Health Care Waste Management Strategy for SADC and COMESA Countries

OCTOBER 2017

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DISCLAIMER

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ABBREVIATIONS AND ACRONYMS

AIDS	acquired immunodeficiency syndrome
BOO	Build, Own, and Operate
BOT	Build, Operate, and Transfer
CIC	**Capital Investment Costs**
COMESA	Common Market for Eastern and Southern Africa
DNA	Dexyribonucleic acid
EIA	Environmental Impact Assessment
FOC	Fixed Operating Costs
GPs	general practitioners
HCW	healthcare waste
HCWM	Healthcare waste management
HIV	human immunodeficiency virus
HW	hazardous waste
IAEA	International Atomic Energy Agency
IDC	In-direct Costs
ISO	International Organization for Standardization
kg	kilogram
NGO	nongovernmental organization
POPs	persistent organic pollutants
PVC	polyvinyl chloride
SADC	Southern African Development Community
TC	Transportation Costs
VOC	Variable Operating Costs
WHO	World Health Organization

1. BACKGROUND

1.1. Introduction

Infectious or hazardous hospital waste represents only a small part of total healthcare waste (HCW), the mismanagement of which poses risks to healthcare workers, patients, waste handlers, waste pickers, and the general public. Improper disposal of special HCW, including open dumping and uncontrolled burning, increases the risk of spreading infections and of exposure to toxic emissions from incomplete combustion. The main sources of illness are injuries with used needles leading to blood-borne infections, which can cause hepatitis and HIV. There are, however, numerous other diseases which could be transmitted simply by contact with HCW.

1.1.1. Definitions and classification of HCW

HCW includes all the wastes generated by medical activities of diagnosis as well as preventive, curative and palliative treatments in the field of human and veterinary medicine. In other words, all wastes produced by a medical institution (public or private), a medical research facility or a laboratory are considered HCW.

HCWs of concern include the following:

a) any waste which consists wholly or partly of human or animal tissue, blood or other bodily fluids, excretions, drugs or other pharmaceutical products, swabs or dressings, syringes, needles or other sharp instruments; and

b) other waste arising from medical, nursing, dental, veterinary, pharmaceutical or similar practice, investigation, treatment, care, teaching or research, or the collection of blood for transfusion, being waste which may cause infection to any person coming into contact with it.

According to the Technical Guidelines on Environmentally Sound Management of Biomedical and HCW provided by the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal (170 Parties in 2008), HCW are classified as follows (see Figure 1.1):

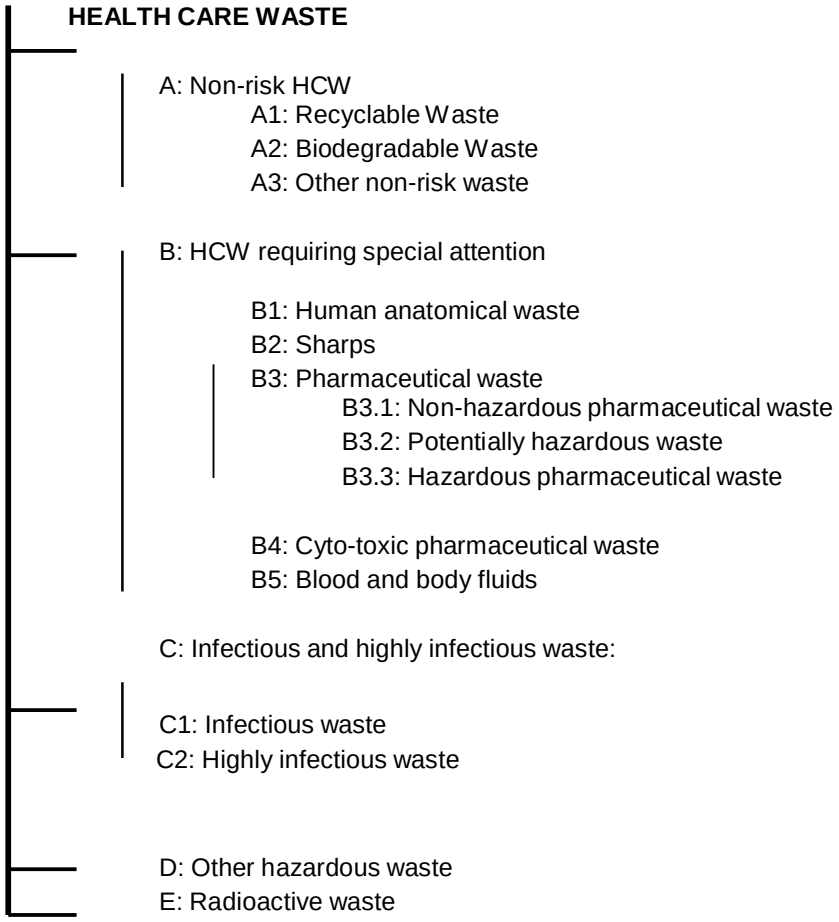


Figure 1.1: Health Care Waste Streams

1.1.2 Objectives of the present health care waste management (HCWM) strategy

HCWM is one of the most challenging sectors in Common Market for Eastern and Southern Africa (COMESA) and Southern African Development Community (SADC) Countries. The rapid survey that has been conducted prior developing this strategy reveals that most of the countries in SADC and COMESA do not have a defined health care waste management system. In most cases the HCW is dumped together with municipal solid waste.

The overall goal of this HCWM Strategy is to assist countries in COMESA and SADC to improve HCWM at the national, regional and local level, thereby promoting safe and sustainable environmental health in health care facilities in these countries

The Strategy provides direction for action of involved stakeholders in the entire HCWM chain.

The specific objectives are to assist COMESA and SADC countries to develop a system of:

i. obtaining and analysing information on the collection, treatment, handling, hauling, and disposing HCWs;
ii. determining the level of knowledge and awareness of individuals involved in healthcare risk waste handling (from the source of generation to the final disposal destination);
iii. highlighting the potential impacts that HCWs pose to both human health and the natural environment due to improper disposal and management techniques;
iv. directing further stakeholder action; and
v. developing their national strategies and plans for implementing this strategy.

While it is possible to develop HCWM system using system, some countries may find it appropriate to develop their own national strategy.

The national strategy for HCWM should:

i. Reflect priorities within healthcare facilities for treatment and disposal of HCW.
ii. Set goals for and means of monitoring of infection control and environmental protection.
iii. Propose choice of technology for packaging, transportation, treatment, and disposal.
iv. Prioritize central or decentralized treatment and disposal.
v. Reflect distribution of responsibility in the sector between national, regional and local governments.
vi. Make recommendations on private sector involvement.
vii. Propose an action and investment plan for implementing an improved HCWM.
viii. Propose mechanisms for financing HCWM.
ix. Propose guidelines for HCWM training programmes at facility and municipal/regional level.

2. HEALTH CARE WASTE MANAGEMENT - GENERAL PRACTICE

The starting point of any HCWM programme at national level should start by:

(i) analysing the existing legal environment concerning the HCWM;
(ii) conducting gap analyses in the existing legal environment;
(iii) analysing strengths and weaknesses of the existing enforcement of existing laws
(iv) identifying the main national and local stakeholders; and
(v) conducting a general overview of the health care sector aimed at identifying and documenting all HCW generators.

2.1. NATIONAL POLICY

A sustainable HCWM system is only possible if it supported by a national policy on HCWM. The national policy should identify the needs and problems in the country, as well as taking into account the relevant international agreements and conventions, to which the country is a Party that govern public health, sustainable development, the environment and safe management of hazardous waste.

2.2. GUIDING PRINCIPLES

The following five principles are widely recognised as underlying the effective and controlled management of wastes and thus should be reflected in the national HCWM policy:

i. **The "polluter pays"** - all producers of waste are legally and financially responsible for the safe and environmentally sound disposal of the waste they produce.
ii. **The "precautionary"** - Where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation".
iii. **The "duty of care"** - any person handling or managing hazardous substances or wastes or related equipment is ethically responsible for using the utmost care in that task. This principle is best achieved when all parties involved in the production, storage, transport, treatment and final disposal of HCW are appropriately registered or licensed to produce, receive and handle such waste.
iv. **The "proximity" -** treatment and disposal of hazardous waste take place at the closest possible location to its source to minimize the risks involved in its transport.

v. **The "prior informed consent principle"** - It requires that affected communities and other stakeholders be apprised of the hazards and risks, and that their consent be obtained. In the context of health- care waste, the principle could apply to the transport of waste and the siting and operation of waste-treatment and disposal facilities.

2.3. National Legal Framework

Healthcare facilities and centralized treatment/disposal facilities need to comply with relevant national legislation. This would include waste regulations; regulations on environmental and health impact assessments; environmental emissions standards; prevention and control of infectious disease regulations; regulations on management of radioactive materials; and emergency special procedures.

Few SADC and COMESA countries have appropriate laws and/or regulations concerning HCWM. In countries where such laws exist, they generally focus on treatment aspects of HCW, usually by providing for on-site incineration. But on-site incineration may be neither cost effective nor environmentally sound.

Regulations developed in conjunction with a national healthcare strategy may be implemented faster than new legislation and yet may have essentially the same effect as laws. Regulations should include clear definitions; precise indications of legal obligations for healthcare facilities, municipal waste managers, and disposal facilities; applicable enforcement and penalty systems; and delegation of legal courts to handle disputes. In some cases, different schedules for compliance with such regulations are recommended: teaching hospitals first, for example, then larger hospitals, and then smaller facilities. This would help in cases where healthcare facilities have widely different levels of resources available to them, and some may need more time to conform to new regulations.

After a thorough analysis of existing laws, a country may decide to develop a national law on HCWM i.e. if the analysis finds out the existing legal regime is not adequately equipped to deal with HCW.

Regulations governing HCWM should be developed to implement the policy. To be most effective, regulations should describe what is expected from health-care staff and explain the methods for their enforcement.

A national law on HCWM may be a stand-alone document, or constitute part of more comprehensive legislation, such as:

i. a law on managing all forms of hazardous wastes, where the application to HCW is stated explicitly;

ii. a law on hospital hygiene and infection control, where a specific section should be devoted to HCW.

A national law may include the following elements:

i. a clear definition of hazardous HCW and its various categories;
ii. a precise indication of the legal obligations of the HCW producer regarding safe handling and disposal;
iii. specifications for record keeping and reporting;
iv. establishment of permit or licensing procedures for systems of treatment and waste handling;
v. specifications for an inspection system and regular audit procedures to ensure enforcement of the law and for penalties to be imposed for contravention; and
vi. designation of courts responsible for handling disputes arising from enforcement of, or non-compliance with, the law.

2.4. International Conventions

National legislation and regulations on HCW should also be in line with the international regulations established by multilateral environmental and waste agreements or international institutions. The following are the relevant international regulations for HCWM.

2.4.1. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (OGRM 49/97)

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989 and entered into force on 5 May 1992. This environmental treaty strictly regulates the transboundary movements of hazardous wastes and obligates its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner. The Basel Convention makes specific reference to the control of HCW like sharps, pathological infectious waste, hazardous chemical waste, and pharmaceutical waste in Annex 8:

i. Clinical wastes from medical care in hospitals, medical centres, and clinics (Y1);
ii. Wastes from the production and preparation of pharmaceutical products (Y2);
iii. Waste pharmaceuticals, drugs, and medicines (Y3); and
iv. Waste from the production, formulation and use of biocides and phytopharmaceuticals (Y4).

2.4.2. The Bamako Convention

The Bamako Convention on the Import into Africa and the Control of Trans-Boundary Movement and Management of Hazardous Wastes within Africa (the Bamako Convention) is a treaty of African nations prohibiting the import of any hazardous (including radioactive) waste. The Bamako Convention uses a format and language similar to that of the Basel Convention, but it is much stronger in prohibiting all imports of hazardous waste.

2.4.3. The Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants (POPs) (the Stockholm Convention) is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel.

2.4.4. United Nations Committee of Experts on the Transport of Dangerous Goods

The United Nations Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods has developed recommendations for governments and international organizations responsible for the transport of dangerous goods, or its regulation. These may be adopted for national health care waste transport codes.

2.5. International Guidelines and Standards

In addition, there are useful internationally available guidance documents that may be used to supplement the national policy.

2.5.1. World Health Organization (WHO) Guidance

The WHO policy paper, *Safe HCWM* (WHO, 2004), recommends that countries conduct assessments before choosing health-care management methods. WHO suggests that government organizations adopt the strategies outlined below:

a) Short-term strategies:
   i. Production of all syringe components using the same plastic to facilitate recycling.
   ii. Selection of polyvinyl chloride–free medical devices.
   iii. Identification and development of recycling options wherever possible (e.g. for plastic, glass).
   iv. Research into, and promotion of, new technology or alternative to small-scale incineration.

v. Until developing countries have access to HCW-management options that are safer for the environment and health, *incineration may be an acceptable response when used appropriately*. Key elements of appropriate operation of incinerators include effective waste reduction and waste segregation, placing incinerators away from populated areas, satisfactory engineered design, construction following appropriate dimensional plans, proper operation, periodic maintenance, and staff training and management.

b) Medium-term strategies:

i. Further efforts to reduce the number of unnecessary injections, to reduce the amount of hazardous health- care waste that needs to be treated.

ii. Research into the health effects of chronic exposure to low levels of dioxin and furan.

iii. Risk assessment to compare the health risks associated with (a) incineration, and (b) exposure to HCW.

c) Long-term strategies

i. Effective, scaled-up promotion of non-incineration technologies for the final disposal of HCW to prevent the disease burden from (a) unsafe HCWM, and (b) exposure to dioxins and furans.

ii. Support to countries in developing a national guidance manual for sound management of HCW.

iii. Support to countries in developing and implementing a national plan, policies and legislation on HCW.

iv. Promotion of the principles of environmentally sound management of HCW as set out in the Basel Convention.

v. Support to allocate human and financial resources to safely manage HCW in countries.

WHO also recommends the *Core principles for achieving safe and sustainable management of HCW* (WHO, 2007). These principles require that everyone associated with financing and supporting health-care activities should provide for the costs of managing HCW. In particular:

a) Governments should

i. allocate a budget to cover the costs of establishment and maintenance of sound HCWM systems;

ii. request donors, partners and other sources of external financing to include an adequate contribution towards the management of waste associated with their interventions; and

iii. implement and monitor sound HCWM systems, support capacity building, and ensure worker and community health.

b) Donors and partners should
- include a provision in their health programme assistance to cover the costs of sound HCW- management systems.

c) NGOs should
- include the promotion of sound HCWM in their advocacy; and
- undertake programmes and activities that contribute to sound HCWM.

d) The private sector should
- take responsibility for the sound management of HCW associated with the products and services it provides, including the design of products and packaging.

e) All concerned institutions and organizations should
- promote sound HCWM;
- develop innovative solutions to reduce the volume and toxicity of the waste they produce and that is associated with their products;
- ensure that global health strategies and programmes take into account HCWM.

2.5.2. ISO 14001 Standards

ISO 14001 is an international standard, whose purpose is to enable an organization of any type or size to develop and implement a policy committing it to prevention of pollution, compliance with legal and other requirements and continual improvement.

The realization of this commitment will be a management system that recognizes and manages the primary environmental issues through awareness and assessment of applicable legal requirements, objectives for improvement, assignment of responsibilities, competent personnel, communications, procedures, controls and monitoring, emergency response capability, self-correction and assessment, and internal reviews. These processes are to be based on the Plan-Do-Check-Act cycle.

Key programmes on implementation of ISO 14001 may include:

i. An environmentally sound purchasing policy
ii. Use of energy from renewable sources
iii. Patients are served healthy meals made from locally-produced, often organic, ingredients.
iv. Health care wastes are sorted and recycled (such as glass, neon lights, paper and cardboard, plastic wrapping, textile, medical imaging and batteries)
v. A safe waste storage system reduces the risk of injury and infection for both patients and staff.

2.5.3. International Atomic Energy Agency (IAEA)

The IAEA is an autonomous intergovernmental organization within the United Nations system, which provides advice to member states on nuclear power development, health and safety, radioactive waste management, legal aspects of atomic energy, and prospecting for and exploiting nuclear raw materials. IAEA has also been promoting efforts to establish standards for safe handling of hazardous waste substances.

Presently, the agency is developing safety standards in the area of pre-disposal of hazardous wastes, which includes collection, handling, treatment, conditioning, and storage of radioactive waste. Such disposal wastes include management of radioactive waste from medicine, industry, and research.

3. HCW-MANAGEMENT PLAN

A national HCWM plan defines the strategies for the implementation of improved HCWM and the allocation of roles, responsibilities and resources. It describes the actions to be implemented by authorities, health-care personnel and waste workers. At the national level, a plan defines its intentions to make improvements, and the resources required across the country for successful implementation.

A national HCWM plan should be based on an assessment of the existing HCW-management options to identify the needed actions to be implemented across the country. A national survey (Chapter 1) of existing health-care practices and technologies in use should precede a planning exercise.

3.1. Action Plan for Developing a National Programme

The national HCWM Plan has 8 steps as shown in Box 3.1

Box 3.1: Steps for a national HCW management plan
Step 1: Establish policy commitment and responsibility for health-care waste management
Step 2: Conduct a national survey of health-care waste management practices
Step 3 Develop national guidelines
Step 4 Formulate a national strategy on health-care waste management
Step 5: Develop a policy on regional and cooperative methods of health-care waste treatment
Step 6: Establish legislation: regulations and standards for health-care waste management
Step 7: Carry out a national training programme
Step 8: Review the national health-care waste-management programme after implementation

Step 1: Establish policy commitment and responsibility for HCWM (Chapter 2)

Step 2: Conduct a national survey of HCWM practices

A survey of existing health care waste management should be carried out. The survey should include both impartial site observations and interviews with health-care managers and medical and support staff (e.g. cleaners, waste handlers) at different levels. A useful survey should include the following:

a) **An inventory of existing health facilities** – this can be used as a database on the distribution of health-care facilities, the medical services provided, the numbers of patients treated and the standards of service achieved.
b) **An analysis of existing legislation** – this is crucial for the planning process, because it defines the amount and type of legal obligations mandated and highlights any deficiencies in legal and regulatory requirements expected of public

bodies, the private sector and individuals for the safe handling of HCW. It is also a point of reference to determine existing responsibilities for waste management and public safety.

c) **An estimate of HCW production nationwide** – a waste-generation survey provides essential data on the quantities and types of waste produced and a comparison of the rates of generation between health-care facilities and regions. Typical approaches to comparisons between medical areas and HCW facilities are to express the waste quantities against the number of hospital beds, bed occupancy rate, or number of outpatients treated per day or per month.

d) **A description of HCW-management practices** – often, central government does not have clear information on the waste practices in use. This information can be gathered by observing staff in hospitals and clinics. Collecting these data is essential so that realistic decisions can be made on where to prioritize interventions according to the magnitude of the risks posed by present methods. The kind of qualitative information that can be collected includes
   i) skills and knowledge of personnel involved in the management of HCW;
   ii) current HCW-disposal practices, including level of health protection achieved from existing segregation, collection, transportation, storage and disposal methods.

e) **An analysis of the availability of training for staff** - in central authorities and at individual health-care facilities.

f) **An analysis of the institutional and monitoring capacities** – this is used to show if, or how, the safe disposal of waste is monitored and quality checked.

Step 3 Develop national guidelines

The guideline brings together the policy and the national survey to identify practical guidance that needs to be prepared.

Step 4 Formulate a national strategy on HCWM (Chapter 5)

Step 5: Develop a policy on regional and cooperative methods of HCW treatment

Identify the resources needed to build up a national network of disposal facilities for HCW, accessible by hospitals and other health-care facilities. There are four basic options for managing HCW treatment that may be considered:

i. Option 1: an onsite treatment facility in each health-care establishment;
ii. Option 2: regional or cooperative HCW-treatment facilities, supplemented by individual facilities for outlying hospitals;
iii. Option 3: treatment of HCW in existing industrial or municipal treatment facilities (e.g. municipal facilities), where these exist;

iv. Option 4: Partial treatment undertaken onsite and remaining waste treated offsite.

Step 6: Establish legislation: regulations and standards for HCWM (Chapter 2)

Action steps		Action elements
8 – Review the implemented national programme	←	6 months[a] ✓ Develop a review system Improve the programme ✓ Develop an information system
7 – Develop and implement a national training programme	←	6 months - Develop "train the trainers"
6 – Establish legislation and standards		**Programme** ✓ Modify health curricula ✓ Obtain professional assistance - 12 months ✓ Consider international principles ✓ Consider best available technologies[b] ✓ Include technical, environ- mental and hygienic standards for the complete logistic chain (segregation, transport, storage) ✓ Include monitoring and documentation
5 – Develop common treatment policies	←	
4 – Formulate a strategy on HCWM	←	**System** ✓ Use hospital input - 3 months ✓ Develop regional or cooperative treatment facilities ✓ Establish onsite treatment facilities ✓ Establish alternative treatment facilities - 3 months ✓ Present a national strategy - 6 months ✓ Present law and national policies ✓ Use hospital input ✓ Use as the basis of incorporating hospital input into policy development - 6 months ✓ Design and test the survey ✓ Distribute nationally ✓ Use to develop guidelines - 3 months ✓ Designate authority Interact with ministries Start implementation of action plan
3 – Develop national guidelines	←	
2 – Conduct a national survey of HCWM	←	
1 – Ensure policy commitment and designate responsibilities	←	

a Time (months) to complete action
b Best available technologies (BAT) are the international standards
Source: Adapted from WHO (1997)

Figure 3.1: Action plan for national programme of sound HCWM

Step 7 Carry out a national training programme

Step 8: Review the national HCW-management programme after implementation

A national programme for HCWM is as a continuous process with periodic monitoring and reassessment by a responsible national government ministry or agency. The review should base assessment on reports from hospitals and clinics on their success in implementing HCWM plans. It should review annual reports submitted by the heads of the facilities and make random visits to carry out audits of the HCWM systems. Any deficiencies in the HCWM system should be pointed out to the hospital or clinic director in writing, together with recommendations for remedial measures. Where practicable, a time limit for implementing remedial measures should be specified and the head of the establishment should be informed of the date of a follow-up visit.

Offsite waste-treatment facilities, operators of treatment facilities, road-haulage contractors and landfill operators should also be audited. Periodic reviews of HCWM operators by both a national government agency and the health-care facilities that use them should be carried out. These latter two bodies should also be expected to press for improvements in the protection of occupational and public health from waste operations.

3.2. Assign Responsibilities

In the larger health-care facilities where large quantities of waste are generated e.g. in regional or referral hospitals, establish a dedicated HCWM committee:

The following members may constitute a committee:

i. head of hospital (as chairperson)
ii. heads of hospital departments
iii. infection-control officer
iv. chief pharmacist
v. radiation officer
vi. matron (or senior nursing officer)
vii. hospital manager
viii. hospital engineer
ix. financial controller
x. HCWM officer (if one is designated).

In larger establishments, the structure may include a specialist hospital hygienist, in addition to, or instead of, the infection-control officer, to address persistent difficulties relating to hospital hygiene, such as persistent methicillin- resistant *Staphylococcus aureus* or *Clostridium difficile* contamination.

In health-care facilities in lower income areas e.g. district hospitals, the suggested approach is to have a smaller infection-control committee with one person responsible for HCWM.

The committee members should be formally appoint by the hospital head in writing. Clear terms of reference should be included in their letters of appointments. The head should appoint a HCWM officer who will have overall responsibility for developing the HCWM plan, and for the day-to-day operation and monitoring of the waste-disposal system. Depending on availability of relevant staff, this post may be assigned to the hospital engineer, hospital manager, or any other appropriate staff member at the discretion of the head of hospital.

In an institution that is not directly involved in patient care, such as a medical research institution, the head of the establishment should use their discretion to appoint members of the HCWM team from among the relevant staff.

3.3. Management Structure, Liaison Arrangements and Duties

A typical hospital HCWM structure is shown in Figure 3.2, with line-management responsibilities and liaison paths between key personnel involved in handling HCW. This structure may be adjusted to the particular needs of each hospital. Key personnel in large hospitals can share duties, while one person can fulfil two or more sets of responsibilities in smaller health-care facilities.

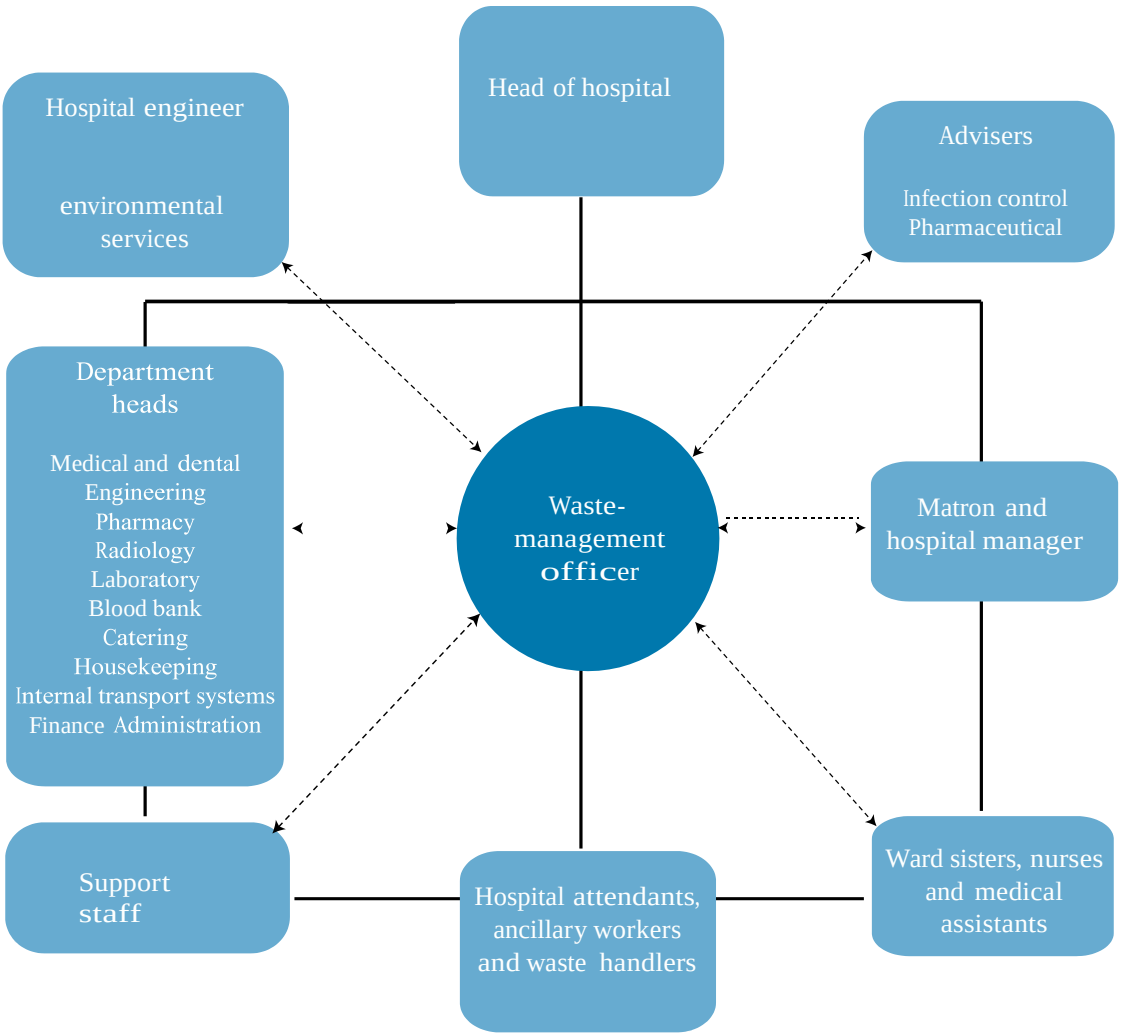
Head of hospital

The head of hospital is responsible for the following tasks:

i. Form a HCWM team to develop a written HCWM plan for the hospital. The team should consist of representatives from clinical and non-clinical areas of the organization, in addition to those who are involved in the removal and management of waste. The plan should clearly define the duties and responsibilities of all members of staff, both clinical and non-clinical, in respect to handling HCW and to establishing lines of accountability.
ii. Oversee and approve a HCWM plan.
iii. Designate a HCWM officer to supervise and implement the HCWM plan. The head of hospital retains overall responsibility for ensuring that health-care and other wastes are disposed of according to national guidelines.
iv. Keep the HCWM plan updated by setting regular (e.g. annual) review dates.
v. Allocate financial and personnel resources to ensure efficient operation of the plan. For example, sufficient staff should be assigned to the HCWM officer to ensure efficient operation of the HCWM plan.
vi. Ensure that monitoring procedures are incorporated in the plan. The efficiency and effectiveness of the treatment and disposal system should be monitored so that the system can be updated and improved when necessary. Any changes should eventually be incorporated into a revised management plan.

vii. Appoint a successor in the event of personnel leaving key positions in the HCWM team (or temporarily assign responsibility to another staff member until a successor can be appointed).

viii. Ensure adequate training for staff members, and designate the staff responsible for coordinating and implementing training courses.



Note: Liaison paths are represented by dotted lines. Line-management paths are represented by solid lines. Source: Adapted from WHO WPR (1994)

Figure 3.2: Hospital HCWM structure

HCWM officer

The HCWM officer is responsible for the day-to-day operation and monitoring of the HCWM system and is usually established as a separate post at larger hospitals. It is therefore important that the HCWM officer has direct access to all members of the hospital staff (see Figure 3.2). The role should be held by a senior member of staff and should be responsible to

the head of hospital. The HCWM officer should liaise with the infection-control officer, the chief pharmacist and the radiation officer so that they become familiar with the correct procedures for handling and disposing of pathological, pharmaceutical, chemical and radioactive wastes.

To manage waste collection, storage and disposal, the HCWM officer should:

a) control internal collection of waste containers and their transport to the central waste-storage facility of the hospital on a daily basis;
b) liaise with the supplies department to ensure that an appropriate range of bags and containers for HCW, protective clothing and collection trolleys is available at all times;
c) ensure that hospital attendants and ancillary staff immediately replace used bags and containers with the correct new bags or containers;
d) directly supervise hospital attendants, ancillary workers and waste handlers assigned to collect and transport HCW;
e) ensure the correct use of the central storage facility for HCW, which should be kept locked but should always be accessible to authorized hospital staff;
f) prevent all unsupervised dumping of waste on the hospital grounds;
g) coordinate and monitor all waste-disposal operations;
h) monitor methods of transportation of wastes both onsite and offsite, and ensure that wastes collected from the hospital are transported by an appropriate vehicle to the designated treatment and disposal site;
i) ensure that waste is not stored for longer than specified in the guidelines and that the transport organization (which may be the local authority or a private contractor) collects the waste with the required frequency.
j) To organize staff training and information, the HCWM officer should be responsible for the following actions:

i. Liaise with the matron (or senior nursing officer) and the hospital manager to ensure that the nursing staff and medical assistants are aware of their own responsibilities for the segregation and storage of waste, as well as for the correct closing and sealing of bags and containers. The HCWM officer also defines the duties of hospital attendants and ancillary staff on the handling and transport of sealed waste bags and containers.
ii. Liaise with department heads to ensure that all doctors and clinical staff are aware of their own responsibilities regarding waste segregation, and storage and closing and sealing of waste bags, to minimize infection risks, as well as the responsibilities of hospital attendants and ancillary staff regarding the handling and transport of sealed bags and containers.
iii. Ensure that waste handlers are properly trained in waste collection and treatment, as well as safe and sufficient disposal methods, including how to

operate and maintain machines and technology. Refresher courses should be provided on a routine basis.

iv. Ensure compliance with occupational health measures, including current practices for post-exposure prophylaxis, as well as the provision and use of personal protective equipment for health workers and waste handlers.

k) To prepare for incident management and control, the HCWM officer should:

i. ensure that written and pictorial emergency and contingency procedures are available, that they are in place at all times, and that personnel are aware of the action to be taken in the event of an emergency;

ii. investigate and review any reported incidents concerning the handling of HCW (in liaison with the infection-control department).

In addition, the HCWM officer should continuously monitor certain parameters, which are listed in Box 3.2.

Department heads

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

i. ensure that all doctors, nurses, and clinical and non-clinical professional staff in their departments are aware of the segregation, sealing and storage procedures, and that all personnel comply with the highest standards;

ii. liaise regularly with the HCWM officer to monitor working practices for failures or mistakes;

iii. ensure that key staff members in their departments are trained in waste segregation and disposal procedures;

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

Matron and hospital manager

Box 3.2: Parameters to be monitored by the waste-management officer

Waste generated each month, by waste category:

- ☞ in each department
- ☞ treatment and disposal methods.

Waste handled safely and in accordance to the safety operation procedures:

- ➢ occupational safety (e.g. personal protective equipment)
- ➢ use of proper and clean equipment and marking equipment
- ➢ proper segregation at source
- ➢ internal safe transport and storage
- ➢ internal safe treatment methods
- ➢ safe disposal methods if on premises of the health-care facility. Financial aspects of health-care waste management:
  - ✓ direct costs of supplies and materials used for collection, transport, storage, treatment, disposal, decontamination and cleaning
  - ✓ training costs (labour and material)
  - ✓ costs of operation and maintenance of onsite treatment facilities
  - ✓ costs for contractor services. Public health aspects:
    - o Incidents resulting in injury, "near misses" or failures in the handling, segregation, storage, transport or disposal system should be reported to the infection-control officer and the waste-management officer. This information should be used to decide the preventive measures to avoid recurrences.

The matron (or senior nursing officer) and the hospital manager are responsible for training nursing staff, medical assistants, hospital attendants and ancillary staff in the correct procedures for segregation, sealing, storage, transport and disposal of waste. They should:

i. liaise with the HCWM officer and the advisers (infection-control officer, chief pharmacist and radiation officer) to maintain high standards of infection control;
ii. participate in staff induction and refresher training in the handling and treatment and disposal of HCW; and
iii. liaise with department heads to ensure coordination of training activities, and decide what to do about HCWM issues specific to particular departments.

Infection-control officer

The infection-control officer should liaise with the HCWM officer on a continual basis, and provide advice about the control of infection, and the standards of the waste treatment and disposal system. The infection- control officer's duties that relate to HCW include:

i. identifying training requirements according to staff grade and occupation;
ii. organizing and supervising staff training courses on the infection risks from poor waste management; and

iii. liaising with the department heads, the matron and the hospital manager to coordinate training.

The infection-control officer may also have overall responsibility for chemical disinfection, the safe management of chemical stores, and minimizing chemical waste creation.

Chief pharmacist

The chief pharmacist is responsible for the safe management of pharmaceutical stores and for minimizing pharmaceutical waste. Duties include:

i. liaising with department heads, the HCWM officer, the matron and the hospital manager, and giving advice, in accordance with the national policy and guidelines, on the appropriate procedures for pharmaceutical waste treatment and disposal;
ii. coordinating continual monitoring of procedures for the treatment and disposal of pharmaceutical waste;
iii. ensuring that personnel involved in pharmaceutical waste handling, treatment and disposal receive adequate training; and
iv. remaining up to date with the proper treatment and safe disposal of expired, damaged and unusable pharmaceuticals, pharmaceutical packaging and equipment.

The chief pharmacist also has the special responsibility of ensuring that genotoxic products are used safely, and that genotoxic waste is managed safely.

Radiation officer

The duties and responsibilities of the radiation officer are the same as those of the pharmaceutical officer but relate to radioactive waste. There may also be additional regulations regarding the storage and safeguarding of radioactive wastes. These regulations need to be followed strictly for the safety of those handling the radioactive wastes.

Supply officer

The supply officer should liaise with the HCWM officer to ensure a continuous supply of the items required for waste management (plastic bags and containers of the right quality, spare parts for onsite HCW-treatment equipment). These items should be ordered in good time to ensure that they are always available, but accumulation of excessive stores supplies should be avoided. The supply officer should also investigate the possibility of purchasing environmentally friendly products (e.g. polyvinyl chloride–free plastic items, mercury free).

Hospital engineer

The hospital engineer is responsible for installing and maintaining waste-storage facilities and handling equipment that comply with the specifications of the national guidelines. The engineer is also accountable for the adequate operation and maintenance of any onsite waste-treatment equipment, and is responsible for the staff involved in waste treatment, ensuring that:

i. staff receive training in the principles of waste disposal and are aware of their responsibilities under the hospital HCWM plan; and
ii. staff operating onsite waste-treatment facilities are trained in their operation and maintenance.

3.3.1. Assessment of waste generation

The HCWM officer should be responsible for coordinating such a survey and for analysing the results. The waste should be categorized according to the classification system specified in the national guidelines (or as described in this handbook, if no such guidelines are available). The survey should determine the average daily quantity of waste in each category generated by each hospital department.

The HCWM team should take special care to test the robustness of the HCWM plan during periods of "peak" waste production – the occasional generation of extraordinary quantities of wastes. For example, the HCWM plan should be able to plan for the impact of epidemics and other emergencies that affect the quantities of waste generated. Table 3.1 shows a sample sheet for the daily assessment of waste, by waste category, for each waste-collection point. The survey system for the waste-production survey could form the basis for routine waste-generation record keeping in each medical area.

Table 3.1: Sample sheet for assessing waste generation

Name of the health-care facility: ..... Week: .....

Waste-collection point: department/ location	Waste category[a] (specify)	Quantity of waste generated per day (weight and volume)													
		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
		kg	litre	kg	litre	kg	litre	kg	litre	kg	litre	kg	litre	kg	litre

[a] Infectious waste, pathological waste, sharps, pharmaceutical waste, cytotoxic waste, waste with high heavy metal content, radioactive waste

Source: adapted from Christen (1996)

3.3.2. Develop a hospital HCWM plan

During development of the Hospital HCWM plan, every member of the HCWM committee should review existing HCWM arrangements in their area of responsibility. Existing practices should then be evaluated in the light of the national guidelines and recommendations made to the HCWM officer on how the guidelines can be implemented in each area. On the basis of the waste-generation survey and these recommendations, the HCWM officer should prepare a draft discussion document for the waste-management committee. This discussion document should include details of changes to the present waste- management system (as outlined in Box 3.3) and should contain sections addressing the following issues:

i. present situation (HCWM practices, personnel and equipment involved);
ii. quantities of waste generated;
iii. possibilities for waste minimization, reuse and recycling; waste segregation; onsite handling, transport and storage practices;
iv. identification and evaluation of waste-treatment and disposal options (onsite and offsite);

v. identification and evaluation of the options for record keeping and documentation, training and monitoring;
vi. estimation of costs relating to waste management, including capital, operational and maintenance costs;
vii. strategy for implementing the plan.

A draft discussion document should be prepared in consultation with all members of the HCWM committee and their staff. Officials from the local municipality and where possible the national government agency responsible for the disposal of HCWs should be invited to assist in the planning process.

Subsequently, a HCWM plan would be based on an expanded version of the discussion document and should be presented to the HCWM committee for approval. When full agreement has been reached, the document should be designated as the hospital HCWM plan.

The HCWM plan should include diagrams that outline the line-management structure and the liaison paths between managers and staff, and a list of names and telephone numbers of responsible personnel to be notified in the event of an emergency. The HCWM plan should also include a clear set of actions for implementing the plan across the health-care facility.

3.3.3. Implement the HCWM plan

Implementation involves the following steps:

i. Interim measures, to be introduced as a precursor to complete implementation of the new HCWM system, should be developed by the HCWM officer, in collaboration with the HCWM committee, and be appended to the plan. A bar chart should also be added, showing dates of implementation of each part of the new system.
ii. Provision for future expansion – of the hospital or of waste-storage facilities – should be made.
iii. The head of hospital appoints personnel to the posts with responsibility for waste management. Notices of these appointments should be widely circulated, and updates should be issued when changes occur.
iv. The infection-control officer should organize and supervise training programmes for all staff, in collaboration with the HCWM officer and other members of the HCWM committee. Initial training sessions should be attended by 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. The infection-control officer should choose the speakers for training sessions and determine the content and type of training given to each category of personnel.

As soon as the actions in steps 1–4 have been completed and the necessary equipment for waste management is available, the operations described in the HCWM plan can be put into practice.

Box 3.3: Details to include in the waste-management plan

Location and organization of collection and storage facilities

1. Drawings of the establishment showing designated bag or disposal container for every ward and department in the hospital; disposal container shall be appropriately designated for health-care waste or other waste.
2. Drawings showing the central storage site for health-care waste and the separate site for other waste. Details of the type of containers, security equipment, and arrangements for washing and disinfecting waste-collection trolleys
3. (or other transport devices) should be specified. The document should also address eventual needs for refrigerated storage facilities.
4. Drawings showing the paths of waste-collection trolleys through the hospital, with clearly marked individual collection routes.
5. A collection timetable for each trolley route, the type of waste to be collected, and the number of wards and departments to be visited on one round. The central storage point in the facility for that particular waste should be identified.

Design specifications

1. Drawings showing the type of bag holder to be used in the wards and departments.
2. Drawings showing the type of trolley or wheeled container to be used for bag collection.
3. Drawings of sharps containers, with their specification.

Required material and human resources

1. An estimate of the number and cost of bag holders and collection trolleys.
2. An estimate of the number of sharps containers and health-care waste drum containers required annually, categorized into different sizes, if appropriate.
3. An estimate of the number and cost of colour-coded bags or bins to be used annually.
4. An estimate of the number of personnel required for waste collection.

Responsibilities

1. Definitions of responsibilities, duties and codes of practice for each of the different categories of personnel of the hospital who, through their daily work, will generate waste and be involved in the segregation, storage and handling of the waste.
2. A definition of the responsibilities of hospital attendants and ancillary staff in collecting and handling wastes, for each ward and department; where special practices are required (e.g. for radioactive waste or hazardous chemical waste), the stage at which attendants or ancillary staff become involved in waste handling shall be clearly defined.

Procedures and practices

1. Simple diagram (flowchart) showing procedure for waste segregation.
2. The procedures for segregation, storage and handling of wastes requiring special arrangements, such as autoclaving.
3. Outline of monitoring procedures for waste categories and their destination.
4. Contingency plans, containing instructions on storage or evacuation of health-care waste in case of breakdown of the treatment unit or during closure for planned maintenance.
5. Emergency procedures

Training

Description of the training courses and programmes to be set up and the personnel who should participate in each. For further information, refer to *Basic steps in the preparation of health-care waste management plans for health care establishments* (WHO CEHA, 2002), which is available for purchase through the website (http://www.emro.who.int/ceha).

The HCWM committee should:

i. review the HCWM plan annually and initiate changes necessary to upgrade the system.
ii. update policies and practices as new national guidance becomes available.
iii. Report, as soon as possible to the infection-control officer and the HCWM officer, on failures in waste handling, segregation, storage, transport or disposal systems, or waste management incidents that result in injury.

The head of hospital should prepare an annual report to the national government agency responsible for the disposal of HCWs, providing data on waste generation and disposal, personnel and equipment requirements, and costs.

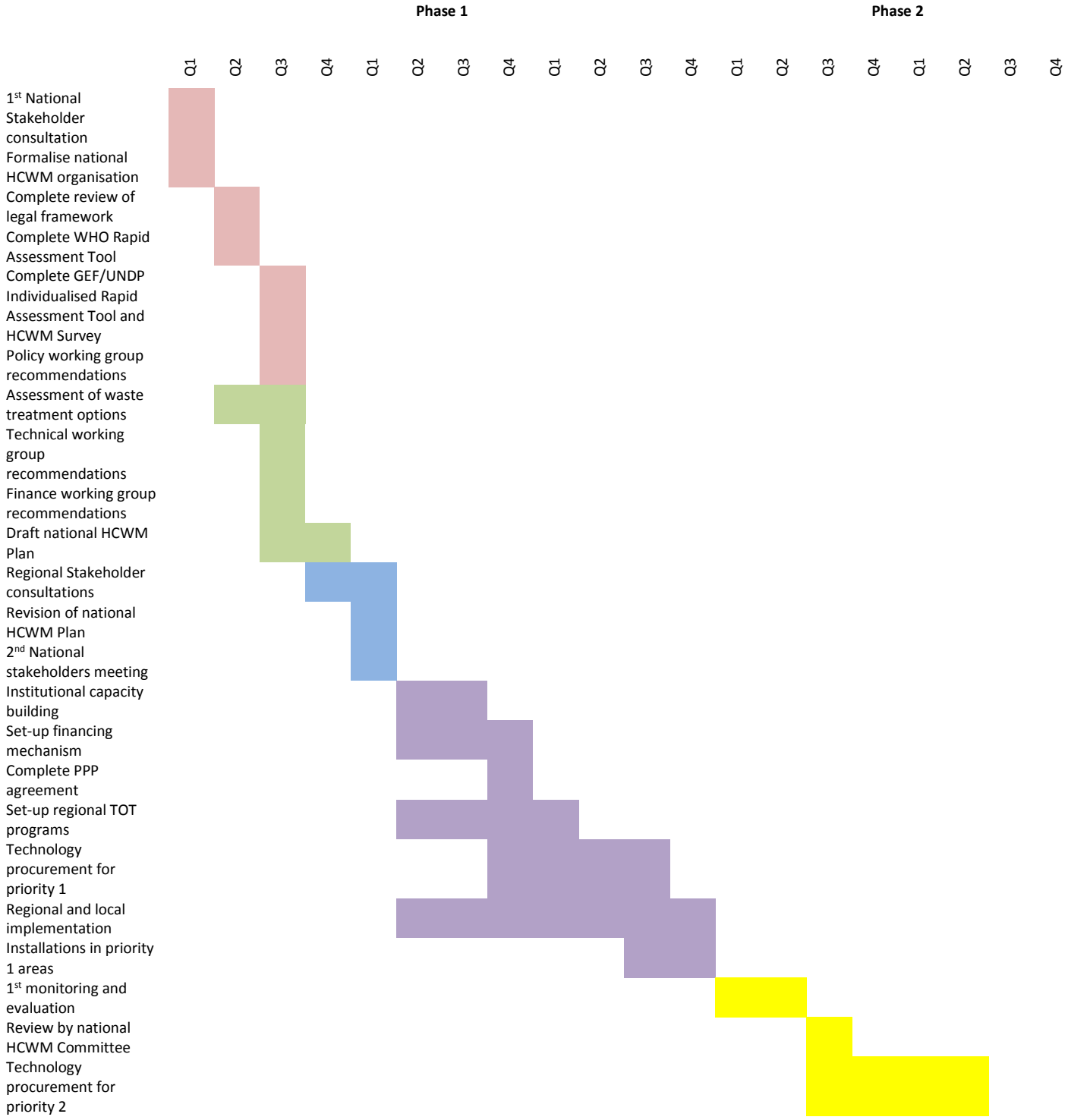
An initial approach to planning

The approach and recommendations in a HCWM plan should be implemented incrementally, through gradual improvements. It is important for public authorities and managers of health-care facilities to be fully aware of the infection-control reasons for having proper HCWM procedures.

Introducing waste segregation is the first step in implementing a HCWM plan. Too often, health-care facilities treat hazardous HCW in the same manner as general waste. Improving the separation and safe storage of used sharps is a good starting point. Specific methods for disposing of hazardous HCWs can then be introduced, followed by measures to encourage waste minimization and the safe reuse of materials, wherever possible.

Table 3.2 shows a typical national HCWM plan Gantt chart. It may be adapted to suit national circumstances.

Table 3.2: Typical national HCWM plan



4. HCWM PRINCIPLES

4.1. Hazards of HCW

HCW includes a large component of general waste and a smaller proportion of hazardous waste. This paragraph addresses the potential hazards of exposure to hazardous (or risk) HCW. Exposure to hazardous HCW can result in disease or injury. The hazardous nature of HCW may be due to one or more of the following characteristics:

i. it contains infectious agents;
ii. it is genotoxic;
iii. it contains toxic or hazardous chemicals or pharmaceuticals;
iv. it is radioactive;
v. it contains sharps.

4.1.1. Hazards from infectious waste and sharps

Infectious waste may contain any of a great variety of pathogenic microorganisms. Pathogens in infectious waste may enter the human body by the following routes:

i. through a puncture, abrasion, or cut in the skin;
ii. through the mucous membranes;
iii. by inhalation;
iv. by ingestion.

Examples of infections that can be caused by exposure to HCW are listed in Table 4.1, together with the body fluids that are the usual vehicles of transmission. There is particular concern about infection with human immunodeficiency virus (HIV) and hepatitis viruses B and C. These viruses are generally transmitted through injuries from syringe needles contaminated by human blood.

The existence of bacteria resistant to antibiotics and chemical disinfectants in health-care establishments may also contribute to the hazards created by poorly managed HCW. It has been demonstrated, for example, that plasmids from laboratory strains contained in healthcare waste were transferred to indigenous bacteria via the waste disposal system. Moreover, antibiotic-resistant *Escherichia coli* have been shown to survive in an activated sludge plant, although there does not seem to be significant transfer of this organism under normal conditions of wastewater disposal and treatment.

Concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) are probably the waste items that represent the most acute potential hazards to health. Sharps may not only cause cuts and punctures but also infect these wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission, sharps are considered as a very hazardous waste 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 patient's blood.

Table 4.1: Examples of infections caused by exposure to health-care wastes, causative organisms and transmission vehicles

Type of infection	Examples of causative organisms	Transmission vehicles
Gastroenteric infections	✓ Enterobacteria, e.g. Salmonella, Shigella spp ✓ Vibrio cholera; helminths	Faeces and/or vomit
Respiratory infections	✓ Mycobacterium tuberculosis; ✓ measles virus; Streptococcus pneumoniae	Inhaled secretions; saliva
Ocular infection	Herpesvirus	Eye secretions
Genital infections	Neisseria gonorrhoeae; herpesvirus	Genital secretions
Skin infections	Streptococcus spp.	Pus
Anthrax	Bacillus anthracis	Skin secretions
Meningitis	Neisseria meningitidis	Cerebrospinal fluid
Acquired immunodeficiency syndrome (AIDS)	Human immunodeficiency virus (HIV)	Blood, sexual secretions
Haemorrhagic fevers	Junin, Lassa, Ebola, and Marburg viruses	All bloody products and secretions
Septicaemia	Staphylococcus spp	Blood
Bacteraemia	✓ Coagulase-negative Staphylococcus spp.; ✓ Staphylococcus aureus; ✓ Enterobacter, Enterococcus, Klebsiella, and	Blood
Candidaemia	Candida albicans	Blood
Viral hepatitis A	Hepatitis A virus	Faeces
Viral hepatitis B and C	Hepatitis B and C viruses	Blood and body fluids

Source: Safe management of wastes from health-care activities, World Health Organization, Geneva,1999

4.1.2. Hazards from chemical and pharmaceutical waste

Many of the chemicals and pharmaceuticals used in health-care establishments are hazardous (e.g. toxic, genotoxic, corrosive, flammable, reactive, explosive, shock-sensitive). These substances are commonly present in small quantities in HCW; larger quantities may be found when unwanted or outdated chemicals and pharmaceuticals are disposed of. 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 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 are particularly important members of this group: they are used in large quantities and are often corrosive. Reactive chemicals may also form highly toxic secondary compounds.

Chemical residues discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving waters. Similar problems may be caused by pharmaceutical residues, which may include antibiotics and other drugs, heavy metals such as mercury, phenols, and derivatives, and disinfectants and antiseptics.

4.1.3. Hazards from genotoxic waste

The severity of the hazards for health-care workers responsible for the handling or disposal of genotoxic waste is governed by a combination of the substance toxicity itself and the extent and duration of exposure.

Exposure to genotoxic substances in health care may also occur during the preparation of or treatment with particular drugs or chemicals. The main pathways of exposure are inhalation of dust or aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals, or waste, and ingestion as a result of bad practice, such as mouth pipetting. Exposure may also occur through contact with the bodily fluids and secretions of patients undergoing chemotherapy.

The cytotoxicity of many antineoplastic drugs is cell-cycle-specific, targeted on specific intracellular processes such as Dexyribonucleic acid (DNA) synthesis and mitosis. Other antineoplastics, such as alkylating agents, are not phase-specific, but cytotoxic at any point in the cell cycle. Experimental studies have shown that many antineoplastic drugs are carcinogenic and mutagenic; secondary neoplasia (occurring after the original cancer has been eradicated) is known to be associated with some forms of chemotherapy.

Many cytotoxic drugs are extremely irritant 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 absolutely essential; any discharge of such waste into the environment could have disastrous ecological consequences.

Box 4.1: Cytotoxic drugs hazardous to eyes and skin

- ✓ Alkylating agents
- ✓ Vesicant drugs: aclarubicin, chlormethine, cisplatin, mitomycin
- ✓ Irritant drugs: carmustine, cyclophosphamide, dacarbazine, ifosfamide, melphalan, streptozocin, thiotepa
- ✓ Intercalating agents
- ✓ Vesicant drugs: amsacrine, dactinomycin, daunorubicin, doxorubicin, epirubicin, pirarubicin, zorubicin
- ✓ Irritant drugs: mitoxantrone
- ✓ Vinca alkaloids and derivatives
- ✓ Vesicant drugs: vinblastine, vincristine, vindesine, vinorelbine
- ✓ Epipodophyllotoxins
- ✓ Irritant drugs: teniposide

4.1.4. Hazards from radioactive waste

The type of disease caused by radioactive waste is determined by the type and extent of exposure. It can range from headache, dizziness and vomiting to much more serious problems. Because radioactive waste, like certain pharmaceutical waste, is genotoxic, it may also affect genetic material. Handling of highly active sources, e.g. certain sealed sources from diagnostic instruments, may cause much more severe injuries (such as destruction of tissue, necessitating amputation of body parts) and should therefore be undertaken with the utmost care.

The hazards of low-activity waste may arise from contamination of external surfaces of containers or improper mode or duration of waste storage. Health-care workers or waste-handling or cleaning personnel exposed to this radioactivity are at risk.

4.1.5. Impacts of HCW

While there is no scientifically documented incidence of widespread illnesses among the general public due to chemical or pharmaceutical waste from hospitals, many examples may be found of extensive intoxication caused by industrial chemical waste. Moreover, many cases of injury or intoxication result from the improper handling of chemicals

or pharmaceuticals in health-care establishments. Pharmacists, anaesthetists, nursing auxiliary and maintenance personnel may be at risk of respiratory or dermal diseases caused by exposure to such substances as vapours, aerosols and liquids.

To minimize this type of occupational risk, less hazardous chemicals should be used whenever possible and protective equipment should be provided to all personnel likely to be exposed. Premises where hazardous chemicals are used should be properly ventilated and personnel at risk should be trained in preventive measures and in emergency care in case of accident.

Within health-care establishments, the surveillance of infection and record-keeping are important tools that can provide indications of inadequate hygiene practices or of contamination of the immediate environment (including contamination caused by HCW). Surveillance allows an outbreak of infection to be recognized and investigated and provides a basis for introducing control measures, for assessing the efficacy of those measures and of the routine preventive measures taken by the establishment and for reducing the level of avoidable infection. It will also ensure that the control measures have maximum effect and are as cost-effective as possible.

Countries should carry out regular studies in order to increase knowledge of:

i. the extent to which HCW is contaminated;
ii. the risk level for contamination of the exposed population by digestive, respiratory, and percutaneous routes; and
iii. growth and survival of pathogens in waste during storage.

4.2. HCWM Principles

Proper management of HCW can minimize the risks both within and outside healthcare facilities. The following steps should be taken to minimise risks:

i. segregate wastes, preferably at the point of generation, into reusable and non-reusable, hazardous and non-hazardous components;
ii. Institute a sharps management system;
iii. Implement a waste reduction program;
iv. avoid hazardous substances whenever possible (e.g. PVC-containing products, mercury thermometers);
v. ensure worker safety;

vi. provide secure methods of waste collection and transportation; and
vii. install safe treatment and disposal mechanisms.

Basic elements for the management of HCW are summarized as follows:

i. Assignment of responsibilities for waste management
ii. Allocation of sufficient resources (financial and human)
iii. Waste minimization/prevention including purchasing policies and stock management practices
iv. Separation of waste into special hazardous waste (HW) with subcategories municipal waste
v. Implementation of safe handling, storage, transportation, treatment and disposal options
vi. Tracking of waste production and waste destination

An important tool for each hospital is a HCWM plan, which is specific for each hospital. It addresses above topics and describes daily routines for collection, handling, separation and packaging of the different categories of waste. Facility managers should ensure that this plan is in place with adequate budget and personnel to implement it. In every plan an Emergency response programme should be integrated.

4.2.1. Emergency response

Principles

Designate a person responsible for the handling of emergencies, including coordination of actions, reporting to managers and regulators, and liaising with emergency services, and a deputy should be appointed to act in case of absence.

In health-care establishments, spillage is probably the most common type of emergency involving infectious or other hazardous material or waste.

Response procedures are essentially the same regardless of whether the spillage involves waste or material in use 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; the impact on patients, medical and other personnel, and the environment is as limited as possible.

Health-care personnel should be trained for emergency response and the necessary equipment should be at hand and readily available at all times to ensure that all required measures can be implemented safely and rapidly. Written procedures for the different types of emergencies should be drawn up. For dangerous spills, the clean-up operation should be carried out by designated personnel specially trained for the purpose.

Dealing with spillages

Spillages usually require clean-up of the contaminated area only. For spillages of infectious material, however, it is important to determine the type of infectious agent; in some cases, immediate evacuation of the area may be necessary.

In general, the more hazardous spillages occur in laboratories. Procedures for dealing with spillages should specify safe handling operations and appropriate protective clothing. An example of such a procedure is provided in Box 4.2. Appropriate equipment for collecting the waste and new containers should be available as well as means for disinfection;

In case of skin and eye contact with hazardous substances:

i. There should be immediate decontamination.
ii. The exposed person should be removed from the area of the incident for decontamination, generally with copious amounts of water.
iii. 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.

Response to injury and exposure

A programme of response should be established that prescribes the actions to be taken in the event of injury or exposure to a hazardous substance. All staff who handle HCW should be trained to deal with injuries and exposures. The programme should include the following elements:

i. immediate first-aid measures, such as cleansing of wounds and skin, and irrigation (splashing) of eyes with clean water;
ii. an immediate report of the incident to a designated responsible person;
iii. retention, if possible, of the item involved in the incident; details of its source for identification of possible infection;
iv. additional medical attention in an accident and emergency or occupational health department, as soon as possible;
v. medical surveillance;

vi. blood or other tests if indicated;
vii. recording of the incident;
viii. investigation of the incident to identify causes of incidence; and
ix. identification and implementation of remedial action to prevent similar incidents in the future.

Box 4.2: Example of a general procedure for dealing with spillages

1. Evacuate the contaminated area.
2. Decontaminate the eyes and skin of exposed personnel immediately.
3. Inform the designated person (usually the Waste Management Officer), who should coordinate the necessary actions.
4. Determine the nature of the spill.
5. Evacuate all the people not involved in cleaning up if the spillage involves a particularly hazardous substance.
6. Provide first aid and medical care to injured individuals.
7. Secure the area to prevent exposure of additional individuals.
8. Provide adequate protective clothing to personnel involved in cleaning-up.
9. Limit the spread of the spill.
10. Neutralize or disinfect the spilled or contaminated material if indicated.
11. 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 used for cleaning should be placed in the appropriate waste bags or containers.
12. Decontaminate or disinfect the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in the case of liquid spillage; for spillages of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.
13. Rinse the area, and wipe dry with absorbent cloth.
14. Decontaminate or disinfect any tools that were used.
15. Remove protective clothing and decontaminate or disinfect it if necessary.
16. Seek medical attention if exposure to hazardous material has occurred during the operation.

In case of a needle stick injury, bleeding of the wound should be encouraged and the area should be washed under clean running water. The remaining elements of the accident response plan should then be followed.

The purpose of incident reporting should not be seen as punitive; active support by managers should encourage prompt and accurate reporting.

Reporting accidents and incidents

All waste management staff should be trained in emergency response and made aware of the correct procedure for prompt reporting. Accidents or incidents, including near-misses, spillages, damaged containers, inappropriate segregation and any incidents involving sharps should be reported to the Waste Management Officer (if waste is involved) or to another designated person.

The report should include details of:

i. the nature of the accident or incident;
ii. the place and time of the accident or incident;
iii. the staff who were directly involved;
iv. any other relevant circumstances.

The cause of the accident or incident should be investigated by the Waste Management Officer (in case of waste) or other responsible officer should also take all possible action to prevent recurrence. The records of the investigation and subsequent remedial measures should be kept.

4.2.2. Key steps during HCWM

Generally, there are four key steps to HCWM:

i. segregation into various components, including reusable and safe storage in appropriate containers;
ii. transportation to waste treatment and disposal sites;
iii. treatment; and
iv. final disposition.

The guiding principle for HW is the prevention of waste. Prior to final disposal of waste, possibilities for reuse and recycling of waste should be investigated. Current principles of waste management are supported through paying attention to procurement of products, particular aspects like replacing certain products (such as PVC containers) by other products, because of their extended lifetime or multi-purpose use should be considered. A considerable reduction of waste can also be achieved if disposable products

such as certain clothes, kitchenware, scissors, scalpels and tweezers are banned in hospitals. Thus modification of purchasing procedures at hospitals is required to further prevent the generation of waste.

Awareness and training related to a safe management of HW in hospitals should cover the following aspects:

i. Awareness rising of all staff about risks related to HW
ii. Training of personnel regarding separation practices
iii. Training of waste workers regarding safe handling, storage and operation and maintenance of treatment technologies
iv. Display of written instructions for personnel

A clear distinction must be made between hospitals having their own treatment options and those transporting their special HW to centralized treatment facility or other hospitals.

The key to minimization and effective management of HCW is segregation (separation) and identification of the waste. Waste avoidance is the first step in minimising the amount of waste generated at a health care facility followed by segregation of the different types of waste generated at the facility.

4.2.3. Waste Avoidance and minimization

Health care facilities and the staff should take all measures possible to avoid the production of waste. Opportunities exist in:

Source Reduction:

i. Purchasing reductions: careful selection of supplies that are less wasteful or less hazardous, e.g. the replacement of chlorinated solvents, where possible, with less hazardous alternatives.
ii. Use of physical rather than chemical cleaning methods; e.g. steam cleaning rather than using detergents and disinfectants.
iii. Prevention of wastage.

Management and Control Measures

i. Purchase of hazardous chemicals should be centralised.
ii. Purchasing and use of chemicals and pharmaceuticals should be controlled and monitored on a regular basis.

iii. The quantities of both hazardous and general waste sent for treatment and disposal should be monitored and steps taken to minimise production as much as possible.
iv. Training programmes should be instituted for all staff that includes waste avoidance and minimisation of materials and wastes.

Stock management of chemicals and pharmaceuticals

i. Small quantities should be ordered frequently rather than large amounts. The oldest batch should be used first (First in first out principal).
ii. All the contents of a container should be used.
iii. Expiry dates should be checked on delivery of supplies.
iv. Procedures for use of less hazardous chemicals should be investigated and applied.

In Table 4.2 proposals for the use of a less hazardous or a non-hazardous reagent as substitutes are displayed:

Table 4.2: Examples of substitution of hazardous with less hazardous chemicals

Hazardous Chemical	Safer Substitute	Used For
Acetamide	Stearic Acid	Freezing point depression
Benzene	Xylene or hexane	Many solvent uses
Benzoyl Peroxide	Lauryl Peroxide	Some polymer catalysis
Carbon Tetrachloride	Cyclohexane	Qualitative test for halides
Formaldehyde (Formalin)	Ethanol	Specimen storage
Halogenated Solvents	Non-halogenated solvents	Some extractions and other solvent uses
Sodium Dichromate	Sodium Hypochlorite	Some oxidation reactions
Sulfide ion	Hydroxide ion	Qualitative test for heavy metals
Toluene-based cintillation Cocktail	Non-ignitable Scintillation Cocktail	Studies using radioactive materials
Chromic acid solution	Ultrasonic baths, Alconox or similar detergents, Pierce	Cleaning laboratory glassware
Mercury thermometers	Alcohol (red liquid), digital or thermocouple	Temperature
Solvents	Detergent and hot water	Parts cleaning
Oil-based paint	Latex paint	Painting operations

Source: LSUHSC Waste Minimization Program, Louisiana State University, 2005

4.2.4. Recycling

The following should be instituted:

i. Recyclable products should be purchased where possible.
ii. Sterilisation of reusable medical and other equipment using approved sterilisation procedures should be practised.

iii. Under no circumstances must disposable items such as needles and syringes be recycled.

4.3. Waste Separation

Appropriate handling, treatment, and disposal of waste by type reduce costs and protects public health. Segregation should always be the responsibility of the waste producer, should take place as close as possible to where the waste is generated and should be maintained in storage areas, during transport and disposal.

Segregation of health care wastes is essential for the following reasons:

a) It ensures that hazardous waste and general (non-hazardous) wastes are separated. This is important in that it is dangerous to have hazardous waste being managed in the general waste stream. Conversely, the volume and contents of general waste e.g. high plastic content, is often not suitable for incineration. Secondly, from a cost point of view, it is important not to pay hazardous waste transport and disposal rates for general wastes. Segregation therefore forms the basis of a sound waste minimisation programme.
b) It ensures that the hazardous wastes are sorted into correct categories for proper handling and disposal. Each type of hazardous health care waste has very specific packaging, handling, storage, transport and disposal instructions. Incorrect separation could have serious consequences e.g. needle stick injuries due to sharps being disposed of in infectious waste cardboard containers and sealed medium and high level radioactive sources ending up in the waste streams destined for incineration.
c) From an environmental point of view, the incineration of chemicals and pharmaceuticals in infectious waste incinerators is not recommended, due to the increase in undesirable air emissions from the incinerators – in fact, the incineration of pressurised containers could lead to explosions.
d) Effective waste segregation is the obligation of hospital staff. The most appropriate way of identifying the categories of HCW is by sorting the waste into colour-coded plastic bags or containers. In addition to the colour coding of waste containers, the *following practices are recommen*ded:
    i. General HCW should join the stream of domestic refuse for disposal.
    ii. Sharps should all be collected together, regardless of whether or not they are contaminated. Containers should be puncture-proof (usually made

of high-density plastic) and fitted with covers. They should be rigid and impermeable so that they safely retain 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; these fold for ease of transport and may be supplied with a plastic lining.

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

iv. Highly infectious waste should, whenever possible, be sterilized immediately by autoclaving. It therefore needs to be packaged in bags that are compatible with the proposed treatment process; red bags, suitable for autoclaving, are recommended.

v. Cytotoxic waste, most of which is produced in major hospital or research facilities, should be collected in strong, leak-proof containers clearly labelled "Cytotoxic wastes".

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

vii. 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 spilled or contaminated drugs or packaging containing drug residues should *not* be returned because of the risk of contamination.

viii. 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 wastes of different types should never be mixed.

ix. Waste with a high content of heavy metals (e.g. cadmium or mercury) should be collected separately.

x. Aerosol containers may be collected with general HCW once they are completely empty, provided that the waste is not destined for incineration.

xi. Low-level radioactive infectious waste (e.g. swabs, syringes for diagnostic or therapeutic use) should be collected separately from other waste. The uniquely defined portion of radioactive material used in hospitals is the so-called radioactive sealed sources. Due to their limited life span, radioactive sealed sources used in radiation therapy need to be regularly removed from hospitals.

Radioactive sealed sources are kept in an inventory at the manufacturer, so they are tracked over their life span. Additionally, they should be inventoried at the hospital to guarantee that they are returned to the manufacturer and their functionality is secured. The manufacturer is responsible for the final disposal of sealed sources at suitable repositories for radioactive waste.

Separation of waste should occur as early as possible, i.e. at the time the waste is produced, for example, when an injection is given, or when packaging is removed from supplies and equipment. Hospital waste must always be separated into special HCW and other waste. It is the aim to minimize the amount of special waste requiring special treatment and disposal techniques.

Each hospital is obliged to designate a person responsible for waste management.

Since costs for safe treatment and disposal of hazardous HCW are typically higher than those for general waste, all general, i.e. non-hazardous, waste should be handled in the same manner as domestic refuse and collected in black bags. No healthcare waste other than sharps should be deposited in sharps containers, as these containers are more expensive than the bags used for other infectious waste. Measures of this sort help to minimize the costs of healthcare waste collection and treatment.

When a disposable syringe is used, for example, the packaging should be placed in the general waste bin and the used syringe in the sharps container. In most circumstances, the needle should *not* be removed from the syringe because of the risk of injury; if removal of the needle is required, special care must be taken. Appropriate containers or bag holders should be placed in all locations where particular categories of waste may be generated. Instructions on waste separation and identification should be posted at each waste collection point to remind staff of the procedures. Containers should be removed when they are three-quarters full. Ideally, they should be made of combustible, non-halogenated plastics.

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 colour. If general and hazardous wastes are accidentally mixed, the mixture should be treated as hazardous healthcare waste.

4.4. Collection, Packaging, Labelling and Storage

4.4.1. Collection

Following guidance should be observed:

i. Nurses and other clinical staff should ensure that waste bags are tightly closed or sealed when they are about three-quarters full.
ii. Light-gauge bags can be closed by tying the neck, but heavier-gauge bags probably require a plastic sealing tag of the self-locking type.
iii. Bags should *not* be closed by stapling.
iv. Sealed sharps containers should be placed in a labelled, yellow infectious HCW bag before removal from the hospital ward or department.
v. Wastes should not be allowed to accumulate at the point of production.
vi. A routine programme for their collection should be established as part of the hospital's waste management plan.

Certain recommendations should be followed by the ancillary workers in charge of waste collection:

i. Waste should be collected daily (or as frequently as required) and transported to the designated central storage site.
ii. No bags should be removed unless they are labelled with their point of production (hospital and ward or department) and contents.
iii. The bags or containers should be replaced immediately with new ones of the same type.
iv. A supply of fresh collection bags or containers should be readily available at all locations where waste is produced.

4.4.2. Colour coding system as minimum requirements

Primary packaging and storage takes place where HCW is generated. Secondary packaging is used for transportation. Primary packaging of special HCW should be in leak-proof and disposable bags or containers. Initially separated sharps should be collected in puncture-proof containers. A colour code should be chosen for all special HCW.

Colour coding makes it easier for medical staff and hospital workers to put waste items into the correct container, and to maintain segregation of the wastes during transport, storage, treatment and disposal. Colour coding also provides a visual indication of the potential risk posed by the waste in that container.

Table 4.3: WHO-recommended segregation scheme

Type of waste	Colour of container and markings	Type of container
Highly infectious waste	Yellow, marked "HIGHLY INFECTIOUS", with biohazard symbol	Strong, leak-proof plastic bag, or container capable of being autoclaved
Other infectious waste, pathological and anatomical waste	Yellow with biohazard symbol	Leak-proof plastic bag or container
Sharps	Yellow, marked "SHARPS", with biohazard symbol	Puncture-proof container
Chemical and pharmaceutical waste	Brown, labelled with appropriate hazard symbol	Plastic bag or rigid container
Radioactive waste	Labelled with radiation symbol	Lead box
General health-care waste	Black	Plastic bag

General waste, similar to municipal waste (colour code black or grey):

Black (or grey) plastic bags, bins and containers should be used. This waste is kept and handled separately from the HCW. If at all possible, depending on the local situation, recyclables such as paper, cardboard and glass should be separated from the ordinary household waste and delivered to recycling companies.

Interim waste storage ready for collection

Waste bins in a dirty utility room

Figure 4.1: Recommended colour codes for general and infectious waste

Infectious waste (colour code yellow):

Yellow plastic bags (size 60-70 litres) should be mounted in a bag rack equipped with a lid. The thickness of plastic bag should be 0.1 mm. Plastic bags should be made of polyethylene (PE) in order to avoid potential release of dioxins and furans in case of incineration. For convenience the yellow plastic bag can be mounted in a double bag rack also holding a black (or grey) plastic bag for general waste. Also individual bag racks can be used. When full the bags are closed using a plastic string locker.

Sharps (colour code yellow):

Sharps should be collected in a WHO yellow cardboard box, a rigid yellow plastic box or re-used plastic cans (5-20 litres), which must be dry, equipped with a lid and clearly labelled with a yellow sticker stating "SHARPS". When full, the sharps box is transferred to the yellow plastic bag for infectious waste. Plastic boxes should be made of polyethylene in order to avoid potential release of dioxins and furans in case of incineration.

Chemicals containing dangerous substances (colour code brown):

Puncture proof plastic or metal boxes (which can be emptied and re-used), equipped with a tight lid and clearly labelled with a brown sticker with "CHEMICAL HAZARDS" written, should be used for these chemicals. The chemicals must not be mixed in the box and should as far as possible be stored in the original packaging for easy identification of the type of chemical. The general warning symbol should be used.

		
Proper disposal of used syringes into a designated sharps container	A proper cardboard sharps container	Sharps box in a Peruvian hospital

Figure 4.2: Recommended colour codes for sharps container

In connection with the above types of colour coding the infectious waste symbol (the Bio-Hazard Symbol) should be displayed clearly visible.

Infectious Waste

Chemical Hazards

Radioactive Waste

Figure 4.3: Recommended symbols to be places on HCW containers

Cytotoxic and cytostatic medicines (colour code blue):
Puncture proof plastic or metal boxes (which can be emptied and re-used), equipped with a tight lid and clearly labelled with a blue sticker with "CYTOTOXIC MEDICINE REMAINS" written, are the appropriate packaging for these substances. The cytotoxic hazard symbol should also be displayed.

Other medicines and pharmaceuticals (colour code blue):
They should be put into puncture proof plastic or metal boxes (which can be emptied and re-used), equipped with a tight lid and clearly labelled with a blue sticker with "DISCARDED MEDICINES AND PHARMACEUTICALS" written.

Amalgam waste from dental care (colour code silver):
Amalgam waste should be put into puncture proof plastic or metal boxes (which can be emptied and re- used), equipped with a tight lid and clearly labelled with a silver sticker with "AMALGAM WASTE" written. Amalgam waste should be collected separately from other chemical waste.

Radioactive waste (colour code orange):
Lead proof boxes (which can be emptied and re-used), equipped with a tight lid and clearly labelled with an orange sticker with "RADIOACTIVE WASTE" written, are the appropriate packaging for radioactive waste. The radioactive hazard symbol should be used.

Due to the very small amounts of HCW (and the general absence of biological/ pathological waste) generated at health institutions (His) other than hospitals and institutes, a more simple procedure can be established in health centres, ambulatories, private general practitioners (GPs), dentists, etc. In these HIs belonging to the primary health care level, a uniform type of receptacle identical to the yellow box should be observed as a minimum requirement. The yellow box must then be supplemented by other types of receptacles depending on the individual type of HI and the waste they produce (e.g. boxes for drugs and pharmaceuticals, boxes for amalgam waste at dentists, etc.).

Labelling
All waste bags or containers should be labelled with basic information on their content and on the waste producer. This information may be written directly on the bag or container or on pre-printed labels, securely attached.

4.4.3. On-site transport

HCW should be transported within the hospital or other facility by means of wheeled trolleys, containers, or carts that are not used for any other purpose and meet the following specifications:

i. easy to load and unload;
ii. no sharp edges that could damage waste bags or containers during loading and unloading;
iii. easy to clean.

The vehicles should be cleaned and disinfected daily with an appropriate disinfectant. All waste-bag seals should be in place and intact at the end of transportation.

4.4.4. Requirements for storage facilities of HCW

Following guidance should be observed:

i. The storage area should have an impermeable, hard-standing floor with good drainage; it should be easy to clean and disinfect.
ii. There should be a water supply for cleaning purposes.
iii. The storage area should afford easy access for staff in charge of handling the waste. It should be possible to lock the store to prevent access by unauthorized persons. Easy access for waste-collection vehicles is essential.
iv. There should be protection from the sun.
v. For the storage of waste for more than 24 hours, refrigeration should be provided so that the temperature does not exceed +10 degrees Celsius. The storage of biological waste might require low temperature.
vi. The storage area should be inaccessible for animals, insects and birds.
vii. There should be good lighting and at least passive ventilation.
viii. The storage area should not be situated in the proximity of fresh food stores or food preparation areas.
ix. A supply of cleaning equipment, protective clothing and waste bags or containers should be located conveniently close to the storage area.

4.4.5. Secondary packaging

For easy transport, the secondary packaging should consist of leak-proof solid containers mounted with wheels. The colour code should comply with primary packaging. In any case, an unauthorized opening of containers carrying special HCW should be prohibited at all times.

4.4.6. Transportation vehicles and containers

Waste bags may be placed directly into the transportation vehicle, but it is safer to place them in further containers (e.g. cardboard boxes or wheeled, rigid, lidded plastic or galvanized bins). This has the advantage of reducing the handling of filled waste bags but results in higher disposal costs. These secondary containers should be placed close to the waste source.

Any vehicle used to transport HCW should fulfil the following design criteria:

i. The body of the vehicle should be of a suitable size commensurate with the design of the vehicle, with an internal body height of at least 2.2 meters.
ii. There should be a bulkhead between the driver's cabin and the vehicle body, which is designed to retain the load if the vehicle is involved in a collision.
iii. There should be a suitable system for securing the load during transport.
iv. 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.
v. The internal finish of the vehicle should allow it to be steam-cleaned, and the internal angles should be rounded.
vi. The vehicle should be marked with the name and address of the waste carrier.
vii. Vehicles or containers used for the transportation of HCW should not be used for the transportation of any other material. They should be kept locked at all times, except when loading and unloading. Where the use of a dedicated vehicle cannot be justified, a bulk container that can be lifted on to a vehicle chassis may be considered. The container may be used for storage at the health-care establishment and replaced with an empty one when collected.
viii. The same safety measures should apply to the collection of hazardous health-care waste from scattered small sources.

Health-care establishments that practice minimal programmes of HCWM should either avoid off-site transportation of hazardous waste or at least use closed vehicles to avoid spillage. The internal surfaces of any vehicle used for this purpose should be easy to clean.

4.5. Handling of HCW Contained in the Municipal Waste

Advances in medicine now allow us to monitor and treat some elements of our health and the health of our family at home. These advances can save us costly and frequent visits to

health care professionals for such health monitoring and treatment as blood glucose, common colds and some allergic reactions, and kidney functions/dialysis.

An increasing challenge that comes with these medical advances is the proper management of the waste generated. These wastes include:

i. Used needles, syringes, and lancets
ii. Medicine - unused or outdated
iii. Broken thermometers
iv. Contaminated dressings/Dialysis filter material

While used needles, syringes, lancets and other sharp implements may be safely disposed with the other solid wastes from the home, it is important to exercise care in packaging needles, syringes, and lancets for disposal. The safe packaging of these wastes may be accomplished very simply at home. Use a rigid plastic bottle with a tight fitting cap, such as empty laundry detergent or fabric softeners bottles to store and dispose "sharps." Do not put sharp objects in any container that will be recycled or returned to a store. Needles and syringes need not be recapped. The rigid bottle will minimize the potential for needle sticks. When the bottle is full, add plaster of Paris to the level of the neck of the container, cap it tightly, and place it with other solid waste for disposal.

Unused and outdated medicines stored at home provide a considerable risk to children as well as individuals with vision or mental impairment. These medicines may be safely disposed by emptying the medicine into the toilet and flushing. Be certain all of the medicine goes down the drain. Thoroughly rinse the medicine container with warm water. Cap the empty container tightly and dispose with other solid waste from the home. Do not give the empty container to a child as a toy. Children should not associate medicine with play or candy.

Mercury filled thermometers provide an effective low cost method for monitoring body temperature. A broken thermometer presents two immediate challenges, the broken glass and the metallic mercury. Both of these materials should be scooped immediately into a rigid container with a tight fitting cap and carefully sealed. Special care must be taken to ensure that all of the mercury "beads" are contained. Many of them may be very small and they will scatter on impact. The contained mercury and glass should be sent to an appropriate recycle operation. Laboratories, fluorescent light recyclers and relevant government department or local recycle coordinator should be able to help to find a recycler. Care should also be taken to avoid contact of the mercury with any items made of gold. Should a gold-to-mercury contact occur, contact a jeweller or chemist immediately

to have the gold treated for mercury removal. This treatment should not be attempted at home.

4.6. Transportation of HCW on Public Roads

HCW should be transported by the quickest possible route, which should be planned before the journey begins. After departure from the waste production point, 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 producer and the carrier.

Transportation of special HW needs to be controlled meaning that it should be ensured that the waste arrives at its destination. This can be achieved by a consignment note to be signed by the recipient of waste and returned to the hospital. Control of the waste stream is in particular important, if an unintended recycling of items such as used syringes occurs, because they are considered as valuable objects.

4.7. Treatment Technologies for Hospital Waste

4.7.1. Environmental Concerns

Currently, each technology that ensures destruction or elimination of infectious and other types of special HCW potentially produces a secondary waste stream. When choosing an appropriate technology (e.g., incineration, autoclave, or microwave irradiation) for the type of HCW, a review of the potential secondary waste stream and the affected population should be made. Weighing the balance of the technology (and its secondary waste stream) with the current problem (while assessing the cost benefit and available technologies) is a key point in decision-making. Quite often, successful HCWM includes several technologies within one facility.

Creation of dioxins (dibenzo-p-dioxins) is of particular concern due to the possible carcinogenic nature of these compounds. Incineration can create dioxins, depending on the HCW material and the temperature (and scrubbers) of the incinerator plant. Plastics and chlorinated substances (such as dyes) can create dioxins when incinerated. Therefore, segregation of materials is vitally important. Furthermore, ensuring that the incinerator plant continually burns its materials at a temperature at or above 1,200 degrees will

virtually eliminate dioxins from release. Incineration remains an important technological tool in HCWM due to its ability to completely destroy infectious or contaminated materials (such as used syringes).

4.7.2. Comparison of available HCW treatment options

Decisions regarding treatment technology should be made at hospital level; however responsible personnel for waste management in the hospital should be in close contact with the competent authority. In principal there are three parties involved in waste management:

i. the producer of the waste;
ii. the transporting/disposal party; and
iii. the competent authority.

Cooperation between these three parties is a good approach to solving problems regarding waste management. Additionally, it also serves to engage the general public as early as possible, which should be considered as an additional party when it comes to sitting of new HCW incinerators.

Treatment and disposal of HCW generally aim at:

i. destruction of viable infectious organisms
ii. destruction/transformation into harmless forms of waste, used pharmaceuticals and medicines destruction of sharps and other materials capable of causing physical injuries
iii. final disposal / destruction of body parts, tissues, blood and other organic material avoidance or minimization of secondary impacts from the disposal system

The largest portion of HCW is regular municipal waste that might be subject to treatment and disposal with other municipal waste. Thus, the first step in treatment and disposal is to ensure that all regular waste is safely sent to the normal municipal waste management system. The remaining fraction of special HCW amounts to about 10-15%.

Unfortunately, in most SADC and COMESA countries even municipal wastes are not managed in an environmentally safe manner.

Broad comparisons of various treatment options based on general international experience are summarized in the following table.

Table 4.4: Comparison on HCW disposal options

	Open burning	Municipal dumps	On-site incineration	High temp. incineration	Autoclaving	microwaving	Chemical stabilisation	Sanitary landfilling
infectious organisms	poor	none	poor to moderate	very good	good	good	good	good
body parts, blood, etc.	good	none	good	very good	poor to moderate	poor to moderate	poor to moderate	poor to moderate
pharmaceuticals	good	none	good	very good	none	none	none	poor to moderate
sharps	moderate	none	moderate	very good	poor to moderate	poor to moderate	poor to moderate	moderate

Source: Safe management of wastes from health-care activities, WHO 2004

4.7.3. Landfilling

Landfilling of special HCW together with other municipal waste should only be considered for small selected quantities of waste. In larger cities with several hospitals it is rather recommended to use a special landfill cell. The cell should be fenced to restrict access and the deposited special HCW should be treated with lime. A thin soil cover should be placed on top of each load.

Since it cannot be ruled out completely that sharps are not disposed of at a controlled landfill, it is advisable to encapsulate sharps in case the final destination is unclear. However, the ultimate goal is to ensure that special HCW should never be disposed of in open dumps in order to avoid the risk of infections. This public risk applies in particular to children that can come in contact with infectious wastes from hospitals. The purpose of encapsulation is to isolate these dangerous items from humans and the environment. Encapsulation involves filling containers with sharps and in some cases with other special HW, adding an immobilizing material, and sealing the container. Cubic boxes made of high-density polyethylene or metallic drums are used as containers. Plastic foam, bituminous sand, cements mortar or clay material is used as immobilizing material. The main advantage of encapsulation is that it is very effective in reducing the risk of scavengers gaining access to the special HCW.

4.7.4. Incineration

Incineration used to be the method of choice for most special HCW and is still widely used. However, recently developed alternative treatment methods are becoming increasingly popular such as autoclave and microwave treatment.

A very common way of treatment of HCW has for a long period been incineration. At the high temperatures in an appropriate incinerator, the micro-organisms are rendered harmless and the residues from the incineration can be disposed of at a landfill. Depending on the character of the residue - hazardous or non-hazardous - the residue must be disposed of at the appropriate type of landfill. Normally the residues should be considered hazardous.

Process flow:

An incinerator facility for HCW will normally include a cold storage room for reception of waste and in addition flue gas cleaning equipment and storage for ash and slag and flue gas cleaning products. There are various types of waste incinerators. The combustion chamber can be rotating or fixed. Several designs and brands are on the market.

Most incinerators have a primary and a secondary combustion chamber. The waste is loaded into the primary chamber and ignited. It operates typically at temperatures of around 800 -1,000 ^{o}C and the waste is kept there until all waste has been turned into ash.

Smoke and gaseous products from the combustion pass into the secondary chamber, which acts as an afterburner, where the gases and smoke are oxidized at temperatures around 1,100 ^{o}C.

Acid gases, such as hydrogen chloride and sulphur dioxide are main potential pollutants from incineration and also heavy metals vaporised from the waste at the high temperatures may be present. Furthermore, any combustion process has the potential to produce halogenated dioxins and furans. The content of chlorine e.g. in the form of PVC plastic products, enhances the formation of these compounds in the incineration process.

In general, the flue gas is first cooled from above 1,000 ^{o}C to around 120-140 ^{o}C by passing it through a boiler. This produces hot water or steam, which can be used to generate electricity and in the heating system of the treatment facility. The lowering of the flue gas temperature prevents that dioxins can be reformed, and also the subsequent treatment of the gasses with e.g. lime is more efficient at lower temperatures.

Dioxins can be formed at temperatures between 250 °C and 450 °C. At temperatures above 1,000 °C they are destroyed and below 250 °C they do not form. This means that dioxins are destroyed in the secondary combustion chamber and the quick cooling (quenching) prevents reformation. Small remains of dioxins that pass through the incineration and cooling can be removed from the flue gas by activated carbon.

Neutralisation and absorption of organic pollutants, especially dioxins and furans, in the flue gas takes place in a reactor, where e.g. lime and activated carbon are injected into the flue gas. The lime neutralises the acid gases and the carbon removes dioxins and furans together with the other organic substances and heavy metals, e.g. mercury and cadmium, by absorbing the substances onto its surface.

Filter bags remove the reaction products from the reaction between the flue gases and the lime together with activated carbon from the flue gas and particles from the incineration process are filtered out.

The spent lime and the carbon, also called the flue gas cleaning product, must be disposed of at a landfill, in general a landfill approved for hazardous waste, as the flue gas cleaning product often has to be classified as hazardous waste according to the legislation.

After passing the reactor and the filter bags, the flue gas is discharged to the atmosphere. The levels of harmful pollutants and dust must be measured - some of the parameters on a continuous basis – and must comply with national air quality standards.

Ash and slag must be removed from the combustion chamber. This can be done either automatically or manually. The ash and slag must be disposed of at a landfill. If the ash and slag are classified as hazardous waste, the disposal must take place at a landfill dedicated for hazardous waste.

Waste types that can be incinerated:

Nearly all types of hazardous waste from HIs can be incinerated in modern incinerators. However, depending on the flue gas cleaning system, some substances are not suitable for incineration and should be disposed of in other ways.

Incinerators can destroy infectious waste, rendering biological and infective waste harmless, as well as most chemicals. Incineration can be considered as an all round treatment option. However, mercury containing waste (e.g. amalgam waste from dentists) should not be incinerated. The same applies to radioactive waste and waste containing significant amounts of heavy metals.

Emissions from incineration:

The emissions from incinerators are regulated by the legislation. In order to reduce the emission of hazardous substances, extensive flue gas cleaning is required. Nevertheless, a certain emission of hazardous substances takes place during operation.

Costs for incineration:

Direct plant investment costs for an incinerator having a capacity 250 kg/hour equal to 1,200 tons/year (operated in two shifts (16 hours) per day, 300 days per year) and meeting air quality standards. In addition, direct plant operational costs due to the flue gas cleaning system and the extensive requirements for monitoring and measurements are high. The direct plant related operational costs (fuel oil, electricity, chemicals for flue gas cleaning, etc.) can be estimated to approx. 200-250 Euros per ton of waste treated.

Benefits and drawbacks of incineration:

The benefits of controlled incineration include the volume reduction of the waste and the removal of pathogenic risk. Drawbacks to incineration include the potential for large capital and operating expenses, the need for skilled labour to operate and maintain the system and the potential for toxic emissions to the air in case no emission control equipment is installed.

Proper incineration is the high technological approach that can adequately treat all types of special HCW and is the preferred option for cytotoxins and other pharmaceuticals. It is important that combustion takes place at a sufficiently high temperature ranging between 1,000°C and 1,200℃ for a long enough time. Also, the combustion chamber should allow for sufficient turbulence and oxygen for a complete combustion to be achieved and problematic gases to be minimized. These large modern treatment facilities are, of course, not an option for single hospitals, but for a centralized solution. In any case, the incineration of special HW generates air emissions and ash.

In addition, treatment facilities of medical waste based on incineration should be subjected to Environmental Impact Assessment (EIA).

Incineration of PVC has the potential to generate emissions of dioxins. The use of PVC as a packaging material in hospitals and other health care establishments should therefore be phased out and eliminated in those areas where incineration facilities are being utilized for waste treatment.

Small capacity incinerators are in use in most SADC and COMESA countries, but because of their simple technology, they constitute in general a serious air pollution hazard to the

surrounding area. All workers involved in the operation of such small-scale incinerators should have available protective equipment, such as gloves, boots and aprons.

The World Health Organization (WHO) has recommended the closure of small incinerators world-wide that are not operating satisfactorily.

4.7.5. Autoclaving

Autoclaving is the exposure of waste to heat in form of steam in order to obtain deactivation and possible sterilisation of the waste. In an autoclave, the infectious waste is heated with steam under pressure (at least 2 bars and 121℃). The process takes place in a tank. Several types of autoclaves have been developed. Some are equipped with a rotating cutter inside the tank, securing that the waste is shredded and thereby properly exposed to the steam, making the process more efficient and at the same time reducing the volume of the waste.

In some autoclaves the sterilisation process takes place using saturated steam building up a pressure of more than 3 bars and a temperature of approximately 135℃. A system of rotating cutting blades inside the autoclave cuts plastic bags and cans holding the waste, thereby ensuring all waste to be exposed to the steam under pressure. The sterilisation cycle typically will last approximately 45-60 minutes, including heating up and cooling down periods.

Autoclaves with cutting and rotating systems inside the tank should be preferred. Cutting and shredding ensures efficient sterilisation, as the steam can penetrate the waste more easily when it is divided into small particles and as cold spots are avoided. Thereby the treatment time can be reduced as well. If the waste is shredded outside the autoclave prior to autoclaving, the shredder must be disinfected on a regular basis. This work can cause health and safety problems, also in connection with the maintenance of the shredder. Autoclave systems both with and without cutter/shredder built-in, are also often equipped with a secondary stage shredder, that further shreds the autoclaved (and sterile) waste.

Waste types that can be autoclaved:

It can be assessed that about 90-95 per cent of the yearly amount of HCW in a given area can be treated in appropriate autoclaves. Chemicals, expired or unused drugs and pharmaceuticals including cytotoxic waste and mercury containing waste must be collected separately and sent for treatment elsewhere in dedicated facilities (e.g. at a national centre for treatment of the much larger amounts of hazardous waste generated by industry and households). Also the biological (pathological) waste, depending on the chosen autoclave,

could be treated more appropriately by incineration or by burial at cemeteries, e.g. because of ethical considerations.

Residues from autoclaving:

The residue from autoclaving in a dedicated HCW autoclave will in principle contain the same substances as were fed into the autoclave. However, due to the shredding process, a considerable volume reduction will take place, approx. up to 80%. Also some limited reduction of weight will take place due to evaporation of water from the waste. The treated waste is unrecognisable.

No other waste than the HCW being treated in the facility will be produced. The HCW will after treatment be sterile and unrecognisable (a shredder is normally standard in autoclaves), and can be disposed of at a landfill together with ordinary municipal waste.

Emissions from autoclaving:

There will be emissions from evacuation of the autoclave vessel before and after each sterilization cycle. Active carbon filters are normally applied for odour elimination and in addition the air evacuated before the sterilization cycle will be exposed to a steam treatment before being emitted to the surroundings.

An autoclave will produce a minor amount of wastewater in the form of condensed steam when the autoclave is evacuated following the sterilisation cycle. The wastewater is sterile and the pollution strength will be similar to or less than ordinary household wastewater. Most of the steam used for disinfection can be condensed after use and the water recycled.

Although, establishment of an autoclave for treatment of medical waste would not need a stringent environmental impact assessment, it is a good practice to conduct one.

Costs for autoclaving:

Direct plant investment costs (budget prices) for autoclaves including shredder and other auxiliary equipment (e.g. steam generator if steam is not available on site, cooling tower, air compressor, etc.) having the following capacities (annual capacities based on two shifts (16 hours) per day, 300 days per year) are:

-	75 kg/h (equal to 360 tons/year):	Euro	300,000
-	125 kg/h (equal to 600 tons/year):	Euro	500,000
-	210 kg/h (equal to 1,000 tons/year):	Euro	600,000
-	350 kg/h (equal to 1,600 tons/year):	Euro	700,000

Direct plant related operational costs (steam production, electricity, etc.) can be estimated to approx. 100-150 Euros per ton of waste treated.

4.8. Training and Campaigns

Training is a crucial aspect to successfully upgrade HCWM practices. The overall aim of training is to develop awareness of the health, safety, and environmental issues relating to HCWM. It should highlight the roles and responsibilities of each actor involved in the management process of the HCW (duty of care).

Trainings should cover all people involved in the HCWM chain. Priority however should be given to nurses, who are predominantly involved in the HCW segregation at the place of generation.

Separate training programs should be designed for the following categories of personnel:

i. hospital managers and administrative staff responsible for implementing regulations on HCWM;
ii. medical doctors; nurses and assistant nurses;
iii. cleaners, porters, ancillary staff, and waste handlers; and
iv. municipal solid waste labourers and waste pickers.

Staff education programmes should cover:

a) Information on, and justification for, all aspects of the HCWM policy;
b) Information on the role and responsibilities of each hospital staff member in implementing the policy; Technical instructions, relevant for the target group, on the application of waste management practices;
c) Information on monitoring techniques;

The overall approach to capacity building must complement the introduction of new equipment and ensure that issues that had been shown to evoke strong feeling were addressed. Thus general assistants should be supplied with new protective gloves and sharps containers were conveniently sited in areas of high activity. Training should therefore be an integrated component of a broader strategy. The capacity building programme should involve:

i. Provision of new policy and procedures for HCWM written as a Code of Practice
ii. Introduction of improved monitoring and reporting

iii. The introduction of a dedicated Health Care Waste Manager and an Assistant
iv. Knowledge, attitudes and skills training
v. Awareness activities
vi. On the job skills coaching
vii. Evaluation of capacity building activities

In addition, trainings should be organized for the following players in the HCWM: licensed transport companies for hazardous waste operators of treatment/disposal facilities.

5. DEVELOP A NATIONAL HEALTH CARE WASTE MANAGEMENT STRATEGY

This strategy may be used directly by a country to implement a HCWM system. However, the country may decide to adapt this strategy to national circumstances. The following sections provide details on the preparation of the national HCWM strategy.

5.1. Estimate HCW Generation

In order to determine whether a dramatic change in the generation of HCW will take place for instance during the coming 10-year period, a number of factors, which could have an influence hereon, must be assessed. Some of the more important factors are the following:

i. Population growth;
ii. Economic and healthcare development;
iii. HCWM development.

5.2. Select Development Scenarios for Treatment of HCW

The prognosis of the HCW generation in combination with the collection / transport and treatment options should be analysed in light of the (i) distribution of generating sources throughout the country, (ii) the amount / composition of the HCW for disposal and the (iii) advantages / disadvantages of the centralized versus decentralized systems and the treatment technologies.

For the available options see chapter 3 (step 5).

5.3. Estimate Investment and Operational Costs

The data requirements for each of available strategic options and related scenarios may take longer to gather. This database will refer to the various hospitals and clinics (location, number of beds, generated HCW and composition, in-house separation and/or treatment, storage facilities etc.), and finally - cost profiles.

The investments and operational costs should mainly be determined by the type and capacity of the transport trucks. These vehicles have to be newly procured. It is perceived that most of the procurement will coincide with the procurement of all other equipment (special containers, bins, coloured bags) required to establish a well-functioning national HCW system.

There should be nationally recognized responsible authority of those procurements. Unit Costs, based on incremental cost analysis for final disposal and transporting in USD per metric ton will depend on the delineation of the region and incinerator site location(s); geographical location(s) where the maximum HCW loads will cover the least distances will be considered for locating either storage (re-loading) places, or regional incineration facilities.

Below the cost elements of the future analyses are listed:

Capital Investment Costs (CIC) for treatment facility (one or three) and healthcare institutions respectively covering buildings and plants, storage facilities, mobile equipment (e.g. collection trucks and vans), collection equipment for medical waste (e.g. containers and other reusable receptacles), etc., including depreciation of investment costs over the expected lifetime of the investment.

Fixed Operating Costs (FOC) for treatment facility and healthcare institutions respectively covering annual maintenance costs of buildings and stationary and mobile machinery, plant and other equipment expressed as fixed percentages of the capital investment costs, and labour costs.

Variable Operating Costs (VOC) for treatment facility and healthcare institutions respectively covering energy and other consumables, including non-reusable receptacles such as plastic bags and sharps boxes, treatment and disposal of part of the medical waste outside the system (e.g. chemical and radioactive waste), and final disposal of treated medical waste at landfills. In this sheet the disposal costs for non-hazardous HCW (similar in composition to municipal waste) is also included. Revenues for selling of recyclable materials such as separately collected paper, cardboard, etc. can also be included in the calculation.

Transportation Costs (TC) covering direct fuel costs in connection with both the “internal” and “external” collection and transport of medical waste. Maintenance of trucks and vans and wages for drivers should be included under the Fixed Operating Costs (FOC) above;

In-direct Costs (IDC) in healthcare institutions covering annual expenditures for planning, training, monitoring and reporting, and the important use of signboards, posters, pictograms, colour code stickers for HCW identification, etc.;

The final cost assessment should take into consideration the alternative transport costs for variant locations of the treatment and/or storage facilities.

Criteria to be taken into account when selecting the site for either incineration or storage facility are as follows:

i. Accessibility.
ii. Distance from healthcare facilities. Distance to sensitive areas.
iii. Future development plans for the area. Possibility of buying the land.
iv. Proximity to cultural and historical sites. Noise and dust impact on nearby areas.
v. If resettlement is an issue, the extent to which it is needed.
vi. Reliability of the power sources to run the treatment facility.

Finally, for the most favoured option the analysis should be carried further to highlight a feasibility assessment for the country.

The implementation phase will ultimately lead to (preliminary) specifications for the collection, transport and/or transfer, and final disposal system for regions to be established.

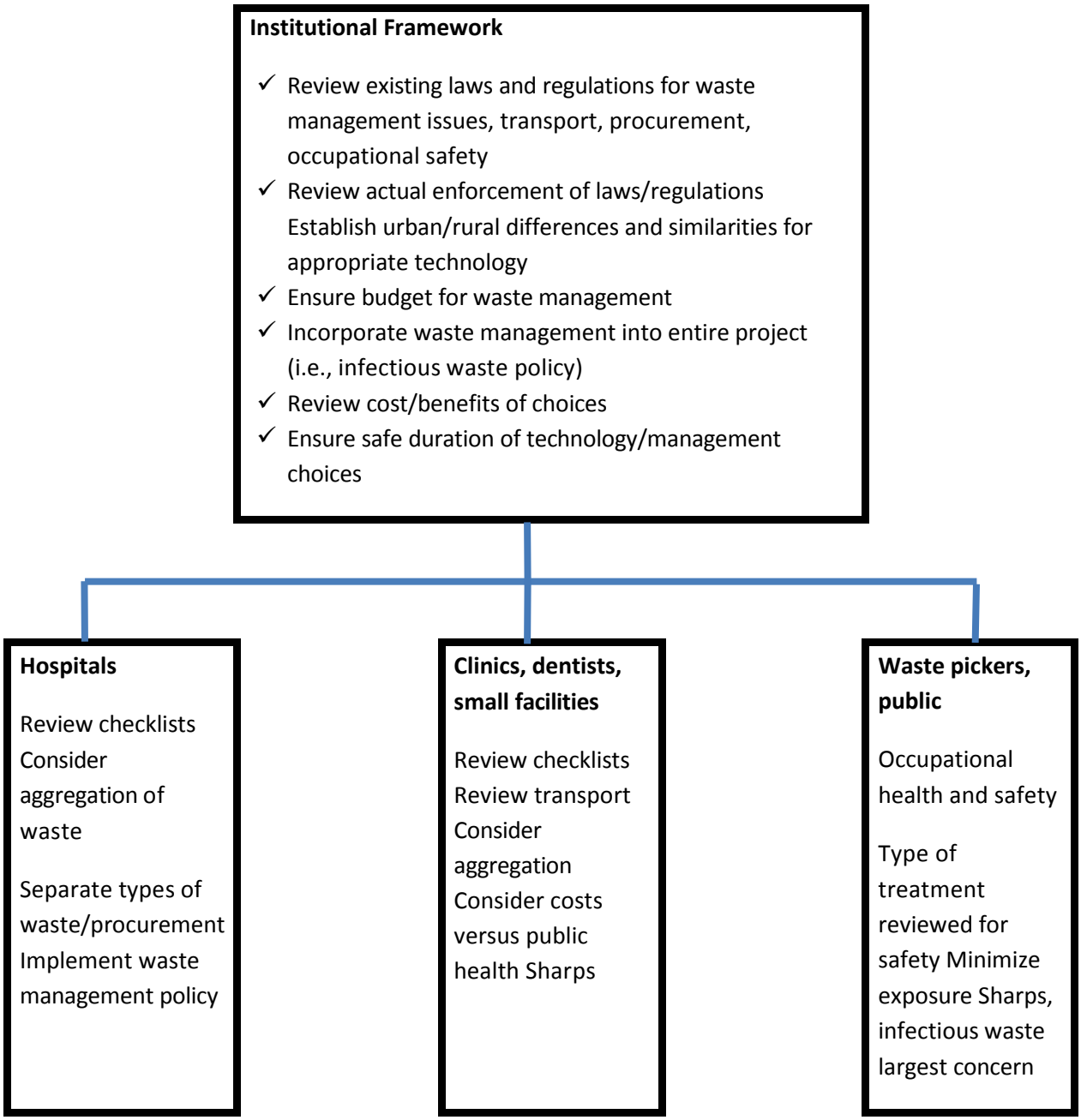


Figure 5.1: Decision Tree for HCWM at the National or Regional Level

Installation of new healthcare facility			
	Determine size		
	Determine prevalence of type of waste		
	Determine institutional framework in country/region		
		If urban	
			Consider air/water pollution
			Determine if other healthcare facilities in area with similar needs
		If rural	
			Review transport issues
			Review technology options for best feasibility (duration and availability of energy source, type of waste stream produced)
	Look at procurement issues for reducing waste stream; where can recycle/reuse		
	Institute measures for reducing burden of cost: reusing items; sending communal waste to landfill or other; picking appropriate technology for type and amount of waste		
	Review worker safety precautions at both facility and ultimate disposition site (this would include waste pickers)		
	Go over appropriate checklist for additional information/		
	Review sample TORs		
	Review costs of total waste management plan (from procurement, separation, transport -if any, treatment, final disposition, worker safety, environmental hazards, public perception)		
Dealing with pre-existing waste problem			
	Conduct site surveys using checklists		
	Determine whether waste stream is continuous or one-stop		
		If continuous	
			Look for nearby healthcare facility with similar types of waste and already instituted good waste management plan
			Determine whether need to institute local waste management plan on site
			Review reuse and treatment technologies for best local alternative
		If one-stop	
			Review institutional framework
			Determine transport, separation, treatment issues
			Pick most cost-efficacious treatment solution

Figure 5.2: Decision Tree for HCWM at the Facility Level

5.4. Assumptions and Risks

In order to set favourable conditions for implementation of the Health Care Waste Management Strategy stakeholders should assign staff and allocate resources. The institutional reform is of utmost importance, whereas financing of in-premises and beyond premises health care waste handling is crucial. General assumptions and risks highlighting the on-going approximation process as well as likely causes for hindering of particular achievements are given below.

Specific risks relating to the implementation of the HCW Strategy are formulated as follows:

i. Existing inadequate and/or unreliable available data on all mentioned types and volumes of HCW. It is assumed that necessary relevant data are not recorded by waste generators, due to the present lack of proper health care waste segregation.
ii. Not all relevant main stakeholders (relevant authorities, hospitals/clinics, private waste collectors/service providers, polluting industries, hospitals, NGO's etc.) will give their full cooperation or react positively in providing necessary information and data.
iii. Not sufficient qualified representatives of the (main) stakeholders will be involved in the implementation of the HCW Strategy.
iv. There is a risk that the required collection/disposal fees will ultimately exceed the willingness of the hospitals/clinics (e.g. 'the polluters') to pay for all the costs involved.

Prior to the establishment of the national system, the first step towards improvement of the present practice at generator's level will be development of management plans for large Health Care facilities (in both the public and private sector.

5.5. Institutional Arrangements

Establish a suitable management organisation for the responsibility for and operation of the future medical waste management system. This should cover both the "internal" (segregation, internal collection, temporary and regional HCW storage centres) and the "external" management (collection from regional storage centres up to the final disposal point(s).

5.5.1. "Internal" management organization

It is proposed that collection of HC waste from the individual healthcare institution and delivery to the central storage facilities established at all general hospitals and health

centres (total number of 47) shall be organised on an "internal" (regional and/or sub-regional) basis; In cases where a town has both a referral hospital, District Hospital and a health centre, an agreement must be made who takes care of this primary collection service from ambulatories, private medical practitioners, etc. The general hospitals and health centres can also decide to tender out the collection services to a private company having the proper permit and license to carry out transportation of hazardous waste. In this way the central storage facilities will act as collection points for medical waste in their respective areas and this management system will be identical in all three proposed scenarios.

The costs of establishing and maintaining proper storage facilities at general hospitals and health centres, as well as the costs for purchase maintenance and operation of a sufficient number of small vans or trucks to be used in the primary collection service, should be incorporated in the economic calculations as costs concern the healthcare institutions directly, together with other internal costs such as investments in small plastic containers on wheels, receptacles, etc. and use of consumables in the form of plastic bags, sharps boxes, etc.

5.5.2. "External" management organisation

When it comes to the collection of health care waste from the central storage facilities and subsequent transport to treatment facilities, the treatment itself and final disposal of the treated medical waste an "external" management organisation should be considered.

No matter how the "external" management organisation is established and no matter which scenario is considered, the following duties of the management organisation will be of universal nature:

Practical duties:

i. Collection and transport of HCW from central storage facilities belonging to general hospitals and health centres;
ii. Registration and reporting of all waste types and amounts collected including preparation of proper
iii. Waste Transportation Lists to be used as consignment documents;
iv. Division of waste collected, for treatment at the medical waste treatment facility and/or for treatment and disposal at other treatment/disposal facilities;
v. Operation of the medical waste treatment facility (incinerator or autoclave(s)) including all necessary maintenance, monitoring and reporting activities; and
vi. Transport of medical waste treatment residues for final disposal including registration of types, amounts and final destination.

Management duties:

i. Preparation of annual budgets on all costs related to the operation and maintenance of the "external" medical waste management system;
ii. Determination of corresponding tariffs to be paid by medical waste generators being serviced by the system and assuring approval of such tariffs;
iii. Daily accounting/bookkeeping and based hereon issuing of invoices at regular intervals to the medical waste generators being serviced by the system and assure that invoices are being paid;
iv. Office and staff management;
v. Reporting of all relevant financial, technical and environmental aspects to the owners of the medical waste management system and to the responsible authorities.

5.5.3. Role of the private sector

Private sector participation in HCWM is possible at different levels. At the simplest level, the private sector may be subcontracted solely to provide waste transportation services to individual healthcare facilities. At the other end of the spectrum, the private sector may sign a contract to Build, Operate, and Transfer (BOT) or Build, Own, and Operate (BOO) an entire HCWM treatment or disposal facility.

The private sector can play a significant role in providing waste treatment and disposal services if the contract establishes a clear set of rules about the division of responsibilities between the parties involved (i.e. regulatory authority, healthcare facility and private operator). The essential conditions for private sector participation are transparency, competition and accountability. Adequate budget provisions are also required at the healthcare facility or the local authority level to pay the private operator.

6. WORKSHOP ON THE NATIONAL HEALTH CARE WASTE MANAGEMENT STRATEGY

The Draft of the National Health Care Waste Management Strategy should be disseminated to various stakeholders. Invitees should be selected based on roles of each stakeholder group, e.g. those who were directly involved in the HCWM on a daily bases: mainly nurses and rarely persons being responsible for either emergency response or infections control.

Four different aspects of the HCW Strategy should be presented and discussed:

i. The Baseline,
ii. The Regional Approach,
iii. the Alternative disposal methods and
iv. The Financing of the future HCWM System.

The following discussions are the most relevant as a workshop output showing the direction and future steps towards the adoption of the Strategy as a tool of stakeholders to work on the improvement of the current situation:

Baseline

The baseline presentation should cover

i. Quality of HCW generation data
ii. information on responsible groups in the HCWM chain
iii. HCW segregation points (e.g. diagnosis, laboratories, preventive, curative and palliative treatment of patients, research etc.).
iv. How the segregated waste being handled (e.g. who takes care of non-hazardous-municipal like and hazardous, including also sharps and the hazardous waste)
v. Various types of receptacles that being used and their use

Participants should be able to identify gaps in the baseline data and advise on how to fill the gaps.

Regional Approach

Presentation should be done based on possible approaches for example regional approach (i.e. centralise system) against decentralised system. The following Table 6.1

summarises possible advantages and disadvantage of the two systems

Table 6.1: Advantages and disadvantages of the centralized and decentralized Option

Alternative	Advantages	Disadvantages
Centralized	Simpler design, construction and commissioning Less problems with land acquisition Easier inspection over the operations Same tariffs for all system users	Low flexibility High transport costs for remote hospitals
Decentralized	Lowering of transport cots Higher flexibility Possibility to implement various institutional models	Longer period for the start-up of operations due to the implementation of three independent projects More complicated inspection Three independent systems

Participant should discuss the advantages of regional approach.

Alternative disposal

Presentation should be made on available option particularly for small generators of HCW (see Chapter 4).

Financing of the HCWM

Presentation should be made on the financing HCWM. There are several options e.g. to pay a tariff for the collection of the non-hazardous (municipal waste) to the public enterprises and a tariff for the collection & transportation & disposal (autoclaving) to the regional centre (hospital) or to the private company having the contract with wither individual hospitals or regional organizations.

7. CONCLUSIONS AND RECOMMENTATIONS

7.1. Immediate needs and proposed activities

Transitioning from the present practice concerning the HCWM to a functional system will require improvements in the following areas:

i. Policy formulation and planning at all levels: national, regional (healthcare area);
ii. Organization and implementation of an improved internal HCW collection: segregation, labelling/packaging and storage; reinforcement of the existing reporting and introduction of reporting where it does not take place;
iii. External collection to the storage points and transportation of HCW by licensed transporters;
iv. Disposal in an environmentally safe manner (e.g. autoclaving);
v. Cost recovery of operations, meaning that the tariffs for municipal and HCW should be separated in a transparent way, while the following costs should be taken into account for the HCWM tariffs;
vi. Inspection and enforcement of the legislation;
vii. Public awareness and education of all stakeholders involved in the HCWM, including the general public.

Not all of above described areas for improvement can be tackled in the same time, nor the country may afford immediate actions which involve excessive costs for the hospitals and the society as a whole. Therefore, the timeline of activities to be undertaken should be planned with utmost care and within a climate of a broad consensus. However, it is not always possible in the given political environment and the Government must be given a clear guidance concerning the priority actions along which the main stakeholders should gather and decide on their implementation. In the following lines the most urgent activities towards an improved HCWM are elaborated.

7.1.1. Enhance internal waste handling

Prior to the establishment of the national system, the first step towards the improvement of the present practice at generator's level should develop management plans for large Health Care facilities.

Plans should take duly into account HCWM principles, being elaborated in Chapter 4. Training of involved personnel should follow, addressing the main issues as described below.

Appointment of waste managers

Based on Plans the internal monitoring and reporting must be carried out. It can be

carried out only if Waste Managers at hospital level would be assigned, changing the current practice where the main nurses are involved both in planning and direct activities concerning waste segregation.

Waste Managers should have requisite knowledge and technical expertise to handle HCW. Health Care Waste Managers should be responsible for the overall planning of the on-site HCWM and for the performance the members of the technical waste teams involved in any chain of the HCW handling.

In order to strengthen the HCWM system there should be inspector with training. In addition, the political will to exert penalties is required. This is again in close relation to the public awareness on the risks associated with the inappropriate HCWM.

In the following text a possible outline of a broad capacity building is proposed.

Training of involved personnel

It is widely acknowledged that training is an essential component of health care waste management. This is partly because it is often assumed that lack of adequate knowledge is the reason behind poor waste segregation practice in the health care sector.

The experience from countries where the HCWM system is working properly shows that at least two different training programmes as part of the capacity building programme of the health care personnel should be developed and conducted.

The first training programme is a programme of on the job informal education to teach attitudes, knowledge and skills essential to the implementation and maintenance of a new HCWM equipment system. The second programme is an intensive training course for HCW Managers.

The importance of understanding the role of training within the broader context of capacity building and the importance of using qualitative research methods to collect information about training needs should be understood.

Identifying training needs

It is tempting to believe that training is the answer to problems that arise in HCWM in health facilities. However, often the reason for poor performance may not be because of a lack of training. For example, an over filled sharps container could have many root causes, such as staff not knowing when to close the sharps container at three-quarters full, the wrong sized sharps container at the point of generation so that it is filling too quickly, an inadequate supply of sharps containers to the health facility so that it is not possible to replace a sharps container on time, and poor ordering and delivery of sharps containers towards from health facility stores etc. It is critical for successful training interventions in HCWM that training needs are identified alongside other capacity needs

that cannot be addressed through training.

This is done by conducting a "performance discrepancy analysis". This approach describes "capacity" in terms of "performance". Performance gaps are associated with equipment failure and inadequacies, poor management, human resource issues, training and policy gaps. Capacity building therefore ensures that the "hard" and "soft" sides to development programmes are sufficiently addressed for a successful implementation and a long-term sustainability.

A performance discrepancy analysis identifies areas of performance where there is less than optimum functioning. These areas of discrepancy or under-functioning can also be described as "gaps". For HCWM, the three critical commonly identified gaps that are relevant to training are:

i. knowledge gaps;
ii. skills gaps; and
iii. attitude gaps.

However, in addition to these areas other important areas are known to impact on the delivery of HCWM systems and include the following:

i. inter-staff relations;
ii. worst case scenarios when the HCWM system breaks down completely;
iii. technology gaps;
iv. policies and procedures gaps; and
v. organisational, management and supervisory gaps.

Each area of discrepancy is summarised in Box 7.1. For a successful training intervention it is essential that the correct knowledge, attitude and skills gaps are identified. Secondly trained health workers then need to operate in a system where their performance is not undermined by other gaps in the system. For example health, workers can be trained to close sharps containers when three quarters full, but this must be supported by a policy that enforces this standard.

Box 7.1: The performance discrepancy analysis for HCWM in a health facility

Knowledge gaps: There is a set of basic information that all categories of health employees should know about HCWM. This includes basic knowledge of types of health care waste, segregation of health care risk waste, occupational health and safety issues, use of specific equipment etc.

Skills gaps: Skills are distinguished from knowledge by being something "you can do" rather than something "you know". Skills include correct use of equipment and the implementation of procedures, for example, closing liners correctly, loading sharps correctly in sharps containers and completing an incident report form.

Attitude gaps: For effective HCWM it is essential that health employees hold positive attitudes towards care of the environment, occupational health and safety and teamwork.

Worst-case scenarios: This category describes situation when the performance of the HCWM system is seriously undermined and jeopardised. For example, there is no collection by the service provider, or no provision of equipment.

Inter-relations: Inter-relations is concerned with staff relations, especially those that adversely impact on the performance of the HCWM system such as poor communication between general assistants, nurses and doctors.

Technology gaps: The specifications, standards and appropriateness of equipment all impact on the performance of the system.

Policies and procedures gaps: Policies, guidelines, procedures and/or codes of practice are essential to support any HCWM system. Policy and procedure gaps happen where policies and/or procedures are missing. Often policy and procedures for HCWM are written into one document called a *Code of Practice*.

Organisational, management and supervisory gaps: These gaps relate to the management function as a whole. The Code of Practice referred to above would normally be expected to describe the organisational structures necessary to support HCWM at a health facility level. This includes roles of senior management, all categories of staff, the role of the occupational health and safety committee and the service contract with the service provider.

Use of qualitative research methods

Information for a performance discrepancy analysis is collected through use of a number of research methods. This includes a review of all relevant documentation, onsite inspections and completion of audit forms and checklists and key informant interviews with senior and middle management.

Target health care officials are as follows:

i. focus group with senior and professional nurses including ward managers;
ii. focus group with auxiliary and enrolled nurses;

iii. focus group with doctors; and
iv. focus group with general assistants and ward helpers.

The purpose of the focus groups is to do the following:

i. explore the range of factors that impact on the behaviour and practices of staff;
ii. explore the knowledge of staff about health care waste management;
iii. explore the attitudes to health care waste management; and
iv. understand the roles and responsibilities in health care waste management.

The advantage of using qualitative methods is that it allowed the researchers to explore with a large number of health workers the range of factors that impact on HCWM. A qualitative research is usually done when aspects of a topic are poorly understood. The focus groups should be conducted by an independent researcher and by the capacity building consultant. A brief information should be prepared for each category of health staff to be interviewed.

Results from the qualitative research relevant to the design of the training interventions

A possible range of results may include the following:

i. usually the best knowledge on HCWM is shown by the lowest level of employees, which is owed to the fact that doctors do not see their involvement in any part of the HCWM;
ii. there is a level of poor practice in HCWM that is related to negligence that probably has it's root causes in broader aspects of low health worker morale in the public sector;
iii. multidisciplinary training is important overcome communication barriers;

The design of the capacity building programme

The capacity building programme should address the gaps identified primarily through the development of appropriate training programmes. However, there are usually three significant performance gaps as follows:

Worst-case scenarios where the HCWM system breaks down completely:

i. The buying department leaves the hospital stores without equipment for waste collection this appears because of a breakdown in timely ordering or a problem with the supplier;
ii. The distribution of equipment around the hospital is not always reliable and therefore there is stockpiling of cardboard boxes and other equipment in the wards;
iii. The budget does not allow for the procurement of sufficient bins for general waste and health care waste at the point of generation;
iv. Inappropriate colour bags are supplied which results in incorrect colour coding.

Policy and procedures

It is essential that new procedures are developed to support the improved HCWM system.

Organisational, management and supervisory gaps

Usually, there is no internal or external auditing of the HCWM system. Supervision of HCWM line functions in the hospital and clinic wards and departments is very poor and there is no internal performance monitoring of the HCWM system.

The approach to capacity building might have seven elements of which training is one part. The overall approach to capacity building should ensure that the capacity building programme complements the introduction of new equipment.

The capacity building programme should involve:

i. Provision of new policy and procedures for HCWM written as a Code of Practice
ii. Introduction of improved monitoring and reporting
iii. The introduction of a dedicated HCW Manager and an Assistant
iv. Knowledge, attitudes and skills training
v. Awareness activities
vi. On the job skills coaching
vii. Evaluation of capacity building activities

Training of the Inspectors

In order to set conditions for implementation of the HCWM strategy stakeholders should assign staff and allocate resources; of utmost importance is the institutional reform whereas financing of in-premises and beyond premises health care waste handling is crucial.

Next step would be carrying out of specific trainings and campaigns aiming to raise awareness and capacity on HCWM throughout the country. A crucial moment is to train the Inspectors who are the main stakeholders to contribute to the above said reforms. As the list of topics to be covered by the training for hospital staff covers the 7 most important issues, all of them are to be a subject for inspection. Examples of inspection include:

i. Inspection if there is a Code of Practice or a Waste Management Plan for the hospital
ii. Inspection if the record keeping and reporting takes place
iii. If a Waste Manager is being appointed and if he/she is qualified for the
iv. If the purchasing policy for receptacles is adequate, i.e. the minimum packaging and labelling is complied with
v. If the storage place is equipped appropriately etc.

Establish regional HCWM

In addition, there should be a regional planning initiated aiming to effectuate the three HCWM systems gravitating to the regional treatment facilities. After a political decision is taken, the regional plans including the technical planning (collection, transport and disposal) as well as the financing schemes (including the user charges) should follow. Upon the fundraising supported by national allocation of the co-financing, there should be "elected" a nationally recognized owner of procurements related to an improved HCWM system.

7.1.2. Further elaboration of scenarios

The two scenarios (central and decentralized systems) should be elaborated in the following terms:

i. Detailed cost estimates for the expenditures listed in paragraph 5.3, "Investment and operational costs";
ii. Operational / Institutional concepts (public enterprises, shareholding companies owned by hospitals, PPP or similar) along with the legal documents involving tenders, contracts etc.;
iii. Broad Public participation and consultation of the governmental bodies.

An advantage to have in mind originating from a PPP approach could for instance be to tender out the collection and transport services to a private waste management company having the necessary permits and licenses. The PPP concept can be further developed in the future to also comprise management of the treatment facility itself.

7.2. Transparent Setting of Tariffs

In order to sustain a HCWM system, the users should be pay for the facility though waste disposal tariffs. For these to work tariffs should be set transparently though participation of key stakeholders. The advantage of involving stakeholders it could be the familiarization of hospitals with the additional fee to be paid for the separate collection/transportation of HCW and its treatment. An improved HCW segregation as well as initiation of recycling, being driven by the higher fee can be expected as well.

If there isn't any institution appointed in the legislation for monitoring over the setting of tariffs in the public sector including the HCWM, an establishment/appointment of a regulatory body may be considered. This entity may not only supervise the health care waste management related tariffs (for internal, external collection / transportation and disposal) but it can oversee the setting of

tariffs for other sectors, such as municipal waste management, water and wastewater management etc.

Taking over the entire system by the HIs would further contribute to setting more equitable and transparent tariffs. Private sector can be invited to take part presumably in the "external" collection and transport; an option for consideration is outsourcing of the HCW treatment to a private operator.

7.3. Enforcement of Existing Regulations which will Make the Institutions Search for ways to Comply with Them

First task for the legislator, is to address the prohibition for transportation of the HCW mixed with the ordinary household waste by the municipal utilities and its disposal at the present dumpsites. With such a measure the hospitals would be imposed to searching ways how to comply with the present Law on Waste, prohibiting the mixing of the municipal waste with the hazardous waste. The crucial part of the enforcement of the legislation is the affordability to implement the system and the stringent practicing of the inspections.

The elements of the Action Plan should be set based on the project analyses. These are outlined below.

Most of the required actions may accompany the investments, such as the public awareness and the establishment the institutional set-up including the appointment of the operator(s) for the external transport and disposal. However, the training of Waste Managers and Inspectors may start independently from the investment upon the available funding. The same applies for HCWM plans of hospitals.

Table 7.1 shows scope of possible activities. The order of specific action coincides with the schedule for implementation.

Table 7.1: Scope of activities for the HCWM Strategy

Strategy Framework	Internal HCW Collection and storage	External collection & transportation	Disposal	Cost recovery	Inspection / Enforcement of the legislation	Education and Public Awareness Raising

Strategy Framework	Internal HCW Collection and storage	External collection & transportation	Disposal	Cost recovery	Inspection / Enforcement of the legislation	Education and Public Awareness Raising
Approval of the HCWM Strategy	Appointment of a Waste Manager	Organize a central storage point for a number of hospitals in a municipality / sub-region	Select a location (preferably at the premises of the biggest HCW generator in the region)	Develop a methodology for setting of tariff	Regular inspections within hospitals	Training of the Waste Manager
Development of HCWM plans of hospitals	Organization of the segregation, packaging/labelling, internal collection and storage at hospital level in accordance with the plan	Purchase suitable equipment (racks, ventilation, refrigerators etc.)	Develop the technical documentation, EIA and the urban plan (plus public consultations)	Appoint the institutions in charge of setting of tariffs (Ministry or a regulatory body)	Inspections on the reporting system	Training of technical staff in hospitals involved in the HCW
Development of HCWM regional plans	Purchase of bags, other receptacles, wheeled trolleys, containers, or carts that are not used for any other purpose	Make contract with a licensed transporter	Obtain a "B" IPPC permit	Set tariffs transparently	Inspections of the transport	Training of Inspectors of the SSI, SEI, SVI and the SCI
Participatory Planning Review	Setting conditions for an in-hospital central storage site	Prepare and deliver transportation consignment forms	Purchase and install the facility	Set incentives / penalties for non-paying hospitals	Inspections of the autoclave operations	Training of high decision making officials
Overseeing of the Strategy Formulation	Appointment of technical staff to implement the HCWM within the hospital			Penalize non-paying costumers	Inspections on illegal dumping of the HCW	Training of the staff operating he autoclave

ANNEX 11: GUIDANCE FOR DEVELOPING A HEALTHCARE WASTE MANAGEMENT (HCWM) SYSTEM

A1. GUIDANCE FOR SMALL HEALTHCARE FACILITIES WITH MINIMAL RESOURCES

This section is generally appropriate for small healthcare facilities (i.e. facilities with less than about 50 beds, immunization posts, reproductive health posts, etc.) that have relatively few resources to devote to HCWM.

To improve HCWM in a small healthcare facility, it is important to begin by surveying the facility's current HCW practices, using a checklist provided in section A1.1. The steps outlined in Section A1.2 are basic elements of good HCWM at small healthcare facilities and should be reviewed carefully by healthcare facility managers and project teams involved in healthcare or waste management projects.

A1.1 Small Facility Assessment Checklist

A1.1.1 General facility information

a) How many employees does the facility have?
b) How many beds does the facility have, and what is the bed occupancy rate?
c) What medical and supporting departments does the facility have? (Include pharmacy, laboratories, kitchen, general store).

A1.1.2 Handling of HCW

a) How much HCW is generated daily by each department or at each ward/lab within the healthcare establishment? (Waste quantity may be measured using a small hand- held scale).
b) How much of this is special HCW? (See Annex 5 for waste definitions). The answer to this question will help determine the magnitude of the problem and treatment method.
c) What is the general composition of the waste, i.e. the percentage of plastic, cotton, food- waste, sweepings, and pathological-waste? Visit all wards, specialized departments, laboratories (including blood bank), pharmacy, kitchen, and general store to note the waste composition at each location. This can be determined visually, by glancing through the waste at the waste end-point inside the healthcare establishment.
d) How and where is the facility's HCW stored before collection?
e) Does any formal or informal separation of waste take place? Are plastic I.V. sets kept separately for recycling? Are x-ray films collected for extraction of silver?
f) Does the establishment generate any wastes of special concern, such as radioactive waste, cytotoxics, pathological waste, reagents, or outdated pharmaceuticals? How

and in which department are each of these special wastes generated? How is their disposal handled? How is liquid waste handled? Specify for cytotoxics, reagents, and used x-ray film processing liquids. If the liquid waste is discharged in the sanitation system, where does the latter discharge and what is its capacity?

A1.1.3 Treatment and disposal of HCW

a) What treatments (if any) are done to the waste before disposal? How efficient are the treatments and how are residuals handled?
b) Is the HCW disposed of at the healthcare facility or off-site?
c) If any waste is taken off-site, how is the waste transported outside the premises of the healthcare facility? How is the waste packaged? What types of vehicles are used to transport the waste?
d) Is any of the waste taken to a dump or landfill site? If so, what happens to the waste at this facility? Is the HCW buried immediately after arriving at the landfill/dump? Is it burned on the site? Is it left unattended at any time after being unloaded?
e) If there is open access to the landfill/dump, to what extent do waste pickers, children, or others have access to the HCW?

A1.1.4 Management issues

a) Who is responsible for HCWM at the healthcare facility?
b) What are the current operational standards for HCW and what are the applicable national, regional, and local policies?
c) How many people are involved in waste collection and are special skills required by the healthcare facility? What sort of worker safety measures are in place?
d) Is procurement of new healthcare materials reviewed to reduce the waste stream and to avoid potential treatment problems (such as PVC)?
e) What are the daily waste collection routines, including waste packaging? What are the transportation needs and costs?
f) How much does HCWM cost the facility? Does the budget provision cover these costs?

A1.1.5 Risks of the current waste management system

a) Does the management of the healthcare facility have concerns about the facility's current
b) HCW practices? If so, what problems do they identify?
c) Does the assessment above indicate that the facility's current waste management practices pose any health risks to patients, nurses or doctors, other staff, or visitors? If yes, what kind of risks?
d) Does the waste pose any risk to waste collectors? If yes, what kind?
e) What are the risks for spillage of waste or for scavenging along the transportation route?
f) Does the waste disposal system pose any risk to waste-pickers or users of resold/recycled waste? If yes, what kind?

A1.2 Basic Steps in HCWM at Small Facilities

A1.2.1 Raise awareness at the management level and develop an integrated waste management plan

The managers of the healthcare facility need to recognize the importance of good HCWM, and should designate a special group with responsibility for overseeing the situation. This may be done by setting up a waste management team or by working with an existing infection control committee. A waste management team should include, at a minimum, the manager of the healthcare facility and a representative for each of the following: procurement or accountants, physicians, nurses, and waste collectors. It is important to move beyond the committee and develop a waste management plan (including HCW) for the facility that is integrated into the daily operations.

A1.2.2 Ensure segregation of special HCW from other waste generated at the establishment

Using the information gathered in A1.1, categorize the waste generated at the facility as either municipal solid waste or special HCW (see definitions in Annex 5). The first priority should be segregating sharps and pathological waste from all other waste. Sharps must be put into rigid, puncture-proof containers, which should be available at the health worker's workplace. Pathological waste should be put into non-transparent plastic heavy-duty bags. When three-quarters full, the containers and bags should be disposed of safely. Toxic liquids and pharmaceuticals should also be separated from regular solid waste materials, and disposed of properly.

A1.2.3 Determine the most appropriate treatment and disposal site for the facility's waste

Generally speaking, small healthcare facilities in urban areas should choose off-site treatment and disposal for both economic and safety reasons - most often in the municipal landfill. Landfills must be carefully sited away from water sources, agricultural land, and land where other development might take place and should include liners to protect leaching. (Technical Guide on Solid Waste Landfills). Landfills should be protected from human and animal waste pickers. Burial of HCW and other municipal solid waste in a municipal landfill (see Table A8.2) could be done by the person who delivers the waste from the healthcare facility, or by a person employed at the landfill. In either case, this person must receive specific instructions for such burial. Cytotoxics and other hazardous chemical wastes (see Annex 5) should never be buried in a landfill, however. Instead, they need to be returned to the original supplier or incinerated at a central facility (see Annex 6) for the difference between burning and incineration). Other special HCW should also receive more intensive treatment to ensure a reduction in public health and environmental consequences.

Small, isolated facilities with limited resources and without access to centralized waste treatment and disposal may find burial of special HCW their best solution. Such burial should be done only under controlled circumstances, in a secluded area following landfill principles, including liners, water diversion, groundwater monitoring, careful siting, and gas release mechanisms.

A1.2.4 Develop and implement a HCWM plan

Every healthcare facility should have or develop a waste management plan that includes daily routines for collection, handling, segregation, and packaging of the different categories of waste. Facility managers should ensure that this plan is in place, with adequate budget and personnel to implement it. Implementation of the HCWM plan and routine monitoring should be carried out in parallel with the information/training program described below.

A1.2.5 Train healthcare workers in proper HCW procedures

All healthcare staff should be aware of the facility's basic HCWM plan and their role in the plan. This includes management and regulatory staff, medical doctors, nurses and nursing assistants, cleaners, waste handlers, and visitors to the facility. The waste management plan should be presented in simple terms and displayed in a diagram at all points of waste generation. Better health and environmental working conditions for waste handlers should be addressed in planning resources for waste management. This includes but is not limited to the use of protective clothing and specialized equipment to ensure worker safety as well as safety for the general public.

Hands-on staff training in the details of the waste management plan is optimal. Training should include:

a) Basic information about HCW and the risks of bad management of HCW. Basic information on the facility's waste management plan.
b) Each employee's responsibility and role in HCWM.
c) Technical instruction on application of the practices described in the waste management plan.

ANNEX 12: GUIDANCE FOR LARGE HEALTHCARE FACILITIES

The checklist and recommended steps outlined below are appropriate to guide a review of waste management operations at a larger healthcare facility (roughly speaking, more than 50 beds). Section A2.1 provides guidelines for assessing current HCWM practices within the healthcare facility. Section A2.2 contains suggested steps to improve HCWM at the facility level. Centralized waste treatment and disposal often make sense for large healthcare facilities, especially those in large urban areas or in smaller communities served by a central waste facility or system. Section A2.2 thus also deals with assessing the municipal or regional context for a facility's waste management.

A2.1 Large Facility Assessment Checklist

A2.1.1 General facility information

Basic data

a) How many employees are there at the facility in total and within each category? Categories should include doctors, nurses, other healthcare workers, waste collectors, cleaners, and other hospital staff.
b) What are the facility's medical specialties and departments?
c) How many beds does the facility have within each medical specialty?
d) What other departments support the medical departments? Examples include laboratories, blood bank, radiology, operating theaters, intensive-care units, renal dialysis units, and outpatient services.
e) What non-medical departments are there? These may include general store, laundry, operations and maintenance, workshops, kitchen, and waste management department.

Financial data

a) What is the facility's annual budget?
b) How much is spent on salaries and wages; medical supplies; pharmaceuticals; maintenance and services expenses; consumables; and waste management?

Health conditions among employees

a) What is the prevalence of HBV, HCV, HIV, malaria, and syphilis among the categories of employees at the healthcare facility, compared to that of the general public?

A2.1.2 Handling of HCW

HCW composition and quantity

a) What is the composition of the facility's HCW? Determine by segregating random portions of the waste into defined waste categories *(*see Annex 5). Weigh the total portion and each segregated fraction of the waste; a hand-held scale may be used.
b) What are the major sources of special HCW? How much is generated by each medical

and non-medical department? Is HCW segregated?

c) What are the major sources of liquid HCW, hazardous waste, and radioactive waste? Can the source be reduced?
d) What is the total quantity of HCW generated at the healthcare facility? This may be determined through a 1-4 week survey in which all waste generated/disposed of at the healthcare establishment is weighed. Weighing may be done by truckload (e.g. at a weigh bridge in the neighbourhood of the healthcare facility) or by weighing every container/ trolley immediately after collection.
e) How much of this is special HCW (based on the composition proportions determined in step one)?
f) What is the amount of total HCW and special HCW generated per bed per day?

HCW collection

a) What are the facility's HCW collection practices? Include:
- Level of segregation at source of waste
- Location of collection points at department/ward level
- Storage before collection by waste collectors

b) Routines for waste and laundry collection (since laundry procedures often can be applied to HCW collection)
- Collection equipment (trolleys, push carts, etc.)
- Storage before final disposal or external transportation
- Special procedures for liquid wastes
- Special procedures for pharmaceuticals and cytotoxics

A2.1.3 Treatment and Disposal

Treatment and disposal on the facility premises

a) What are the on-site practices for HCW treatment? (e.g. crushing of sharps; sterilization; chemical disinfection; destruction through burning or incineration).
b) What are the practices for on-site disposal? (e.g. landfilling or dumping of HCW or residuals from treatment, incineration).
c) Is any of the HCW recycled? (e.g. using kitchen waste for animal feeding, recovering silver from x-ray films, reusing cardboard from the general store).
d) Does informal segregation/recycling of waste (syringes, unused medicine, etc.) take place by healthcare workers or waste collectors? If so, does this informal activity contribute to healthcare workers' income?
e) The ability to properly treat and dispose of liquid HCW should be included in this section.

Treatment and disposal outside the facility's premises

a) Is the facility's HCW treated at a central treatment facility before final disposal? Is the facility's HCW disposed of at a municipal dump/landfill?
b) Does any scavenging of HCW occur at the treatment or disposal site? If so, what waste is

being scavenged and how does it contribute to waste-pickers' income? How significant is the scavenging in terms of the number of people involved?

A2.1.4 HCWM and regulations (*See* Annexes 6 and 7 for further information)

HCWM on the facility premises

a) Which departments and staff members at the facility are involved in HCWM?
b) Who are the key people within the facility responsible for HCW issues? These are likely to include upper management, members of the infection control committee, the internal HCW manager (if one exists), and the engineering department manager.
c) Have any outside parties been hired to help with the facility's waste collection, treatment, transportation, or disposal? If so, what aspects of waste management are they responsible for, and who is accountable for their performance?
d) Does the facility conduct any training and public awareness programs on HCWM?
e) Who pays for hauling and disposal of special HCW? This is often paid for in part by the local government or through a subsidy from the Ministry of Health for shared facilities. See Section A2.2.4 on Financing.

The role of outside authorities

Which authorities are involved in HCWM at the municipal/regional/ national level? These may include municipal waste management authorities for bylaws on disposal of HCW; environmental authorities (local/regional) for emissions standards from treatment plants; health authorities (regional/national) for internal hygiene and infection control requirements; and occupational health authorities (local/regional) for regulations governing for healthcare workers and waste collectors.

Budget issues

a) How much does HCWM cost the facility? Is the budget provision adequate for these costs?
b) Who pays for hauling and disposal of HCW? (This is often paid for by the local government or through a subsidy from relevant Ministry for shared facilities).

HCW regulations

a) What existing HCW regulations govern the facility? Are they specific to the facility or set by a higher governing body?
b) What regional and national regulations apply to the facility's HCW situation?

A2.1.5 Risks of the current waste management system

a) Does the management of the healthcare facility have concerns about the facility's current
b) HCW practices? If so, what problems do they identify?
c) Does the assessment above indicate that the facility's current waste management system poses any health risks to patients, nurses or doctors, other staff, or visitors? If yes, what kind of risks?

d) Does the waste pose any risk to waste collectors inside the hospitals? If yes, what kind? What are the risks for spillage of waste or scavenging along the transportation route?
e) Does the disposal system pose risks to scavengers or users of resold/recycled waste? If yes, specify.
f) Are there other problems involved in the handling of the facility's HCW?

The ability to properly treat and dispose of liquid HCW should be included in this section.

A2.2 Basic Steps in HCWM at Large Facilities

The steps outlined below are basic elements of good HCWM at large facilities, listed in order of priority. These steps should be reviewed carefully by facility managers, even if completion of the checklist above does not identify problems or risks involved in waste management at the facility. If a facility cannot implement these steps on its own, it should seek help from waste management experts. Section 6 of this report contains a list of information sources that may provide further assistance.

A2.2.1 Raise awareness

As described in A1.2.1, managers of the healthcare facility should raise awareness of the importance of proper HCWM and designate a group with responsibility for overseeing the HCW situation.

A2.2.2 Ensure that special HCW is segregated from other waste for disposal. HCW must always be segregated into special HCW and other waste. Waste segregation facilitates safe handling of special HCW and minimizes the amount of special waste requiring special treatment or disposal techniques. First, sharps must be separated from all other waste and stored properly in appropriate containers (see also A2.2.5). If any radioactive waste is generated, international standards for disposal must be followed, as described in Annex 6.

A2.2.3 Determine appropriate treatment technology

Some decisions regarding treatment technology are made at the healthcare facility level and others are made at the national or regional level. The satisfactory destruction of special HCW is a major problem facing health services today. Research and development are still needed to find inexpensive and acceptable ways of destroying special HCW.

Landfilling of special HCW by burial in other municipal solid waste should only be considered for small quantities of waste. For a city with larger facilities, a special landfill cell or pit should be developed to receive special HCW. The cell should be fenced to restrict access by waste pickers and animals, and at the end of each day the HCW deposited should be treated with lime and covered with 10 cm of soil.

If land filling is not an option, incineration, sterilization (autoclave or microwave), chemical disinfection, or a combination of these technologies need to be considered. See Annex 7 for the difference between incineration and burning, and for a summary of different technologies for waste disposal and treatment.

A2.2.4 Consider facility-based vs. centralized waste treatment and disposal options

a) The choice between on-site or off-site treatment and disposal is often a political decision made at the regional or municipal level. If a healthcare facility is very large, or located near many other healthcare facilities, potential economies-of-scale should play a role in the decision. In many cases, environmentally-sound incineration sterilization, and/or landfill disposal will necessarily take place off-site. However, a large healthcare facility with adequate technical and financial capacity can consider installing an incinerator and even providing services to other nearby healthcare facilities (at cost). The questions below may help facility managers prioritize their options.
b) Is the healthcare facility part of a larger healthcare system?
c) Is there a comprehensive waste management system locally or regionally?
d) Do waste management organizations or service firms exist that could be part of this facility's waste solution?
e) Are there any local treatment facilities or operators that specialize in HCWM?

A2.2.5 Ensure proper packaging and storage of special HCW

Primary packaging and storage takes place where waste is generated. Secondary packaging is used for transportation. Primary packaging of special HCW should be in leak-proof and disposable bags or containers. Containers for sharps must be puncture-proof and should not be made of glass. A colour code of yellow or red should be chosen for all special HCW. For pathological waste, the opposite (and non-transparent) colour should be used. For secondary packaging, leak-proof solid containers mounted with wheels should be used for easy transport. Colour coding of secondary packaging should follow the primary packaging colour code. For environmental reasons, non-PVC products are preferred. (For more on packaging choices, see Annex 10). The centrally located storage room should also be secured. In-house storage may consist of two levels: a) A well-ventilated room at or near the ward, where waste collectors will pick up the waste; and b) A centrally-located storage room, where temperatures can be kept low (e.g. air conditioned), until waste is picked up for treatment.

A2.2.6 Ensure safe transportation of special HCW on public roads.

If the waste treatment and/or disposal facility is located off-site, the vehicle that transports special HCW should be used exclusively for this purpose. The vehicle should also be able to accommodate the secondary transportation packaging in a safe and controlled manner.

A2.2.7 Determine whether or not an environmental assessment is needed

If major new waste treatment facilities are being planned, an environmental assessment study should be carried out. Simple projects or the upgrading of HCWM systems generally do not cause significant environmental impacts. However, if a healthcare project generates significant

quantities of HCW that overwhelm the existing capacity of the waste management system, or involves construction of major new waste disposal facilities, then a formal review of the environmental impact is needed. If the management of HCW requires a municipal or regional solution that goes beyond the boundaries of the healthcare sector, an environmental assessment study may be required as for other similar works. (See Annex 10) for guidelines on conducting an environmental assessment).

A2.2.8 Develop a HCWM plan for the facility

Develop a waste management plan that includes daily routines for collection, handling, segregation, and packaging of the different categories of waste. Facility managers should ensure that this plan is in place, with adequate budget and personnel to implement it.

A2.2.9 Train healthcare workers in HCWM procedures

All healthcare staff should be aware of the facility's basic HCWM plan and their role in the plan. This includes management and regulatory staff, medical doctors, nurses and nursing assistants, cleaners, waste handlers, and visitors to the facility. Hands-on staff training in the details of the waste management plan is optimal, as described in A1.2.5. Training programs should include proper instruction on the use of protective clothing, materials, and special equipment to ensure the safety of both the HCW worker and the general public.

A2.2.10 Address scavenging issues

If scavenging has been identified as a problem, steps need to be taken to protect waste pickers and to prevent access to hazardous waste. If possible, waste-pickers should also receive assistance to move into other income-generating activities. Alternative methods of waste management might be considered in these cases, to help reduce the risk to public health.

ANNEX 13: GUIDANCE FOR MUNICIPAL, OR REGIONAL HCW PROJECTS

This section deals with centralized HCWM projects, which are often components of broader municipal/metropolitan solid waste projects or projects of the regional environmental authority. These projects often focus on proper treatment and final disposal of special HCW at a central regional facility. Environmental authorities will primarily be concerned with indiscriminate disposal of special HCW at open dumps and landfills. Public health authorities and environmental authorities also need to be involved in planning, licensing and monitoring. And, since the method of treatment employed dictates the level of segregation of special HCW at its source, it is imperative that the managers of the affected healthcare facilities be involved in the planning stage of these waste projects.

Central waste facilities at the municipal, metropolitan or regional level offer several advantages over those at individual healthcare facilities in treating special HCW:

a) They are more cost effective through economies of scale. Provision of spare capacity is more economical.
b) Future modification or expansion is less expensive
c) Operations are more efficient.
d) Reduction of emissions is more effective.
e) Monitoring and supervision are easier than for dispersed facilities. Environmental monitoring and control are easier.
f) Healthcare facility administrators can devote their full attention to the primary activities of the healthcare facility.
g) Specialized private sector operators can be invited to design, build, and operate central waste facilities.

A3.1 Regional HCW Sector Assessment

A regional HCW sector assessment like the one outlined below is usually conducted by an outside consultant with expertise in HCWM, due to the number of facilities and relative complexity of the issues involved.

A3.1.1 General information

The first step is to identify all healthcare facilities in the area under consideration and gather basic information on these facilities. This basic information may be gathered for a "study sample" that includes one or more facility of each major type in the region, including, where relevant, university hospitals, regional hospitals, general hospitals, municipal hospitals, and other healthcare facilities. The data from facilities in this sample can then be extrapolated to get a picture of all the healthcare facilities in the region. Section A2.1.1 provides guidance on the type of data needed from each facility in the sample.

A3.1.2 HCW issues

Assess the HCW generation, storage, and collection at one major healthcare facility of each type in the sample. Section A2.1.2 indicates the type of information that should be gathered at each sampled facility. Extrapolate the results to cover the entire region. Next, review and analyse existing HCW treatment and disposal systems (on-site and off- site) at each healthcare facility in the study sample, following the guidelines in Section A2.1.3.

Assess the current regulations covering HCWM, treatment, and disposal in the region, following the guidance in Section 3.3.1. In addition, the assessment will need to:

a) Determine air emission standards required by law and those likely to be required in the next ten years.
b) Determine the permit requirements, including environmental building permits and other permits and procedures that HCW treatment/destruction facilities need to address.
c) Outline any public participation or public hearing requirements and procedures. For each requirement, list the lead agency to be contacted. Assess the typical time demands for proposed facilities to obtain permits and address environmental impact assessment and public participation requirements.
d) Examine the existing training and public awareness programs on HCWM at the healthcare facilities in the survey sample and prepare a training needs assessment for the region.

A3.2 Planning New Regional Waste Management Projects

In cases where new municipal or regional treatment and/or disposal facilities are indicated by the assessment results, the steps below should be taken for sitting and developing new facilities. During this planning stage, technical assistance will usually be needed from specialists with expertise in the following areas: waste management; environment; public health; training; financial analysis; regulatory and institutional issues; and procurement.

A3.2.1 Institute a waste management plan

A waste management plan should be integrated into the overall planning process (from procurement to treatment and disposal) to ensure the most cost-effective decisions are taken at all levels. The waste management plan should also incorporate aspects of infectious and hazardous materials management, often in conjunction with officials overseeing these aspects. Furthermore, a budget for waste management should be allocated from the beginning.

A3.2.2 Ensure segregation of waste streams

Proper segregation of waste generated from healthcare facilities will greatly reduce the amount of waste that needs expensive treatment. For this reason, items such as foodstuffs, packaging, and non-consumable disposables (e.g., gauze pads) should be segregated from special HCW. Additionally, reusable items such as beds, bedpans, and other medical

equipment should be segregated from special HCW. Only those items which pose a public health threat or are listed as special HCW should continue on to treatment (versus landfilling or reuse).

A3.2.3 Determine appropriate technology

For the types and quantities of HCW generated in the study area (relying on data from the cross-section of facilities included in the regional assessment), assess alternative technologies and facility sizes for waste treatment and destruction. The technologies to be considered include safe landfills, incineration, sterilization (autoclaves and microwaves), and chemical disinfection. (See Annex 8 for information on the advantages and disadvantages of each). Compare the alternatives on the basis of capital cost, operating cost, ease of operation, local availability of spare parts, local availability of operational skills, demonstrated reliability, durability, and environmental impact.

On the basis of this assessment, the consultant should be prepared to recommend a process flow for economically efficient and environmentally sound treatment and final disposal of HCW at a regional facility, leading to a final choice of technologies.

A3.2.4 Determine siting of facility

Once the choice of technology has been made, careful sitting of the facility is required. For a regional facility it is cost-effective to select a site in or near the centre of gravity for the waste catchment area. For most treatment facilities, non-sensitive industrial areas may be considered as a potential site. Public consultation/hearings must be held as part of the final assessment for siting of the treatment facility. (For detailed guidance on sitting of a treatment facility, see information sources cited in Section 6). Other site considerations include:

a) Accessibility.
b) Distance from healthcare facilities. Distance to sensitive areas.
c) Future development plans for the area. Possibility of buying the land.
d) Proximity to cultural and historical sites. Noise and dust impact on nearby areas.
e) If resettlement is an issue, the extent to which it is needed. Reliability of the power sources to run the treatment facility.

A3.2.5 Financing

The regional or local government, potentially in conjunction with other municipal solid waste treatment and disposal activities, may finance a regional facility. An alternative approach is for the private sector to provide the HCW transport and treatment services for the entire region. Annex 5 contains more information on private sector participation.

Cost recovery at the regional level (public or private service provider) can be through user charges, based on the “polluter pays” principle, where each healthcare facility pays according to the volume of waste generated. Although user charges can generate substantial revenue, facilities are often unwilling to pay the full cost for treatment and disposal. This is true in general

in municipal solid waste management systems and may also be true, although it has not been confirmed, in the healthcare sector. Experience in many countries has shown that charging the full cost of treatment and disposal may create incentives for indiscriminate disposal of waste. Therefore, enforcement of regulations is essential and financial incentives for healthcare facilities to improve their HCWM may be warranted.

In most cases, Micro and Small Enterprises (MSEs) should not become involved in the collection of HCWs from hospitals and other medical establishments. It is acceptable for these businesses to become involved in the collection of non-hazardous, domestic wastes from medical establishments. However, separation of hazardous waste is sometimes not practiced. When environmental and health risks associated with HCWs are known, MSEs may dump theses wastes at unauthorized locations.

A3.2.6 Conduct environmental assessment

After determining the appropriate technology and site for the treatment facility, an environmental assessment of the project should be carried out. If proper management of the HCW requires a municipal or regional solution that goes beyond the boundaries of the healthcare sector, then the responsible authority should undertake the environmental impact study. (See Annex 9 for guidelines on conducting an environmental assessment).

A3.2.7 Conduct regional training and awareness program

Training at the regional level is a critical step for successful HCWM. The training program should be designed for the following main groups: a) regional decision-makers and regulatory staff; b) healthcare facility administrators/managers; c) relevant regional/local authorities; d) solid waste managers (municipal and/or private); and e) healthcare and/or waste management workers (this can involve staff at all levels of waste management from healthcare staff who sort HCW, transport workers, disposition workers, and other related activities). The training aims to raise awareness of the health, safety, and environmental protection issues related to HCW. An integral component of training would be the proper use of protective materials, clothing, and special equipment for HCWM workers and the general public.

ANNEX 14: GUIDANCE FOR NATIONAL HCW PROJECTS

This section provides guidance for HCWM at the national level. The national government should regulate and enforce proper HCWM, since mismanagement is associated with strongly negative health and environmental externalities. A sound national policy and planning framework is required to improve HCWM.

Every country should have a national strategy for HCWM, either separately or as part of its national solid waste management strategy. Developing such a strategy requires direct dialogue with the appropriate decision-making authorities. National authorities need to be committed to the process, and willing to change existing regulations and laws as necessary. The ministries involved are typically the Ministry of Health, the Ministry of Local Government; the Ministry of Labour, and the Ministry of Environment.

To facilitate consensus-building, the national HCW planning process might be led by a task force that includes representatives from all the relevant ministries. It is frequently useful for the task force to hire outside experts to provide technical assistance in planning. Experts needed for a national planning project might include strategic planners and institutional experts on health and the environment; public health specialists; HCWM/solid waste specialists; legal specialists; technology specialists; and economists. These experts should be familiar with the country, and it is essential that they work with local experts in all aspects of the national strategy and action plan.

This section is designed to be useful to national planners in various ministries whose area of responsibility includes or relates to HCWM. It includes guidance for conducting a national sector assessment (A4.1) and preparing and implementing a national HCW strategy (A4.2). Existing strategies may need revision if they are not being implemented properly, if they are proving ineffective, or are leading to negative health and environmental outcomes.

Due to increasing private sector involvement in waste management activities, it is important to have established laws and regulations on all aspects of waste management (worker safety, adoption of segregation, transportation, treatment, and disposition). Increasingly, national ministries provide an oversight service, including monitoring and evaluation of services, emissions, and waste characterization.

A4.1 National Sector Assessment

A national sector assessment can be carried out at various levels of detail, depending on the time and resources available. Information about the healthcare sector, types of facilities and current HCWM practices, may be collected by interviewing national and regional authorities, as well as by

gathering data from a representational sample of facilities (as described in Section A3.1.1). The following should be included as a minimum:

A4.1.1 General information

Compile basic data on healthcare facilities in the nation (see A3.1.1). Include the total number of healthcare facilities (public, private, and military); the total number of hospitals with more than 50 beds; the total number of beds at all hospitals (nationwide, private, and public); the total national healthcare budget; and the estimated annual budget for healthcare programs nationwide.

A4.1.2 HCW issues

a) Estimate the total quantity of HCW and special HCW generation nationwide. A "quick and dirty" approach is to use key figures on HCW generation per bed per day from other studies and extrapolate that to the number of occupied beds nationwide. In general about 10–15 percent of HCW is special HCW. Outline current HCWM practices, including segregation, transportation, and disposal.
b) Identify ministries/authorities involved or potentially involved in HCWM at national, regional, and local levels (see Annex 5). The distribution of responsibility between ministries/authorities should be identified. Also national and regional waste management training institutions that can contribute should be identified**.**
c) Identify and review relevant legislation on HCWM, municipal solid waste management, hazardous waste management, and radioactive waste management (see Annex 4).
d) Identify international donor agencies active in the area of HCWM and municipal solid waste management that can provide technical and financial support.

A4.2 A National Strategy and Action Plan for HCWM

A4.2.1 Formulate a national strategy

Once the sector assessment is completed, planners can begin to identify a list of national priorities for HCWM that can be used as a tool to develop a national HCWM strategy. Where national legislation on HCWM already exists, the strategy should reflect the limitations provided by the legislation and recommend needed changes in the legislation.

A national strategy for HCWM should:

a) Reflect priorities within healthcare facilities for treatment and disposal of HCW.
b) Set goals for and means of monitoring of infection control and environmental protection. Propose choice of technology for packaging, transportation, treatment, and disposal. Prioritize central or decentralized treatment and disposal.
c) Reflect distribution of responsibility in the sector between national, regional and local governments.

d) Make recommendations on private sector involvement.
e) Propose an action and investment plan for implementation of improved HCWM. Propose mechanisms for financing HCWM.
f) Propose guidelines for HCWM training programs at facility and municipal/regional level.

A4.2.2 Develop national guidelines

National guidelines for HCWM should provide practical and technical advice for those implementing the national strategy. In large countries where great differences exist in between regions, sub-national guidelines may also be considered. The guidelines should aim to accomplish the following:

a) Establish legal frameworks for safe HCWM, healthcare establishment hygiene, and occupational health and safety.
b) Compile and clarify/expand on definitions from legislation.
c) Establish standards for emission from treatment and disposal facilities. Make recommendations for infection control procedures.
d) Delineate responsibility of competent authorities, owners and managers of healthcare facilities, and HCW treatment and disposal facilities.
e) Provide guidance on segregation, packaging, collection, storage and transportation (internal and external) of HCW.
f) Provide guidance for treatment and disposal methods for HCW (liquids and solids).
g) Make recommendations on central or decentralized treatment of special HCW. The guidelines may also include recommendations on purchasing policy for goods, services and equipment; guidance on safe waste minimization; and models for private sector involvement in HCWM.

A4.2.3 Formulate a national action plan

A national HCW strategy should include a plan for action, which may be implemented gradually through sustainable and affordable steps. These steps should include the following:

a) Initial measures to be taken at all healthcare facilities for upgrading internal handling of special HCW (e.g. provide steps for simple segregation of sharps from all other waste generated).
b) Demonstration project at a national teaching hospital, including all steps of the developed strategy.
c) Introduction of monitoring procedures for infection control, HCWM inside hospitals, and environmental impacts.
d) Assessment of lessons learned from the demonstration project for incorporation in the next implementation steps.

e) Development of regional and local institutional structure.
f) Gradual implementation of strategy at teaching hospitals; regional hospitals; general hospitals; all other hospitals; and, finally, all healthcare facilities.
g) In parallel, gradually plan and construct new treatment facilities as needed, that comply with the national strategy and regulations.
h) Investment of the private sector in such areas as transportation and treatment.

A4.2.4 Launch capacity-building and training measures

A national awareness program should be launched at the time of development of the national strategy for HCWM. However, the awareness program should only be launched when appropriate means (budgetary and technical) for physical implementation of HCW segregation plan are made available. The following target groups should receive training:

- Regulators and decision makers. Regional/municipal authorities. Healthcare facility managers.
- Healthcare workers and waste collectors. Transportation, treatment, and disposal operators.
- Local manufacturers of collection equipment and treatment facilities.

A4.2.5 Ensure adequate financing

Implementing a national strategy is a gradual process that often requires a minimum of one to two years. Depending on the level of local input, size of the country, and level of existing information, the budget to prepare a HCWM project at the national level may range from US$30,000 to as much as US$600,000.

An often important role for national authorities is to provide technical and financial assistance to lower-level authorities in implementing the national strategy. The Ministry of Environment and Ministry of Health may also help finance new waste regional treatment facilities when new HCWM regulations are introduced. But these ministries are less likely to provide national subsidies for operation and maintenance of regional treatment facilities. Those generating the waste, i.e. the healthcare facilities, should absorb these costs based on the “polluter pays” principle. However, it should again be noted that recovering the full cost of treatment and disposal may create incentives for indiscriminate disposal. Therefore, enforcement of regulations is also essential, and financial incentives for healthcare facilities to improve their HCWM may be warranted.

ANNEX 15: HCW TERMS USED

A5. 1 Types of HCW

Healthcare waste (HCW): The total waste stream from healthcare facilities, research facilities, and laboratories. Can be divided into municipal solid waste and special HCW.

No risk HCW includes all waste comparable to domestic waste, such as packaging materials, non-infectious bedding, building rubble/demolition waste, hotel function waste (household, kitchen, administration), and other such wastes generated from patient wards and other patient care not related to medical care.

Special HCW always needs special attention and includes:

a) ***Sharps*****:** All sharp objects that could cause a cut or puncture (whether infectious or not) including hypodermic needles, suture needles, injector tips, scalpels, lancets, knives, blades, razors, pipettes, and broken glass (non-exhaustive list).
b) ***Pathological waste***: Body tissues, organs, body parts, human foetuses, animal carcasses, liquid waste blood, plasma, coagulated factors, and body fluids.
c) ***Redundant potential infectious waste*****:** Disposable items contaminated with excreta, dressings, gowns, gloves, etc.; containers with blood products, I.V. tubing, emptied peripheral dialysis fluid bags, intravascular access devices introducers, culture dishes, microbiological slides and cover slips, test tubes, vials, vacutainers, etc.
d) ***Hazardous chemical waste*****:** Any substance, liquid or solid, with at least one of the following properties: explosive, flammable, toxic, corrosive, locally chafing, reactive or genotoxic (carcinogenic, mutagenic, teratogenic) including cytotoxic drugs. Also, all containers contaminated by these substances.
e) ***Pharmaceutical waste*****:** All pharmaceutical products, drugs, drug residuals and therapeutic chemicals that have been returned from wards; have been spilled; are outdated, contaminated, or are to be discharged because they are no longer required. Particular attention should be given to these wastes in the segregation process, as they may otherwise be resold by waste pickers. ***Radioactive waste****:* Solids, liquids and gaseous waste contaminated with radionuclides. This type of waste is generated from in vitro analysis of body tissues and fluids, in vivo body organ imaging and tumour localization, and investigative and therapeutic procedures.
f) ***Pressurized containers:*** Containers holding gases used for anaesthesia, oxygen delivery, or cleaning mechanisms. Can include gas cylinders, cartridges, and disposable aerosol cans. The most common types of gas are: ethylene oxide, oxygen, and compressed air.
g) The WHO definition for special HCW is found in the box below.

Health Care Waste * is defined as the total waste stream from a health care establishment, research facilities, laboratories, and emergency relief donations. HCW includes several different waste streams, some of which require more stringent care and disposal:

1. **Communal Waste** is all solid waste **not** including infectious, chemical, or radioactive waste. This waste stream can include items such as packaging materials and office supplies. Generally, this stream can be disposed of in a communal landfill or other such arrangement. Segregation of materials which are able to be reused or recycled will greatly reduce the impact burden of this waste stream.
2. **Special Waste** consists of several different subcategories:

a) *Infectious*: Discarded materials from health-care activities on humans or animals which have the potential of transmitting infectious agents to humans. These include discarded materials or equipment from the diagnosis, treatment and prevention of disease, assessment of health status or identification purposes, that have been in contact with blood and its derivatives, tissues, tissue fluids or excreta, or wastes from infection isolation wards. Such wastes shall include, but are not limited to, cultures and stocks; tissues; dressings, swabs or other items soaked with blood; syringe needles; scalpels; diapers; blood bags. Incontinence material from nursing homes, home treatment or from specialized health-care establishments which do not routinely treat infectious diseases (e.g. psychiatric clinics) is an exception to this definition and are is not considered as infectious health-care waste. Sharps, whether contaminated or not, should be considered as a subgroup of infectious HCW. Includes: Syringe needles, scalpels, infusion sets, knives, blades, broken glass.

b) *Anatomic:* consists of recognizable body parts.

c) *Pharmaceutical:* Consisting of/or containing pharmaceuticals, including: expired, no longer needed; containers and/or packaging, items contaminated by or containing pharmaceuticals (bottles, boxes).

d) *Genotoxic:* Consisting of, or containing substances with genotoxic properties, including cytotoxic and antineoplasic drugs; genotoxic chemicals.

e) *Chemical:* Consisting of, or containing chemical substances, including: laboratory chemicals; film developer; disinfectants expired or no longer needed; solvents, cleaning agents and others.

f) *Heavy Metals:* Consisting of both materials and equipment with heavy metals and derivatives, including: batteries, thermometers, manometers.

g) *Pressurized containers:* Consisting of full or empty containers with pressurized liquids, gas, or powdered materials, including gas containers and aerosol cans.

h) *Radioactive materials:* Includes: unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources.

ANNEX 16: TYPES OF HEALTHCARE FACILITIES

The facilities generating HCW considered in these guidance notes include:

a) ***Hospitals*:** Including private and public hospitals, university hospitals, general hospitals, district hospitals, and military hospitals.

b) ***Other types of health facilities:*** Including blood banks, convalescent nursing homes, dental clinics, emergency medical care centres, facilities implementing vaccination programs, healthcare centres and dispensaries, obstetrical and maternity clinics, out-patient clinics, dialysis centres, first-aid posts and sick bays, long-term healthcare establishments and hospices, transfusion centres, military medical service centres, mortuary and autopsy centres, animal research and testing facilities, veterinary service centres, and pharmacies.

c) ***Related laboratories and research centres:*** Including medical and biomedical laboratories, biotechnology institutions, and medical research centres.

ANNEX 17: MANAGEMENT ISSUES

A7.1 Authorities Involved in HCWM

Healthcare Facility Authorities

a) *Healthcare facility management:* The upper management of each healthcare facility has overall responsibility for HCWM. However, routine HCWM is often delegated to an engineering or waste collection department. The handling of HCW at the ward/department level is usually the responsibility of the person in charge of each ward/department.

b) *Infection control committee (ICC):* The authority within the healthcare facility that customarily sets hygienic standards, monitors hygiene, and guides the relevant health surveillance. The ICC may also be responsible for awareness campaigns, training of personnel, and setting standards for the use of chemicals and pharmaceuticals. The ICC therefore plays an important role in successful implementation of a HCWM program. It is important to involve the ICC at an early stage of project preparation at healthcare facilities.

Some large hospitals can also have a separate "Waste Management Committee"

Municipal and Regional Authorities

a) *Health authorities:* Regional or municipal health authorities are likely to be involved in HCWM, in terms of monitoring healthcare facilities, infectious diseases, and occupational health issues. However, only the national health authority will normally be responsible for setting HCWM policies and regulations and enforcing them.

b) *Environmental authorities*: These authorities often operate as regional divisions of a national environmental authority, delegated with implementing and enforcing national regulations and legislation. With respect to HCWM, regional environmental officials are often responsible for setting emissions standards for treatment plants, approval of environmental (impact) assessments (*see* Annex 9), and licensing of treatment and/or disposal facilities. The regional authorities may also be responsible for supervision and monitoring of transportation, and treatment and final disposal of special HCW.

c) *Solid waste management authorities:* These may be a municipal or, in larger metropolitan areas, inter-municipal authorities. They are responsible for collection, treatment, and final disposal of municipal solid waste (MSW). If no special treatment is provided for HCW, it is often handled as MSW. The system for transportation,

treatment, and disposal of such HCW will therefore normally be the responsibility of the local solid waste authorities.

National Authorities

a) *Health authorities* (usually the Ministry of Health [MoH]): The responsibility of a health ministry in the area of HCWM is to regulate HCW procedures inside healthcare facilities, including infection control and surveillance related to handling of HCW. Changes in organizational arrangements in public hospitals may, in some countries, require approval, from the MoH.

b) *Environmental authorities* (usually the Ministry of Environment, Environmental Protection Agency): The responsibility of national environmental authorities in relation to HCWM is to regulate and set standards for emissions and monitoring of treatment and final disposal facilities for HCW.

c) *Occupational health authorities* (often the Ministry of Social Affairs, the Ministry of Labour or the Ministry of Health): Their responsibility within HCWM is to regulate and set standards for safety of waste collectors and handling of HCW, both inside and outside of healthcare facilities.

A7.2 ROLE OF THE PRIVATE SECTOR

Private sector participation in HCWM is possible at different levels. At the simplest level, the private sector may be subcontracted solely to provide waste transportation services to individual healthcare facilities. At the other end of the spectrum, the private sector may sign a contract to Build, Operate, and Transfer (BOT) or Build, Own, and Operate (BOO)[1] an entire HCWM treatment or disposal facility.

The private sector can play a significant role in providing waste treatment and disposal services if the contract establishes a clear set of rules about division of responsibilities between the parties involved (i.e. regulatory authority, healthcare facility, and private operator). The essential conditions for private sector participation are transparency, competition, and accountability. Adequate budget provision is also required at the healthcare facility or the local authority level to pay the private operator.

[1] For guidance on contracting services see draft in progress, "Checklist of Issues to be covered in different types of MSWM Contracts," World Bank May 11, 1997.

ANNEX 18: TECHNOLOGY CONSIDERATIONS FOR SPECIAL HCW TREATMENT AND DISPOSAL

A8.1 TECHNOLOGY OPTIONS

The choice of technology for waste treatment and disposal should always be driven by the objective of ***improving current health and environmental impacts.*** The technology choice should also be functional, safe, economically feasible, and sustainable. Choice of treatment/ disposal technology needs to be made with cultural and religious sensitivities in mind.

A basic principle in all waste management schemes is to segregate wastes as early as possible in the waste stream and to find the simplest solution for each type of waste. The first step in treatment and disposal is to ensure that all regular HCW that can safely be sent to the normal municipal waste management system is managed in this way. The remaining wastes (special HCW) have characteristics that need particular treatment and disposal. A set of technical requirements for this treatment and disposal is provided in Table A8.1.

Table A8.1: Technical Requirements for Treatment and Disposal of Special HCW

Elimination of hazardous characteristics of the wastes	i. Destruction of viable infectious organisms Destruction of waste/used pharmaceuticals and medicines or transformation into harmless forms Destruction of sharps and other materials capable of causing physical injuries ii. Final disposal or destruction of body parts, tissues, blood, and other organic material Transformation of wastes into unrecognizable or inoffensive forms
Controls on processes	i. Assured long term performance in eliminating the hazardous characteristics ii. Ability of the treatment and disposal system to cope with variations in waste composition and throughput
Environmental impacts of system	i. Avoidance or minimization of secondary impacts from disposal system ii. Prevention of human access and/or scavenging activities iii. Control of contamination of land, air or water Avoidance of disease vectors (insects, rodents, etc.)

Source: ERM for World Bank

Controlled disposal in a sanitary landfill may be an acceptable disposal option for some types of special HCW but other types should – in ideal conditions – be treated before disposal. In any case, final disposal in a landfill will usually be required for the residues from a treatment system.

Capability should also be carefully assessed when planning HCW disposition. Urban areas might have sophisticated incineration, sterilization, or disinfection technologies available, while rural areas might have limited options. When reviewing disposition plans, the technological standards are vital to a safe, appropriate plan. For instance, incineration may be considered when the incinerator can reliably reach temperatures over 1000°C (over 1200°C is necessary if burning sharps or infectious waste). Lower temperature incinerators produce greater amounts of toxic releases. Autoclave or microwave facilities may generate contaminated wastewater that needs treatment. Landfills should also be reviewed for appropriate liners and leachate collection systems, and should include ground water monitoring (if applicable). A reliable affordable local technological solution is preferable to infeasible (and therefore not implemented) solutions. A summary of treatment and disposal technologies is provided in Table A8.2. Table A8.3 indicates the performance of typical practices and treatment options in relation to the requirements of Table A8.1.

Table A8.2: Treatment and Final Disposal Technologies for Special HCW

Type of	Advantages	Disadvantages
Safe land filling: Trench method where HCW is buried in a trench excavated in other waste (Final disposal)	✓ Simple and inexpensive to operate ✓ No specific construction costs required ✓ Operates within readily available landfill system ✓ Waste pickers are unable to access the special HCW	✓ Special HCW is not treated and preserves potential infectiousness ✓ High demand for coordination between collector and landfill operator ✓ Reduces awareness among healthcare workers of need to segregate waste types ✓ Potentially long transportation to landfill
Safe land filling: Separate disposal cell (Final disposal)	✓ Simple and relatively inexpensive to operate if operated in connection with existing landfill for other waste	✓ Special HCW is not treated and preserves potential infectiousness ✓ Requires a safe landfill with fencing ✓ Requires control of scavenging and animals ✓ Needs conscientious operation according to manual
Incineration : 1)Batch incineration 2) Dual chamber, or 3) Rotary kiln (Destruction treatment)	✓ Elimination of health risks ✓ The waste is non-recognizable ✓ Fully destroys micro-organisms and sharps ✓ Reduces volume/mass of the waste ✓ Destroys all types of organic waste ✓ (liquids, pharmaceuticals, and other solids) ✓ Heat recovery possible ✓ High quantities of waste can be treated (except for batch incinerator)	✓ High investment costs ✓ Complicated to operate ✓ Continuous monitoring required ✓ High maintenance, especially for rotary kilns ✓ Relatively high operation costs; ✓ costs rise with the level of sophistication of the emission controls system

		✓ For batch incinerator: limited capacity ✓ Emits toxic flue gases (including dioxins and furans; level varies) Currently there is no accepted level of emission for dioxins and furans, however EU standards provide a good basis for comparison. ✓ Generates residue that needs safe landfilling ✓ Any residue generated may be toxic
Steam Disinfection: Autoclave (Sterilization)	? Simple to operate ?A known technology at healthcare facilities	✓ Relatively expensive to install and operate ✓ Requires boiler with stack emissions controls ✓ Relatively high maintenance costs ✓ Cannot be used to treat some hazardous wastes, pharmaceuticals, and cytotoxics ✓ Requires separate and additional packaging ✓ Generates odours ✓ Final disposal must be as for untreated special HCW ✓ Generates contaminated wastewater that needs treatment
Microwave: Microwave or radiowave irradiation (Disinfection)	✓ The shredding process reduces the volume of the waste (not mass)	✓ Highly sophisticated and complex ✓ Relatively expensive to install ✓ Only solids can be treated and only when shredded ✓ Cannot be used to treat some hazardous wastes, pharmaceuticals, and cytotoxics ✓ Highly skilled operator required ✓ Expensive and difficult to maintain ✓ Final disposal must be same as for untreated special HCW ✓ Generates contaminated wastewater that needs treatment
Chemical treatment: (Disinfection)	✓ The shredding pro cess reduces the volume of the waste (not mass)	✓ Cannot be used to treat some hazardous wastes, pharmaceuticals, and cytotoxics ✓ Highly skilled operator required ✓ Expensive and difficult to maintain ✓ Final disposal must be same as for untreated special HCW ✓ Generates hazardous water that needs treatment

It must be emphasized that the advantages and disadvantages listed assume the proper operation of the described treatment methods.

Table A8.3: Comparisons with Technical Requirements

(Broad comparisons, based on general experience – individual examples will vary)

	Typical Current Practices				Typical Disposal Options – properly operated				
	On-site dumps	Open burning	Municipal dumps	On-site incineration	High temp. incineration	Auto-claving	Micro-waving	Chemical sterilization	Sanitary landfill
Elimination of hazardous characteristics:									
Destruction of infectious organisms	none	poor	none	poor to moderate	Very good	good	good	good	good
Destruction of body parts, blood etc.	none	good	none	good	very good	poor to moderate	poor to moderate	poor to moderate	good
Destruction of waste pharmaceuticals	none	good	none	good	very good	none	none	poor to moderate	moderate to good
Destruction of sharps, etc	none	moderate	none	moderate	very good	poor to moderate	poor to moderate	moderate	moderate
Transformation of wastes	none	moderate	none	good	very good	moderate	moderate	moderate	good
Controls on process:									
Assured elimination of hazards	none	very poor	none	very poor	very good	moderate	moderate	moderate	moderate
Ability to cope with variations	good	poor	good	poor	very good	poor	poor	poor	vgood
Environmental Impacts:									
Avoidance of secondary impacts	poor	very poor	Poor	poor	poor to moderate	poor to moderate	moderate	poor to moderate	Poor to moderate
Prevention of human access	moderate	moderate	very poor	good	very good	very good	very good	very good	Moderate to good
Prevention of contamination of land	very poor	poor	very poor	good	very good	very good	very good	very good	good
Avoidance of disease vectors	poor	poor to moderate	very poor	very good	very good	very good	very good	very good	moderate

Direct disposal in a sanitary landfill may be the least expensive disposal option, if an acceptable landfill is located within reasonable transportation distance. However, some special HCWs, such as cytotoxics, should not be put in a landfill. A dual chamber or rotary kiln incinerator can be used for treatment of this type of special HCW. Pollution control systems (scrubbers, etc.) on incinerators are essential in order to avoid release of dioxins and other chemicals. The choice of an appropriate technology for treatment of the special wastes will depend on a range of local circumstances.

A number of general comments can be made:

Incineration is not the same as burning. Proper incineration is a highly advanced technology that can adequately treat all types of special HCW. The key parameters of controlled incineration are summarized as "TTT": combustion at a sufficiently high **temperature** (between 1,000°C and 1,200°C in the combustion chamber) for a long enough **time,** in a combustion chamber with sufficient **turbulence** and oxygen for complete combustion to be achieved and problematic gases to be minimized.

An incinerator requires skilled operators, extensive flue gas emission controls and, frequently, imported spares and supplies. Properly controlled incineration is relatively expensive. Incineration of wastes generates residues, including air emissions and ash. Environmental controls on incinerators in developed countries have been tightened in recent years, principally because of concerns over air emissions of pollutants such as dioxins (see D.2) and heavy metals.

The technology of small-capacity incinerators, for use by a single medical facility, is often rudimentary. These installations are not recommended, since they may constitute a serious air pollution hazard to the surrounding area. WHO recommends closing down small incinerators that are not operating satisfactorily.

Incineration is an option for certain types of HCW (and is the preferred method for some substances such as cytotoxins and other pharmaceuticals) but it needs to be carefully operated and controlled. Regulatory agencies in the United States and the European Union have adopted emissions limits for medical waste incinerators that include, among others, values for dioxins. It is recommended that incinerators installed under any major project pay attention to national regulations and/or look to the examples set in other countries such as in the EU Member States.

Autoclaving involves the heating of waste material, with steam, in an enclosed container at high pressure. At the appropriate levels of time (> 60 min), temperature (>121°C), and pressure (100 kPa) effective inactivation of all vegetative microorganisms and most bacterial spores can be achieved. Preparation of material for autoclaving requires segregation to remove unsuitable material and shredding to reduce the individual pieces of waste to an acceptable size.

Small autoclaves are common for sterilization of medical equipment but a waste management autoclave can be a relatively complex and expensive system requiring careful design, appropriate segregation of materials, and a high level of operation and maintenance support.

The output from an autoclave is non-hazardous material that can normally be landfilled with municipal waste. There is also a wastewater stream that needs to be disposed of with appropriate care and controls. Furthermore, large autoclaves may require a boiler with stack emissions that will be subject to control.

At present, the use of autoclaving, chemical disinfection or any other non-destructive technology like microwave or radiowave irradiation is not allowed for the treatment of special HCW such as

organs, tissues, or amputated human body parts. Incineration or burial are the only accepted techniques for the treatment of such special type of HCW.

Microwave and Radiowave Irradiation involves the application over the wastes of a high energy electromagnetic field that provokes the liquid contained within the waste, as well as the liquid cell material of microorganisms, to oscillate at high frequency, heat up rapidly, and eventually cause the destruction of all infectious components of the waste. The technique takes place in enclosed containers at atmospheric pressure and temperatures below the normal water boiling point. The waste passes through a preparative process of segregation to remove undesirable material, then it is triturated, pulverized, and compressed prior to its disinfection.

Similar to the autoclaving technique, the output from a microwave or radiowave facility is considered non-hazardous and can be landfilled together with municipal waste. Since the technology does not involve the application of steam, there is a minimal generation of wastewater stream, and with the appropriate conditioning it can be recycled to the system. Since electricity is the main source of energy for operating this technology, gas emissions are also minimal compared to incineration or even autoclaving, which requires the combustion of fuel for the generation of steam.

Chemical disinfection, used routinely in healthcare to kill microorganisms on medical equipment has been lately extended to the treatment of HCW. Chemicals (mostly strong oxidants like chlorine compounds, ammonium salts, aldehydes, and phenolic compounds) are added to the waste to kill or inactivate pathogens. This treatment is most suitable for treating liquid wastes such as blood, urine stools or hospital sewage, but solid and highly hazardous HCW like microbiological cultures, or sharps must undergo a relatively complex and expensive preparative process of segregation shredding, and milling prior to the application of the chemical reagents. This technology requires special treatment of hazardous wastewater streams.

Land deposition of HCW is performed in the same manner as solid industrial wastes; that is, in a pit excavated in mature municipal waste at the base of the working face and immediately covered by a two-metre deep layer of fresh municipal waste. Alternatively, a specially constructed small fenced landfill pit or bunded area could be prepared on part of the site to receive only HCW. It should be covered immediately with soil after each load. For added health protection and odour suppression, it is suggested that lime be spread over the waste. In both cases it is essential to cover the HCW layer well enough to prevent animals or scavengers from re-excavating it. Landfilling is considered as a "bottom of the list" option for disposal of HCW, and is only recommended when the economic situation of the country does not permit access to environmentally safer technologies, such as the ones previously described.

Other technical issues:

Transport of special HCW on public roads is inevitable under any system designed to treat and

dispose of special HCW outside the generating premises. Transportation of special HCW should, as a minimum, be carried out by trained staff in a dedicated vehicle with closed containers. Recommended design criteria for special HCW transportation vehicles are provided in the WHO handbook.

Operation and maintenance of equipment and facilities is essential for proper waste management. Good operation and maintenance requires trained and motivated staff, an adequate supply of consumables and spares, and a sufficient ongoing budget. Assessment of these matters must be a fundamental part of any decisions on choice of waste management treatment technology.

A8.2 Dioxins and Related Compounds

The range of chemical compounds described as polyhalogenated aromatic hydrocarbons (PAHs) have been of concern over several decades because of their increasing occurrence and persistence in the environment and their biochemical and toxic effects. Some compounds, such as phenols, benzenes and polychlorinated biphenyls (PCBs) have been produced industrially because of their commercial uses. Other PAHs have been formed as residues or by-products of chemical production, of combustion, or of other uses of chlorinated compounds. Among the most significant of these PAH compounds is the group known as dioxins, including the polychlorinated dibenzo-p-dioxins (PCDDs) and the dibenzofurans (PCDFs). These compounds tend to accumulate in fatty tissue. A broad range of toxic and biochemical effects has been reported for several of these compounds. In particular, there has been considerable debate about the carcinogenic impacts of exposure to low levels of these compounds.

ANNEX 19: CONDUCTING ENVIRONMENTAL ASSESSMENTS

An environmental assessment (EA) must be carried out following guidance for the appropriate environmental category. Depending on results of the environmental screening procedure, projects that include treatment of special HCW should be rated either environmental (WB) category A or B. Projects which contain special HCW, especially including infectious waste and/or toxic materials, most likely become a WB category A, unless rigorous environmental measures can be enforced. This is especially an issue in rural areas or IDA countries. EAs assess the level of release to the environment and public health in a waste management project. Most HCW projects would most likely become a category B after a WB EA. This classification might mean that HCW waste is prevalent, but the treatment and management options are sufficient to keep environmental and public health risks at a minimum.
A category C is also possible-this type of project frequently present little risk to the environment or public health sectors.

An environmental assessment (EA) report evaluates environmental issues related to the proposed treatment facility/facilities. These assessments must be prepared in accordance with local environmental impact assessment guidance, as well as the World Bank's Operational Directive 4.01, "Environmental Assessment." Specific EA reports should apply to specific methods considered for waste management. Where adverse impacts are identified, the EA should outline mitigating measures to be included within the proposed design (including wastewater treatment, air pollution control, odour control, access of population, etc.). Mitigating measures that should be included within the operational procedures should also be part of the EA. In addition, the EA should provide a program for monitoring throughout implementation and operational activities. If any of the proposed facility sites have inhabitants that must be resettled, check the World Bank's requirements in Operational Directive 4.30, "Involuntary Resettlement," or any other relevant guidance provided by the agencies participating in this project.

The EA should include consultations with the responsible local authorities and affected communities. The consultations shall inform the community of the project proposal and incorporate their legitimate concerns in the design and selection of effective siting layouts, mitigation measures, monitoring programs, and community communication programs.

Following the recommendations in the EA, detailed design of the facility can be prepared, including performance specifications, cost estimates, annual operation and maintenance costs, and mechanisms for cost recovery.

Present and discuss a full draft EA report with the responsible authorities, and focus on the significant environmental issues in a format similar to the following:

a. Executive Summary
b. Policy, Legal and Administrative Framework
c. Project Description

d. Baseline Data
e. Environmental and Health Impacts
f. Analysis of Alternatives
g. Mitigation Plan
h. Environmental Management and Training for Institutions and Agencies
i. Environmental Monitoring Plan
j. Appendices
   - List of persons preparing the EA
   - References
   - Record of Interagency/Forum/Consultation Meetings

ANNEX 20: PACKAGING OPTIONS

Packaging and storage of special HCW consists of primary packaging at the source and secondary packaging for transportation. For primary packaging, all special HCW should be packed in leak-proof and disposable bags or containers. In addition, containers for sharps must be puncture proof and glass containers are regarded unsuitable. A colour code of either yellow or red should be chosen for all special HCW. For pathological waste, the opposite (and non-transparent) colour should be used.

In the case of secondary transport packaging, leak-proof solid containers mounted with wheels should be used for easy transport. Color-coding should follow the primary packaging colour code. For environmental protection reasons, non-PVC products are preferred.

In-house storage may consist of two levels:

1) a well ventilated room at or near the ward, where waste collectors pick up the waste, and
2) a centrally-located air-conditioned storage room, where temperatures can be kept low, until waste is picked up for treatment.

Table A10.1: Packaging Requirements for HCW and for Different Types of Treatment

	Landfill	Incineration	Autoclave	Microwave	Chemical disinfection
MSW	bag (black) containers	bag (black) containers	N/A	N/A	N/A
Special HCW sharps	sealed containers	containers	containers w. holes	Containers w. holes	containers w. holes
Pathological waste	non-transparent bags, heavy duty (often red)	non-transparent bags, heavy duty (often red)	N/A	N/A	N/A
Other potentially infectious waste	coloured bags/containers (often	coloured bags (often yellow)	coloured bags (often yellow)	coloured bags (often yellow)	coloured bags (often yellow)
Hazardous chemicals	containers (liquids) bags (solids)	containers (liquids) bags (solids)	N/A	N/A	N/A
Pharmaceutical waste	coloured bags/container	coloured bags/container	N/A	N/A	N/A
Radioactive waste	-[1/]	-[1/]	N/A	N/A	N/A

[1/] Special handling and treatment required. N/A: Not applicable.

ANNEX 21: SAMPLE TERMS OF REFERENCE: REGIONAL HCWM

Study Area

A feasibility study is planned for the study area of [please fill in], [please fill in]. The study area is located [please fill in], covers an area of [please fill in] square kilometres and has a population of [please fill in] inhabitants. The income level of the study area, expressed as Gross Domestic Product per capita per year, is [please fill in].

Introduction

Project background and project justification.

Goal

The project goal is to improve the health and reduce environmental impacts from handling of HCW by its proper disposal.

Development Objective

The objective of the feasibility study is to identify the level of HCWM that will be relevant to help implement and enforce proper health and environmentally-sound, technically-feasible, economically viable, and socially-acceptable systems for management of HCW in [please fill in].

Outputs

The project will have the following outputs:

1. Report on regional sector assessment, including suggestions on institutional development, completed;
2. Choice of preferred treatment technology and siting of treatment facility made with determination of level of Environmental Assessment, based on report assessing various treatment technologies and a siting study carried out;
3. Preliminary design report and draft feasibility study report completed;
4. Draft environmental assessment report completed;
5. Final report on HCWM in [please fill in] completed.

Activities

The Consultants alone will be accountable for their analyses and recommendations and for the interpretation of any information made available to them. [Please fill in] will make available to the Consultants existing data and reports relevant to their work and will provide all reasonable assistance in the retrieval of, and access to information appropriate to carry out the activities. The Consultants shall interact with those agencies, whether public or private, which are actively involved in research or development programs in waste management and environmental protection.

Task 1. Regional Sector Assessment

a) Determine the regulatory framework on HCWM and treatment/ destruction facility in [please fill in]. Include air emission standards which are currently required by [please fill in] law and which would likely be required in the next ten years.

b) Identify permit requirements, including environmental building, and other permits and procedures that HCW treatment/destruction facilities would need to address.

c) Outline any public participation or public hearing requirements and procedures. For each requirement, list the lead agency to be contacted. Assess the typical time demands for proposed facilities to obtain permits and address environmental impact assessment and public participation requirements.

d) Identify all healthcare facilities in [please fill in], and include all basic information for each healthcare facility, such as: number of beds, bed occupancy rate, specialties, divided into the categories: university hospitals, regional hospitals, general hospitals, municipal hospitals, and other healthcare establishments.

e) Assess the HCW generation at: i) one major teaching hospital (where existing); ii) one major regional hospital and, iii) one general municipal hospital. The details should include the minimum weigh of total waste generated at each healthcare facility for one week.

f) Composition of the waste should be determined through segregation at the waste end-point, e.g. following specified definitions. Extrapolate the results to cover the entire [please fill in].

g) Assess the level of scavenging, if any, or recycling taking place inside healthcare facilities; along transportation routes, and at final disposal. Determine social issues in relation to scavenging taking place.

h) Review and analyze existing HCW storage, collection and disposal systems with due regard for level of separation, the frequency of collection; and environmental and health impacts for existing treatment.

i) Review existing training and public awareness programs on HCWM at hospitals and other healthcare establishments and prepare a training needs assessment.

j) Submit a Sector Assessment Report for [please fill in] with all compiled information in the form of technical annexes. These annexes should be updated as the remainder of the study progresses, as they are intended to eventually become annexes to the final environmental assessment and feasibility reports.

Task 2. Determination of technology and siting of facility

For the types and quantities of HCW generated in the study area, assess alternative technologies and facility sizes for treatment and destruction. The assessment shall compare the alternatives on the basis of capital cost, operating cost, ease of operation, local availability of spare parts, local availability of operational skills, demonstrated reliability, durability, and environmental impacts. The technologies to be considered include: safe landfilling, incineration, sterilization (autoclaves and microwaves), and chemical disinfection. On the basis of this assessment, recommend a process flow for economic and environmentally sound treatment and final disposal of HCW, leading to choose of technology for [please fill in].

Submit interim report for discussion with [please fill in]. The final decision on choice of technology should be made by [please fill in].

If site for disposal exists, collect all existing maps and topographical plans of suitable sites to be considered for the locations of the treatment facility(ies) and review general transport and traffic systems relative to appropriate sites. Further consider:
i) accessibility to the site; ii) distance from healthcare facilities to the site; iii) distance to sensitive areas; iv) future development plans for the area; v) possibility to acquire area; vi) cultural and historical sites; vii) public opinion; viii) noise and dust impact to nearby areas. Public consultation/hearing must be held as part of the final assessment for siting of the treatment facility.

Submit siting report for discussion with [please fill in]. The final decision on choice of site(s) is be made by [please fill in].

Task 3. Preliminary design and feasibility study

a) Develop a model process flow diagram and site layout for the recommended treatment facility(ies). Include treatment processes for wastewater, cooling water, drainage, odour, and air pollution in the model process flow diagram. Include facilities for parking, gate control, weighing loads, administration, worker sanitation and washing/changing, worker facilities, and truck washing and other relevant facilities. Assess spatial requirements for the facilities, as a

function of their recommended HCW handling capacities.

b) Determine the electrical power supply required and the type of fuel (i.e., oil, natural gas) required for operating the facility(ies). Assess the potential for energy recovery and which type of energy recovery would be preferred. Outline user requirements, such as steam pressure requirements or hot water requirement and outage procedures.

c) Determine how much land is required for each recommended facility. Outline the land acquisition issues and constraints that might exist in the study area, including human resettlement issues and constraints. Based on local land values and resettlement costs, estimate the costs of land acquisition.

d) Determine the required equipment needed inside healthcare facilities, with respect to disposable bags and containers; internal transportation equipment, and storage rooms. Estimate the investment costs and the annual preparation costs e.g. unit costs in bed/day and price/kg of waste generated.

e) Prepare a list of storage, collection, and transport equipment with performance specifications, as well as general collection frequencies and routings for each collection area.

f) For the model facility designs developed, prepare an estimate of the cost of construction, as well as operation and maintenance costs for the entire treatment and transportation system.

g) Calculating the annual operating costs of the entire system and cost recovery mechanisms (including the tipping charge to be applied per ton of HCW), and the rate of return.

h) Prepare a Draft Feasibility Report for discussion with [please fill in], including: description of an action plan for management of HCW with an accompanying implementation plan to include all necessary time schedules, cost estimates, and terms of reference; presentation of an optimal long term concept to separate, store, collect, and treat/dispose of HCW; preliminary engineering designs showing the layout plans, typical sections and elevations of the treatment facilities, with performance specifications of all equipment; recommendations for private sector participation in construction and management of hospital wastes, with scenarios for pragmatic implementation; a financial and institutional framework that would assume responsibility for oversight and supervision of the HCWM system as well as the proposed method of recovering the cost of debt service, operation and maintenance; a plan for implementation covering all project sub-components, including scheduling, cost estimates and terms of reference for training, institutional strengthening, additional studies, detailed engineering, and for all other work required to implement the HCWM system.

Task 4. Environmental Assessment

Prepare an environmental assessment report which states and evaluates the environmental issues related to the proposed treatment facility(ies). These assessments are to be prepared in accordance with local environmental impact assessment guidance, as well as the World Bank's Operational Directive 4.01, "Environmental Assessment". For adverse impacts identified, outline mitigating

measures which need to be included within the proposed design (including wastewater treatment, air pollution control, odour control, access of population, etc.). Further outline mitigating measures that should be included within the operational procedures. In addition, provide for a monitoring program throughout implementation and operational activities. If any of the proposed sites for the facilities have inhabitants or tribal nomadic dwellers, address the World Bank's requirements under Operational Directive 4.30, "Involuntary Resettlement" or any other relevant guidance provided by the agencies participating in this project.

Perform consultations with local community and municipal representatives in coordination with [please fill in]. The consultations shall inform the community of the project proposal and ensure that their concerns that are deemed appropriate are incorporated in the design and selection of effective siting layouts, mitigation measures, monitoring programs and community communication programs.

Present and discuss a full draft EA report with [please fill in], and focus on the significant environmental issues in a format similar to the following:

a. Executive Summary
b. Policy, Legal and Administrative Framework
c. Project Description
d. Baseline Data
e. Environmental and Health Impacts
f. Analysis of Alternatives
g. Mitigation Plan
h. Environmental Management and Training for Institutions and Agencies
i. Environmental Monitoring Plan
j. Appendices
   - List of EA Preparers
   - References
   - Record of Interagency/Forum/Consultation Meetings

Task 5. Final report

Revise the Draft EA Report and the Draft Feasibility Report in accordance with the comments of [please fill in] and international financial institutions and submit the Final EA Report and a separate Final Feasibility Report, incorporating all changes and modifications required to [please fill in].

STUDY SUPERVISION AND TIME SCHEDULE

The work of the Consultant would be supervised by [please fill in], who will coordinate with all other ministries, agencies, and international financial institutions.

The Consultant shall begin work no later than [please fill in] days after the date of effectiveness of the contract. It is anticipated that the Consultant would complete output 1 and 2 of the work over a

maximum duration of [please fill in] months, while output 3, 4 and 5 of the work should be completed within a maximum additional [please fill in] months duration, with completion of the entire study within [please fill in] months. The Consultant should propose a clear schedule with critical milestones, and make all possible efforts to meet or complete the work in a shorter duration then the proposed time schedule.

STAFFING REQUIREMENTS

It is anticipated that the Consultant would establish a strong, focused team of specialists that contains a clearly indicated mix of local and foreign specialist inputs. It is envisaged that an (please fill in] expert would serve as project team leader with a resident national as deputy. The Consultant should create a project team that has technical competence in scientific, health, environmental, and engineering fields as well as competence in the private sector participation fields with skills in financial analysis, training, institutional strengthening, and regulatory fields. The team is expected to provide pragmatic and insightful planning to justify the chosen form of HCWM in [please fill in].

The Consultant shall propose and justify the range of disciplines to be included in the project team. It is expected that the proposed project team will contain several of, but not necessarily be confined to, the following specialists:

Technical Specialists:

a) HCWM specialist
b) environmental specialist
c) public health specialist
d) technology specialist familiar with operations and transport
e) public consultation\social science specialist
f) siting / environmental planning specialist
g) infrastructure\cost estimation specialist

Institutional Specialists:

a) public administration specialists with knowledge of health municipal and environment institutions
b) training specialist
c) financial analyst
d) environment and health regulatory and institutional specialist
e) supervision and quality assurance / control specialist
f) project preparation\procurement specialist