment shredding, gravity separation in water of shredded plastic and metal pieces, recycling of treated waste, solar-powered autoclaves and melters, and needle destroyers. Various stakeholders felt that many of these options could be implemented in the future. Further research is suggested for several methods, shown in Table III, proposed as best practices for immunization waste treatment and disposal.

Interviews conducted after the campaign showed that stakeholders affirmed the value of waste management for the protection of public health and the environment. Data from the documentation sites show that the cradle-to-grave management of immunization waste was completed relatively safely and with minimal impact on the environment. The PMEC waste management study shows that it is indeed possible to treat waste from mass immunizations successfully, while remaining in full compliance with the incinerator ban under the Philippine Clean Air Act.

Table III. Proposed Best Practices for Immunization Waste Treatment and Disposal *

I – Large to Medium Scale

VACCINATION SITE	→		TREATMENT	→		FINAL DISPOSAL
Collect syringes in reusable sharps container	Transport	Central storage	Autoclave treatment	Post-treatment shredding	Gravity separation	Recycle all plastic and metal pieces
Collect syringes in reusable sharps container	Transport	Central storage	Microwave treatment	Post-treatment shredding	Gravity separation	Recycle all plastic and metal pieces
Collect syringes in reusable sharps container	On-site storage or local transport & storage		Small on-site solar-powered autoclave or syringe melter	Manual grinding or	Screen separation	Recycle plastic and metal pieces, or bury residues in landfill

II – Small Scale

VACCINATION SITE	TREATMENT	→		FINAL DISPOSAL
Insert syringe in needle destroyer	Needle melting by electric arc	Automatic slicing of hub	Collect plastic and metal portions	Recycle plastic; recycle or bury metal pieces
Insert syringe in electric or manual needle cutter or needle remover		Needle cutting and mutilation	Collect plastic and metal portions	Recycle plastic; bury or encase metal pieces in cement

III – Medium to Large Scale

VACCINATION SITE	→	FINAL DISPOSAL
Collect syringes in safety box	On-site storage or transport & central storage	Encase in a concrete septic vault, secure with fence & sign

IV – Small Scale

VACCINATION SITE	→	FINAL DISPOSAL
Collect syringes in safety box	On-site storage or local transport & storage	Bury in a pit with cement or clay floor, secure with fence & sign

* Shown in order of decreasing priority; the selection of treatment and disposal methods depends on the amount of waste generated, local conditions, and availability of resources.

Beneficiaries of the Philippine Follow-Up
Measles Elimination Campaign