Department of Health
Manila

Foreword

In these times of heightened environment consciousness, addressing the issue of proper health care waste disposal is of paramount concern not only for environmentalists or other members of the health sector but for the whole society as well, most especially for the agencies involved in the regulation of this very vital element.

The Clean Air Act (CAA) of 1999 and the Ecological Solid Waste Management (ESWM) Act of 2000 which both push for reforms in the management of health care waste highlight the imperative to deal with this issue squarely.

Thus, in order to widely disseminate the proper use of existing technology and knowledge on this particular concern, this revised **Health Care Waste Management Manual** was conceived and produced, in close collaboration with other government agencies, civil society, the academe and various professional groups.

This Manual provides practical information regarding safe, efficient and environment-friendly waste management options. It also contains, in detail, safety procedures attendant to the collection, handling, storage, transport, treatment and disposal of health care waste.

We hope that this will serve as a useful guide in the planning, implementation, monitoring and evaluation of the Health Care Waste Management Programs of hospitals, health centers, laboratories, pharmaceutical firms, blood banks and other health-related establishments.

With the dissemination and strict adherence to the measures contained herein, we aim to promote the health and welfare of our people and protect them from the risks and hazards of exposure to health care waste.

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Acronyms

AIDS	Acquired Immune Deficiency Syndrome
BOD	Biochemical Oxygen Demand
CHD	Center for Health Development
COD	Chemical Oxygen Demand
DBP	Development Bank of the Philippines
DENR	Department of Environment and Natural Resources
DNA	Dioxy Ribo-nucleic Acid
DOH	Department of Health
ECC	Environmental Compliance Certificate
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EISCP	Environmental Infrastructure Support Credit Program
EMB	Environmental Management Bureau
EOHO	Environmental and Occupational Health Office
EUFS	Environmental User Fee System
FIFO	First In, First Out
HCHO	Formaldehyde
HDPE	High Density Polyethylene
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
HWMC	Health Care Waste Management Committee
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
IMS	Information Management Service
IRR	Implementing Rules and Regulations
IV	Intravenous
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
NaOCl	Sodium Hypochlorite

PD	Presidential Decree
PNRI	Philippine Nuclear Research Institute
PPE	Personal Protective Equipment
PVC	Polyvinyl chloride
RA	Republic Act
RPS	Radiation Protection Section
TSS	Total Suspended Solids
UV	Ultraviolet
WHO	World Health Organization
WMO	Waste Management Officer

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CHAPTER 1

INTRODUCTION

1.1 Background

The management of health care waste in the country is driven by concerns about adverse health and environmental effects, uncertainty regarding regulations, and the negative perceptions by waste handlers. Although significant progress has been made on health care waste management, two (2) studies conducted by the Department of Health (DOH) namely, the Waste Management Practices of DOH-Retained Hospitals in 1995 and the Waste Management Practices of Private and Government Hospitals in Metro-Manila in 1997, indicated the need to introduce modifications to the existing health care waste management practices. Some of the most common problems identified are inadequate waste management, lack of awareness about the health hazards, insufficient financial and human resources and poor control of waste disposal.

In response, the Environmental and Occupational Health Office (EOHO), DOH in consultation with other stakeholders initiated the revision of the existing Hospital Waste Management Manual (EHS-DOH, 1997). The primary purpose of this revision is to assist facility administrators in evaluating their operations in order to improve the health care waste management practices. It also aims to promote the use of appropriate technologies and to communicate with health care personnel as well as to the public the risks associated with health care waste.

1.2 Coverage

This manual is designed for use by many different classifications of workers within the health care facilities, local government units (LGU) and private service providers who are involved in the generation, handling, storage, treatment, and disposal of health care waste. The major target groups of this manual are individuals responsible for overseeing the health care waste stream. The unit in-charge of health care waste management should be the first to become familiar with this manual so that they can oversee implementation of the program throughout the health care facility.

1.3 Outcome

Hospitals and other health care establishments have the responsibility of ensuring that there are no adverse health and environmental consequences on their handling, storage, treatment and disposal of health care waste. Through this manual, health care establishments will be able to install a more appropriate waste management system that could provide other benefits such as:

i. Improved regulatory compliance;

ii. Protection of human health by reducing the exposure of employees, patients, watchers, and entire community to hazardous health care waste in the work environment;

iii. Enhance community relations by demonstrating a commitment to environmental protection;

iv. Economic benefits resulting from pollution prevention products that reduce and recycle waste;

v. Avoidance of long-term liability. (Health care establishments are the ones responsible for the proper management and disposal of the waste they generate.);

vi. Increased employee morale resulting from a healthier and safer work environment.

CHAPTER 2

IMPACTS OF HEALTH CARE WASTE

A framework for health care waste management should always consider health and occupational safety. There are many potential hazards associated when dealing or handling health care waste such as physical, chemical and biological hazards as well as ergonomic factors. Health care facilities should identify all these specific environmental and occupational hazards during handling, storing, treating, and disposing of health care waste. A team consisting of environmental services staff and workers who will be using the equipment as well as trained industrial hygienist, safety officer, infection control nurse, occupational health practitioner, facility engineer, and other professionals can work together to identify such hazards and ways to reduce if not to eliminate them.

Minimizing these hazards may entail the institution of administrative, engineering and medical controls including the provision of personal protective equipment. Administrative control includes proper and regular training, change of job schedules, rotation of workers. Engineering control includes the substitution of equipment/devices, change of process to a much safer method, mechanization or computerization, proper upkeep and regular maintenance of equipment/machine and imposition of warning devices. Medical control includes a written occupational health and safety program – physical examination (pre-employment and annual), regular immunization, health education, regular exercise, healthy diet and continuous medical monitoring and periodic evaluation of safety measures. Adequate and good designed personal protective equipment should be provided. These include protection for the head, face, body, arms, legs and feet.

Exposure to hazardous health care waste can result to disease or injury. The hazardous nature of health care waste maybe due to one or more of the following characteristics:

- Contains infectious agents;
- Genotoxic;
- Contains toxic or hazardous chemicals or pharmaceuticals
- Radioactive;
- Contains sharps

2.1 Persons at Risk

All individuals exposed to hazardous health care waste are potentially at risk, including those within the health care establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management. The main groups of people who are at risk of exposure to health hazards associated with health care waste are the following:

- Staff of the health care establishments such as physicians, nurses, health care auxiliaries, and hospital maintenance personnel;
- Patients in the health care establishments or receiving home care;
- Visitors, comforters, and caregivers to health care establishment;
- Personnel and workers providing support services and allied to health care establishments, such as laundries, waste handling and transportation;
- Persons transporting hazardous health care waste;

- Workers and operators of waste treatment and disposal facilities, i.e. sanitary landfill including scavengers;
- Workers in mortuaries, funeral parlors and autopsy centers; and
- General public.

2.2 Exposure to Hazardous Health Care Waste

Hazards from Infectious Waste and Sharps

Infectious waste may contain any of a great variety of pathogenic organisms. Pathogens in infectious waste may enter the human body by a number of routes: (a) through a puncture, abrasion, or cut in the skin; (b) through the mucous membrane; (c) by inhalation; and (d) by ingestion.

The presence of concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) in the waste stream represents the most acute potential hazards to health. Sharps may not only cause cuts and punctures but also infect the wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission, sharps are considered as a very hazardous class.

The principal concerns are infections that may be transmitted by subcutaneous introduction of the causative agent, e.g, viral blood infections. Hypodermic needles constitute an important part of the sharps waste category and are particularly hazardous because they are often contaminated with patients' blood.

The consequences of improper handling and disposal of medical waste are serious. For example, the reuse of improperly discarded needles by IV users or accidental needle-sticks injuries as recyclers sifting through waste dumps could lead to the spread of hepatitis, AIDS and other blood-borne diseases. Epidemiological studies show that exposure to pollutants from medical waste incinerators increases the risk of various types of cancers and heart diseases.

The elements required for infection in the context of medical waste are:

- Some components of medical waste are potential reservoirs of disease-causing microorganisms (culture dishes, liquid blood, pathological waste, etc.).
- The infective dose depends on the virulence of the microorganisms, the portal of entry, and the susceptibility of the host.
- Modes of transmission may involve contact (e.g., contaminated needles or blood splatter), vehicle-borne (e.g., contaminated wastewater), airborne (e.g., aerosolized pathogens from broken culture dishes or the rupture of yellow bags), and vector-borne transmission (e.g., rodents in a medical waste storage area).
- Portals of entry include breaks in the skin and mucous membranes (e.g., needle-stick injuries or blood splashes into the mucous membranes), the respiratory tract (inhalation of pathogenic aerosols), etc.

- Potential susceptible host include health care workers, waste handlers, patients and visitors in the health care facility, landfill operators, scavengers, and the public, in general.

Hazards from Chemical and Pharmaceutical Waste

Although chemical and pharmaceutical products may be found in small quantities in health care waste, these substances are hazardous. They may cause intoxication, either by acute or by chronic exposure, and injuries, including burns. Intoxication can result from absorption of a chemical or pharmaceutical substance through the skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes, or the mucous membranes of the airways can be caused by contact with flammable, corrosive, or reactive chemicals (e.g. formaldehyde and other volatile substances). The most common injuries are burns. Disinfectants such as chlorine and sodium hypochloride are particularly important members of this group; they are used in large quantities and are often corrosive. It should be noted that reactive chemicals might form highly toxic secondary compounds.

Hazards from Genotoxic Waste

Inhalation of dust or aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals, or waste and ingestion are the main pathways of exposure to genotoxic substances. The severity of the hazards also depends on the mode of exposure (inhalation, dermal contact, etc.). Exposure to genotoxic substances may also occur during the preparation of treatment with particular drugs or chemicals or through contact with bodily fluids and secretions of patients undergoing chemotheraphy.

Many cytotoxic drugs are extremely irritating and have harmful local effects after direct contact with skin or eyes. They may also cause dizziness, nausea, headache, or dermatitis. Special care in handling genotoxic waste is therefore essential; any discharge of such waste into the environment could have disastrous ecological consequences.

Hazards from Radioactive Waste

Health effects caused by exposure to radioactive substances or materials contaminated with radioactivity can range from reddening of the skin and nausea to more serious problems such as cancer induction and genetic consequences to succeeding generations of the exposed individual. The handling of high activity sources, e.g. certain sealed and unsealed radiation sources used in cancer therapy poses higher health risks such that adequate protection measures have to be established to minimize these risks. The health hazards from low activity contaminated wastes may arise from external and internal exposures from undetected contaminated working environment and improper handling and storage of radioactive wastes and spent/unused radiation sources. Both the workers and other staff personnel are at risk to this health hazard.

2.3 Impacts of Health Care Waste to Public Health and the Environment

Apart from the risk to the patients and health care personnel, consideration must be given to the impact of health care waste to the general public and the environment. In particular, attention should be paid to the possible pollution of the air, water and soil including the aesthetic aspects. Minimizing the risk to public health and the environment will require actions to deal with health care waste within the health care establishment such as proper waste segregation and minimization so that it does not enter the waste stream requiring disposal.

While the hospital personnel are at greater risk of infection through injuries from contaminated sharps, other hospital workers and waste management operators outside of the health care establishment are also at risk. Certain infection, however, spread through media or caused by more resilient agents, may pose a significant risk to the public. For example, the uncontrolled discharges of sewage from field hospitals treating cholera patients are a potential source of cholera epidemic. Feces and urine from patients in isolation wards should be disinfected before disposal in the sewer. However, the use of strong disinfectants should be minimized when there are alternatives.

Chemicals used in health care establishments are a potential source of water pollution via the sewer system. Chemical waste survey is a prerequisite to the development of an effective waste management program. Any hazardous chemical waste generated should be dealt with by a proper chemical waste management system. Substituting chemicals with lesser environmental and health impacts than those presently in use is a sound practice.

In addition, the public is very sensitive about the visual impact of anatomical waste, that is, recognizable body parts, including fetuses. The present culture in the country do not accept the disposal of anatomical waste inappropriately, such as on a landfill.

CHAPTER 3

HEALTH CARE WASTE

3.1 Definition

"Health care waste" includes all the waste that is generated or produced as a result of any of the following activities:

- Diagnosis, treatment, or immunization of human beings or animals;
- Research pertaining to the above activities;
- Production or testing of biologicals; and
- Waste originating from minor or scattered sources.

3.2 Categories of Health Care Waste

1) *General Waste* - Comparable to domestic waste, this type of waste does not pose special handling problem or hazard to human health or to the environment. It comes mostly from the administrative and housekeeping functions of health care establishments and may also include waste generated during maintenance of health care premises. General waste should be dealt with by the municipal waste disposal system.

2) *Infectious Waste* – This type of waste is suspected to contain pathogens (bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. This includes:

   - Cultures and stocks of infectious agents from laboratory work;
   - Waste from surgery and autopsies on patients with infectious diseases (e.g. tissues, materials or equipment that have been in contact with blood or other body fluids);
   - Waste from infected patients in isolation wards (e.g. excreta, dressings from infected or surgical wounds, clothes heavily soiled with human blood or other body fluids);
   - Waste that has been in contact with infected patients undergoing haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable towels, gowns, aprons, gloves, and laboratory coats);
   - Infected animals from laboratories; and
   - Any other instruments or materials that have been in contact with infected persons or animals.

3) *Pathological Waste* - Pathological waste consists of tissues, organs, body parts, human fetus and animal carcasses, blood and body fluids. Within this category, recognizable human or animal body parts are also called anatomical waste. This category should be considered as a subcategory of infectious waste, even though it may also include healthy body parts.

4) *Sharps* - Include needles, syringes, scalpels, saws, blades, broken glass, infusion sets, knives, nails and any other items that can cause a cut or puncture wounds. Whether or not they are infected, such items are usually considered as highly hazardous health care waste.

5) *Pharmaceutical waste* - Includes expired, unused, spilt, and contaminated pharmaceutical products, drugs, vaccines, and sera that are no longer required and need to be disposed of appropriately. This category also includes discarded items used in handling of pharmaceuticals such as bottles or boxes with residues, gloves, masks, connecting tubing and drug vials.

6) *Genotoxic Waste* - Genotoxic waste may include certain cytostatic drugs, vomit, urine, or feces from patients treated with cytostatic drugs, chemicals, and radioactive materials. This type of waste is highly hazardous and may have mutagenic, teratogenic, or carcinogenic properties.

   Harmful cytostatic drugs can be categorized as follows:

   - Alkylating agents: cause alkylation of DNA nucleotides, which leads to cross-linking and miscoding of the genetic stock;

   - Anti-metabolites: inhibit the biosynthesis of nucleic acids in the cell; mitotic inhibitors: prevent cell replication

   Cytotoxic wastes are generated from several sources and include the following:

   - Contaminated materials from drug preparation and administration, such as syringes, needles, gauges, vials, packaging; outdated drugs, excess (left over) solutions, and drugs returned from the wards;

   - Urine, feces, and vomit from patients which may contain potentially hazardous amounts of the administered cytotoxic drugs or of their metabolites and which should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration.

7) *Chemical Waste* - Chemical waste consists of discarded solid, liquid, and gaseous chemicals, for example from diagnostic and experimental work and from cleaning, housekeeping, and disinfecting procedures. Chemical waste from health care may be hazardous or non-hazardous.

   Chemical waste is considered hazardous if it has at least one of the following properties:

   - Toxic
   - Corrosive (e.g. acids of pH <2 and bases of pH >12)
   - Flammable
   - Reactive (explosive, water-reactive, shock-sensitive)
   - Genotoxic (e.g. cytostatic drugs)

   Non-hazardous chemical waste consists of chemicals with none of the above properties, such as sugars, amino acids, and certain organic and inorganic salts.

8) *Waste with high content of heavy metals* - Wastes with a high heavy-metal content represent a subcategory of hazardous chemical waste, and are usually highly toxic. Mercury wastes are typically generated by spillage from broken clinical equipment (thermometers, blood pressure gauges, etc.). Whenever possible, spilled drops of mercury should be recovered. Residues from dentistry have high mercury content. Cadmium waste comes mainly from discarded batteries. Certain "reinforced wood panels" containing lead is still being used in radiation proofing of X-ray and diagnostic departments. A number of drugs contain arsenic but these are treated here as pharmaceutical waste.

9) *Pressurized Containers* - Many types of gas are used in health care and are often stored in pressurized cylinders, cartridges, and aerosol cans. Many of these, once empty or of no further use (although they may still contain residues), are reusable, but certain types notably aerosol cans, must be disposed of. Whether inert or potentially harmful; gases in pressurized containers should always be handled with care; containers may explode if incinerated or accidentally punctured.

10) *Radioactive Waste* – Includes disused sealed radiation sources, liquid and gaseous materials contaminated with radioactivity, excreta of patients who underwent radio-nuclide diagnostic and therapeutic applications, paper cups, straws, needles and syringes, test tubes, and tap water washings of such paraphernalia. It is produced as a result of procedures such as in vitro analysis of body tissues and fluids, in vivo organ imaging, tumor localization and treatment, and various clinical studies involving the use of radioisotopes. Radioactive health care wastes generally contain radionuclides with short half-lives, which lose their activity in a shorter time. However, certain radionuclides e.g. C-14 contaminated wastes have much longer half-life, more than a thousand years, which need to be specially managed in a centralized treatment facility for radioactive wastes. The same is required for the management of disused sealed radiation sources used for cancer treatment.

3.3 Sources and Composition of Health Care Waste

Sources

Sources of health care waste include health care facilities, institutions, business establishments and other similar health care services with activities or work processes that generate / produce health care waste. Activities or processes that produce health care waste, which include, but not limited to, a provider of health care services. Below are examples of facilities that generate health care waste:

1) Hospitals

2) Clinics

- Medical
- Veterinary
- Health care centers and dispensaries
- Alternative medicine
- Dental
- Maternity and Lying-in
- Dialysis centers
- Physician Offices

3) Laboratories and Research Centers

- Medical and biomedical laboratories
- Medical research centers and institutions
- Blood banks and blood collection services
- Biotechnology laboratories
- Animal research and testing
- Nuclear medicine laboratories

4) Drug Manufacturers

5) Institutions

- Medical
- Nursing homes
- Dental
- Paramedics
- Nursing
- Drug rehabilitation centers
- Veterinary

6) Mortuary and Autopsy Centers

7) Ambulances and Emergency Care

8) Home Treatment (e.g. Dialysis, Insulin injection, etc.)

9) Cosmetic Ear Piercing and Tattoo Parlors

Composition

The type of source often characterizes the composition of wastes. For example, the different units within the health care establishment would generate waste with the following characteristics:

- *Medical wards* – mostly general waste; a limited amount of infectious waste such as blood-soaked dressings, bandages, and sticking plaster; contaminated gloves, contaminated packaging and disposable medical items; used or unused hypodermic needles and intravenous sets; and certain body fluids.

- *Operating theatres and surgical wards* – general waste (including packaging); pathological and anatomical waste, including tissues, organs, products of conception and body parts, other potentially infectious wastes (blood soaked gauze and materials, contaminated gloves, tubing, body fluid containers, and sharps).

- *Other health care units* - mostly general waste with small percentage of infectious waste (mostly sharps).

- *Laboratories* - general waste (including packaging and containers), pathological (including some anatomical) wastes, tissue samples, microbiological cultures and stocks, blood and body fluids, contaminated gloves, tubing and containers, sharps, possibly some radioactive materials, a large number of chemicals. Many tissue samples will come packed in formalin or will be put in containers with formalin. They will no longer be infectious, but the tissue sample and the formalin must be separated creating a chemical and a pathological waste for proper disposal.

- *Pharmaceutical and chemical stores* - mainly general waste, product packaging, small quantities of pharmaceutical and chemical wastes (if stocks are properly managed to prevent large quantities from expiring), possibly cytotoxic drugs, if chemotherapy treatment are prepared in the pharmacy.

- *Support units* - general waste only.

Health care waste from other sources generally has the following composition:

- *Health care provided by nurses* – general waste, a limited amount of infectious and some sharps
- *Physician's offices* – general waste, a limited amount of infectious and some sharps
- *Dental clinics and dentist's offices* - general waste, a limited amount of infectious, sharps and waste with high heavy metal content
- *Home health care* (e.g. dialysis, insulin injections) - general waste, a limited amount of infectious waste, and sharps.

CHAPTER 4

HEALTH CARE WASTE MINIMIZATION

4.1 Waste Minimization

The waste management hierarchy consists of source reduction, recycling, treatment and residuals disposal. In addressing waste management, waste minimization basically utilizes the first two elements that could help reduce the bulk of health care wastes for disposal. Waste minimization is beneficial not just to the waste-receiving environment but to the waste producers also. The cost for both the purchases of goods and for waste treatment and disposal are reduced and the liabilities associated with the disposal of health care waste is lessened. The extent to which a hazardous waste minimization program is implemented depends upon the health care establishment's particular operations and procedures.

If waste minimization is to be undertaken by the health care facility, it is important to develop a good baseline data of the amount of waste generated prior to implementation of the waste minimization program. Health care waste generation data from the various units of the health care facility should be properly recorded on a chart with the amount of waste displayed in descending order. This method can be used easily to determine the highest waste generating areas in which the minimization strategies should be initiated. This information should be displayed and communicated throughout the facility.

The waste minimization strategy should be formally approved in writing by the top management within the health care facility as a demonstration of their support and commitment to the program.

4.2 Principles of Waste Minimization

- Identify baseline waste generation rates, current hazardous waste management strategies, and current waste management costs.
- Health care establishment operators/owners must be committed to waste minimization for it to be successful and sustainable in the long run.
- Waste minimization programs should include a written policy with specific goals, objectives, and timeliness.
- Train employees in hazardous waste handling and site specific waste minimization methods.
- Be aware of and keep updated on the hazardous materials regulations.

Health care waste minimization is centered on the elimination or reduction of the health care waste stream. There are several measures that can be instituted to achieve waste minimization including the following:

1) *Reduction at source*

Some reduction involves measures that either completely eliminate use of a material or generate less waste. Examples are: improving housekeeping practices to eliminate use of chemical air fresheners (which only serve to masks odors and release toxic compounds such as formaldehyde, petroleum distillates, p-dichlorobenzene, etc.); replacing mercury thermometers with digital electronic thermometers; working with suppliers to reduce packing of the products; and substituting a non-toxic biodegradable cleaner for a hazardous chemical cleaner.

2) *Re-use*

Reuse is not only finding another use for a product but, more importantly, reusing product over and over again for a given function as intended. Promoting re-use entails the selection of reusable rather than disposable products whenever possible. Reuse will also entail setting reliable standards for disinfection and sterilization of equipment and materials for use.

3) *Recycling*

Recycling is collecting waste and processing it into something new. Many items in the hospital can be recycled. Items such as organics, plastic, paper, glass and metal can be recycled easily.

4) *Segregation of Waste*

Segregation is an important step to waste management. There are several reasons to undertake waste segregation:

- Segregation minimizes the amount of waste that needs to be managed as bio-hazardous or hazardous waste (since mixing non-infectious waste with infectious or hazardous waste renders the combined amount as infectious or hazardous respectively);

- Segregation facilitates waste minimization by generating a solid waste stream which can be easily, safely, and cost-effectively managed through recycling or composting;

- Segregation reduces the amount of toxic substances release to the environment through disposal of general waste (e.g., by removing mercury from general waste).

- Segregation makes it easier to conduct assessments of the quantity and composition of different waste streams thereby allowing health care facilities to obtain baseline data, identify options, determine waste management costs, and assess the effectiveness of waste minimization strategies.

5) *Composting*

Composting is another important strategy to minimize waste such as food discards, kitchen waste, cardboard, and yard waste. Some hospitals in other countries have also successfully composted placenta waste. Sufficient land space for on-site composting far enough from patient care and public access area would be needed. Food scraps can provide most of the nitrogen while bulking agents commonly found in hospitals such as cardboard and wooden chips could provide carbon. Composting techniques range from simple un-aerated static piles to aerated windrows to vermi-composting. The resulting rich compost can be sold or donated to local farmers and gardeners or used for plants around the health care facility grounds.

4.3 Implementing Waste Minimization Strategies

Implementing workable health care waste minimization practices should be incorporated into the on-going operations of the health care facility through policy directives to staff. The implementation should consider the following:

- Applying health care waste minimization strategies to specific areas of the facility
- Tracking the waste minimization efforts and comparing the results with the waste data gathered during the assessment phase of the program
- Documenting results and studying the system for continuous improvement
- Evaluating the waste minimization process to document success, determine training efficiency and needs
- Instituting policy directives incorporating improved health care waste minimization processes
- Planning new health care waste minimization pilot projects for further waste reduction

4.4 Examples of Policies and Practices That Encourage Waste Minimization

Reduction of Waste at source

- Purchase/select supplies and materials that are less wasteful and less hazardous
- Use less hazardous method in cleaning (e.g. steam disinfection instead of chemical disinfection)

  <u>Management and control measures at hospital level</u>

  - Centralized purchasing of hazardous chemicals
  - Monitoring of chemical flows within the health facility from receipt as raw materials to disposal as hazardous waste

  <u>Stock management of chemical and pharmaceutical products</u>

  - Systematize use of product "first in, first out (FIFO)"
  - Frequent ordering of relatively small quantities rather than large amounts at one time (applicable in particular to unstable products/unpredictable consumption rate)
  - Use all the contents of each container
  - Checking of the expiry date of all products at the time of delivery and based on its optimum consumption rate

Recycling and Reuse

Waste contaminated with radioactivity such as plastic and paper cups, disposable gloves, syringes and needles may not be recycled and reused unless the radioactivity levels are below the clearance levels established by the Philippine Nuclear Research Institute (PNRI) for specific radionuclides.

Health care facilities generate large amount of waste and end up throwing away valuable resources into landfills. Keeping recyclables out of the landfill, and returning them as resources to be processed again, hospitals decrease the burden placed on the environment. Safe reuse and recycling process is an important practice in health care facilities to prevent excess waste whenever possible.

Medical and other equipment used in health care establishments may be reused provided that it is designed for the purpose and will withstand the sterilization process. Reusable items may include certain sharps, such as scalpels, glass bottles and containers. After use, these should be collected separately from non-reusable items, carefully washed and sterilized by the DOH-approved method such as autoclaving. Plastic syringes and catheters should not be thermally or chemically sterilized nor reused but should be properly discarded.

Certain types of container may be reused provided that they are carefully washed and disinfected. Pressurized gas containers, however, should generally be sent to specialized centers to be refilled. Containers that once held detergents or other liquid may be reused as containers for sharps waste (if purpose-made containers are not affordable) provided that they are puncture proof and correctly and clearly marked on all sides. Recycling of papers, metals, glass and plastics can result in savings for the health care facility either through reduced disposal costs or through payments made by the recycling company.

In determining the economic viability of recycling, it is important to take account of the cost of alternative disposal methods and not just the cost of the recycling process and the value of the reclaimed material.

4.5 Basic Steps in the Development of a Waste Minimization Program

There are five basic stages in the development of a waste minimization program: planning and organization, assessment, feasibility analysis, implementation, and periodic inspection.

Planning and Organization

The initial stage entails getting top management to be committed to waste minimization (as reflected in a formal policy statement), setting overall goals, finding “champions” who can provide the initiative and energy to sustain the program, and creating a task force to get crucial personnel from key departments involved.

Assessment

The assessment phase begins with establishing a baseline of how much is being produced and by whom. This involves gathering data regarding waste streams, processes and operations, types of practices, information on input materials and economic information. A waste audit is a valuable tool for the assessment phase, providing data on the sources of waste, compositions, generation rates and waste flow within the facility. Waste analysis involves preparation, data collection, analysis, and recommendations. Preparation entails defining goals, planning, enlisting the cooperation of key personnel and department heads, and a preliminary "walk through survey" of the facility. Data can be collected in-house using self-audit forms and questionnaires. Another approach is to employ an outside consultant. Data collected for a few days provides a snapshot of the waste flow. Collecting data for two or more weeks requires greater staff effort but it may reveal important variations.

From the data, one establishes the flow of waste and generation rates of every unit of the facility. Data on waste composition can be used to evaluate segregation practices. A waste analysis can uncover inefficiencies, reveal the true costs of waste management, and show the levels of compliance to policies. It is useful to prioritize waste streams based on quantity, toxicity, environmental impact, potential liability, cost and other factors. An assessment team of selected staff should review the data and come up with waste minimization options, which may involve determining recycling equipment, changing purchasing policies, improving inventory management, product substitutions, or changing procedures or processes.

Feasibility Analysis

In the feasibility analysis phase, a technical and economic evaluation of possible waste minimization options is conducted. Among the criteria for technical evaluation are worker safety, maintaining quality of service, compatibility with existing operating procedures and schedules, minimal disruption, and space availability. The economic evaluation could use standard measures of comparative analysis such as payback period and return on investment.

Implementation

The final phase is implementation. This entails obtaining top management approval, launching educational and communication programs, installing new equipment or initiating new procedures and evaluating performance. A pilot project or demonstration may be necessary to evaluate an option before final installation. Measures to assess the effectiveness of waste minimization include comparing recorded quantities of waste based on the number of patients per day or comparing the cost of waste disposal before and after implementation.

Educational and communication programs are key factors. These programs must be designed to reach out to the entire staff, tap existing channels of education, provide education on a continuing basis especially for new staff, and respond to feedback from employees. Documenting, publicizing, and celebrating successes as well as rewarding individuals and departments, provide incentives for greater staff support and participation in waste minimization.

Periodic Inspection

Regular monitoring and evaluation could uncover problems, identify areas that need improvement, and reveal new issues that may arise in managing waste. Regular inspection provides an opportunity to educate staff further and reinforce good practices.

CHAPTER 5

WASTE HANDLING, COLLECTION, STORAGE, AND TRANSPORT

5.1 Waste Segregation and Storage

The effective management of health care waste considers the basic elements of waste minimization, segregation and proper identification of the waste. In the past, there were no incentives to separate, recycle, or reduce waste. Appropriate handling, treatment and disposal of waste by type reduce costs and do much to protect public health. Segregation at source should always be the responsibility of the waste producer. Segregation should take place as close as possible to where the waste is generated and should be maintained in storage areas and during transport.

Segregation is the process of separating different types of waste at the point of generation and keeping them isolated from each other. Appropriate resource recovery and recycling technique can be applied to each separate waste stream. Moreover the amount of hazardous waste that needs to be treated will be minimized or reduced subsequently prolonging the operational life of the disposal facility and may gain benefit in terms of conservation of resources.

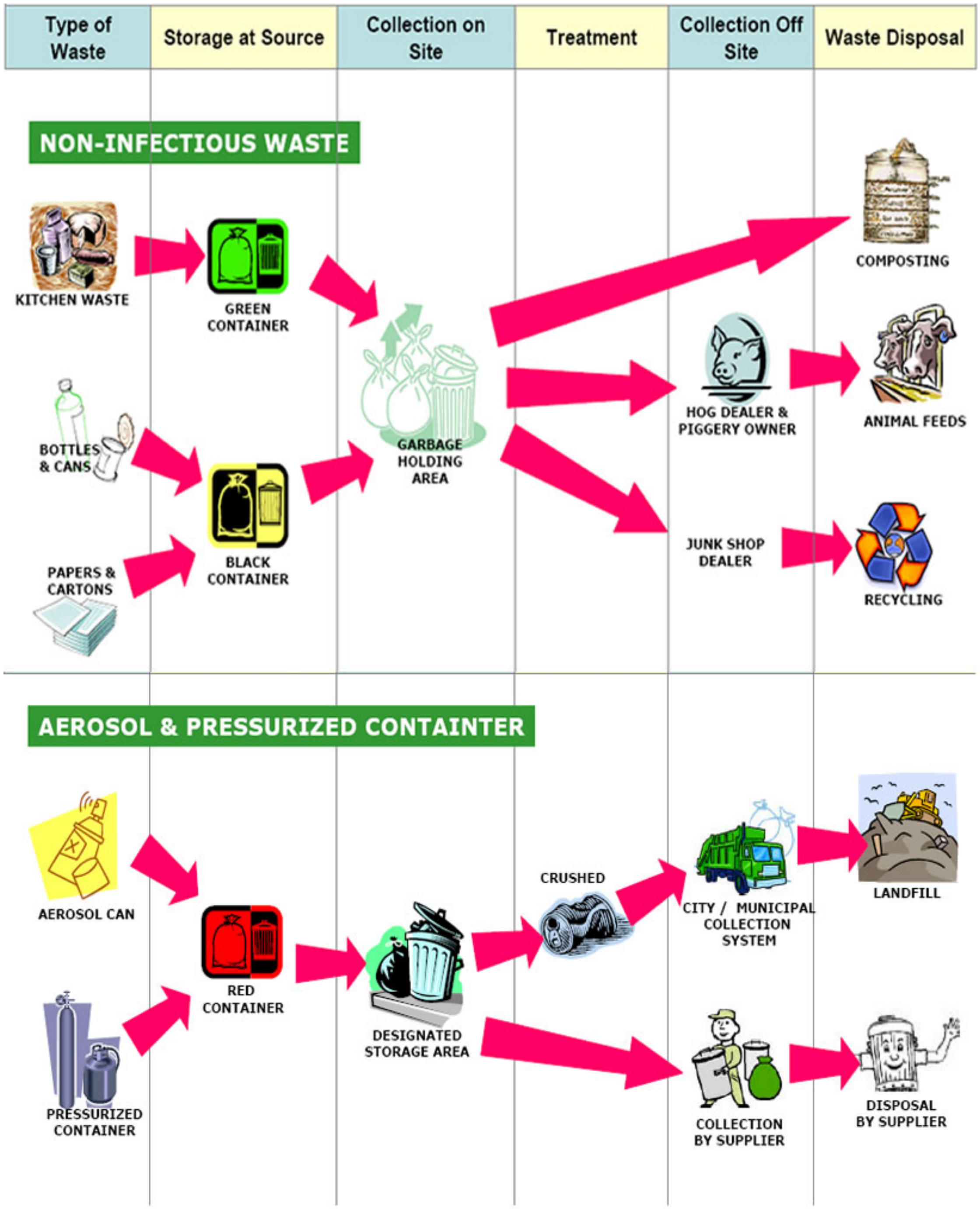
Hazardous waste should be placed in clearly marked containers that are appropriately labeled for the type and weight of the waste. Except for sharps and fluids, hazardous wastes are generally put in plastic bags, plastic lined cardboard boxes, or leaked proofed containers that meet specific performance standards.

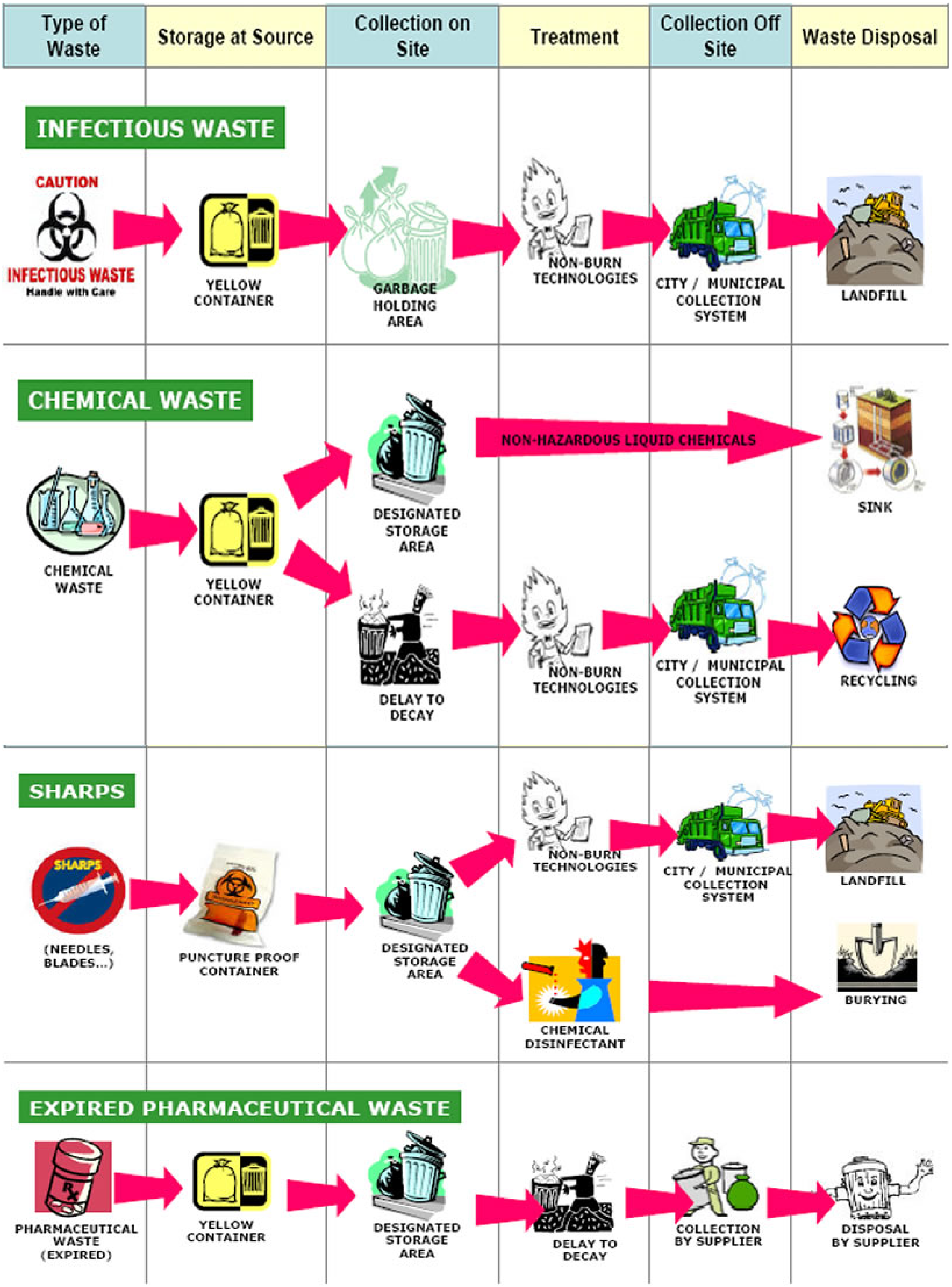
To improve segregation efficiency and minimize incorrect use of containers, proper placement and labeling of containers must be carefully determined. General waste containers placed beside infectious waste containers could result in better segregation. Too many hazardous waste containers tend to inflate waste volume but too few containers may lead to non-compliance. Minimizing or eliminating the number of hazardous waste containers in patient care areas (except for sharp containers, which should be readily accessible,) may further reduce waste. Facility management should develop a segregation plan that includes staff training.

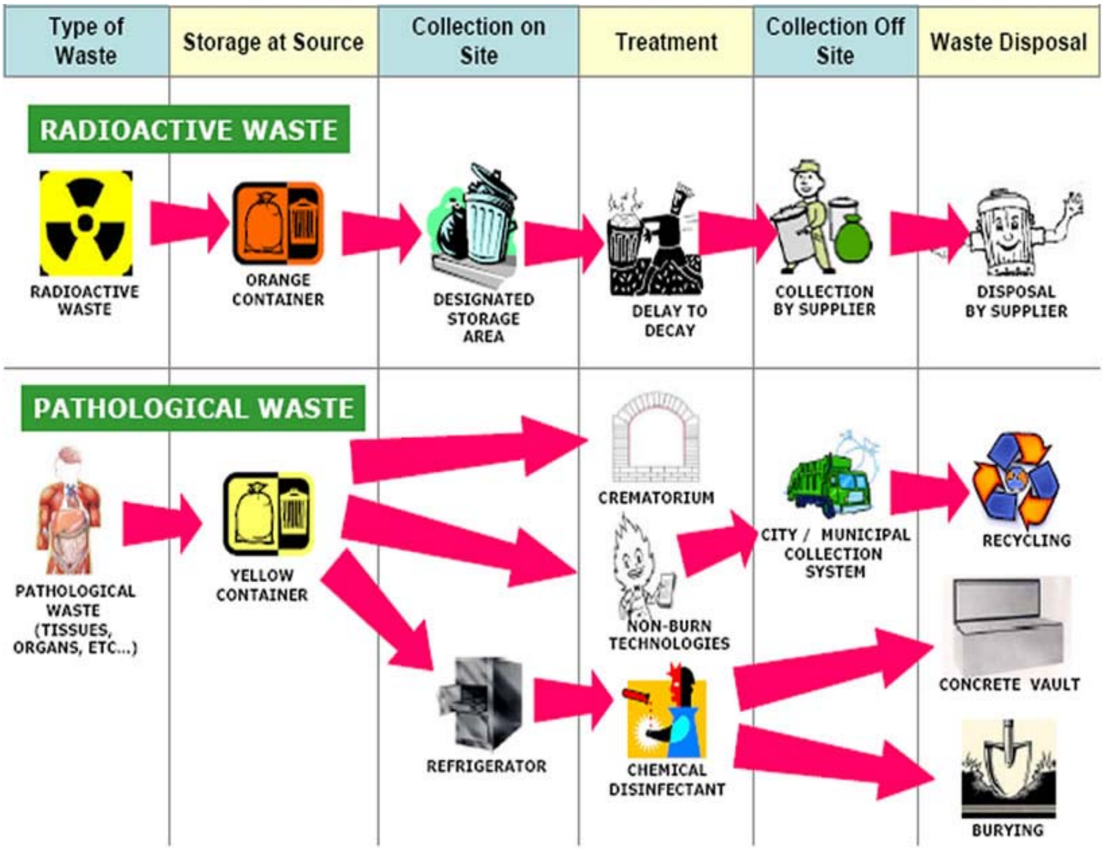
5.2 Color Coding Scheme for Health Care Waste

The most appropriate way of identifying the categories of health care waste is by sorting the waste into color-coded plastic bags or containers. Recommended color-coding scheme for health care waste is shown in Table 1.

Figure 1 Basic Steps in Health Care Waste Handling




Type of Waste
Storage at Source
Collection on Site
Treatment
Collection Off Site
Waste Disposal
INFECTIOUS WASTE
CAUTION
INFECTIOUS WASTE
Handle with Care
YELLOW CONTAINER
GARBAGE HOLDING AREA
NON-BURN TECHNOLOGIES
CITY / MUNICIPAL COLLECTION SYSTEM
LANDFILL
CHEMICAL WASTE
CHEMICAL WASTE
YELLOW CONTAINER
DESIGNATED STORAGE AREA
NON-HAZARDOUS LIQUID CHEMICALS
SINK
DELAY TO DECAY
NON-BURN TECHNOLOGIES
CITY / MUNICIPAL COLLECTION SYSTEM
RECYCLING
SHARPS
SHARPS
(NEEDLES, BLADES...)
PUNCTURE PROOF CONTAINER
DESIGNATED STORAGE AREA
NON-BURN TECHNOLOGIES
CITY / MUNICIPAL COLLECTION SYSTEM
LANDFILL
CHEMICAL DISINFECTANT
BURYING
EXPIRED PHARMACEUTICAL WASTE
PHARMACEUTICAL WASTE (EXPIRED)
YELLOW CONTAINER
DESIGNATED STORAGE AREA
DELAY TO DECAY
COLLECTION BY SUPPLIER
DISPOSAL BY SUPPLIER



Type of Waste
Storage at Source
Collection on Site
Treatment
Collection Off Site
Waste Disposal
RADIOACTIVE WASTE
RADIOACTIVE WASTE
ORANGE CONTAINER
DESIGNATED STORAGE AREA
DELAY TO DECAY
COLLECTION BY SUPPLIER
DISPOSAL BY SUPPLIER
PATHOLOGICAL WASTE
PATHOLOGICAL WASTE (TISSUES, ORGANS, ETC...)
YELLOW CONTAINER
CREMATORIUM
NON-BURN TECHNOLOGIES
CITY / MUNICIPAL COLLECTION SYSTEM
RECYCLING
CONCRETE VAULT
REFRIGERATOR
CHEMICAL DISINFECTANT
BURYING

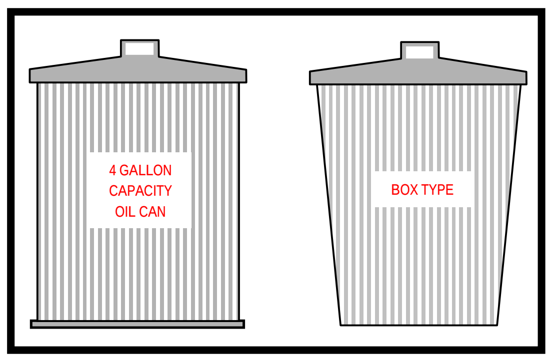
Table 1. Color-coding Scheme for Containers

Color of container/bag	Type of waste
Black	Non-infectious dry waste
Green	Non-infectious wet waste (kitchen, dietary etc.)
Yellow	Infectious and Pathological waste
Yellow with black band	Chemical waste including those w/ heavy metals
Orange	Radioactive waste
Red	Sharps and pressurized containers

Apart from the color-coding system for health care waste, the following practice should also be observed:

a. Residuals of the general health care waste should join the stream of domestic refuse or municipal solid waste for proper waste management.

Figure 2. Refuse Receptacle for General Waste with Plastic Bag Cover



b. Sharps should all be collected together, regardless of whether or not they are contaminated. Containers should be puncture proof (usually made of metal or high-density plastic) and fitted with covers. It should be rigid and impermeable to contain not only the sharps but also any residual liquids from syringes. To discourage abuse, containers should be tamper proof (difficult to open or break) and needles and syringes should be rendered unusable. Where plastic or metal containers are unavailable or too costly, containers made of dense cardboard are recommended.

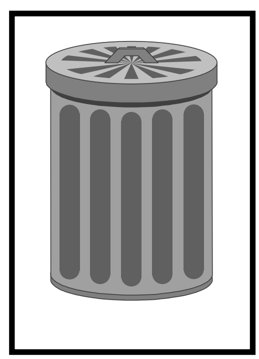


Figure 3. Refuse Receptacle for Pathological Waste lined with Heavy Gauge Plastic Bag and Cover

c. Bags and containers for infectious waste should be marked with the international infectious substance symbol.

d. Highly infectious and other hazardous waste should, whenever possible, be treated immediately by any method recommended in this manual. It therefore needs to be package in bags that are compatible with the proposed treatment process.

e. Cytotoxic waste, most of which is produce in major hospital or research facilities, should be collected in strong, leak proof containers clearly labeled "Cytotoxic wastes".

f. Radioactive wastes should be segregated according to its physical form: solid & liquid and according to its half-life or potency: short-live and lived in especially marked containers as prescribed by the pertinent regulation of the Philippine Nuclear Research Institute (PNRI) specific to such authorized practice.

g. Small amounts of chemical or pharmaceutical waste may be collected together with infectious waste.

h. Large quantities of obsolete or expired pharmaceuticals stored in hospital wards or departments should be returned to the pharmacy for disposal. Other pharmaceutical waste generated at this level, such as expired drugs or packaging containing drug residues should not be returned because of the risk of contaminating the pharmacy. It should be deposited in the specified container at the point of generation.

Figure 4. International Infectious Substance Symbol

i. Large quantities of chemical waste should be packed in chemical resistant containers and sent to specialized treatment facilities (if available). The identity of the chemicals should be clearly marked on the containers. Hazardous chemical waste of different types should never be mixed.

j. Waste with a high content of heavy metals (e.g. cadmium or mercury) should be collected separately. These wastes can be sent to waste treatment facility available in the area.

k. Aerosol containers may be collected with general health care waste once they are completely empty. Aerosol containers should not be burnt or incinerated.

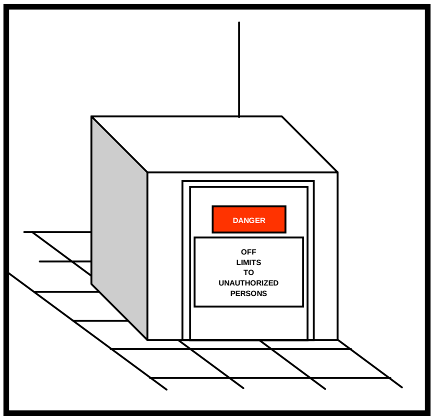


Figure 5. For Radioactive Waste and Chemical Waste

l. Appropriate containers or bag holder should be placed in all locations where particular categories of waste may be generated.

m. Staff should never attempt to correct errors of segregation by removing items from a bag or container after disposal or by placing one bag inside another bag of a different color. If general and hazardous waste are accidentally mixed, the mixture should be classified as hazardous health care waste.

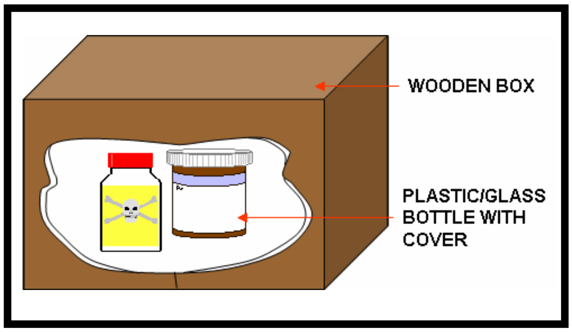


Figure 6. Perspective Angle of the Wooden Box

n. Cultural and religious constraints in certain parts of the country make it unacceptable for anatomical waste to be collected in the usual yellow bags; such waste should be disposed of in accordance with the local custom, which commonly specifies burial.

5.3 Storage

All health care waste should be collected and stored in waste storage area until transported to a designated off-site treatment facility. This area shall be marked with warning sign: **"CAUTION: BIOHAZARDOUS WASTE STORAGE AREA - UNAUTHORIZED PERSONS KEEP OUT."**

Storage areas for health care waste should be located within the establishment or research facility. However, these areas should be located away from patient rooms, laboratories, hospital function/operation rooms or any public access areas. The waste in bags or containers should be stored in a separate area, room or building of a size appropriate to the quantities of waste produced and the frequency of collection. In cases where the health care facility lacks the space, daily collection and disposal should be enforced.

Cytotoxic waste should be stored separately from other waste in a designated secured location. Radioactive waste should be stored separately in containers that prevent dispersion, and if necessary behind lead shielding. Waste that is to be stored during radioactive decay should be labeled with the type of radionuclide, the date, and details of required storage conditions. Storage facility for radioactive waste must bear the sign “Radioactive Waste” placed conspicuously. Methods of treatment and disposal of radioactive waste shall conform to the requirements and guidelines of the PNRI.

During “storage for decay”, radioactive waste should be separated according to the length of time needed for storage, for example, short-term storage (half-lives less than 30 days) and long-term storage (half-lives from 30 to 65 days). Low level radioactive waste should be stored for a minimum of ten times the half-life of the longest-lived radionuclides in the container and until radioactivity decays to background levels as confirmed by a radiation survey.

Requirements for Storage Facilities

1. The storage area should have an impermeable, hard-standing floor with good drainage; it should be easy to clean and disinfect.
2. There should be water supply for cleaning purposes.
3. The storage area should allow easy access for staff in charge of handling the waste.
4. It should be possible to lock the storage area to prevent access by unauthorized persons.
5. Easy access for waste collection vehicle is essential.
6. There should be protection from sun, rain, strong winds, floods, etc.
7. The storage area should be inaccessible to animals, insects and birds.
8. There should be good lighting and adequate ventilation.

9. The storage area should not be situated in the proximity of fresh food stores or food preparation areas.

10. A supply of cleaning equipment, protective clothing, and waste bags or containers should be located conveniently close to the storage area.

11. Floors, walls, and ceilings of the storage area must be kept clean in accordance to established procedures, which at a minimum should include daily cleaning of floors.

12. Biodegradable general and hazardous waste should not be stored longer than 2 days to minimize microbial growth, putrefaction, and odors. If the waste must be stored longer than 2 days, application of treatment like chemical disinfection or refrigeration at 4^{o}C or lower is recommended.

5.4 Collection and Transport of Health Care Waste

The proper collection and transportation is an important component in health care waste management. Its implementation requires the direct involvement of the health care facility's maintenance services, housekeeping services, motor pool service personnel and cooperation of all the health care personnel.

Health care waste collection practices should be designed to achieve an efficient movement of waste from points of generation to storage or treatment while minimizing the risk to personnel.

Suggested collection frequency on room to room basis is once every shift or as often as necessary. Time of collection regardless of category should be at the start of every shift.

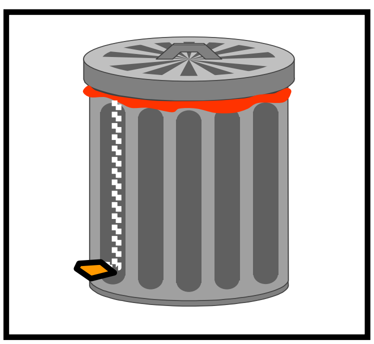


Figure 7. Foot Operated Lid Container Refuse Receptacle for Infectious Wards Lined with Heavy-Gauge Plastic Bag with Cover

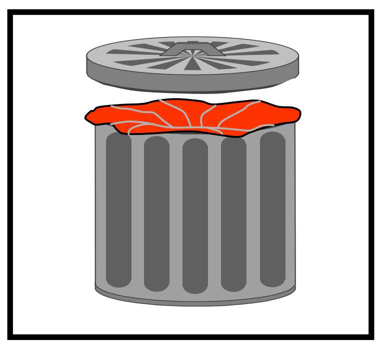


Figure 8. Refuse Receptacles for Sharps with Heavy Gauge Plastic Bag and Cover (Plastic Container)

On-site Collection

Waste should not be allowed to accumulate at the point of production. A program for their collection and transportation should be established as part of the health care waste management plan. Nursing and other clinical staff should ensure that waste bags are tightly closed or sealed when they are about three-quarters full. Light-gauge bags can be closed by tying the neck, but heavier gauge bags probably require plastic sealing tag of the self-locking type. Bags should not be closed by stapling. Sealed sharp containers should not be placed in a labeled, yellow infectious health care waste bag.

The following are recommendations that should be followed by health care personnel directly involved in waste handling and collection:

- Waste should be collected daily (or as frequently as required) and transported to the designated central storage site or waste transfer station.

- No bags should be removed unless they are labeled with their point of production (hospital ward or department) and contents.

- The bags or containers should be replaced immediately with new ones of the same type.

- A supply of fresh collection bags or containers should be readily available at all locations where waste is produced.

- Collection practice for active solid radioactive waste shall consist of distributing orange color-coded suitable containers with the radiation symbol colored magenta or black. The collection of active solid radioactive waste from designated storage area can only be made when the activity (delay-to-decay) decays to a safe level and upon the strict supervision and guidance of the radiological health and safety officer.

- Handling, collection, transport and disposal of these materials shall be based on the guidelines issued by PNRI.

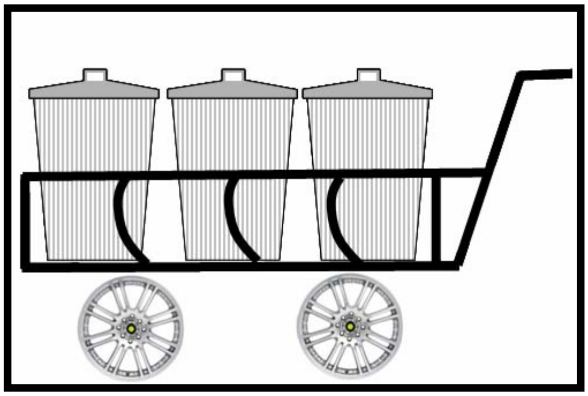
On-site Transport

Transportation of waste within the establishment could utilize wheeled trolleys, containers, or carts that are dedicated solely for the purpose. On-site transportation vehicle should meet the following specifications:

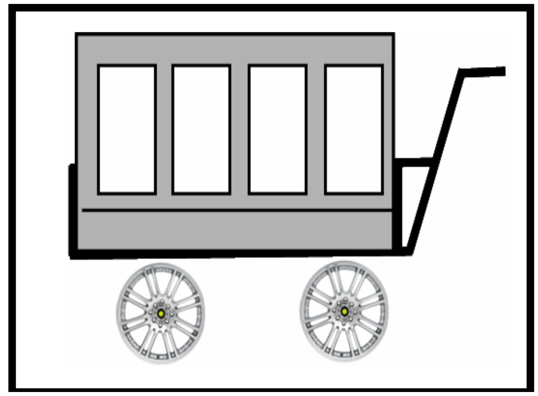
- Easy to load and unload
- No sharp edges that could damage waste bags or containers during loading and unloading
- Easy to clean

The on-site collection vehicles should be cleaned and disinfected daily with an appropriate disinfectant like chlorine compounds, formaldehyde, phenolic compounds and acids. All waste bag seals should be in-place and intact at the end of transportation.

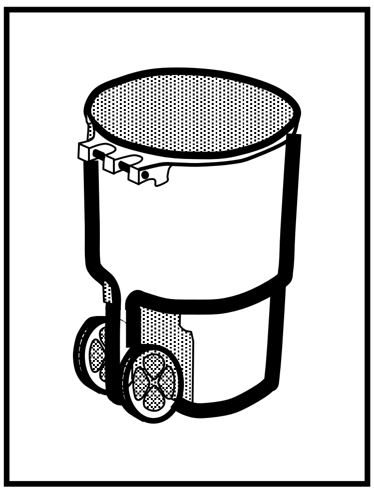
Workers transporting the waste should be equipped with appropriate personal protective equipment including heavy-duty gloves, coveralls, thick-soled boots and leg protectors.



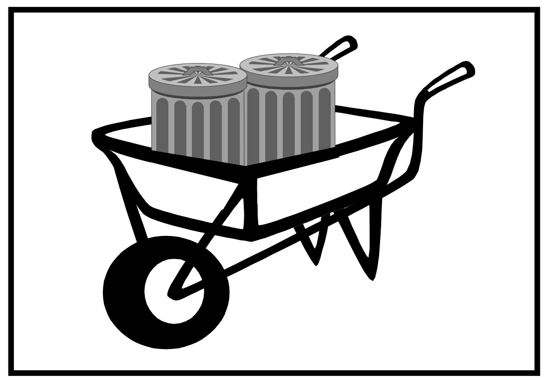
A. One Refuse Collector with a Handcart of 300 Liters (6 Bins x 50 Liters) with Plastic Bag and Cover



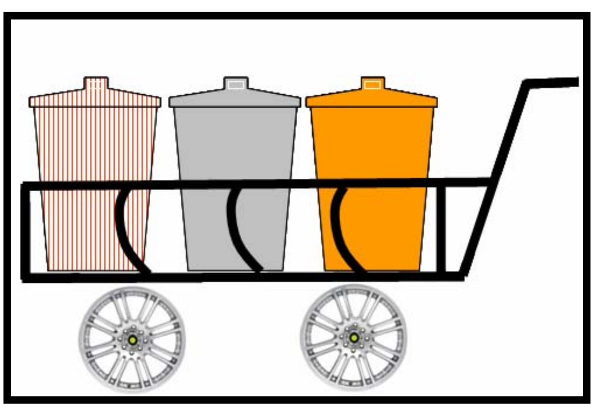
B. Bins from Handcrafts are emptied into a trailer of 6,000 Liters capacity in different coding equivalent to one-day waste (One Trailer Load of 2.4 Tons serves 7,200 people)



C. Handcraft with Round Body for refuse collection capacity from 52 Gallons emptied by dumping contents to the ground



D. Two-Bin Handcraft with total capacity 120-200 Liters according to bin size. The bins are emptied directly into a transfer facility as to color coding with plastic bag and cover.



E. Six-Bin Handcraft Suitable for daily collection of different types of hospital waste with plastic bag and cover and should conform with the color coding. Total capacity ranges from 300 to 500 liters emptied directly into a transfer capacity.

Figure 9. Examples of On-Site Collection Vehicle

Off-site Transportation of Health Care Waste

The health care waste generator is responsible for the safe packaging and adequate labeling of waste to be transported off-site for treatment and disposal. Packaging and labeling should comply with the national regulation governing the transport of hazardous wastes (RA 6969) and maintaining that it presents no danger to the public during transport. Likewise, the waste generators are ultimately responsible for ensuring that their wastes are properly treated and disposed of in an approved disposal facility.

Tracking of wastes could be done with the implementation of the consignment system.

Consignment Note

All health care waste to be transported to an approved off-site waste treatment facility shall be transported only by a DENR-accredited transporter or carrier. The authorized transporter / carrier shall maintain a completed consignment note (see Annex 4 for a prototype Consignment Note) of all health care waste taken from the health care establishment for treatment or disposal.

By the time that waste transporter receives the waste, the transporter shall provide the waste generator with a copy of the consignment note for the generator's waste records.

The transporter and the generator shall separately maintain a copy of the consignment note. The consignment note shall include, but not limited to the following information:

- The name address, telephone number, and accreditation number of the transporter, unless the transporter is the generator
- The type and quantity of waste transported
- The name, address, and telephone number of the generator
- The name, address, telephone number, permit number, and the signature of an authorized representative of the approved facility receiving the waste
- The date that the waste is collected or removed from the generator's facility, the date that the waste is received by the transfer station, or point of consolidation, if applicable, and the date that the waste is received by the treatment facility.

If the waste generators are the ones who transport the wastes or directs a member of its staff to transport the wastes to an approved waste treatment and disposal facility, the consignment note for health care wastes should show the name, address and telephone number of the wastes generator when the wastes are transported to the waste treatment and disposal facility.

The transporter or generator transporting the waste should have the consignment note in his or her possession in the vehicle while transporting the waste. The tracking document should be available upon demand by any traffic enforcement agency personnel. The transporter shall provide the facility receiving waste with a copy of the original tracking document.

Contingency Plan for Health Care Waste

The development of a plan of action should be considered in the event of an accidental spill, loss of containment, equipment failure or other unexpected circumstances.

The owner/operator of vehicles used in the transportation of health care waste should carry contingency plans for emergencies that address the following:

- Plan for the disinfection of the truck and any contaminated surface if a leaking container is discovered.

- A notification list of individual or agencies to be contacted in the event of a transportation accident.

- Clean-up and decontamination of potentially contaminated surfaces; designation of backup transportation for the health care waste, a description of the plans for the re-packaging and labeling of health care waste where containers are no longer intact.

- Procedures for the management of a leaking container.

Requirements for Packaging for Off-site Collection

Waste should be packaged in sealed bags or containers to prevent spilling during handling and transportation. The bags or containers should be robust for their content (for example: puncture proof for sharps and resistant to aggressive chemicals) and for normal conditions of handling and transportation, such as vibration or changes in temperature, humidity or atmospheric pressure. (In case of plastic bags, minimum gauge should be at least 0.009 mm)

Radioactive wastes must be packaged for off-site collection and transported in accordance with the acceptance criteria for low level radioactive wastes established by PNRI (AO No. 01 series of 1990, Annex 3).

All waste bags or containers should be labeled with the basic information about their content and about the waste generator. This information may be written directly on the bag or container or on pre-printed labels, securely attached. Basic information should include but not limited to the following:

- Type of health care waste
- Form of waste and waste category
- Date of collection
- Volume/quantity of waste
- Precautions to be taken while handling
- Emergency procedures in the event of accident or spillage
- Destination of the waste

Requirements for Off-site Collection Vehicles

Collection vehicles used for the transport of health care wastes should not be used for the transport of any other materials that could be seriously affected by contamination such as food, livestock, people or retail goods. The vehicle should have an enclosed leak proof body and capable of being locked to secure the waste. Waste can be loaded directly to especially designed vehicle, but it is safer to place them first in containers (e.g. cardboard boxes or wheeled, rigid, lidded plastic or galvanized bins). Infectious and pathological waste should be bagged in appropriate colored-coded bags or other special containers when transported. Each package should be marked or coded for easy identification. Containers should be leak-proofed and be fitted with self-sealing lid and be tight enough to withstand being spilled in the vehicle. The design of the collection vehicle must conform to the following:

- The body of the vehicle should be of suitable size commensurate with the design of the vehicle.
- The vehicle should have totally enclosed car body with the driver seat separated from the loader to prevent coming into contact with the waste in the event of collision/accident.
- There should be a suitable system for securing the load during transport.
- The vehicle should be easy to clean and the internal surface of the body should be smooth enough that allows it to be steam cleaned and with all corners/angles rounded. The vehicle should be cleaned at the end of each working day and in the event of any spillage.
- The vehicle should be marked with the name and address of the waste carrier.
- The international hazard sign should be displayed on the vehicle or container, as well as the emergency telephone number.
- Empty plastic bags, suitable protective clothing, cleaning equipment, tools, and disinfectant, together with special kits for dealing with liquid spills, should be carried in a separate compartment in the vehicle.

Routing

Health care waste should be transported through the quickest or shortest possible route and should be planned before the trip begins. After departure from the source, every effort should be made to avoid further handling. If handling cannot be avoided, it should be pre-arranged and take place in adequately designed and authorized premises. Handling requirements can be specified in the contract established between the waste generator and the transporter.

An efficient and effective collection system route should consider the following:

- Collection schedule either by route or zone
- Assignment of personnel responsible for the zone or area
- Logical planning of the route (should avoid passing the collected package of waste on congested area)
- Collection system route must be laid out from the farthest point of the designated transfer station and as collection progresses towards the collection storage area.

- Routes drawn shall be practicable and must consider the logical progression of health care waste throughout the area
- Revised routing plan should be established due to circumstances arising to alteration in the original routing plan.
- Suggested collection frequency on room to room basis is once every shift or as often as necessary. Time of collection regardless of category should be at the start of every shift.

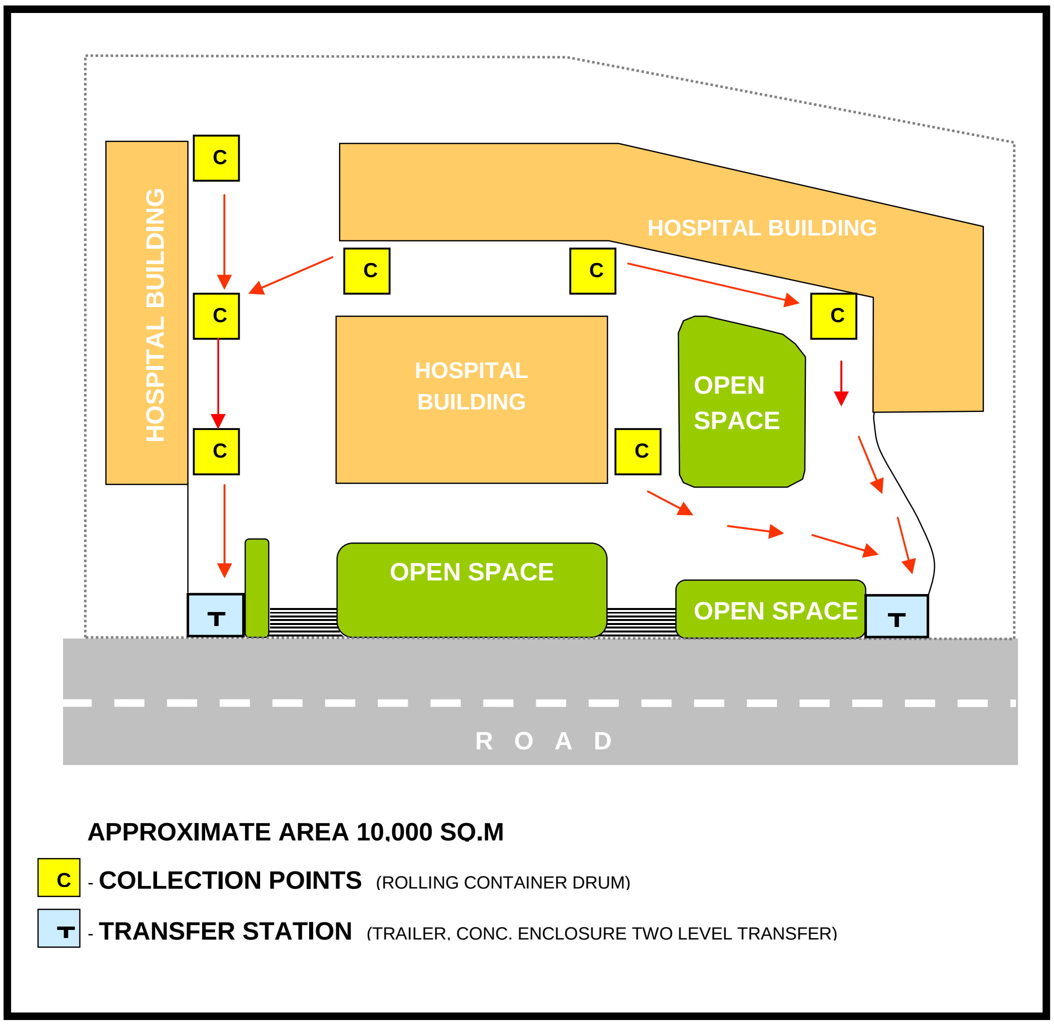
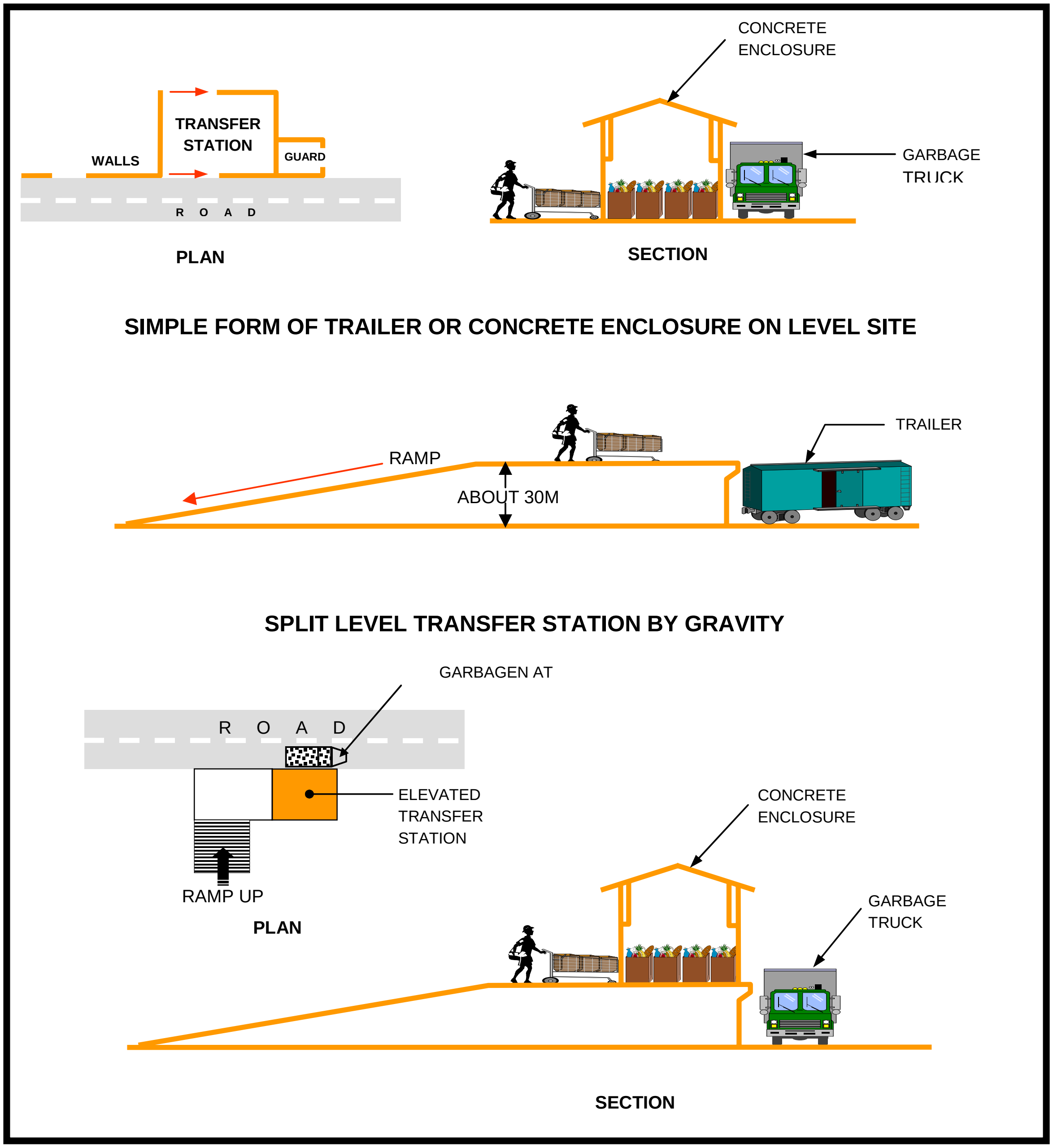


Figure 10. Typical Route Layout of Hospital Collection System

Figure 11. Simple Two-Level Transfer Station



CHAPTER 6

WASTE TREATMENT AND DISPOSAL SYSTEM

6.1 Health Care Waste Treatment

The purpose of treating health care waste is to change the biological and chemical character of the waste to minimize its potential to cause harm. There are a number of terms used to denote the level of treatment, such as decontamination, sterilization, disinfection, render harmless and kills. These terms do not provide any mechanism of measuring the degree of process efficiency. As such, it is critical that terms and criteria be established that quantitatively define the level of microbial destruction accomplished by any health care waste treatment process.

Sterilization is defined as a $6\log_{10}$ survival probability of the most resistant microorganism of concern in a given process and disinfection is defined as low, intermediate or high (using the Spaulding system) depending on the survival probability of specific microbial groups. For medical waste disinfection, however, the emerging international consensus is to define levels of microbial inactivation as follows:

Level I Inactivation of vegetative bacteria, fungi, and lipophilic viruses at a $6\log_{10}$ reduction or greater

Level II Inactivation of vegetative bacteria, fungi, lipophilic/hydrophilic viruses, parasites, and mycobacteria at a $6\log_{10}$ reduction or greater

Level III Inactivation of vegetative bacteria, fungi, lipophilic/hydrophilic viruses, parasites, and mycobacteria at a $6\log_{10}$ reduction or greater; and inactivation of B. stearothermophilus spores and B. subtilis spores at a $4\log_{10}$ reduction or greater

Level IV Inactivation of vegetative bacteria, fungi, lipophilic/hydrophilic viruses, parasites, and mycobacteria, and B. stearothermophilus spores at a $6\log_{10}$ reduction or greater

Mechanical grinding devices are sometimes introduced prior to treatment, during treatment, and/or at the end of the treatment process. A few facilities insist on shredding the health care waste either as a matter of preference or because they falsely believe that their liability will somehow be limited. Some technologies, however, depend upon shredding as an integral part of the treatment process, i.e., those systems that shred prior to treatment and during treatment. Shredders are typically a high maintenance item due to unavoidable volumes of trapped waste in the waste stream, such as high-quality stainless steel found in orthopedic blades, drills, reamers, and prosthetic devices. Glass is also inherent in the health care waste and over time, glass wears the cutting surfaces of the shredder blades. Therefore, if the facility intends to shred waste either pre- or post-treatment, anticipate that a rigorous maintenance schedule with associated cost would be required. Shredding the waste simply to render it unrecognizable makes the task more burdensome and more expensive than necessary and a cost benefit analysis should be conducted prior to making that decision. Also, consider the potential down time when the shredder is out of commission with those technologies that depend upon shredding.

Selection Criteria of Treatment Technology

On-site treatment of health care waste allows health care facility to have more control over both the waste disposal process and waste disposal cost. Treatment system maybe a cost-effective alternative and many manufacturers have already simplified their systems so that processing is relatively effortless.

Hospital and other health care establishments should perform a preliminary assessment and determine the issues that are important to the facility. Develop a list of selection criteria and rank in order of importance. In selecting a technology, the following key points should be considered:

- Treatment efficiency
- Occupational health, safety and environmental considerations
- Volume and mass reduction
- Types and quantity of wastes for treatment and disposal/capacity of the system
- Infrastructure and space requirements (investment and operational cost)
- Locally available treatment options for final disposal
- Training requirements for operation of the method
- Operation and maintenance considerations
- Location/surrounding of the treatment site and disposal facility
- Social and political acceptability
- Regulatory requirements

These criteria are also applicable in selecting off-site treatment technology for health care wastes.

Health Care Waste Treatment Technologies/Processes

Incineration used to be the method of choice in treating health care waste. However, with the implementation of the Clean Air Act of 1999, the use of this method is no longer allowed. With this development, alternative technologies are being looked into to address the problem on health care waste management using the aforementioned selection criteria.

Most common technologies and processes used in health care waste treatment are (1) thermal, (2) chemical, (3) irradiation, (4) biological processes, (5) encapsulation, and (6) inertization.

1. Thermal Processes

Thermal processes rely on high heat to destroy pathogens (disease-causing microorganisms).

- **Pyrolysis** - Pyrolysis is the thermal decomposition of substance and materials in the absence of supplied molecular oxygen in the destruction chamber in which the said material is converted into gaseous, liquid, or solid form. Pyrolysis can handle the full range of health care waste. Waste residues may be in form of greasy aggregates or slugs, recoverable metals, or carbon black. These residues are disposed of in a secure facility i.e. sanitary landfill.

- **Wet and Dry Thermal Treatment** - Wet thermal or steam disinfection is based on exposure of shredded infectious waste to high temperature, high pressure steam, and is similar to the autoclave sterilization process. It inactivates most types of microorganisms if temperature and contact time are sufficient. For sporulated bacteria, a minimum temperature of 121^{o}C is needed and exposure time of 30 minutes. For sharps, milling or crushing is recommended mainly to eliminate physical hazards from needles, render syringes unusable, and reduce waste volume as well as increasing the surface area subject to exposure to high temperature and high pressure steam subsequently increasing the efficiency of the treatment.

  - **Autoclave** - Autoclave uses steam sterilization to render waste harmless and is an efficient wet thermal disinfection process. This technique has been used for many years in hospitals for the sterilization of reusable medical equipment.

    Autoclaves come in a wide range of sizes. A typical autoclave designed for medical waste treats about 100 kg per cycle (a cycle being about 1 hour) to several hundred kilograms per cycle for larger hospitals. Autoclaves used in centralized treatment facilities can handle as much as 3,000 kg in one cycle.

    The microbial inactivation efficacy of autoclaves should be checked periodically. For autoclaves that do not shred waste during steam disinfection, color-changing indicator strips may be attached to the outside of the yellow bag in the middle of each load and that the strip be checked to ensure that steam penetration has occurred. In addition, a microbiological test (using for example commercially available validation kits containing bacillus stearothermophilus spore strips, vials or packs) should be conducted periodically.

  - **Microwave** – This technology typically incorporates some type of size reduction device. Shredding of wastes is being done either before disinfection or after disinfection. In this process, waste is exposed to microwaves that raises the temperature to 100^{o}C (237.6^{o}F) for at least 30 minutes. Microorganisms are destroyed by moist heat which irreversibly coagulates and denatures enzymes and structural proteins.

    The efficiency of microwave disinfection should be checked routinely through bacteriological and virological tests. The microwave process is widely used in several countries and is becoming popular. However, the system has a relatively high investment and operating costs. The process is inappropriate for the treatment of anatomical waste and animal carcasses, and will not efficiently treat chemical or pharmaceutical waste.

2. Chemical Disinfection

Chemical disinfection is now being applied for treatment of health care waste. Chemicals like aldehydes, chlorine compounds, phenolic compounds, etc. are added to waste to kill or inactivate pathogens present in health care waste. Chemical disinfection is most suitable in treating blood, urine, stools and sewage. This method is also applicable in treating infectious wastes containing pathogens. If possible, wastes should be shredded to increase the extent of contact between waste and the disinfectant by increasing the surface area and eliminating the enclosed space. However, application of this method should only be done when there is no available treatment facility in the area to prevent environmental problems associated with the disposal of chemical residues.

Some chemical systems use heated alkali to destroy tissues, organs, body parts, and other pathological wastes that can be used to treat contaminated animal waste and cytotoxic waste as well.

Chemotherapy waste (including bulk cytotoxic agents) can be treated by chemical decomposition. Examples are: reaction with 5% sodium hypochlorite; acid hydrolysis followed by alkaline hydrolysis; reduction using zinc powder; degradation using 30% hydrogen peroxide; or destruction using heated alkali.

Studies showed that chlorine-based technologies using sodium hypochlorite and chlorine dioxide as well as its by products in wastewater may possibly have long-term environmental effects. Non-chlorine based technologies are quite varied in the way they operate and the chemical agents they employ. Others use peroxyacetic acid, ozone gas, lime-based dry powder, acid and metal catalyst, or biodegradable disinfectants. Also, occupational and safety exposures should be monitored when using the chemical processes.

3. Biological Processes

The process uses an enzyme mixture to decontaminate health care waste and the resulting by-product is put through an extruder to remove water for sewage disposal. The technology is suited for large applications and is also being developed for possible use in agricultural sector. The technology requires regulation of temperature, pH, enzyme level, and other variable. Design application is mainly for regional health care waste treatment center.

Composting and vermiculture as biological processes for treating and disposing of placenta waste, as well as food waste, yard trimmings and other organic waste is also recommended.

4. Radiation Technology

The disposal of biologically contaminated waste from hospitals, clinics and laboratories is of particular concern. Waste containing potentially infectious microorganisms (sewage sludge, biomedical wastes, wastewater) are treated using irradiation systems which are currently being used in waste treatment operations. The four main elements of the waste handling system are: (1) identification of the contaminated waste, (2) collection, (3) sterilization and (4) final disposal or recycling.

Machines generating high energy electron beams, among other types, can sterilize a wide range of waste. If regulations permit, the processed material can then be directed to general waste disposal or recycling operations.

Sterilization is achieved by breaking down the DNA molecules of the contaminated organism. Ionizing radiation is very efficient at DNA disruption, and requires far less total energy than would be used in an equivalent thermal process. Their use in the disinfection of sewage sludge has been demonstrated on a full-scale basis at a plant near Munich, Germany; and at a biomedical waste sterilizer in Arkansas, USA for the treatment of hospital waste.

5. Encapsulation

Encapsulation involves the filling up of containers with waste, adding and immobilizing material, and sealing the containers. The process uses either cubic boxes made of high-density polyethylene or metallic drums, that are three quarters filled with sharps or chemical or pharmaceutical residues. The containers or boxes are then filled up with a medium such as plastic foam, bituminous sand and cement mortar. After the medium has dried, the containers are sealed and disposed of in landfill sites. The process is particularly appropriate for the disposal of sharps and chemical or pharmaceutical residues. The main advantage of the process is that it is very effective in reducing the risk of scavengers gaining access to the health care waste.

6. Inertization

Especially suitable for pharmaceutical waste is the process of inertization that involves the mixing of the waste with cement and other substances before disposal. This is to minimize the risks of toxic substances contained in the waste migrating into surface water or groundwater. For the inertization of pharmaceutical waste, the packaging should be removed, the pharmaceuticals ground, and a mixture of water, lime and cement added. The homogenous mass produced can be transported to a suitable storage site. Alternatively, the homogenous mixture can be transported in liquid state to a landfill and poured into municipal waste. The process is relatively inexpensive and can be performed using relatively unsophisticated equipment. The following is the typical proportion for the mixture: 65 % pharmaceutical waste, 15 % lime, 15 % cement, and 5 % water.

Siting of Waste Treatment Facilities

Some treatment facilities particularly larger ones would require a new structure to house the technology or renovate existing space. Each technology have different requirements for space, foundation, utility service connections, ventilation, and support equipment. In determining a safe location for the facility, one must take into account the safe transfer routes, average distances from waste sources, temporary storage requirements, as well as space allowances needed by workers to maneuver safely around the treatment unit. The location of the facility should not cause traffic problems as waste is brought in and out. Odor, noise, the visual impact of medical waste operations on patients and visitors, public access, and security should also be considered.

In the past, the decision involving the location of the treatment system have been the responsibility of engineers dealing with the foundation, electrical connections, sewer, HVAC (heating ventilation and air conditioning) and utilities. By taking a team approach and involving facility engineering, environmental services, housekeeping, safety or industrial hygiene, infection control, and occupational health, important aspects such as occupational safety and health become part of the decisions relative to siting and installation.

6.2 Waste Disposal Systems

Sanitary Landfill

Sanitary landfill is an engineered method designed to keep the waste isolated from the environment. Appropriate engineering preparations should be completed before the site is allowed to accept waste. There should be trained staff present on site to control operations, organize deposits and daily coverage of waste. Some essential elements for the design and operation of sanitary landfill are:

- Access to site and working areas possible for waste delivery and site vehicles
- Presence of site personnel capable of effective control of daily operations
- Division of the site into manageable phases, appropriately prepared, before landfill starts
- Adequate sealing of the base and sides of the site to minimize the movement of wastewater (leachate)
- Adequate mechanisms for leachate collection and treatment systems are necessary
- Organized deposit of waste in a small area, allowing them to be spread, compacted and covered daily
- Surface water collection trenches around site boundaries
- Construction of a final cover to minimize rainwater infiltration when each phase of the landfill is completed.

Safe Burial on Hospital Premises

In remote locations and rural areas, the safe burial of waste on the health care premises may be the only viable option available at the time. However, certain rules need to be established for the proper health care waste management. These include:

- Access to the disposal site should be restricted to authorized personnel only.
- The burial site should be lined with a material of low permeability, such as clay, if available, to prevent pollution of any shallow groundwater that may subsequently reach nearby wells.
- Only hazardous health care waste should be buried. If general health care waste were also buried on the premises, available space would be quickly filled-up.

- Large quantities (>1kg) of chemical/pharmaceutical wastes should not be buried.

- The burial site should be managed as a landfill, with each layer of waste covered with a layer of earth to prevent odor, as well as to prevent proliferation of rodents and insects.

- Burial site should not be located in flood prone areas.

- Hospital ground should be secured. (e.g. fenced with warning signs).

- The location of waste burial pit should be downhill or down-gradient from any nearby wells and about 50 meters away from any water body such as rivers or lakes to prevent contaminating sources of water.

- Health care facilities should keep a permanent record of the size and location of all their on-site burial pits to prevent construction workers, builders, and others from digging in those areas in the future.

- The safe burial of waste depends critically on rational operational practices. The bottom of the pit should be at least 1.50 meters higher than the ground water level. It should be noted that safe on-site burial is practicable only for relatively limited period, say 1 to 2 years, and for relatively small quantities of waste, say up to 5 to 10 tons in total. Where these conditions are exceeded, a longer-term solution will be needed.

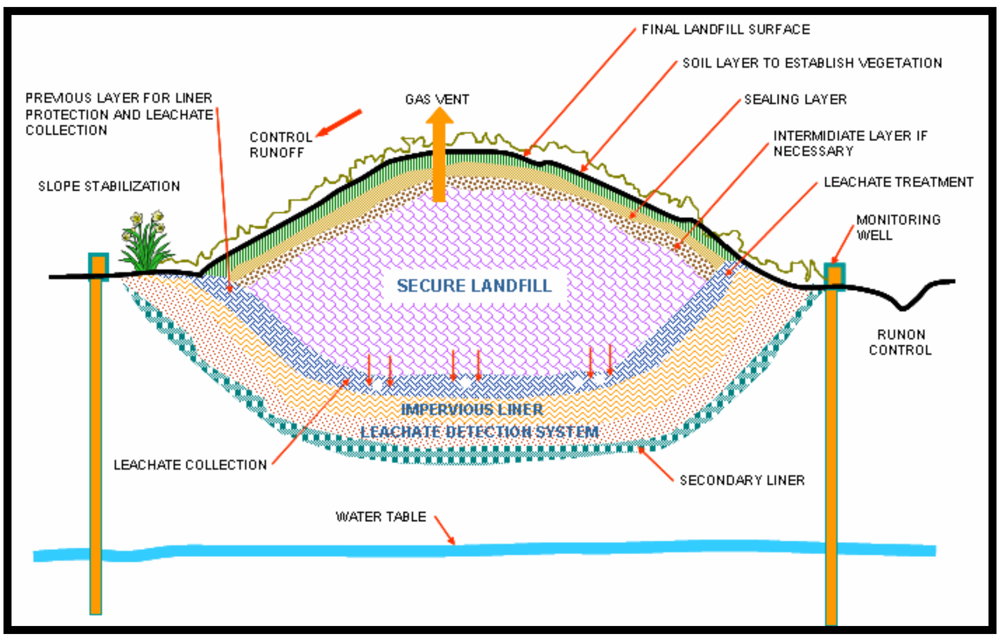


Figure 12. Schematic Cross Section of a Secure Landfill

Septic/Concrete Vault

This method is especially suitable for the disposal of used sharps and syringes. The following procedures for the safe burial of sharps and syringes through septic/concrete vault are recommended:

- Dig a pit (minimum size of 1 m x 1 m x 1.8 m depth), enough to accommodate sharps and syringes for an estimated period of time without reaching the groundwater level. The site must be isolated and at least 500 feet away from the groundwater supply sources and dwelling units.

- Construct concrete walls and slabs of the pit. Provide slab with opening or manhole for easy deposition of collected sharps and syringes. The manhole should be extended a few centimeters above the soil surface to overcome infiltration of surface water.

- Deposit the collected safety boxes filled with used sharps and needles inside the septic/concrete vault.

- Install a security fence around the site.

Figure 13. Burial Pit (Volume = 1x1x1.8)

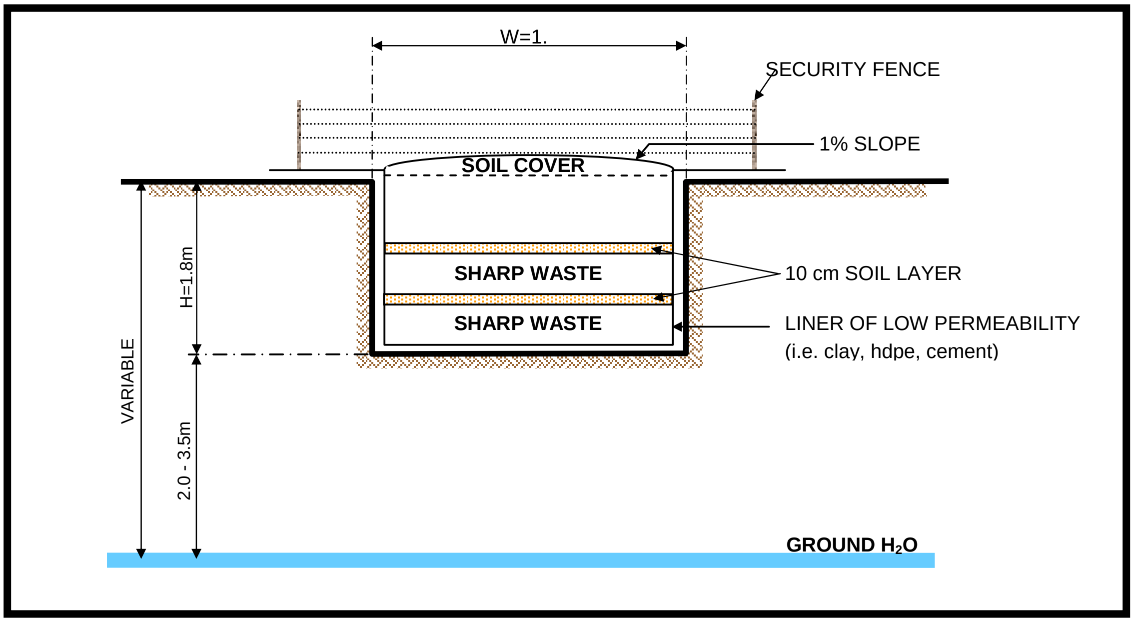
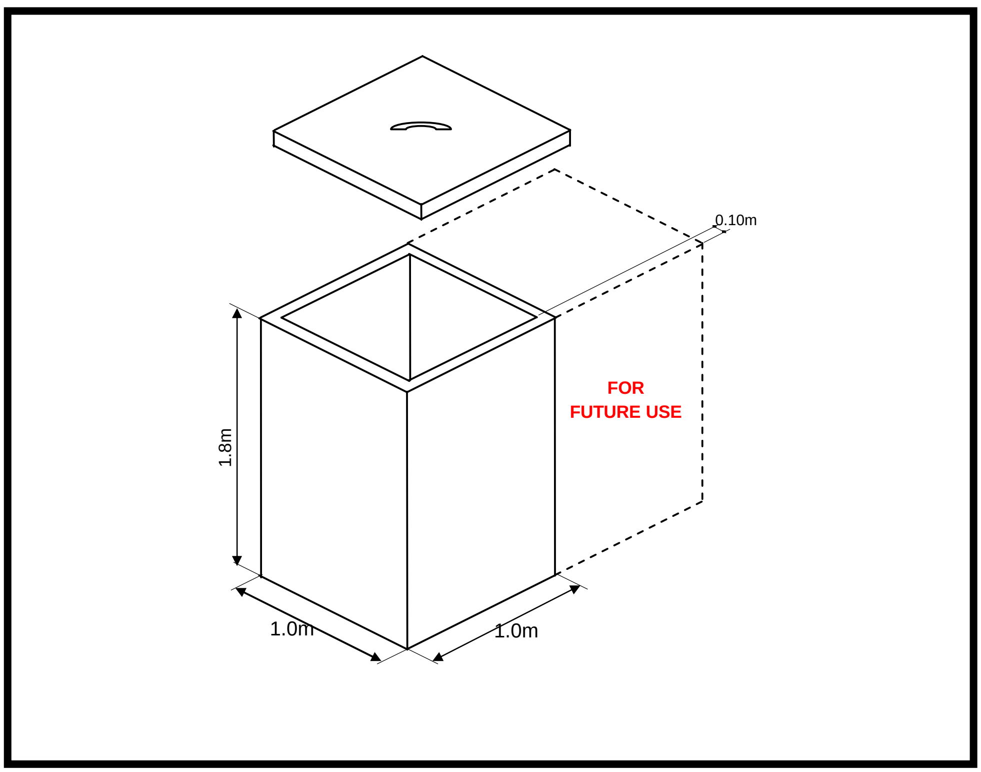


Figure 14. Septic/Concrete Vault



CHAPTER 7

WASTE MANAGEMENT

7.1 Characteristics of Wastewater from Health Care Establishments

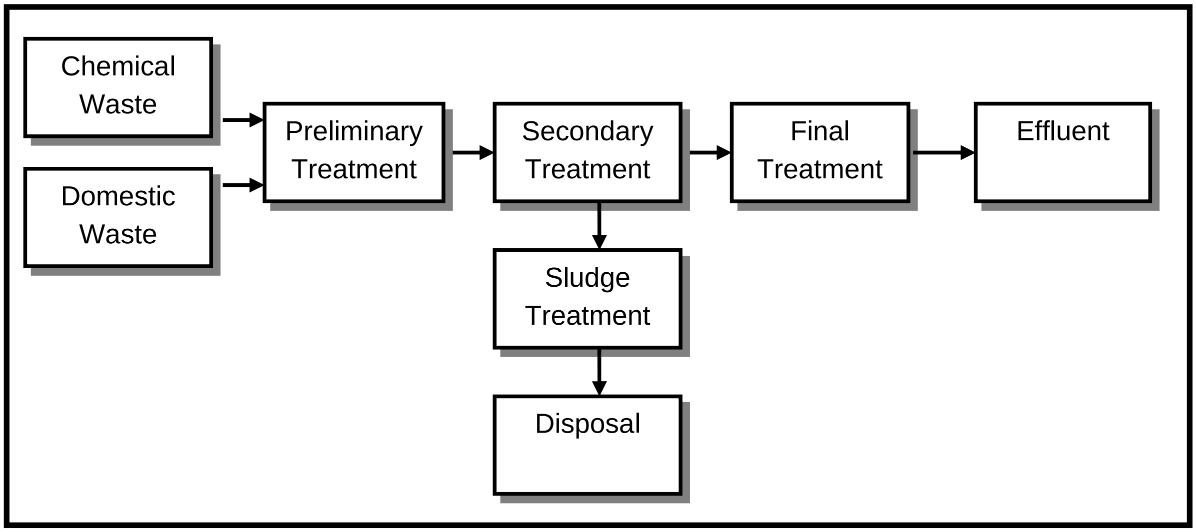
The basic principle underlying the effective wastewater management in health care establishments is a strict limit on the discharge of hazardous liquids to sewers. The quality of wastewater from health care establishment contains potentially hazardous elements including:

- Microbiological pathogens (bacteria, viruses, and helminths), which are easily transmitted through water;
- Small amounts of hazardous chemicals from cleaning and disinfection operations;
- Hazardous chemicals and pharmaceutical waste being generated from other business establishments (clinics, laboratories and research centers, drug manufacturers, mortuary and autopsy centers, cosmetics and tattoo parlors);
- Trace amounts of radioactive effluents from nuclear medicine laboratories;
- Wastewater or sewage from health care establishment can be discharged into domestic (municipal or city) sewers without pre-treatment, provided that the following requirements are met:
- The municipal sewers are connected to efficiently operate sewage treatment plant that ensure at least 95 % removal of bacteria;
- The sludge resulting from sewage treatment plant is subjected to anaerobic digestion, leaving no more than one helminth egg per liter in the digested sludge;
- The hazardous wastewater having significant quantities of toxic chemicals such as formaldehyde, pharmaceuticals, radionuclides, cytotoxic drugs and antibiotics, coming from laboratories and research centers, clinics, mortuary and autopsy centers should be discharged to a pre-treatment/neutralization tank for sewage (toxic) neutralization and disinfection by chlorination prior to discharge or connected to the sewage treatment plant; and
- Excreta from patients being treated with cytotoxic drugs are collected separately and adequately treated (as for other cytotoxic waste).

7.2 On-Site Treatment of Wastewater

When a health care facility cannot access a community sewage treatment plant it is recommended that the establishment should have their own waste water treatment plant. An efficient on-site wastewater treatment plant should include the following operations:

Figure 15. Schematic Diagram of Wastewater Treatment



- Primary Treatment - this includes multi-chamber septic tank, comprising of primary sedimentation tank and digestive chamber. This action results in partial biodegradation of organic pollutants. The effluent should be conveyed to the secondary treatment facility for further oxidation of sewage.

- Secondary Treatment - this employs a complete biological process of treatment including aeration and sedimentation system. It involves the importance of aerobic microorganisms that will actually degrade the organic pollutants in the effluent. The aeration phase is the introduction or supply of oxygen to the system for the aerobic microorganisms. The sedimentation phase is the settling of sludge and separation of clear water effluents. This combined system signifies the higher purification and degradation of parameters such as BOD, COD, TSS, Oil and Grease. The clear water should be conveyed to the tertiary treatment while the sludge shall be conveyed to the sludge treatment.

- Tertiary Treatment - In order to meet the standard parameters prescribed by the DENR Administrative Order No. 35 series 1990, this stage should therefore serve as the final treatment. The clear water will pass through micro filter and chlorine disinfection before being discharged to the nearest drainage or body of water. Due to outbreaks of enteric diseases and occurrence of waterborne diseases and other critical periods, UV-Hygienization is further recommended. This process involves the use of UV-Radiation of 254 - mm wavelength.

- Sludge Treatment - A supplement to the Implementing Rules and Regulations (IRR) of Chapter 17, "Sewage Collection and Disposal and Excreta Disposal and Drainage" of PD 856 or the Sanitation Code of the Philippines, details the collection, handling, transport, treatment and disposal of "Domestic Sewage and Septage".

Health care establishments may apply a combination of the treatment process enumerated in the above section depending on the volume and characteristics of their wastewater.

7.3 Factors to be Considered in the Establishment of Wastewater Treatment Plant

To have an efficient and cost-effective establishment of on-site wastewater treatment plant, it is important to have an objective approach in considering the following factors:

- Quantity of wastewater for treatment and disposal
- Type of wastewater for treatment and disposal
- Location of the treatment and disposal facility
- Infrastructure requirements
- Treatment efficiency
- Locally available equipment and parts
- Space availability
- Investment and operating cost
- Operation and maintenance
- Training requirement for operation
- Regulatory requirements

7.4 Safety Requirements

Measures to minimize health risks should be implemented in health care establishments that cannot afford any sewage treatment plant such as:

- Patients with enteric diseases should be isolated in wards where their excreta can be collected for chemical disinfection. This is of utmost importance in case of cholera outbreaks, for example, and strong disinfectants will be needed.

- No chemicals or pharmaceuticals should be discharged into the sewer.

- Sewage from health care establishments should never be used for agriculture or aqua cultural purposes.

- Health care sewage should not be discharged into natural water bodies that are used to irrigate fruit or vegetable crops, to produce drinking water, or for recreational purposes.

- Grease, oil and paints should not be discharged into the sewer line

7.5 Sanitary Requirements

Human excreta are the principal vehicle for the transmission and spread of a wide range of communicable diseases, and excreta from health care patients may be expected to contain far higher concentration of pathogens, and therefore are far more infectious, than excreta from households. This underlines the prime importance of providing access to adequate sanitation in every health care establishment. The health care establishment should ideally be connected to a sewerage system.

7.6 Regulatory Requirements

All implementing rules and regulations of all concerned agencies (local and national) and all existing laws shall be strictly followed. Chapter 9 provides a discussion of applicable environmental laws and regulations for health care establishments.

CHAPTER 8

FINANCING OPTIONS FOR HEALTH CARE WASTE MANAGEMENT

The shift to a regime that improves health care waste management to conform to current laws and policies of the government entails additional costs to health care establishments. An understanding of the costs of the waste management hierarchy is necessary in order for the establishments to determine what options it needs to take. Each step in the waste management hierarchy should therefore be examined with respect to the costs it will entail.

- Can the investment be done by the organization/establishment itself with its own funds?
- Does it need to partner with other organizations/establishments?
- Does the organization/establishment need to take out a loan to invest in such technologies and facilities?
- Can the treatment be done off-site by an accredited treater?

This manual lists a few of the options available to establishments to treat their wastes and this chapter allows these options to be examined in relation to the effort and resources that are needed to operationalize them.

8.1 Cost and Benefits of Source Reduction, Recycling, and Reuse

As discussed in Chapter 4, source reduction and recycling or reuse are the first approaches in the waste minimization hierarchy that could help reduce the bulk of health care wastes for disposal. Source reduction either means elimination of the waste by using other materials or using less of the material through improved practices. Reuse and recycling consider alternative uses for the materials that are otherwise already regarded as wastes that will be bound for disposal. Some of these efforts may mean less cost to the establishment in the long run. What is advantageous to health care establishments is that even the companies that supply their needs are themselves practicing waste reduction. An example is the increasing use of repairable and reusable products which companies are re-engineering to lessen its disposal cost. The main cost to health care establishment is the in-depth study of all the waste streams of the establishment to determine what alternatives can be made with regards to source reduction, reuse, and recycling. Alternatives can include the following:

- **Reduction of the amount of material used to accomplish tasks.** An example of this is to use email to reduce the use of paper in the facility. A smaller amount of disinfectant may be adequate to clean rooms.

- **Purchase of materials that may be reused and recycled.** This may mean a higher initial cost at the onset but cost savings more than makes up for these initial costs. What must be needed is a firm accounting of all the costs attributed to a material, including disposal costs. For example, the purchase of reusable salad plates for the hospital cafeteria by Itasca Medical Hospital in Minnesota may have been more expensive at the onset but it reduced wastes by 94% and generated savings of about US$2200 per year. Examples of sterilization methods for recyclable materials include the following:

- **Thermal sterilization**
  - *Dry sterilization* Exposure to 160 °C for 120 minutes or 170 °C for 60 minutes in a "Poupinel" oven.
  - *Wet sterilization* Exposure to saturated steam at 121°C for 30 minutes in an autoclave.
- **Chemical sterilization**
  - *Glutaraldehyde* Exposure to a glutaraldehyde solution for 30 minutes. This process is safer for the operators than the use of ethylene oxide but is microbiologically less efficient.

- **Reduction of the toxicity of the materials used.** This diminishes both the disposal costs and the hazards to the health workers. An example is the use of non-toxic x-ray developing solution at the same cost that does not diminish the quality of processed x-ray film.

- **Practice just in time delivery.** This allows the establishment to minimize on wastes incurred because of expiry of items like drugs and chemicals. Many industries already practice this. It also allows them less space for storage of materials and places the burden of storage on the supplier. A supply chain management cycle must be instituted within the establishment to make this work; big firms like Nestle, for example, have supply chain structures in place to insure that only adequate amounts of raw materials are purchased for production to meet the demand forecast for the week.

- **Practice good management and control measures at the hospital level**. This means that the purchase and use of chemicals and pharmaceuticals should be centralized with a central monitoring of chemical flows within the hospital premises.

The central idea in accounting for these costs is to allow health care establishments to understand that source reduction, recycling, and reuse may result in lower operating costs for the facility in the long run. While these may entail a change in the way the establishment conducts business, the tangible benefits should provide the impetus for change. Costs like the staff time required to set up a waste minimization plan and the implementation of information and education strategy for the personnel should also be included; all of which would result in a better understanding of waste streams and better operations for the establishment as a whole.

8.2 Cost and Benefits of Health Care Waste Treatment Options

A major portion of health care wastes still has to be treated to remove its toxic and infectious nature prior to final disposal. This amounts to about 7 to 15% of the establishment's total wastes, if we look into statistics from American hospitals[1]. Several

[1] **Medical Waste Treatment Technologies. Evaluating Non-Incineration Alternatives**. Health Care Without Harm. May 2000

technologies are available to treat these wastes. Investment in on-site treatment facilities may be costly but allows the establishment to control the manner by which the waste is treated and the costs associated with treatment. Off-site treatment facilities, when available, may be more costly in the long run but allows the establishment to concentrate on its basic occupational function and not on operations it is not built to do, which is the treatment of wastes.

In some of the health care treatment technologies, waste is first subjected to shredding, mainly to increase the contact of the reducing agent with the waste, to decrease the volume of the final output, or to render the waste unrecognizable at the output streams. The world's most common technologies are based on steam or steam and vacuum and microwave sanitation.

Health care establishments should evaluate the technologies indicated in Chapter 6 of this guide to determine which is most appropriate for the wastes they produce and is within the budget they have appropriated for the facility. Since the Clean Air Act has banned incineration, there is a need to scour the marketplace for less expensive but complete treatment systems, i.e. systems that remove all infectious and toxic character of hospital wastes without introducing new pollutant streams into emission and effluent systems.

A general discussion of the cost and capacities of the technologies discussed in Chapter 6 are presented below. The indicated prices are for the equipment purchase only from suppliers in the United States. Such prices do not include freight charges for shipment, which may increase the purchase cost by 10% or more. Additional cost items such as a building for the equipment and auxiliary facilities may increase the total capital cost depending on the facility design.

High Temperature Systems / Pyrolysis

Pyrolysis involves the thermal decomposition of substance and materials in the absence of supplied molecular oxygen in the destruction chamber during which the material is converted into gaseous, liquid, or solid form. Included among these zero-oxygen pyrolysis technologies are:

- Plasma pyrolysis
- Induction-based pyrolysis
- Laser-based pyrolysis

Pyrolysis can handle the full range of medical toxic and infectious wastes, including bulk chemotherapy waste, many hazardous substances, spent solvents and chemicals (e.g., formaldehyde, glutaraldehyde, xylene, isopropanol, etc.), expired pharmaceuticals, low-level radioactive waste, except mercury. The waste residue is practically sterile and low combustible gas emissions can be expected. Waste mass for disposal is drastically reduced. However, poorly designed pyrolysis systems may still emit dioxins and may be prone to equipment failures. The installation costs may also be very high for a small throughput. Electricity costs may also be substantial.

The economics of pyrolysis systems become better if energy is recovered from the pyrolysis gases of medical wastes. Induction-based pyrolysis is still in the planning and demonstration stage. Plasma pyrolysis is likewise new and has little experience in the health care waste as is laser-based pyrolysis.

Plasma pyrolysis uses a plasma arc torch in a pyrolysis chamber that heats the waste to about 1,650°C. The wastes here are completely destroyed, forming a product gas that has hydrocarbons and has a significant heating value. The solid residue from plasma technologies may include carbon black, vitrified glassy aggregates, and metallic residues and are inert. Plasma pyrolysis, however, are designed mainly for high capacity, large-scale operations and have high capital and operating costs.

Laser plasma pyrolysis technology uses a high-energy laser that creates temperatures of 3,300 to 5,500°C. It produces the same outputs as a plasma pyrolysis system although is much more expensive. The technology has been tested to treat hazardous solvents, shredded tires, PCBs, waste oils, diesel fuel, and municipal solid waste. Capacities range from five to 100 tons per day.

Table 2 shows the comparative approximate capital costs of the pyrolysis systems.

Table 2. Approximate Capital Costs of Pyrolysis Systems

Pyrolysis Operating Capacity and Technology	Approximate Range of Cost (PhP)[2]
PLASMA PYROLYSIS	
One to 10 ton/day units	33,000,000 – 55,000,000
LASER BASED PYROLYSIS	
5 to 100 tons/day	440,000,000 to 1.375 billion

Wet and Dry Thermal Systems

This type of treatment technology includes the following:

- Autoclaves and Retorts
- Microwave systems
- Electro Thermal Deactivation Systems
- Dry heat Treatment Systems
- Vacuum Steam Compaction

Autoclaves and retorts (which are similar to autoclaves but without a steam jacket) are easy to operate and are available in various sizes. It is a proven technology to disinfect infectious wastes but does not reduce the waste volume as pyrolysis does nor does it deactivate toxic chemical components in the waste stream. These toxic chemical substances may find their way into the output streams. Costs for autoclaves vary across vendors. Front end engineering devices such as one-stage and two stage shredders and conveyor systems must also be installed. Shredders and compactors after the process may also be needed. Additionally, wastewater systems and air pollution control devices should be installed to guard against the introduction of both organics and toxics into the air and water waste streams. Autoclave bags must also be purchased.

The types of waste commonly treated in autoclaves are: cultures and stocks, sharps, materials contaminated with blood and limited amounts of fluids, isolation and surgery wastes, laboratory wastes (excluding chemical waste), and soft wastes (gauze,

[2] Ibid. Costs are taken from US costs and based on an exchange rate of P55/US$

bandages, drapes, gowns, bedding, etc.) from patient care. Volatile and semi-volatile organic compounds, bulk chemotherapeutic wastes, mercury, other hazardous chemical wastes, and radiological wastes should not be treated in an autoclave or retort. Huge and bulky bedding material, large animal carcasses, sealed heat-resistant containers, and other waste loads that impede the transfer of heat should be avoided.[3] Poorly segregated wastes (i.e. wastes with mercury, heavy metals, some drugs) may allow the release of toxics into the air and may cause bad odors. Hence, autoclaves should be coupled with a good segregation regime. The waste is not diminished in appearance and may even increase in volume and mass (due to water retention) after autoclaving. Hence, a significant amount of waste still has to be disposed of.

Capacities of autoclaves vary widely depending on the intended use. The sizes may start from small autoclaves having a capacity of 18 lbs/hr to large systems capable of more than 6,000 lb per cycle. Autoclaves can even be custom designed. Depending on the size of the autoclaves and the engineering units that are installed before and after the process unit, the costs may fall from a few hundred thousand to over PhP15 million with complete systems. Most of these systems require steam at 55-60 psig. The following table shows the approximate cost ranges of autoclave systems at various capacities.

Table 3. Approximate Capital Costs of Autoclave Systems

Autoclave Operating Capacity	Approximate Range of Cost (PhP)[4]
100 lbs/ cycle[5]	1,000,000 to 5,000,000
250 lbs/cycle	1,500,000 to 5,600,000
450 lbs/cycle	1,800,000 to 6,200,000
750 lbs/cycle	2,000,000 to 6,700,000
1,500 lbs/cycle	2,500,000 to 9,600,000
SHREDDERS	2,750,000 to 4,300,000
COMPACTOR	1,000,000
AUTOCLAVE BAGS (100s)	1,000 to 7,000
AUTOCLAVE CARTS	55,000 – 80,000

In the last decade, second generation of steam-based systems have been developed for the purpose of improving the transfer of heat into the waste, achieving more uniform heating of the waste, rendering the waste unrecognizable, and/or making the treatment system a continuous (rather than a batch) process. These new systems have sometimes been referred to as advanced autoclaves. These systems basically function as autoclaves or retorts but they combine steam treatment with pre-vacuuming and various kinds of mechanical processing before, during, and/or after steam disinfection. These technologies, similar to autoclaves, include:

- Vacuum/Steam Treatment/Compaction
- Stream Treatment-mixing-fragmentation/drying/shredding or Rotoclaves
- Shredding/Steam Treatment-Mixing/Drying and Chemical Cleaning
- Steam Treatment-Mixing-Fragmenting/Drying or the Hydroclave
- Shredding-Steam Treatment-Mixing/Drying or Steam Sterilization Macerator

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[3] **Non-Incineration Medical Waste Treatment Technologies**. Health Care Without Harm. August 2001
[4] Ibid. Costs are taken from US costs and based on an exchange rate of P55/US$
[5] Cycle = about 1 hour

- Shredding-Steam Treatment-Mixing-Compaction

These technologies are generally more expensive than autoclaves since they integrate into their systems the shredding, compacting, and other innovations needed by ordinary autoclaving systems. Some systems, specifically those with integrated shredders, allow the treatment of anatomical wastes previously untreatable in autoclave systems because of aesthetic reasons.

A Vacuum/Steam Treatment/Compaction treatment device operates as a part-autoclave, part compactor system. The autoclave cycle begins with a high vacuum to remove air, followed by exposure to 150°C steam. The chamber is allowed to reach temperatures of 140^{o}C (about 38 psig). After treatment, the waste is automatically conveyed to the compaction chamber. The compactor section can be used separately for regular trash. Capacities range from 25 lbs to 2,240 lbs/hr. Capital costs vary and is given in the following table

Table 4. Approximate Capital Costs of Vacuum/Steam Treatment/Compaction

Operating Capacity (lbs/hr)	Approximate Range of Cost (PhP)[6]
25	1,430,000
160	8,470,000
560	15,730,000
2,240	Over 27,500,000

Steam Treatment-mixing-fragmentation/drying/shredding device changes the standard autoclave into a rotating drum, thereby combining steam treatment with agitation that serves to break up or fragment the waste. Drying and shredding are added. Capacities are from 109 cu ft per cycle (50 mins) to 1,038 cu ft per cycle. The smallest units cost PhP21,000,000.00.

Shredding/Steam Treatment-Mixing/Drying and Chemical Cleaning devices are primarily steam treatment units, with a chemical disinfectant process (hypochlorite) mainly for cleaning the equipment during shutdown or maintenance and for odor control. 600 and 1000 lb per hour systems are available and should cost about PhP20,200,000 and PhP23,500,000 respectively.

The Hydroclave steam treatment units combine the idea of an autoclave (except that steam is applied to an outside jacket only) and agitation in a way that breaks up or fragments the waste for more even heating. Model capacities are from 250 to 2000 lbs / hour and capital costs are from PhP11,000,000 to over PhP27,500,000, depending on the size.

Shredding-Steam Treatment-Mixing/Drying device combines internal shredding or maceration with steam treatment and mixing, followed by a dewatering process. In 1996, the device was installed and tested at John Hopkins University School of Medicine, and later at Franklin Square Hospital/Helix Health System. A model that handles 150 lbs of waste / hour costs about PhP11,000,000.

[6] Ibid. Costs are taken from US costs and based on an exchange rate of P55/US$

Shredding-Steam Treatment-Mixing-Compaction devices feed health care waste into a funnel through a hydraulic lift mechanism and then shredded after the funnel lid is closed. Steam is added. The waste is then carried by a rotating screw that is heated using an oil jacket heating system. The waste is both heated and compressed on its way to the discharge end. A model that can handle 440 lbs per hour of waste would cost about PhP52,500,000.00.

Microwave systems are more expensive than autoclaves but are easier to use and operate. Some systems have the additional advantage of producing no effluents. However, toxics are not deactivated by this method and may be released into the air or remain in the waste. If segregation is practiced, these toxics may be reduced in the ensuing emissions. Microwaves typically treat the same kind of wastes as autoclaves and retorts.

Before the process, the waste is shredded, then granulated. The waste is then humidified, and the air, permeated with hot steam up to the temperature of 110°C, is removed through a system of filters. The waste is moved to a waste collection chamber where it is heated by microwave generators for 20 to 30 minutes. The waste volume is reduced by up to 80%, however, weight remains unchanged. Odors may be less significant than microwave systems. Any large metal object in the waste could likewise damage the system. The electricity required is nominally about 0.1 kWh per pond of waste [7]A full microwave system may cost from PhP27 Million to PhP33 Million.

Table 5. Approximate Capital Costs of Microwave Systems

Microwave Operating Capacity (lbs/cycle)	Approximate Range of Cost (PhP)[8]
220-400	27,000,000
550-900	33,000,000

Chemical Disinfection

This type of technology includes the following:

- Sodium Hypochlorite-Hammermill
- Sodium Hypochlorite-Shredding (mobile)
- Chlorine Dioxide-Shredding/Grinding
- Ozonation
- Electrocatalytic Wet Oxidation
- “Stericid”-Shredding-Mixing MCM Environmental Technologies (Gilboa, Israel)
- Dry Inorganic Chemical-Shredding
- Peracetic Acid-Grinding
- Alkaline Hydrolysis

Chemical disinfection systems have been in use for decades and are well understood. Liquid effluents can generally be disposed of in the sanitary sewers; however, the large-scale use of chlorine agents may introduce toxic substances in the air and wastewaters. Chemical disinfection generally can treat the same wastes as autoclaves. Chemical and radiological wastes generally cannot be treated through chemical disinfection. Likewise,

[7] **Non-Incineration Medical Waste Treatment Technologies**. Health Care Without Harm. August 2001
[8] Ibid. Costs are taken from US costs and based on an exchange rate of P55/US$

body parts and animal carcasses are excluded for aesthetic reasons. Segregation should be practiced prior to chemical disinfection processes to eliminate these chemical and radiological wastes from entering; otherwise these wastes may be found in the process end-streams. Chlorine systems may cost about PhP15 Million for a 3,000-lb/hour system.

Non-chlorine processes are quite varied – from systems that use gas such as ozone, a liquid such as alkali (sodium or potassium chloride) to a dry chemical such as calcium oxide. Ozone does not physically alter the waste, while some may initiate chemical reactions that change the physical and chemical characteristics of the wastes. However, most of these chemicals are corrosive and poisonous, and some are irritants. Care has to be taken to limit worker exposure. Since some of the systems initiate chemical reactions, toxic chemicals may be treated. Alkaline hydrolysis, for example, may treat aldehydes, fixatives, and cytotoxic agents apart from tissue wastes, animal carcasses, anatomical parts, blood, and bodily fluids. Such systems are mainly specialized and costs may vary widely.

Table 6. Approximate Capital Costs of Chemical Disinfection Systems

Pyrolysis Operating Capacity and Technology	Approximate Range of Cost (PhP)[9]
SODIUM HYPOCHLORITE -HAMMERMILL	
3,000 lb/hr	16,250,000
PERACETIC ACID GRINDING	
5-8 lbs/ 10 min	110,000
ALKALINE HYDROLYSIS	
600 lbs/hr	20,000,000
1000 lb/hr	23,500,000

Biological Processes

There had been a very few biological systems made for medical wastes[10]. These are still in the planning and development stages and are not yet mature for the commercial market. Establishments which would like to go into biological treatment process should study first the pros and cons of investing in such technologies.

Radiation Technology

Radiation technology is well understood in the health industry since it is used in other applications like cancer therapy. It does not produce any toxic emissions (except for a small amount of ozone) and produces no liquid effluents. An advantage is that nothing is added to the waste; no steam, water, chemicals nor heated air. It also has a low operating cost. The main disadvantages are also integral to radiation systems; workers should have radiation protective wear, concrete or tin shields should be built, low-level radiation may be induced. Radiation systems also do not diminish the amount of waste nor make them unrecognizable. Again volatile and semi-volatile compounds, chemotherapeutic wastes, hazardous wastes, and radiologic wastes should be treated in radiation treatment systems.

[9] Ibid. Costs are taken from US costs and based on an exchange rate of P55/US$
[10] Ibid

A system that treats wastes at a rate of 400 to 550 pounds/hr may cost about PhP19.25 Million. However, this type of technology is still in its demonstration stage and the feasibility of partnering with the technology provider for a demonstration unit has to be studied.

The following table presents a comparison of the different treatment methods that are applicable to health care wastes.

Table 7. Side-by-Side Comparison of Different Treatment Methods of Health Care Wastes That Are Commercially Available

Features	Autoclave	Microwave	Pyrolysis Systems	Chemical Treatment
Treatment Method	Steam treatment	Microwave generator frequency	Pyrolysis chamber at elevated temperatures	Chemical (sodium hypochlorite) and mechanical (hammermill)
Feed preparation	Shredding after disinfection	Shredding and granulation	Boxed	Shredding and grinding
Operating Temperature	120-160^{o}C	110^{o}C max	Plasma Pyrolysis: 1650 ^{o}C Laser Pyrolysis: 3,300^{o}C-5,500 ^{o}C	None
Energy	Boiler	75 kW	300 kW	400 Volts
Capacity	100-1,500 lbs/hr	230-900 lbs/hr	Plasma Pyrolysis: 1-10 tons/day Laser-Based Pyrolysis: 5-100 tons/day	30-3,000 lbs/hr
Unrecognizable waste	Yes	Yes	Yes	Yes
Waste Volume % Reduction	80-85% with shredder, mass essentially the same	80-85%, however, mass remains essentially the same	80-95% reduction both in mass and in volume depending on the waste matrix	60-90% with shredding and heat treatment
Residues	Inert waste	Inert waste	Inert slag and combustible gases	Chemical wastes for treatment
Treatment Level	IV	III	IV	IV
Environmental Pollutants	Possible odors	Odor problem in immediate vicinity	No liquid effluent	Very high noise levels, offensive odor, liquid effluents
Environmental Control	Closed system	Closed system with HEPA filters	Scrubber	HEPA filters

Features	Autoclave	Microwave	Pyrolysis Systems	Chemical Treatment
Capital costs	Autoclave: PhP1-4.6 Million Shredders: PhP2.75-4.3 Million Compactors: 1 Million Autoclave bags = PhP1,000-7,000; advanced autoclaves are much higher in capital costs	PhP27-33 Million	Plasma pyrolysis: PhP33-55 Million Laser-based pyrolysis: PhP440-1,357 Million	Sodium hypochlorite-hammermill: PhP16.25 Million Paracetic acid-grinding: PhP0.11 Million Alkaline hydrolysis: PhP20-23.5 Million
Advantage	Waste suitable for landfill; well-proven technology	Waste suitable for landfill; well-proven technology	Waste suitable for landfill; Recovers at least 80% heat in the form of hot water steam	Well-proven technology
Disadvantage	Possible odors	Possible odors; large metal object can damage the system	Relatively high capital cost; maybe extensive maintenance cost. May produce dioxins and furans at very small quantities	Chemical management and disposal required because of use of chemical reagents.
Limitations	No body parts, chemical and pharmacological wastes; however, advanced autoclaves can treat anatomical parts.	No body parts, liquid blood and hazardous chemical substances	No lead, cadmium, and mercury	No human and animal remains, chemical wastes

8.3 Other Factors to Consider in Selecting Health Care Waste Treatment Technology

The decision about what health care waste technology to utilize goes far beyond cost implications since this may have significant impact on the environment, the workers in the establishment, and the surrounding community. Several questions need to be asked and answered regarding this.[11] The following are some guide questions that health care establishments can use when deciding what technology to use.

ON-SITE TREATMENT TECHNOLOGIES

- How important is volume reduction in choosing a technology? What is the ratio of waste produced by your establishment to the waste treated by the treatment technology? Is the technology dependent on a certain volume of material?
- How would waste reduction programs affect the process? If the waste volume changes radically for any reason (e.g., reduced patient-days, merger, better waste minimization efforts) will this technology still meet the treatment needs?
- Have staff from your establishment talked to colleagues at other establishments about their disposal options, made comparisons, discussed technologies, contracts and services, as well as violation histories and ranges of service costs?
- What is the Philippine regulatory climate for onsite treatment technologies? (Some types of technologies require more complicated permits than others) Does your establishment have staff on-site that are trained and certified to fulfill the testing requirements, time, etc., involved in these permits? If not, consider those staffing and testing costs in your evaluation.
- How long has the treatment technology been in use, and where?
- What is the estimated "life" of this equipment?
- What volume of waste can the technology treat?
- Will it always be operating at peak capacity, or will there be wide variations in the amount of waste treated?
- What are the operational cost implications of using this technology? What are the environmental and fiscal impacts of utilities usage (electricity, water and sewer)?
- What is the safety and repair history of the waste disposal equipment?
- What worker safety and ongoing equipment education is required and who provides it?
- What are the cost(s) of equipment failure and need for a back-up or alternative system?
- Is waste fed into the treatment system automatically (by machine) or by hand (stop feed)? What impact does this have on your establishment's staff limitations?
- Can equipment repair be completed within 24 hours without an emergency clause and/or additional costs?
- Does the technology require ancillary equipment such as shredders? Are they an integral part of the treatment process?
- What are the total associated costs for this equipment?
- Are there any worker-safety concerns with this equipment?
- How is the volume and weight of the waste measured with the disposal equipment? Who measures it? Is it cost-effective to weigh the wastes on-site?

[11] Ibid.

OFF-SITE TREATMENT ISSUES (COMMERCIAL TREATMENT FACILITIES)

- How many trucks will enter and leave the facility daily? Will traffic vary by day of the week, or remain fairly constant?
- From what geographic area will waste be accepted? What sort(s) of waste will be treated?
- Is it possible to bargain collectively with area healthcare establishments for waste treatment disposal services?
- Are there any environmental violations against the treatment facility your establishment is considering? Is the facility fully permitted?
- Are there any community or environmental health concerns associated with this off-site facility?

If the decision is to let an offsite facility treat the wastes, then the cost to be considered would only be the charge of the waste treater and the associated transportation cost. However, if the decision is to invest in an on-site facility, then the following costs need to be considered:

- Capital equipment costs
- Installation and facility costs: installation labor, facility modifications - cement pad(s), curb cuts, sewers, electricity, space, security, etc.
- Costs of pollution control equipment if required to control emissions and effluents from the facility
- Direct labor costs: number of employees needed to operate the treatment and disposal equipment
- “Down time” costs: including repair (parts and labor), and alternative treatment;
- Operating costs if the facility uses special chemicals and catalysts
- Utility Costs
- Permitting and compliance fees: water and air quality monitoring fees
- Fines: depending upon permitting requirements and state and federal regulations, violations of permits or emissions may result in fines
- All transportation, processing and tipping fees
- Supply costs – Personal protective equipment, spill supplies, special bags (for example, some autoclaving systems require particular bags), collection containers (boxes or reusable containers)
- Community approval costs if a public hearing is required

8.4 Credit Financing for Environmental Investments in Health Care Waste Management

In case in-house funds are not available, there are numerous loan facilities that may be availed by hospitals for its environmental investment projects particularly for waste treatment. One of them is the Environmental Infrastructure Support Credit Program (EISCP) of the Development Bank of the Philippines (DBP).

Environmental Infrastructure Support Credit Program - Phase II (EISCP II)

<table>
<tr><td>Type of Assistance:</td><td colspan="2">Loans for financing the improvement of the quality of the environment through reduction or prevention of pollution.</td></tr>
<tr><td>Wholesale Establishment:</td><td colspan="2">Development Bank of the Philippines</td></tr>
<tr><td>Eligible Borrowers:</td><td colspan="2">The program is available in Philippine Pesos for lending to investment enterprises in the industry, mining and service sectors.</td></tr>
<tr><td>Eligible Projects:</td><td colspan="2">• Cleaner Production / Waste Minimization / Pollution Prevention
• Waste Recycling / Waste Treatment or Disposal System
• Conservation of Natural Resources (e.g., energy, materials)
• Occupational Health and Safety Improvements
• Wastewater Treatment Facilities
• Air Pollution Control Equipment
• Alternative Fuel Vehicles and Infrastructure
• Environmental Monitoring Instruments and Equipment
• Establishment of Environmental Management Systems (EMS) and certification under ISO 14001
• Relocation of Pollutive Industry from Residential Area</td></tr>
<tr><td rowspan="6">Loan Features:</td><td>Loan Area</td><td>Nationwide</td></tr>
<tr><td>Interest Area</td><td>Fixed throughout the term of the loan</td></tr>
<tr><td>Loan amount per project</td><td>Eligible expenditures up to a maximum of 80% of the total project cost</td></tr>
<tr><td>Repayment Period</td><td>From 3 to 15 years with a maximum 5 years grace period. Amortization payments shall be at least on a semi-annual basis</td></tr>
<tr><td>Eligible Investment Enterprises</td><td>Filipino Citizens or corporations with at least 70% Filipino capital</td></tr>
<tr><td>Commitment Fee</td><td>0.75% per annum of the undisbursed amounts</td></tr>
</table>

Health care establishments and off-site waste treaters can avail of credit financing for the operation of health care waste treatment equipment, wastewater treatment facilities, and air pollution control devices.

Health care establishments can also apply for a loan under the Environmental Infrastructure Credit Support Program (EISCP) Phase II for the acquisition of hospital equipment that promotes cleaner technology. Examples of projects of health care establishments that have been financed under EISCP are sterilization equipment that eliminates the use of generation of toxic and hazardous gases, diagnostic equipment that will replace old and inefficient equipment, conserve energy, increase patient load, minimize worker exposure to radiation, and minimize wastes.

8.5 Other Cost Factors in Health Care Waste Management

Waste Segregation and Handling

The proper segregation and handling of wastes will entail some additional costs that may or may not be offset by lower treatment and disposal costs since only the right kinds of wastes go to specific disposal streams. These investments include:

- Costs of color-coded containers that should be placed in appropriate places in the hospital.
- Cost of proper labels for the wastes.
- Cost of training personnel to place wastes in the appropriate container and to handle them in a safe manner
- Cost of storage spaces within the facility for the wastes that should include whatever measures should be put in place to secure and protect the wastes when needed.
- Costs of personal protective equipment needed to safely and properly handle wastes
- Cost of packaging the wastes for transport if the treatment facility is sited a distance from the establishment
- Transportation costs if this will be borne by the establishment.

Segregation of wastes follows the waste management paradigm. This effectively reduces the amount of wastes needed for transport to (if located off-site), treatment, and disposal at the treatment facility. When done at the source, the facility may be able to save on the maintenance personnel needed to sort through and segregate the wastes when they are brought to the storage area. Segregation likewise may entail a change in the operations management of the establishment. Investments in training and equipment may not be offset by lower treatment costs. However, total costs to the environment will diminish because the inclusion of materials that may release harmful substances to the environment during treatment processes is lessened.

Disposal

Costs with regards to final disposal of treated waste streams should also be considered. When systems that do not deactivate chemical and toxic agents are used to treat wastes, additional processes such as encapsulation and inertization should be considered. Disposal to a sanitary landfill is considerably more costly than disposal in open dumpsites. Sanitary landfills may charge a higher fee for wastes coming from medical establishments. In evaluating treatment options, costs with relation to final disposal should be inputted since some treatment systems can almost eliminate wastes altogether (pyrolysis) but some even increase the weight of wastes (steam systems without dryers). Care should also be taken to render the wastes unrecognizable. Some costs that should be considered when an on-site facility is used include the following:

- Construction of temporary storage and hauling areas for treated wastes
- Landfill tipping fees
- Labor costs for hauling, labeling, waste documentation, security, and maintenance of temporary storage areas.
- Hauling costs
- Transport containers
- Costs related to wastes not handled by the hauler
- Cost of encapsulation, inertization, septic vault

CHAPTER 9

POLICIES AND LEGISLATION

Several legislations have been enacted that form the basis of improving health care waste management in the country. The implementation of these laws will enable the different agencies concerned to provide the legal controls and permits for health care facilities to operate within the framework and with due consideration to protect public health or safely manage health care waste.

Some of these laws that were passed and are considered significant to an effective management of health care waste are discussed hereunder and are grouped according to the lead implementing agency.

9.1 DOH

Republic Act No. 4226
"Hospital Licensure Act"

The Hospital Licensure Act requires the licensure of all hospitals in the country and mandates the DOH to provide guidelines for hospital technical standards as to personnel, equipment, and physical facilities.

The revised rules and regulations (DOH Administrative Order No. 70-A) provides for the registration, licensure, and proper operation of hospitals and other health care facilities. Prior to application or renewal of license, submission of plans and other design requirements of the Sanitation Code of the Philippines, National Plumbing Code, National Fire and Building Code of the Philippines, Manual on Hospital Waste, and Health Facilities Maintenance Manual are verified by the DOH. The planning and design considers the following criteria:

- Location and the environment
- Occupancy
- Security
- Patient movements
- Lighting and ventilation
- Water supply
- Waste disposal

Presidential Decree No. 856
"The Code on Sanitation of the Philippines"

The Code of Sanitation of the Philippines mandates the DOH to promote and preserve public health and upgrade the standard of medical practice. In line with the DOH mandate, a Manual on Hospital Management was published in 1997 and the Implementing Rules and Regulations of Chapter XVIII, Refuse Disposal of PD 856 was promulgated.

The Manual on Hospital Management recommended color-coding scheme for segregated wastes to avoid any accidents or hazards to personnel. When the DOH released the IRR of Chapter XVIII, the classification of refuse/solid waste was expanded by recognizing the existence of different types of hospital waste such as biodegradable waste, chemical waste, infectious waste, pharmaceutical waste, pathological waste, and radioactive waste. The IRR also provides the detailed sanitary requirements for the segregation, storage, collection, transportation, and disposal of refuse/solid waste.

In 2002, the Bureau of Health Facilities and Services of the DOH requires hospitals to submit the approved plan on health care waste management prior to issuance or renewal of license. The said office likewise required hospital establishments to submit plans of wastewater treatment facilities.

Other DOH Requirements:

DOH Department Circular No. 156-C, series of 1993
"Provides guidelines on hospital waste management"

Specific instructions include:

"All undevolved government hospitals, clinics, laboratories, and research offices shall incorporate satisfactory segregation, treatment, collection and disposal systems."

"All infectious and hazardous hospital waste shall be treated before storage, collection and disposal."

"The use of appropriate technologies and indigenous materials for storage, treatment, collection and disposal of hospital waste shall be utilized to support the country's socioeconomic development program."

"All hospitals and other related institutions shall inform their staff and personnel about the proper treatment, segregation (color coding) and storage, collection and disposal of hospital waste"

DOH Memorandum No. 1-A, series of 2001

"Requiring the Department of Health Central Office, Centers for Health Development, and all concerned hospitals to practice proper solid waste management".

9.2 DENR

Presidential Decree No. 1586
"Environmental Impact Statement (EIS) System"

The Environmental Impact Statement (EIS) System of the Philippines or PD 1586 requires projects like construction of new hospital buildings or expansion of existing hospitals to secure an Environmental Compliance Certificate (ECC) prior to construction and operation of the facility. An ECC is required for the installation and operation of health care waste treatment systems like pyrolysis, autoclave, microwave, landfills, and other similar treatment technology discussed on Chapter 6.

Under the EIS System, a project proponent is tasked to undertake an environmental impact assessment (EIA) study and to prepare an EIS or an IEE, depending on the scope of the project. The EIS/IEE is a written report containing an assessment of the most likely impacts of the project on the environment and on the people in the areas to be affected by the project. The EIS/IEE is submitted to the DENR for review and forms the basis for the approval or denial of the project's ECC application.

Republic Act No. 8749
"Clean Air Act of 1999"

The Clean Air Act of 1999 prohibits the incineration of biomedical wastes effective July 17, 2003. It promotes the use of state-of-the-art, environmentally sound, and safe non-burn technologies for the handling, treatment, thermal destruction, utilization, and disposal of sorted, unrecycled biomedical and hazardous wastes.

RA 8749 defines non-burn technologies as those technologies used for the destruction, decomposition or conversion of wastes other than through the use of combustion and which comply with at least one of the following conditions (Section 2, Rule XXVIII, RA 8749):

- The environment within the destruction chamber is free of oxygen
- Fire is not used in the destruction chamber
- The source of heat is not fire
- A heat conducting material or medium whether it is a solid, liquid, gaseous, sol or gel form is used to destroy the waste

<u>Supreme Court Ruling on the Ban of Incinerators</u>

In a decision promulgated by the Supreme Court involving a case between the Metro Manila Development Authority (MMDA) and JANCOM Environmental Corporation in January 2002, it held in agreement with the ruling of the Court of Appeals on 13 November 2001 that Section 20 of RA 8749 does not prohibit incineration of wastes except those burning processes which emit poisonous and toxic fumes. An excerpt from the decision read as follows,

> *"Section 20 does not absolutely prohibit incineration as a mode of waste disposal, rather only those burning processes which emit poisonous and toxic fumes are banned."*

<u>Memorandum Circular No. 05, series of 2002 dated July 12, 2002</u>
"DENR Clarificatory Statement on Incinerator Ban"

In connection with the Supreme Court ruling, the DENR clarifies that any thermal treatment technology, whether burn or non-burn as defined in DAO 2000-81, that meets the emission standards for stationary sources as listed in Section 19 of RA 8749 and complies with all other relevant provisions of RA 8749 and other applicable laws of the Republic is allowed to operate in the country.

<u>Permitting Requirements of RA 8749</u>

Based on RA 8749, operators of air pollution source installations and its corresponding air pollution control system are required to secure the necessary permits from DENR prior to construction and during the operation of the equipment. These permits are:

1. Authority to Construct for air pollution source installations such as boiler, generator set, and its pollution control system *(prior to construction/installation)*

2. Permit to Operate for air pollution source installations such as boiler, generator set, and its pollution control system *(prior to operation and renewed annually thereafter).*

Republic Act No. 9003
"Ecological Solid Waste Management Act, 2000"

The Ecological Solid Waste Management Act of 2000 mandates the segregation of solid wastes at the source including households and institutions like hospitals by using a separate container for each type of waste from all sources (Section 21, Article 2, RA 9003). However, the term "solid waste" specifically excludes infectious waste from hospitals such as equipment, utensils, laboratory wastes, pathological specimens, disposable fomites, and similar disposal materials (Section 3(2), Article 2, RA 9003; Section 1, Rule III, DENR AO 2001-34).

Collection and transport of segregated general wastes or non-infectious wastes are covered by RA 9003 and may be bought to a landfill for disposal. The collection and transport of infectious biomedical wastes or hazardous wastes are governed by RA 6969 and cannot be disposed in open dumps or landfill. The infectious wastes once disinfected may be treated similar to a general waste.

Presidential Decree 984
"Pollution Control Law"

The Pollution Control Law is the primary legislation that governs discharges of potentially polluting substances to air and water. It provides the basis for the DENR regulations on water pollution through its IRR, DENR Administrative Order Nos. 34 and 35. The IRR for air emissions was initially set by DENR AO 14, but was later replaced by the Clean Air Act of 1999 (RA 8749).

DENR AO 34 classifies water bodies in accordance with its use and degree of protection required with Class AA and SA requiring the most stringent water quality. The prescribed allowable concentration of effluent from a hospital or health care waste facility is outlined in DENR AO 35 (Revised Effluent Standards).

Under PD 984, hospitals and other health care establishments are required to secure from the DENR the following permits related to the generation and discharge of wastewater into the environment:

1. Authority to Construct for wastewater treatment plant *(prior to construction)*

2. Permit to Operate for wastewater treatment plant *(prior to operation and renewed annually thereafter).*

The Permit to Operate has a maximum validity of one year from the date of issuance.

With the enactment of the Clean Water Act, it is expected that these provisions of PD 984 will be subsumed under the new law.

Republic Act No. 6969
"An Act to Control Toxic Substances and Hazardous and Nuclear Wastes"

The law and its implementing rules and regulations classify infectious, pathological, and pharmaceutical wastes as hazardous (Table 1, Section 25, Chapter VII of DENR AO 29) that require proper treatment and disposal.

RA 6969 requires the registration of waste generators, waste transporters, and operators of toxic and hazardous waste treatment facilities with the EMB. The waste generators (i.e., hospitals) are required to ensure that its hazardous or biomedical waste is properly collected, transported, treated, and disposed. Quarterly monitoring reports should be submitted to the EMB.

Health care facilities also have the option to contract the services of off-site waste treaters. However, these off-site waste treaters should be accredited/recognized by DENR and should have all the necessary permits from DENR.

9.3 Laguna Lake Development Authority (LLDA)

The LLDA is a quasi-government agency organized in 1966 by virtue of Republic Act 4850. The LLDA is empowered to provide regulatory and proprietary functions.

Presidential Decree 813 and Executive Order 927

By virtue of Presidential Decree 813 in 1975 and Executive Order 927 in 1983, the powers and functions of the LLDA were further strengthened to include environmental protection and jurisdiction over surface waters of the lake basin. In 1993, the administrative supervision over LLDA was transferred to the DENR by virtue of Executive Order 149.

Through EO 927, the LLDA is empowered to issue permits for use of surface waters. The LLDA requires the following permits from health care establishments located within its area of jurisdiction:

1. LLDA Clearance

   Facilities in the watershed of the Laguna de Bay are required to get a clearance from the LLDA. The Laguna de Bay watershed consists of the provinces of Rizal (13 towns) and Laguna (28 towns), chartered cities of Pasay, Caloocan, Quezon, Manila, Muntinlupa, Pasig, San Pablo, Tagaytay, Antipolo, Calamba, and Tanauan; the towns of Sto. Tomas, and Malvar in Batangas; SIlang, Carmona, and GMA in Cavite; Lucban in Quezon; and Taguig and Pateros in Metro Manila. An ECC issued by the DENR is a prerequisite for the LLDA Clearance. In addition, companies have to present a description of the business activity, Locational Clearance, water supply and disposal methods.

2. Discharge Permit

   The Discharge Permit is a legal authorization for the establishment to discharge wastewater into the tributary rivers within the Laguna de Bay region. It is based on the Environmental User Fee System (EUFS) which was launched by LLDA in January 1997. The EUFS is a market-based instrument that applies the "Polluter Pay Principle". It encourages companies to invest in and operate pollution prevention and/or abatement systems. The LLDA issues and renews the Discharge Permit only if the wastewater effluent complies with the effluent standards set under DENR AO 35. The company also needs to appoint a Pollution Control Officer whom LLDA or EMB will accredit.

CHAPTER 10

ADMINISTRATIVE REQUIREMENTS

10.1 Organization and Functions

Appropriate health care waste management practices depend largely on the administration and organization and require adequate legislative and financial support as well as the active participation by trained and informed staff. The entire organizational structure and services of the health care facility must be responsible in the proper storage, collection and disposal of waste generated by the health care facility. However, there are certain units and individuals in the establishment that usually have more responsibility related to health care waste management. Particular services/units within the health care establishment identified to have a major role in health care waste management are:

Office of the Administrator of Health Care Facility

- Form a waste management committee to develop a written waste management plan for the health care facility.
- Designate a Waste Management Officer / Pollution Control Officer to supervise and coordinate the waste management plan.
- Keep an up-to-date waste management plan.
- Allocate sufficient financial and personnel resources to ensure efficient operation of the plan. For example, the Waste Management Officer should be complimented with sufficient staff to ensure efficient implementation of the waste management plan.
- Ensure that monitoring procedures are incorporated in the plan. The efficiency and effectiveness of the disposal system should be monitored so that the system can be updated and improved when necessary.
- Appoint/designate immediately a successor in the event of personnel leaving key positions in the waste management committee or temporarily assign responsibility to another staff member until a successor can be formally appointed/designated.
- Ensure adequate training for key staff members and designate the staff responsible for coordinating and implementing training courses.
- Attend to complaints and legal matters regarding existing and unforeseen problems arising from the implementation of the program
- Establish good working relationship with other related agencies by proper referral, consultation and cooperation concerning health care waste management.

Housekeeping Services

- Maintain cleanliness and orderliness of the health care premises for aesthetic reasons.
- Assist in the preparation of the health care waste management plan.

- Initiate a sanitary manner of implementing the pre-treatment processes, appropriate collection system/procedures and disposal of waste either by individual group or municipal system.

- Establish baseline data and maintain proper filing system and update program records.

- Maintain constant good working relationship with all health care facility personnel for their support and full participation in implementing the program.

- Enhance or provide continuous training program for housekeeping/janitorial services on waste management and government policies.

Maintenance and Ground Services

- Assist in the proper collection, pre-treatment and disposal of health care waste.

- Carry out directly the activities related to the operation and maintenance of pre-treatment, collection and disposal system as soon as possible with importance to the drainage system and plumbing facilities of the establishment.

- Attend immediately to problems arising from the repair/installation of waste equipment.

Motorpool Services

- Assist in the provision of vehicle for transporting health care waste to transfer station or disposal sites.

- Prepare and plan the collection system routes and frequency of collection of health care waste.

- Inspect and schedule maintenance work on vehicles use for transporting health care waste.

10.2 Health Care Waste Management Committee (HCWMC)

Functions of the HCWMC

- Promulgate a policy formalizing the commitment of the health care institution to proper management of its waste with the goal of protecting health and the environment.

- Establish baseline data and develop the facility's health care waste management plan which should include a minimization plan, training, and written guidelines on waste management.

- Implement the health care waste management plan; and review and update the policy, plans, and guidelines on an annual basis.

- Ensure adequate financial and human resources for implementation of the health care waste management plan.

Assignment of Responsibilities

The Administrator of the health care facility will have the overall responsibility of ensuring that health care waste is disposed of in accordance with the national policies and guidelines. He or she is required to form a waste management committee to comprise of the following members:

- Administrator of the Health Care Facility - Chairperson
- Heads of the Departments
- Infection Control Officer
- Chief Pharmacist
- Radiation Officer
- Senior Nursing Staff
- Health Care Facility Engineer
- Financial Controller
- Waste Management Officer
- Health Educator/Information Officer

However, for other health facility, the composition may vary depending upon the category of health facility or availability of personnel. In some health care establishments, the structure may be different. It may include a hygienist or instead an Infection Control Officer, to address specific problems relating to health care hygiene. The Administrator of the health care facility should formally appoint/designate the members of the waste management committee in writing, informing each of them of their duties and responsibilities. The appointment/designation of a Waste Management Officer with overall responsibilities for the development of the waste management plan will also be responsible for the subsequent day-to-day operation and monitoring of waste disposal system. Depending on the availability of relevant staff, this post maybe assigned to the Health care Facility Engineer, or to any other appropriate staff member at the discretion of the Administrator of the Health care Facility.

The sharing of duties of key personnel in large health care facilities is described in the following paragraphs. In smaller facilities, one or more individual may fulfill two or more sets of responsibilities, but the same principles will apply. The plan should clearly define the duties and responsibilities of all members of staff, both clinical and non-clinical, in respect of handling of health care waste.

Waste Management Officer (WMO)

The WMO is responsible for the day-to-day operation and monitoring of the waste management system. It is therefore essential that he/she have direct access to all members of the HCWMC. The WMO is directly responsible to the Administrator of the Health care Facility. He or she should liaise with the Infection Control Officer, the Chief Pharmacist, and the Radiation Officer in order to become familiar with the correct procedures for handling and disposing of pathological, pharmaceutical, chemical and radioactive waste. The responsibilities of the WMO include among others:

- The internal collection of waste and their transport, ensuring availability of waste bags, protective clothing and collection carts, and directly supervising collection crews;

- Ensure correct use of central storage facility, which should be kept locked but is accessible to authorized staff at all times;

- Coordinate and monitor waste disposal operations, waste transport for both on-site and off-site;

- For training, liaise with the Senior Nursing Officer and Department Heads to ensure that nursing staff and medical assistants as well as doctors and other qualified clinical staff are aware of their responsibilities for segregation and storage of waste; and

- Ensure that written emergency procedures are available and that personnel are aware of the action to be taken in the event of an emergency. Investigate and review reported incidents concerning the handling of health care waste.

Department Heads

Department heads are responsible for the segregation, storage, and disposal of waste generated in their departments. Among their responsibilities are:

- Ensure that all doctors, nurses, and clinical and non-clinical professional staff in their departments are aware of the segregation and storage procedures and that all personnel comply with the highest standards in health care waste management;

- Liaise with the WMO to monitor working practices against failures or mistakes;

- Ensure that key staff members in their departments are given training in waste segregation and disposal procedures; and

- Encourage medical and nursing staff to be vigilant so as to ensure that hospital attendants and ancillary staff follow correct procedures at all times.

Senior Nursing Officer

The Senior Nursing Officer is responsible for the training of nursing staff, medical assistants, hospital attendants, and ancillary staff in the correct procedures for segregation, storage, transport, and disposal of waste. They should therefore:

- Liaise with the WMO and the advisers (Infection Control Officer, Chief Pharmacist, and Radiation Officer) to maintain the highest standards in health care waste management;

- Participate in staff introduction to, and continuous training in, the handling and disposal of waste; and

- Liaise with the Department Heads to ensure coordination of training activities, other waste management issues specific to particular departments.

Infection Control Officer

The Infection Control Officer should liaise with the WMO on a continuous basis and provide advice concerning the control of infection and the standards of the waste disposal system. His or her duties are to:

- Identify training requirements according to staff grade and occupation;
- Organize and supervise staff training courses on safe waste management;
- Liaise with the department heads and Senior Nursing Officer regarding training of staff.

The Infection Control Officer also has the overall responsibility for chemical disinfection, sound management of chemical stores, and chemical waste minimization.

Chief Pharmacist

The Chief Pharmacist is responsible for the sound management of pharmaceutical storage and for pharmaceutical waste minimization. His or her duties are to:

- Liaise with the Department Heads, the WMO, the Senior Nursing Officer and give advice, in accordance with the national policy and guidelines, on the appropriate procedures for pharmaceutical waste disposal;
- Coordinate continuous monitoring of procedures for the disposal of pharmaceutical waste;
- Ensure that personnel involved in pharmaceutical waste handling and disposal receive adequate training; and
- Ensure safe utilization of genotoxic products and the safe management of genotoxic waste.

Radiation Officer

The duties and responsibilities of the radiation officer are the same as those of the Pharmaceutical Officer but related to radioactive waste management.

Supply Officer

The Supply Officer should liaise with the WMO to ensure a continuous supply of the items required for waste management (plastic bags and containers of the right quality, spare parts for on-site health care waste treatment equipment, etc.). These items should be ordered in reasonable time to ensure that they are always available, but accumulation of excessive storage should be avoided. The Supply Officer should also investigate the possibility of purchasing environmentally friendly products (e.g. PVC-free plastic items).

Health Care Facility Engineer

The Health Care Facility Engineer of the facility is responsible for installing and maintaining waste storage facilities and handling equipment that comply with the specifications of the national guidelines. He or she is also accountable for the adequate operation and maintenance of any on-site waste treatment equipment and is responsible for the staff involved in waste treatment, ensuring that: (a) staff should receive training on the principles of waste disposal and are aware of their responsibilities under the health care waste management plan and (b) staff operating the on-site waste treatment facilities are trained in their operation and maintenance.

10.3 Health Care Waste Management Plan

A comprehensive health care waste management plan is the key ingredient to a successful waste management within a health care facility. It is important that the plan should be understood or followed to be of great value to the institution. Training of staff to ensure that they are familiar with and understand the plan is critical to the successful implementation of the plan and effective handling of health care waste.

Assessment of Waste Generation

In developing a waste management plan, the waste management committee needs to make an assessment of all waste generated in the health care facility. The WMO should be responsible for coordinating such a survey and for the analysis of the results. The study should determine the average daily quantity of waste per category generated in each department. Survey results should include an assessment of any future changes in facility, departmental growth, or the establishment of new department. Data from the waste production survey should form the basis on which an appropriate waste management plan can be developed.

Procedures for Developing the Health Care Waste Management Plan

Step 1. Understanding of the existing government policies, laws and regulations related to health care waste management.

Step 2. Review of the Current Waste Management System within the Facility before the drafting or revising a health care waste management plan, is important to assess the current waste management system. Some of the issues that need to be addressed are:

- Where the waste is generated
- What types of health care waste are being generated
- How the wastes are being stored. Where it is stored
- The cost effectiveness of the current handling processes.

Step 3. Designing of the Plan - Primary consideration in the design of the health care waste management plan is that it must address the existing and future needs of the facility. Care must be taken in the design phase of the planning process to ensure that the plan is capable of handling the current waste stream as defined in steps one and two.

Step 4. Training - Comprehensive training and orientation on how the plan is to be implemented must be provided to employees. In carrying- out the plan, each of the staff should know their individual roles.

Step 5. Plan Evaluation - The plan should be regularly reviewed and updated to reflect the improvements made in the handling of waste within the health care facility.

Plan Implementation

The overall in-charge of implementing the waste management plan is the Administrator of the Health Care Facility. The implementation of the plan involves the following activities:

1. Interim measures to be introduced as a precursor to complete implementation of the new waste management system, should be developed by a designated WMO in collaboration with a waste management team, and be appended to the plan. A bar chart should be added, showing dates of implementation of each part of the new system.

2. Provision for future expansion of the health care facility or of waste storage facilities should be made.

3. The Chief of Hospital or Medical Director appoints personnel to the post who would be responsible for the waste management. Notices of this appointment should be circulated and updates should be issued when changes occur.

4. In collaboration with the WMO and other members of the HCWMC, organize and supervise training program for all the staff. Key staff members, including medical staff, who should be urged to be vigilant in monitoring the performance of waste disposal duties by non-medical staff, should attend the initial training sessions.

5. As soon as the activities in items 1-4 have been completed and necessary equipment for the waste management is available, the operations described in the waste management plan can be put into practice.

6. The HCWMC should review the plan annually and initiate changes to upgrade the system. Interim revisions may also be made if and when necessary.

7. The Chief of Hospital or Medical Director should prepare an annual report for the disposal of health care waste, providing data on waste generation, disposal of personnel and equipment requirements, and the costs.

8. Failures in the waste handling, segregation, storage, transport, or disposal system, or waste management incidents that result in injury should be reported as soon as possible to the infection control officer.

9. Feedback/reporting of violations and compliance made thereto should be reported to the Chief of Hospital/Medical Director copy furnish the DOH.

CHAPTER 11

HEALTH AND SAFETY PRACTICES

Because wastes are produced in so many different areas within the health care establishment, it takes a team effort to properly manage health care waste. Support from the Chief of the health care establishment is one critical factor in ensuring the success of the program.

Policies or plans on health care waste management should consider the continuous monitoring of the health and safety of health care personnel and that proper collection, treatment, storage and disposal procedures are being followed. Essential occupational health and safety measures include the following:

- Proper training of health care workers
    - No training/no hiring policy should be instituted
    - Immunization at the first day of work
- Provision of personal protective equipment (from head to toe)
- Establishment of an effective occupational health program that includes immunization, post exposure prophylactic treatment, and continuous medical surveillance
- Information, Education and Communication (IEC) activities

Everyone within the health care establishment can play a role in the management of health care waste. For this reason, the training program should cast a wide network. Every employee and manager should be made aware of the policy, the significant health and environmental impacts of their work activities, their roles and responsibilities, the procedures that apply to their work and the importance of conformance with the requirements. The staff should understand the potential consequences of **NOT** following the requirements.

Worker's Protection

All personnel who are directly involved in the handling of potentially hazardous health care waste must be provided with adequate protection from the hazards associated with it. Protection against personal injury is very important for all workers at risk. The individual responsible for the management of health care waste should ensure that all these risks are identified and that suitable protection from those risks is provided. The installation of the required protection measures will proceed after the conduct of a comprehensive risk assessment of the activities in health care waste management. The design of the measure will focus on the prevention of workers exposure or at least an exposure within safe limits. Suitable training should be provided to the health care workers on this aspect.

Personal Protective Equipment

Health care waste management program requires that the following personnel protective equipment be made available to all health care personnel who collect and handle health care waste:

- Hard hats with or without visor - depending on the nature of operation
- Face masks - depending on the nature of operation
- Eye protectors/Safety goggles - depending on the nature of operation
- Overalls (coveralls) - obligatory

- Industrial aprons - obligatory
- Leg protectors and/or industrial shoes/boots - obligatory
- Disposable gloves (medical staff) or heavy duty gloves (waste workers) - obligatory
- Respirators (HEPA) filters - depending on the nature of operation

Industrial boots and heavy-duty gloves are particularly important for waste workers. The thick soles of the boots offer protection in the storage area, as a precaution from spilled sharps, and where floors are wet and slippery. If segregation is inadequate, needles or other sharp items may have been place in plastic bags; such items may also pierce thin-walled or weak plastic containers. If it is likely that health care bags will come into contact with workers' leg during handling, leg protectors may also need to be worn.

Personal Hygiene

Provision for washing facilities (with soap and warm water) should be made available to personnel.

Immunization

Health care personnel should be given immunization against the potential infection from virus causing hepatitis B and tetanus infection.

Special Precautions for Clearing up Spillage of Potentially Hazardous Substances

The place to be cleared must be secured or cordoned. Only authorized personnel or the pollution control officer should be allowed in the area.

In clearing-up spillage of body fluids or other potentially hazardous substances, particularly if there is a risk of splashing, eye protectors and facemask should be worn, in addition to gloves and overalls. The need for respirators/gas masks is also necessary if an activity is particularly dangerous, for example, if it involves toxic dust, chemical reagents, the clearance of incinerator residues, or the cleaning of contaminated equipment. Residues should be recovered as completely as possible using hand tools (e.g. shovel), and then packed safely. It is especially important also to recover spilled droplets of metallic mercury. If a leakage or spillage involves infectious material, the floor should be cleaned and disinfected after most of the waste has been recovered.

It is important that the correct type of respirator be used for each situation and that the workers be trained and fit-tested.

Response to Injury and Exposure

All staff that handles health care waste must be trained to deal with injuries and exposures. Health care establishment should develop a program that would prescribe the actions taken in the event of injury or exposure to a hazardous substance. Essential elements of the program should include the following:

- Immediate first-aid measures, such as cleansing of wounds and skin, and irrigation (splashing) of eyes with clean water
- An immediate report of the incident to a designated responsible person
- Retention, if possible, of the item involved in the incident; details of its source for identification of possible infection

- Additional medical attention in an accident and emergency or occupational health department, as soon as possible
- Medical surveillance
- Blood or other test if indicated
- Recording of the incident
- Investigation of the incident, and identification and implementation of remedial action to prevent similar incident in the future

In case of needle stick injury, bleeding of the wound should be encouraged and the area should be washed under running water. The remaining elements of the accident response plan should then be followed. The purpose of the incident reporting should not be seen as punitive; active support by managers should encourage prompt and accurate reporting.

Safe Use of Cytotoxic Drugs

In order to ensure safe use of cytotoxic drugs, the senior pharmacist of the health care establishment should be appointed to supervise the safe management of cytotoxic waste. To minimize exposures, the following measures should be observed:

- Written procedures that specify safe working methods for each process;
- Data sheets, based on the suppliers specifications, to provide information on potential hazards;
- Established procedures for emergency response in case of spillage or other occupational accident
- Appropriate education and training for all personnel involved in the handling of cytotoxic drugs.

If it is difficult to ensure safe use of cytotoxic and radioactive materials, it is advisable that the use of these substances be limited to specialized (e.g. oncological) health care establishment that are better able to implement appropriate safety measures.

Guidelines in safe handling cytotoxic products should include rules on the following waste handling procedures:

- Separate collection of waste in leak proof bags or containers, and labeling for identification
- Return of outdated drugs to suppliers
- Safe storage separately from other health care waste
- Provision for disposal of contaminated material, for the decontamination of reusable equipment, and for the treatment of spillage;
- Provision for the treatment of infectious waste contaminated with cytotoxic products, including excreta from patients and disposable linen used for incontinent patients.

CHAPTER 12

EMERGENCY RESPONSE

Training in emergency response should be provided to health care personnel, and the necessary equipment should be at hand and readily available at all times to ensure that the required measures can be implemented safely and rapidly.

Spillage is probably the most common type of emergency involving infectious and other hazardous material or waste. Spills are inadvertent discharges that occur at various places in the health care facility. Spills include accidental tipping over of containers, and dropping and breaking of containers as well as spills which occur mainly because of splashing during manual transfer, overfilling, and leaks in process equipment and piping.

Regardless of whether the spillage involves waste or material in use, the response procedures are practically the same and should ensure that: (i) the waste management plan is respected; (ii) contaminated areas are cleaned and, if necessary, disinfected; (iii) exposure of workers is limited as much as possible during the cleaning-up operation; (iv) the impact on patients, medical and other personnel, and the environment is limited as much as possible.

12.1 Spill Control

In the past, many employees did not realize that mercury was an extremely hazardous waste and would rinse the mercury from broken thermometers down the sink. Although there may only have a few small spills, spill control can help reduce wastes generated by unnecessary clean ups.

Spillage usually requires clean up only of the contaminated area. For spillage of infectious material, however, it is important to determine the type of infectious agent; in some cases, evacuation of the area may be necessary. Procedures for dealing with spillage should specify safe handling operation and appropriate protective clothing. In case of skin and eye contact with hazardous substance, there should be immediate decontamination. The exposed person should be removed from the area of the incident for decontamination, generally with copious amounts of water. Special attention should be paid to the eyes and any open wounds. In case of eye contact with corrosive chemicals, the eyes should be irrigated continuously with clean water for 10-30 minutes; the entire face should be washed in a basin, with the eyes being continuously opened and closed.

12.2 General Guidance for Spill Control

1. Vacate and secure the area to prevent further exposure of other individuals.
2. Provide first aid and medical care to injured individual.
3. Inform the designated person (usually the waste management officer) who should coordinate the necessary actions.
4. Determine the nature of the spill.
5. Provide adequate protective clothing to personnel involved in cleaning-up.
6. Limit the spread of spill.

7. Vacate all people not involved in cleaning up if the spillage involves particularly hazardous substance.

8. Neutralize or disinfect the spilled or contaminated material if indicated.

9. Collect all spilled and contaminated material (sharps should never be picked up by hand; brushes and pans or other suitable tools should be used). Spilled material and disposable contaminated items for cleaning should be placed in the appropriate waste bags or containers.

10. Decontaminate or disinfect the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should be turned during this process, because this will spread the contamination. Working from the least to the most contaminated part, with a change of cloth at each stage should carry out the decontamination. Dry cloth should be used in the case of liquid spillage, spillage of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.

11. Decontaminate or disinfect any tools that were used.

12. Seek medical attention if exposure to hazardous material has occurred during the operation.

12.3 Reporting Accidents and Incidents

Health care employees should be encouraged to report any spillage. They should be educated on what hazardous wastes are so that spill can be properly reported. Accidents or incidents, including near-misses, spillage, damaged containers, inappropriate segregation, and any incidents involving sharps should be reported to the waste management committee (if waste is involved) or to another designated person. The report should include the details of:

1. The nature of the accident or incident
2. The place and time of the accident or incident
3. The staff who are directly involved
4. Any other relevant circumstances

The waste management officer or other responsible officer, who should also take all possible action to prevent recurrence, should investigate the cause of the accident or incident. The records of the investigation and subsequent remedial measures should be kept.

CHAPTER 13

COMMUNICATION AND TRAINING

The increasing awareness of the health and environmental hazards related to health care waste has greatly increased public demand for information and guidance on the issue. The need to promote appropriate handling and disposal of health care waste is important for community health and every member of the community have the right to be informed about the potential health hazards associated to health care waste.

Public education plays an important role in health care waste management. The three objectives of public education related to health care waste are:

1. To inform the public about the risks linked to health care waste, focusing on people either living or working in close proximity to, or visiting health care establishment, families of patients being treated at home, and scavengers on waste dumps.

2. To create awareness and foster responsibility among hospital patients and visitors to health care establishments regarding hygiene and health care waste management.

3. To prevent exposure to health care waste and related health hazards; this exposure may be voluntary, in the case of scavengers, or accidental, as consequence of unsafe disposal methods.

In communicating the hazards of health care waste to the public, the following methods can be considered:

- Information, Education and Communication (IEC) campaign materials development, reproduction and dissemination. Poster exhibitions of health care waste issues, including the risk involved in scavenging discarded syringes and hypodermic needles.

- Policy dissemination - responsible staff of the health care establishment should be able to explain to incoming patients and visitors the health care waste management policy.

- Information poster exhibitions in health care establishment, at strategic points such as waste bin location that provides instructions on waste segregation. Poster should be explicit, using diagrams and illustrations to convey the messages to a large number of audiences as possible, including illiterate people.

13.1 Training of Health Care Personnel

Personnel and patients should be fully aware of the need to exercise caution when handling health care waste. All personnel should receive appropriate training. Such training should be tailored to the different needs at various levels or functions in the health care establishment. The overall aim of the training is to develop awareness on the health, safety and environmental issues relating to health care waste, and how these can affect employees in their daily work. It should also highlight the roles and responsibilities of the health care personnel in the overall management program.

Separate training activities should be designed for each of the following targeted categories of personnel:

- Health care facility managers and administrative staff responsible for implementing regulations on health care waste management
- Medical doctors
- Nurses and assistant nurses
- Cleaners, porters, auxiliary staff, and waste handlers

The training needed from those producing the waste as well as the waste handlers, is equally important. Medical doctors may be educated through senior staff workshops and general hospital staff through formal seminars. The training of waste managers and regulators, however, could take place outside the hospitals, at public health schools or university departments.

Basic education program for health care staff should include:

- Information on, and justification for, all aspects of the health care waste policy;
- Information on the role and responsibilities of each health care staff member in implementing the policy;
- Technical instructions, relevant for the target group, on the application of waste management practices.

All personnel must receive initial and annual training. A trained individual must be available during training sessions. The instructors should have experience in teaching and training, and be familiar with the hazards and practices of health care waste management; ideally, they should also have experience in waste handling.

13.2 Suggested Training Package for each Target Group

The development of a training package should be suitable for the various types of health care establishments, including government, private, teaching, and dental clinics, polyclinics, health centers, health care research institutions, clinical laboratories and similar establishments.

For Personnel Providing Health Care

The training course should provide an overview of the waste management policy and underlying rationale and information on practices relevant to the trainees' responsibilities. Waste segregation is a key element for this training in waste management. All staff who produces health care waste should be responsible for its segregation, and should therefore receive training in the basic principles and practical applications of segregation. Training should make the staff aware of the potentially serious implications of the mismanagement of waste for the health of waste handlers and patients, provide them with an overview of the fate of waste after collection and removal from ward, and teach them the importance of proper segregation of waste.

For Waste Handlers

Topics covered may include the waste management policy, health hazards, on-site transportation, storage, safety practices, and emergency response. Among staff who routinely handles health care waste, awareness of the need for safety may decrease with time, which will increase the risk of injury. Periodic refresher course is therefore recommended.

For Health Care Waste Management Operators

The training course should include:

- Information on the risks associated with the handling of health care waste;
- Procedures for dealing with spillage and other accidents;
- Correct use of protective clothing.

For Staff who Transport the Waste

In carrying out the responsibility of waste transportation, the drivers and waste handlers should be aware of the nature and risk of the transported waste. Transport staff should be able to carry out all procedures for:

- Handling, loading and unloading of waste bags and containers;
- Dealing with spillage or accidents;
- The use of Personal Protective Equipment (PPE); and,
- Documentation and recording of health care waste, e.g. by means of consignment note system to allow waste to be traced from the point of collection to the final place of disposal.

For Treatment Plant Operators

Health care establishment should make arrangement to provide training to prospective treatment plant operators specifically on the following areas:

- General operation of the treatment facility;
- Health, safety, and environmental implications of treatment operations;
- Technical procedures for plant operation;
- Emergency response, in case of equipment failures and alarms for example;
- Maintenance of the plant and record keeping;
- Surveillance of the quality of emissions and discharges, according to the specifications.

GLOSSARY OF TERMS

Glossary of Terms

Autoclaving shall refer to the method of disinfection using an apparatus for effective sterilization by steam under pressure.

Ancillary or Auxiliary Workers shall refer to all support staff in the health care establishments aside from those in the ancillary services i.e., institution workers, nursing attendants, dental aides, laboratory aides, etc.

Collection shall refer to the act of removing health care waste from the source or from a communal storage point.

Cytostatic refers to a substance causing suppression of growth and multiplication of cells.

Cytotoxic refers to a substance possessing a specific destructive action on certain cells; used in particular in referring to the lysis (disintegration or dissolution) of cells brought about by immune phenomena and to antineoplastic drugs that selectively kill dividing cells.

Decontamination refers to the reduction of microbiological contamination to a safe level.

Disinfection shall refer to the process of killing infectious agents or other harmful organisms by the application of chemical agents or through physical means.

Disposal shall refer to the discharge, deposit, dumping, placing or release of any health care waste into or on any air, land, or water.

Half-life shall refer to the rate that a radiation element decays.

Infectious Waste shall refer to those that contain pathogens like bacteria, viruses, parasites or fungi in sufficient concentration or quantity to cause disease in susceptible hosts.

Genotoxic refers to a substance that is capable of interacting directly with genetic material, causing DNA damage that can be assayed. The term may refer to carcinogenic, mutagenic, or teratogenic substances.

Leachate shall refer to the liquid produced when health care waste undergoes decomposition, and when water percolates through solid waste undergoing decomposition. It is a contaminated liquid that contains dissolved and suspended materials.

Municipal Waste shall refer to wastes produced from activities within the local government units which include a combination of domestic, commercial, institutional, industrial and street litters.

Pyrolysis refers to the thermal decomposition of substance and materials in the absence of supplied molecular oxygen in the destruction chamber in which the said material is converted into gaseous, liquid, or solid form.

Radioactive Waste refers to material that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels and for which no use is foreseen.

Recyclable shall refer to any waste material retrieved from the waste stream and free from contamination that can still be converted into suitable and beneficial use or for other purposes, including, but not limited to cardboard, glass, office paper, drink cans, newspapers, magazines and plastics.

Recycling shall refer to the process of reducing the size of hospital waste by extracting domestic trade waste for industrial use such as paper for re-pulping, metals for re-smelting and plastic for the production of an inferior grade.

Re-use shall refer to the process of recovering materials intended for the same or different purpose without the alteration of physical and chemical characteristics.

Sanitary Landfill shall refer to a waste disposal site designed, constructed, operated and maintained in a manner that exerts engineering control over significant potential environmental impacts arising from the development and operation of the facility.

Segregation shall refer to a health care waste management practice of separating different waste materials found in health care establishment in order to promote recycling and re-use of resources and to reduce the volume of waste for collection and disposal.

Sludge refers to the accumulated solids that separate from liquids such as water or wastewater during processing, or deposits on the bottom of streams or other bodies of water.

Sterilization refers to the reduction in microorganisms of more than 10^6 (more than 99.9999% of the microorganisms are killed), achieved by physical, chemical, or mechanical methods or by irradiation.

Storage shall refer to the interim containment of health care waste after generation and prior to collection for ultimate recovery or disposal.

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- Training Guide on "Hospital Waste Management", Environmental Health Service, Department of Health, Manila, 1995

ANNEXES

ANNEX 1

HANDLING, STORAGE, COLLECTION AND TRANSPORTATION, TREATMENT AND DISPOSAL OF SHARPS

(Department of Health)

Packaging and Storage

Sharps should be stored in a puncture-proof (made of metal and high-density plastic) containers and fitted with covers. Containers should be rigid and impermeable to retain or contain residual liquid from syringes. This should also be temper-proof (difficult to open or break).

In the absence of metals or plastic containers, the use of containers made of dense cardboard with plastic lining is recommended.

Needles should not be removed from the syringe because of the risk of injury however, if removal is required, special care must be taken. No healthcare waste other than sharps should be deposited in sharp containers, as these (containers) are more expensive. The sealed sharp containers must be properly labeled in accordance with the Revised DOH Healthcare Waste Management Manual. Supply of sharp containers should be readily available at the source of (sharps) waste generation.

Collection and Transport

Sealed sharp containers should be collected regularly or as frequently as required and transported to the designated on site or off-site disposal area. The waste generator is responsible for safe packaging and adequate labeling of waste to be transported off-site. Packaging and labeling must conform to the manual to prevent spilling during handling and transport.

Treatment and Disposal

Satisfactory treatment process prior to disposal of sharp wastes in healthcare establishments is necessary to maximize the promotion of health, safety and protection of environment. The following are the recommended methods of disposal of used sharps.

- Chemical Disinfection

  Chemical disinfection is used to destroy or kill microorganisms on healthcare wastes like sharps. The types of chemical used for disinfection of healthcare waste are mostly aldehydes, chlorine compounds, and phenolic compounds. Used syringes and needles shall be put into containers with 1:10 solution of 5-10% sodium hypochlorite or other approved disinfectants for at least 30 minutes.

- Wet and Thermal Treatment (Autoclaving)

  Wet thermal – or steam – disinfection is based on exposure of shredded infectious waste to high temperature, high pressure steam, and is similar to the autoclave sterilization process. Sharps must be milled or crushed to increase disinfection efficiency.

- Land Disposal

  Sanitary Landfill is an engineered method of disposing solid waste on land in a manner that protects the environment, e.g. by spreading the waste into layers, compacting it to the smallest particle volume, and covering it with soil by the end of each working day, constructing barriers to infiltration, evacuating the gases produced.

  Encapsulation is the process of pre-treating sharps and other healthcare wastes. This process involves filling container with sharps, adding an immobilizing materials and sealing the containers. Examples of the immobilizing materials are plastic foam, bituminous sand, cement, mortar or clay material. Encapsulation process used either cubic boxes of high density polyethylene (HDPE) or metallic drums. Once sharp waste was encapsulated, this can be disposed of in a sanitary landfill. The cell site for this waste should be separated from general wastes.

  Safe Burial on Hospital/Health Center Premises, when there is no available disposal facility within the area, safe burial on health establishment premises is considered as the only viable option. However, certain basic rules should be established such as:

  - Access to the disposal site should be restricted to authorize personnel only.
  - The burial site should be lined with a material of low permeability, such as clay to prevent ground water contamination

ANNEX 2

GUIDELINES FOR DISCARDING DISPOSABLE SYRINGES AND NEEDLES

(Department of Health)

Objectives:

- To prevent accidental needle prick injury and possible HEPA A & B, HIV infection to medical and health personnel.
- To render all used disposable syringes and needles useless from use by potential users (drug addicts)

Precautions*:*

To avoid needle prick injuries:

- Do not recap or re-sheath needles after collecting blood or giving injection
- Do not bend disposable needles by hand
- Do not re-use or sterilize disposable needles

Methods for Disposal

Recommended disposal methods and procedures:

a. Autoclave

- The used disposable needles and syringes are directly placed into a puncture-proof container.
- At the end of each working day, (sharp) wastes are gathered centrally and autoclave at 121°C for at least 20 minutes.

b. Burial

- The used disposable needles and syringes are directly placed into a puncture-proof container.
- At the end of each working day, (sharp) wastes are gathered centrally, bury in designated site within the healthcare establishment premises.
- The burial site are lined with materials of low permeability rate and properly marked that such types of waste are buried there.
- The burial site are isolated and covered with fence.

c. Encapsulation

- Put the used needles and syringes in a container made of high density polyethylene or metallic drums.
- Once the container is already three-quarters filled with needles and syringes, the container is filled with a medium such as plastic foam, bituminous sand, cement mortar or clay material.
- After the medium has dried, the containers are sealed and disposed off in a sanitary landfill.

Occupational Health and Safety

Persons directly involved in the collection and disposal of used sharps and syringes are at greater risks and therefore need suitable protection from such risks. Workers and personnel shall be trained on proper sharp management and must be oriented on the hazards associated with the improper handling and disposal of sharps and syringes.

Workers must be provided with protective clothing like gloves, mask, boots and long-sleeved shirt.

Supervision and Responsible Personnel

Within the healthcare establishment i.e. clinics, a supervisor or person in-charge must be identified and shall be responsible in ensuring the safety of workers and personnel. He/she must ensure that the used needles and syringes are properly disposed off.

Annex 2

ANNEX 3

March 1990

Philippine Nuclear Research Institute
ADMINISTRATIVE ORDER NO. 01
Series of 1990

RADIOACTIVE WASTES BY PHILIPPPINE NUCLEAR RESEARCH INSTITUTE (PNRI) FROM OFF-SITE WASTE GENERATORS

By authority of Section 16(a) of Republic Act Mo. 2067, as amended, and E.O. 128 and pursuant to Section 3(g) of P.D. 606 and Section 26(a) of Part 3 of The Code of PAEC Regulations, the following guidelines for the acceptance of low-level radioactive wastes from off-site generators by the Philippine Nuclear Research Institute (PNRI) is hereby established:

The Philippine Nuclear Research Institute (PNRI) provides radwaste management services through its Radiation Protection Section (RPS).

The guidelines for the acceptance of low-level radioactivated wastes as set forth in this document apply to offsite waste generators who are authorized to collect and transport unconditioned low-level radioactive wastes for conditioning and interim storage at the PNRI. A waste generator who is authorized to collect and transport radioactive wastes to PNRI is an agency, firm, or institution using radioactive materials and possessing a valid Radioactive Material License. Radioactive wastes generated may be in the form of solid or liquid materials contaminated with radioactive substances or spent radioactive sealed sources.

The PNRI is establishing specific requirements within the framework of the proposed NRMC Low-level Waste Disposal Site, discussed in the Appendix VI of the Regional Fuel Cycle Center Project (National Radwaste Management Center dated April 1986) for each category of waste materials. Each waste category has to meet the requirements.

The segregation, collection, packaging and transport requirements established in this criteria guarantee the effective treatment and conditioning procedures in the Radwaste Management Facility at the PNRI. PNRI requires that the size and configuration of the waste packages for transport should be standardized. Proper segregation of low-level wastes at the placed of origin will permit processing of wastes with the appropriate method or procedure. This will considerably extend the space available for the interim storage of conditioned wastes at the PNRI Radwaste Management Facility.

The acceptance criteria contained in this document are based on current practices optimized to the extent possible and in no way supersede PNRI Regulations and Standards.

GENERAL GUIDELINES

1. REQUEST FOR RADWASTE MANAGEMENT SERVICES

PNRI will consider requests from waste generators on the basis of their compliance to PNRI requirements. The waste generator must submit a written request addressed to the Director of PNRI, attention of Head of the RPS. The request should provide the required information for evaluation purposes.

The waste generator shall provide separate information sheet for each type/category of waste materials that they want to send to PNRI for conditioning and interim storage.

The following information must be provided as an attachment to each request submitted:

a. Waste Coordinator - provide the name, position, address, and telephone number of the person/s responsible for the segregation, collection, packaging, and transport of the waste generated.

b. Proposed Schedule - provide the proposed date of shipment and the expected arrival at PNRI.

c. Waste Material - provide the information corresponding to the type of radwaste material.

For Spent Sealed Sources - provide the following information for each package containing a specific type of:

1. Type of casing (specify the type of device where the source is encased)
2. Number of units
3. List of Radionuclides present (indicating the elements and the corresponding mass number
4. The marked activity, the reference data and the corresponding name of manufacturer and serial number of each unit of spent sealed source
5. Dimension of waste package
6. Weight of the completed transport package
7. Handling device (Rigging, tie-down, etc.)
8. Maximum radiation dose-rate reading at contact and at one (1) meter distance from surface of packaging

For Other Solid Waste Materials - the following information must be declared for each package of solid waste

1. Volume of waste material in m^3
2. Waste category (See Table 1)
3. List of radionuclides present
4. Beta-gamma/alpha contamination level per cm^2 in the waste materials
5. List of non-radioactive waste components (such as glass, metal sheets, paper, and destroyed biological components)

6. Radiation dose-rate reading at surface of package and at one (1) meter distance from surface
7. Total weight of completed package
8. Type of transport container (Refer to Required Transport Containers)

For Liquid Waste - provide the following information for each container of liquid waste

1. Waste Category (See Table 1)
2. List of radionuclides present
3. Approximate activity per unit volume of waste
4. Type of solvent/chemicals present (indicate if organic, acidic, or aqueous)
5. Other non-radioactive components (include destroyed biological or pathogenic components)
6. Waste Volume in liters
7. Type of waste container (glass, plastic, carboy, etc.
8. Transport container (Refer to the Required Transport Containers)

PNRI will evaluate the request upon receipt and respond with 15-30 days for offsite waste generators. If the request is acceptable, the waste generator will be sent two copies of the PNRI forms (NRLSD/RP-101 for radwaste, or NRLSD/RP-102 for spent sealed sources) to be accomplished. Offsite waste generators will be required to comply with Transport Regulations prior to shipment of waste materials to PNRI. The accomplished PNRI forms, the Certificate of Transport, and other documents that may be required (e.g. radioactive sealed source specifications or brochure), should accompany the radioactive wastes/spent sealed sources on its arrival to PNRI. Request is only valid for one shipment which may contain several packages of waste materials.

2. TRANSPORT EXPENSES

The waste generator shall have budgetary responsibility for all cost necessary to deliver wastes/spent sealed sources to PNRI.

Any radioactive waste/spent sealed source received at the PNRI for conditioning and storage that violate the criteria stated herein may not be accepted by PNRI. The material may be returned to the waste generator or PNRI may perform the corrective action. The cost of either of the two actions will be charged against the account of the waste generator.

3. ACCEPTANCE CRITERIA

The following materials shall not be accepted for conditioning and/or interim storage at the PNRI:

a. Materials containing radioisotopes of half-lives less than two years and with exempt quantities of radioactivity as stated in NRLSD Bulletin No. 89-4.

b. Contaminated pressurized containers such as aerosol cans. These cans will qualify for acceptance only if pressure is released by punching holes on the container.

c. Materials containing explosive chemicals. The explosive chemicals must be chemically converted to a stable state by the waste generator before they are sent to PNRI for disposal. Procedure for the conversion/chemical destruction done shall be attached to the waste generator's request for evaluation.

d. Waste materials containing biological or pathogenic components. Treatment such as autoclave method must be done by the waste generator, so as to destroy these components prior to packaging. A certification indicating that such procedures were done and that the waste no longer contain active pathogenic components shall be attached to the accomplished request forms upon submission.

4. TRANSPORT REQUIREMENTS

All waste shipments shall be accompanied by all the required documents. They should be packaged and contained in a transport container as provided for under the Requirements on Transport Containers. Radiation levels from waste container must conform with the values provided by the Rules and Regulations on the Safe Transport of Radioactive Materials in the Philippines specified in Part 4 of the Code of PAEC Regulations.

Radiation and waste package contamination levels declared by the waste generator shall be verified at the PNRI. If the radiation and contamination readings obtained by the waste generator at the time of transport and the PNRI reading at the time of receipt vary by a factor of 20%, the attention of waste generator may be called to provide explanation.

The exterior of all packages sent to PNRI shall be reasonably free of dirt, moisture, rust, and removable surface contamination.

Waste packages shall be identified. Labeling shall either be painted, stenciled, or neatly hand-lettered using 1-inch block lettering. The following information shall be on each waste package:

a. Sign indicating "Radioactive Waste Material" and radiation symbol
b. Generator's Name
c. List of radionuclides present
d. Maximum radiation level at contact and at 1 meter distance from surface
e. Waste transport package gross weight

Transport containers shall also be labeled with sign indicating "Radioactive Material" and a radiation symbol which shall be placed neatly and clearly on top and on side of each drum. Boxes shall be labeled on the upper right quadrant of each of the two long sides and shall be visible during transport.

Spent sealed sources packages shall be provided with permanent/auxiliary handle or lifting device.

Bulky and heavy waste material such as heavy spent sealed source metal casing shall be blocked and braced inside the waste package to prevent a shift of the waste item material during transport and handling.

5. WASTE CHARACTERIZATION, SEGRAGATION, AND PACKAGING

Radioactively contaminated materials that are identified as waste must be properly characterized and segregated by the waste generators according to the waste categorization system provided in Table 1. This will enable PNRI to treat and condition wastes in the most efficient manner available and to optimize the interim storage capacity at the PNRI site.

The above mentioned waste materials must be collected and packaged as follows:

a. Contaminated Solid Materials

Radwaste materials belonging to the same waste category must be collected in a 100 liter drum lined with polyethylene plastic bag. When the container is full the plastic bag must be tightly closed by wrapping a tape around the empty side near the open end of the plastic bag.

b. Liquid Waste

Liquid waste belonging to the same waste category may be collected in 2-liter glass containers or in 20-liter plastic carboy with dependable screw cap, depending on whichever will be appropriate for the type and the amount of substance to be contained.

Spent Sealed Sources belonging to the same type of radionuclides can be packaged in the same transport container, provided that Transport Regulations are not violated, e.g. Transport Index, package classification.

6. REQUIRED TRANSPORT CONTAINERS

The waste generator shall load the prescribed containers to ensure that the container volume loading is optimum. Optimum loading is necessary to reduce the number of shipments or delivery to PNRI and will enhance space utilization at the PNRI Radwaste Management Facility. This will also help to obtain maximum benefit from its waste processing system.

a. Standard 200 liter (55-gal.) steel drum with removable head is prescribed for packages of solid wastes and liquid wastes contained in glass or plastic containers. The drums must be provided with head gasket, bolt ring and bolt lock. It can also be used for spent sealed sources.

b. Steel boxes which can withstand 73.30 g/cm^2 (150 lbs/ft^2) is the minimum prescribed for packaging spent sealed sources whose original casings cannot fit the 200 liter (55-gal) drums. Installed or permanent handle must be provided for safe and convenient handling and transport. The maximum weight allowed per package is 1000 kilograms.

Table 1

RADIOACTIVE WASTE MATERIAL CATEGORIES

Waste Category	**Content** (Single radionuclide or combination of what are listed in a specific category)
A - 1	radionuclides with half-lives ≤ one month ex. I - 131
A - 2	radionuclides with half-lives > one year but ≤ one year
B - 1	radionuclides with half-lives > one year but ≤ five years ex. Cs - 134, Co - 60
B - 2	radionuclides with half-lives > five years but ≤ 20 years ex. H - 3
B - 3	radionuclides with half-lives > 20 years but ≤ 100 years ex. Cs - 137
C - 1	radionuclides with half-lives > 100 years but ≤ 500 years ex. Am - 241
C - 2	radionuclides with half-lives > 500 years Ex. C - 14, U - 238, Pu - 239, Th - 230

This Administrative Order repeals prior Administrative Orders inconsistent herewith and takes effect after fifteen (15) days of notification of PNRI licenses.

Quezon City : March 1990

B. R. Aleta
Officer-in-Charge

Annex 3

ANNEX 4

CONSIGNMENT NOTE
(Sample Format)

A. TRANSPORTER

Name: ______________________________ Address: ____________________________
Telephone No.: ______________________ Accreditation No.: ____________________
Type of Waste Transported: _________________________ Quantity (kg): ___________

B. GENERATOR

Name: ______________________________ Address: ____________________________
Telephone No.: _____________________________

C. TREATMENT FACILITY

Name of Manager/Authorized Representative: ________________________________
Address: ____________________________ Telephone No.: _______________________
Permit to Operate: (Permit No.) __________________________________
Signature of Manager/Authorized Representative: ______________________________

C. DATE WASTES ARE COLLECTED/TRANSPORTED/RECEIVED

Date Collected/Removed from Generator's Facility: _____________________________
Date Received by the Transfer Station (Point of Consolidation): __________________
Date Received by the Treatment Facility: _____________________________________

ANNEX 5

Segregation of Healthcare Waste According to Types of Waste and Sources

RED (Sharps and Pressurized Containers)	• Needles & syringes • Scalpel blades • Glass vials -tuberculin/ insulin • Stylet • Capillary tubes • Ampules • Test tubes • Blood evacuation tubes • Pipette slides/ cover slips • Aluminum Cover • Blood Lancets • Empty Aerosol Cans • Rusty pins, nails, clips and screws • Broken Glasses
YELLOW (Infectious & Pathological Wastes)	• Gauze, cotton bandage, cotton applicators soaked with blood/body fluids from dressing of infected wounds and post operative cases, procedures such as Paps smear, immunization • Foreign bodies removed from any body parts • Placenta, umbilical cord • Used gloves • Used foley catheters • Used tubing – IV, nebulizer • Used diapers, sanitary napkins • Used suction tubes • Used NGT • Used test strips • Used urine bags • Used drains-penrose • Used cord clamp • Used plaster • Empty colostomy bag • Used swabs • Heplock endo-tracheal tubes • Used tongue guard • Used oxygen tubing • Used gladwrap • Used mask/face mask • Used thoracic tube • Used hemovac • Used sensor/ electrodes • Used bandages • Used rubber sheet • Used rubber tubing • Used CVP tubes • Used t-tubes • Used central lines • Used oxygen catheter • Amputated limbs, toes, fingers, organs, extracted tooth • Tissues from minor/major operation • Specimen containers of blood and body fluids • Used culture media, tissue culture plate • Used test strips • Used beads/plates • Used kit from laboratory analyzer • Used reaction pads, foils • Used plastic wares/ disposables

	• Used Hemoline Diphasique • Used T & B cell separator • Used tissue typing/x-matching trays for discards • Used filter • Used blood products bags and tubing
YELLOW WITH BLACK BAND (Chemical and Pharmaceutical Wastes)	• Empty bottles of acids - HCl, H2SO4, HNO3, etc. • Empty bottles of betadine, Iodine, KMNO3 • Empty bottles of laboratory reagents (Formaline, Tolouene, Xylene) • Empty bottles/cans of Kerosene, Acetone, Alcohol, Anaesthetic, lacquer • Empty bottles of disinfec-tants • Busted Flourescent bulb • Defective thermometer • Empty cans of glue, epoxy and floor wax • Expired and adulterated drugs and medicines • Used batteries
BLACK (Non-Infectious Dry Wastes)	• Paper and paper products - used papers - newspapers - tetra packs, paper cups - boxes/cartons • Bottles - Glass & plastic • Packaging materials - styropore - aluminum - plastic, candy/food wrapper
GREEN Non-Infectious Wet Wastes)	• Kitchen left- over food • Used cooking oil • Fish entrails, scale and fins • Fruits and vegetables peelings • Rotten fruits and vegetables • Non-infectious left-over foods
ORANGE (Radioactive/Nuclear Wastes)	• 1125 (Iodine 125) • Iodine 131 • H3 – Thymidine • Cesium-137 • Chromium – 51 • Things contaminated with these radio-active materials - Gloves - tissue papers - cotton swabs - aluminum foil - gauze - test tubes - pipette tips - repetitive syringes - technecium 99m - tridium • Used x-ray films, developers, and fixers

ANNEX 6

Characteristics of Formaldehyde (HCHO) as A Chemical Disinfectant

Inactivating effect against all microorganisms, including bacteria, viruses, and bacterial spores, may be applied to dry, solid waste, in combination with steam at 80^{o}C. Contact time: 45 minutes.

Physical and chemical properties
Gas at ambient temperature, flammable and explosive in mixtures with air at concentrations of 7-73%; reactive at ambient temperature; polymerizes at temperature below 80^{o}C. Formalin is a 37% solution of formaldehyde. Formaldehyde odor threshold: 0.1-1ppm.

Health hazards
WHO guideline value for the general public: 0.1 ppm. WHO guideline value for occupational exposure: 1 ppm for 5 minutes, with no more than 8 peaks in one working period (of up to 8 hours). Irritant effects may be experienced at concentrations of 1-3 ppm upwards; exposure to concentrations above 10 ppm may result in severe irritation of eyes or respiratory tract. Occupational Safety limit: 1 ppm in the USA. Formaldehyde has been classified as a probable human carcinogen by the International Agency for Research on Cancer; all precautions should therefore be taken to avoid inhalation of this compound during handling. NIOSH IDLH: 20 ppm.

Protective measures
Gloves and protective eyeglasses should be worn during handling of formaldehyde to protect skin and eyes; in case of skin contact, the affected area should be rinsed abundantly with water.

Corrosiveness
Formalin is slightly corrosive to most metals except stainless steel and aluminum; it should be stored in stainless steel, aluminum, or polyethylene containers, in well ventilated and leak-proof-room.

Fire
Firefighters should wear breathing masks when tackling fires involving formaldehyde.

Comments
Formaldehyde is suitable for use as a chemical disinfectant only in situations in which a high level of chemical safety can be maintained.

ANNEX 7

Characteristics of Sodium Hypochclorite (NaOCl) as a Chemical Disinfectant

Application
Active against most bacteria, viruses, and spores; not effective for disinfection of liquids with high organic content such as blood or stools; widely used for treatment of wastewater.   For waste, operating parameters should be adjusted on the basis of bacteriological tests.

Physical and chemical properties
Available as aqueous solution with 2-12% of active chlorine; at ambient temperature slowly decomposes into sodium chloride, and oxygen; solutions of low concentration are more stable; solutions should be protected from light which accelerates decomposition; reacts with acids to produce hazardous chlorine gas.

Health hazards
Irritant to skin, eyes, and respiratory tract; toxic.

Protective measures
Gloves and protective eye glasses should be worn during handling of sodium hypochlorite to protect skin and eyes; in case of eye contact, the eyes should be rinsed abundantly with water.

Corrosiveness
Aqueous solutions are corrosive to metals, usually stored in plastic containers in well ventilated, dark, and leakage-proof rooms; should be stored separately from acids.

Comments
Sodium hypochlorite may be widely used because of relatively mild health hazards. Unused solutions should be reduced with sodium bisulfite or sodium thiosulfate and neutralized with acids before discharge into sewers. Large quantities of concentrated solutions should be treated as hazardous chemical waste.

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